Comprehensive Energy Audit
For
White Mountain Water Treatment Plant

Prepared For

White Mountain Utilities

December 13, 2016

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PREFACE

This energy audit was conducted using funds provided by the Denali Commission. Coordination with the City of White Mountain has been undertaken to provide maximum accuracy in identifying facilities to audit 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 White Mountain, Alaska. The author of this report is Bailey Gamble, Mechanical Engineer I.

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in November 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 Energy Projects Group gratefully acknowledges the assistance of Water Treatment Plant Operator Edward Titus, White Mountain Utilities Manager Yvonne Galsy Gregg, City of White Mountain Mayor Daniel Harrelson, City Clerk Amy Titus as well as everyone at the Head Start building who assisted with lodging.

1. EXECUTIVE SUMMARY

This report was prepared for White Mountain Utilities. The scope of the audit focused on White Mountain Water Treatment Plant and Lift Station. The scope of this report is a comprehensive energy study, which included an analysis of building shell, interior and exterior lighting systems, heating and ventilation, and plug loads.

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy costs are $28,331 per year. Electricity represents the largest portion with an annual cost of approximately $20,451. This includes about $10,166 paid by the village and about $10,285 paid by the Power Cost Equalization (PCE) program through the State of Alaska. Fuel represents the remaining portion, with an annual cost of approximately $7,870. Recovered heat from the nearby power plant contributes to the heating demand in the water distribution loop as well and is currently provided free of charge.

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 White Mountain, the cost of electricity without PCE has averaged $0.61/kWh and the cost of electricity with PCE has averaged $0.31/kWh for the past three years, saving the village just over $10,000 a year on electricity for the Water Treatment Plant.

Boilers supply heat for the water storage tank and space heating in the water treatment plant. The water in the distribution looped is heated by a heat recovery system. As the distribution loop pipeline passes by the city shop, a portion of the water is diverted through a heat-add system in the shop that utilizes recovered heat from the diesel power generators in the power plant.

Table 1.1 lists the total usage of electricity, #2 heating oil, and recovered heat in the White Mountain Water Treatment Plant before and after the proposed retrofits.

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

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	32,792 kWh	26,149 kWh
#2 Oil	2,641 gallons	2,173 gallons
Recovered Heat	933.20 million Btu	933.20 million Btu

Benchmark figures facilitate comparing energy use between different buildings. Table 1.2 lists several benchmarks for the audited building. More details can be found in section 3.2.2.

Table 1.2: Building Benchmarks for the Water Treatment Plant

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	839.0	61.79	$16.86
With Proposed Retrofits	787.1	57.97	$13.58
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 White Mountain 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 - Controls Retrofit: Distribution Loop Circ Pump	Adjust controls on heat recovery system so that heat isn't added to the distribution loops during summer months. Turn circ. pumps off during summer months when ground temperature is above freezing.	$1,745 / 9.5 MMBTU	$900	22.77	0.5	7,874.0
2	Lighting - Combined Retrofit: Outdoor Lighting	Replace with new energy-efficient LED lighting, replace manual switching with daylight sensor.	$564 / 3.1 MMBTU	$860	5.52	1.5	2,547.9
3	Setback Thermostat: Water Treatment Plant	Install programmable thermostats and implement a heating setback to 50°F during WTP unoccupied hours.	$505 / 21.3 MMBTU	$2,000	3.38	4.0	3,591.3
4	Lighting - Combined Retrofit: Main Mechanical Room	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$470 / 0.6 MMBTU	$1,300	3.01	2.8	1,982.7

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
5	Other Electrical - Controls Retrofit: Pressure Pump	Replace pressure switches with more user friendly version so that operator may reduce system pressure as appropriate, reducing the run time of the pressure pumps.	$436 / 0.6 MMBTU	$1,300	2.79	3.0	1,838.7
6	Lighting - Combined Retrofit: Boiler Room	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$216 / 0.2 MMBTU	$860	2.09	4.0	904.7
7	Lighting - Combined Retrofit: Utility Room	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$193 / 0.2 MMBTU	$820	1.95	4.3	808.3
8	Air Tightening	Air seal exterior doors, old louvres, vents and old intake arctic box to reduce air leakage by 30%.	$750 / 31.8 MMBTU	$4,200	1.65	5.6	5,347.2
9	Heating and Ventilation	Clean and tune boilers, close the door to boiler room to reduce heating load. Move existing and add second temp sensor to water return and supply lines in city shop so that operators can easily gauge water temp. Replace broken flow indicators on WH line. Provide boiler cleaning and tuning training to operators.	$483 + $200 Maint. Savings / 14.9 MMBTU	$7,300	0.83	10.7	3,052.8
10	Lighting - Power Retrofit: Boiler Room	Replace with new energy-efficient LED lighting.	$32 / 0.1 MMBTU	$480	0.55	15.2	134.3
11	Lighting - Power Retrofit: Tank Corridor	Replace with new energy-efficient LED lighting.	$2 / 0.0 MMBTU	$80	0.22	37.0	9.0

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**
12	Window/Skylight: Non-South Facing Windows	Replace windows with new, triple pane windows. Train operators in removal, installation and sealing. Window replacement is necessary to realize the benefits of air tightening retrofit.	$98 / 4.4 MMBTU	$9,612	0.18	98.0	716.8
13	Window/Skylight: South Facing Window	Replace windows with new, triple pane windows. Train operators in removal, installation and sealing. Window replacement is necessary to realize the benefits of air tightening retrofit.	$15 / 0.7 MMBTU	$1,602	0.17	104.9	111.6
14	Lighting - Power Retrofit: Hall	Replace with new energy-efficient LED lighting.	$3 / 0.0 MMBTU	$160	0.15	56.8	11.9
15	Lighting - Power Retrofit: Storage Room	Replace with new energy-efficient LED lighting.	$0 / 0.0 MMBTU	$30	0.11	79.2	1.6
16	Lighting - Power Retrofit: Bathroom	Replace with new energy-efficient LED lighting.	$1 / 0.0 MMBTU	$60	0.10	84.9	3.0
17	Lighting - Power Retrofit: Storage Room	Replace with new energy-efficient LED lighting.	$1 / 0.0 MMBTU	$80	0.06	137.9	2.5
18	Lighting - Power Retrofit: Bathroom	Replace with new energy-efficient LED lighting.	$0 / 0.0 MMBTU	$80	0.03	301.2	1.2
19	Lighting - Power Retrofit: False Wall/Corridor	Replace with new energy-efficient LED lighting.	$0 / 0.0 MMBTU	$90	0.01	658.3	0.6
	TOTAL, all measures		**$5,514 + $200 Maint. Savings / 87.3 MMBTU**	**$31,814**	**1.83**	**5.6**	**28,940.1**

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 $5,514 per year, or 19.5% of the buildings' total energy costs. These measures are estimated to cost $31,814, for an overall simple payback period of 5.6 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**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Service Fees**	**Total Cost**
Existing Building	$2,897	$2,120	$17,776	$3,983	$9	$1,425	$120	**$28,331**
With Proposed Retrofits	$1,484	$530	$15,541	$3,780	$9	$1,352	$120	**$22,817**
Savings	$1,414	$1,590	$2,235	$203	$0	$72	$0	**$5,514**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the White Mountain Water Treatment Plant. The scope of this project included evaluating building shell, lighting and other electrical systems, and heating and ventilation 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 and ventilation equipment
- Lighting systems and controls
- Building-specific equipment
- Water treatment

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 White Mountain 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.

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

1) Water Treatment Plant: 1,680 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. WHITE MOUNTAIN WATER TREATMENT PLANT

3.1. Building Description

The 1,680 square foot White Mountain Water Treatment Plant was constructed in 1980, with a normal occupancy of 1 person. The number of hours of operation for this building average 7 hours per day, considering all seven days of the week, with the operator passing in and out of the plant as he tends to various components of the system.

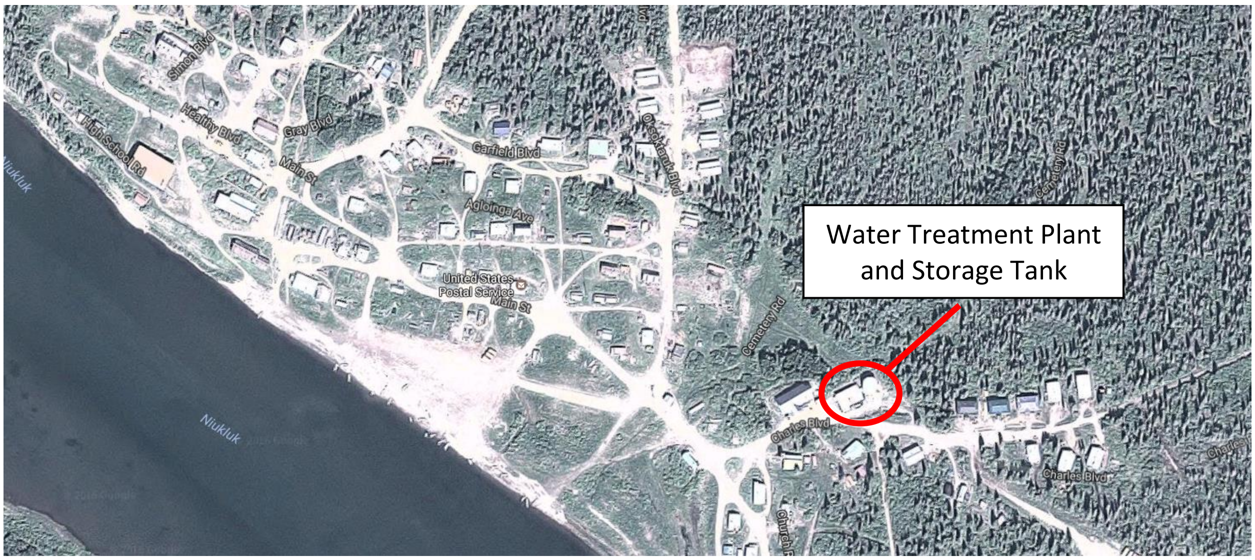


Figure 1: Aerial view of the White Mountain Water Treatment Plant and Storage Tank

Raw water is pumped daily from a 120' well located at the northern corner of the water treatment plant. The submersible intake pump is controlled by a float valve in the water storage tank (WST) resulting in water being pumped about 50% of the time.

After the raw water enters the building, chlorine is injected for disinfection. The water is then stored in a 150,000 gallon storage tank. The tank exhibits multiple leaks. During the colder months, a heat add system heats the water in the tank to 42°F.

Water is pumped from the storage tank into two pressure tanks by two pressure pumps operating in lead/lag mode. The pressure setting at the time of this audit what 95 psi. Design pressure is within the range of 70-90 psi. A small portion of water is diverted from the pipeline prior to entering the pressure tanks and sent down the well to keep water circulating and prevent freezing in the intake line at times when raw water is not being pumped.

Water from the pressure tanks flows to a single distribution loop as needed. The 9700' long loop distributes water to the homes and community buildings through 4" HDPE artic pipe. Recovered heat from the generators in the power plant is used to heat the water in the distribution loop as it passes through the shop building approximately 600'from the water treatment plant. There is a distribution loop heat add system in the water treatment plant as well, however, this system rarely has to transfer heat because the heat recovery system is able to meet the loop's heating demand.

Remote monitory equipment collects valuable data on the plant's operation including circulation loop supply and return temperature to the plant and shop, water tank level and temperature, raw water temperature, glycol temperature to and from boilers and boiler run time.

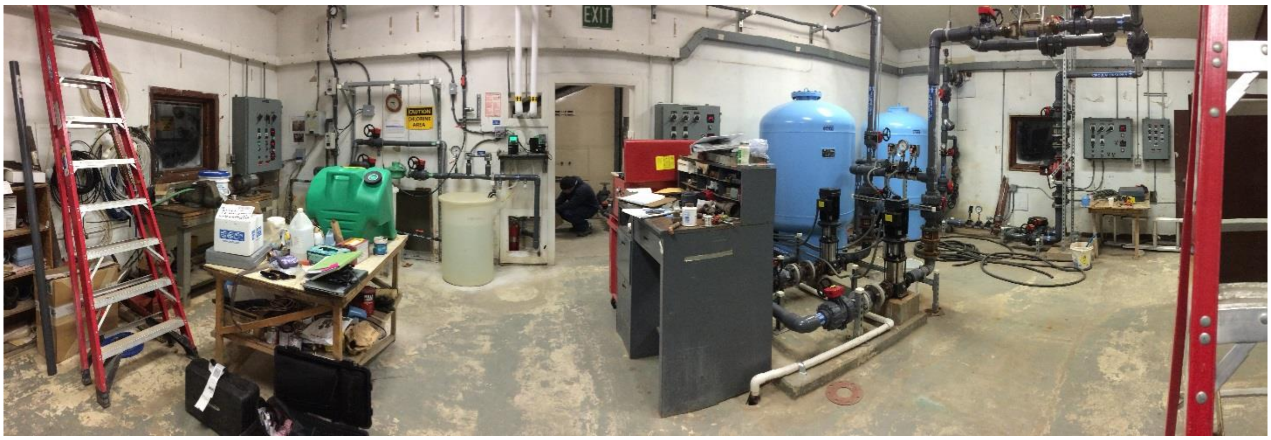


Figure 2: Main room in White Mountain Water Treatment Plant

Description of Building Shell

The exterior walls of the water treatment plant are constructed with single stud 2x6 lumber construction with a 16-inch offset. The average wall height is approximately 10 ft. The walls have approximately 5.5 inches polyurethane panel insulation damaged due to age. There is approximately 1,283 square feet of wall space in the WTP.

The WTP has a cathedral ceiling with 2x6 lumber construction. The roof has standard framing and a 24-inch offset. The peak ceiling height is approximately 16 ft. The ceiling has approximately 5.5 inches of insulated polyurethane panels with significant damage due to age. There is approximately 1,743 square feet of roof space in the building.

The WTP is built on grade on a gravel pad. The concrete floor contains an insulated layer of 6 inch polyurethane panels damaged by age. There is approximately 1680 feet of floor space in the building.

There are seven windows located throughout the building. All windows are the same size, approximately 2.875' x 3.125'. All windows are double-pane glass with wooden frames. Over time, the window seals have deteriorated causing them to function as single pain windows. Frost is present on the window interiors. The exterior pane on one of the windows is broken.


Figure 3: Frost present on mechanical room window and boiler room door.

There is a 3’ x 6’8” wooden door with an arctic entry on the front (southwestern) side of the building. There is a 6’ x 6’8” double exterior door in the boiler room on the southeastern side of the building. The door itself is aluminum with wood added to the bottom to block drafts. The wood is worn and there is significant air leakage surrounding the door. Frost is present on the interior of the door.

<u>Description of Heating Plants</u>

The Heating Plants used in the building are:

Boiler 1

Nameplate Information:	Weil McLain Ultra UO-40
Fuel Type:	#2 Oil
Input Rating:	168,000 BTU/hr
Steady State Efficiency:	76 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	Sep – Jun
Fire Rate:	1.2 gallons/hour

Boiler 2

Nameplate Information:	Weil McLain Ultra UO-40
Fuel Type:	#2 Oil
Input Rating:	168,000 BTU/hr
Steady State Efficiency:	76 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	Sep – Jun
Fire Rate:	1.2 gallons/hour

Recovered Heat

Fuel Type:	Recovered heat from power plant
Input Rating:	425,000 BTU/hr
Steady State Efficiency:	99 %
Idle Loss:	0 %
Heat Distribution Type:	Water
Boiler Operation:	All Year

The demand for heat in the water treatment plant is seasonal and includes space heating and two heat-add systems – the water storage tank heat-add and the circulation loop heat-add. Heat is also added to the raw water line via a small line of watered diverted from the main lines just before the pressure tanks. This line serves as a heat trace and keeps water in the intake line circulating at times when it is not being pumped. Two Weil McLain High Efficiency boilers serve to meet the heating demand of the water treatment plant. The boilers are turned on or off manually and controlled by two thermostats. The operator turns usually begins running the boilers in late September and shuts them down in early June. Typically only one boiler is run at a time and they are rotated manually every few months. Each boiler has a circulating pump that circulates heated glycol through the boilers and into the main hydronic heating loop when the boilers are firing.

Figure 4: Boilers in the water treatment plant.

Space Heating Distribution Systems

Space heating is provided by a hydronic loop. A Grundfos Magna 40 circulates glycol through the hydronic loop, varying flow rate with heating demand. The heat is distributed through baseboard heaters and one 1/20 HP unit heater located in the main room of the water treatment plant.

Heat Recovery Information

After leaving the water treatment plant, the distribution loop passes by the city shop which also houses the local power plant. A portion of the water is diverted through a heat-add system in the shop that utilizes recovered heat from the diesel power generators in the power plant.

This recovered heat system meets the entire heating demand of the distribution loop. The water temperature is boosted to an average of 78° F after passing through the recovered heat heat-add system, then returns to the water treatment plant at an average temperature of 58° F. Diverting a portion of the heated water in the distribution loop to offset the heating demand of the water storage tank warrants further exploration.

Description of Building Ventilation System

Ventilation in the building is achieved through a currently inoperable, leaky louvre and two air make-up vents covered with cardboard, all located in the boiler room.

Lighting

Lighting in the water treatment plant consumes approximately 3,400 kWh annually constituting about 10% of the building's current electrical consumption.

Table 3.1: Breakdown of Lighting by Bulb Type

Type of bulb	Total Number of Bulbs	kWh/year	Location(s)
25 W, 4' T8 fluorescent	55	2,316	Boiler room, main mechanical room, tank corridor, hall, storage room, bathroom, utility room
15 W compact fluorescent spiral	16	18	False wall/corridor, storage room, bathroom, attic
100 W metal halide	3	1,085	Exterior

Major Equipment

Table 3.2 contains the details on each of the major electricity consuming mechanical components found in the water treatment plant. Major equipment consumes approximately 28,671 kWh annually constituting about 87% of the building's current electrical consumption.

Table 3.2: Major Equipment List

Major Pumps + Motors	Purpose	Motor Size	Operating Schedule	Annual Energy Consumption (kWh)
WST heat-add circ pump x 2	Circulate water from WST through heat exchanger	0.11 HP	always on during colder months	531
Distribution loop heat-add circ pump x 2	Circulate water from distribution loop line through heat exchanger	0.11 HP	always on during colder months	531
Pressure pump x 2	Boost pressure in distribution loop headed out to community	2 HP	~28% of the time (measured)	3,662
Distribution loop circ pump x 2	Circulate water in distribution loop to prevent freezing	1.5 HP	always on	9,809
Well intake pump	Transmit water from source to water treatment plant	0.75 HP	operating about half the time	2,659
Chlorine injection pump	Inject chlorine into water for disinfection	0.18 HP	Operating about half the time	641
Saw	Cutting	2.3 HP	rarely used, ~2% of the time	38
Grinder	Grinding	4.2 HP	Rarely used, ~2% of the time	68
Control panel x 3	Controlling various system components	45 W	always on	1,315
Lift station effluent pumps x 2	Transmit water from wastewater system to sewage lagoon	2 HP	varies significantly with amount of water in the system, 25%-85% of the time	9,417
			Total Energy Consumption	28,671

Heat Tape

There are two heat tapes in the water treatment plant, but they are not used.

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 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.

White Mountain Utilities runs the power plant in the city of White Mountain. The utility provides electricity to the residents of White Mountain as well as commercial and public facilities.

The average cost for each type of fuel used in this building is shown below in Table 3.1. This figure includes all surcharges, subsidies, and utility customer charges:

Table 3.3: Energy Rates by Fuel Type in White Mountain

Table 3.3 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.62/kWh
#2 Oil	$ 2.98/gallons
Recovered Heat	$ 0.00/million Btu

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, White Mountain Utilities pays approximately $28,331 annually for electricity and other fuel costs for the White Mountain Water Treatment Plant.

Figure 5 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.

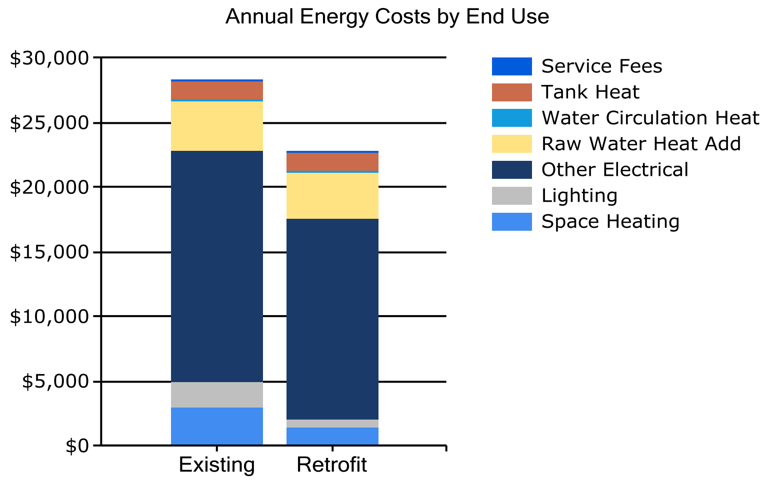


Figure 5: Annual energy costs by end use.

Figure 6 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.

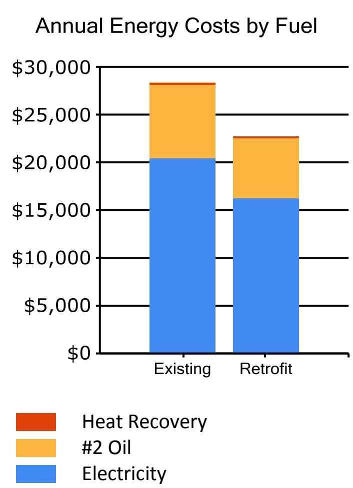


Figure 6: Annual energy costs by fuel type.

Figure 7 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. Note that many components are related – poorly sealed doors and windows contribute to air leakage, increasing space heating demand. 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.

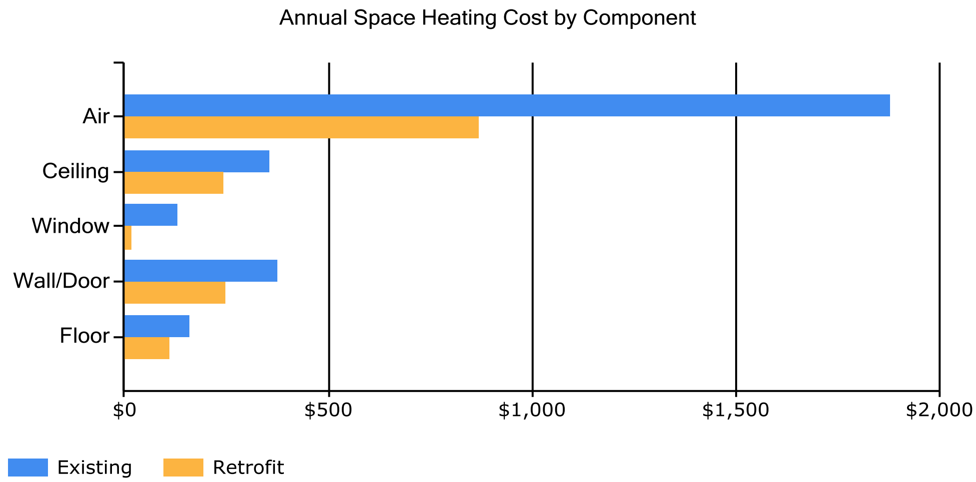


Figure 7: Annual space heating costs by component.

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.

Table 3.4: Electrical Consumption Records by Category

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	88	84	78	44	3	0	0	0	0	23	57	89
Lighting	321	293	309	267	256	247	255	274	285	307	298	308
Other_Electrical	2470	2251	2470	2390	2470	2268	2343	2343	2337	2470	2390	2470
Raw_Water_Heat_Add	21	19	21	20	21	0	0	0	11	21	20	21
Water_Circulation_Heat	0	0	0	0	0	0	0	0	0	0	0	0
Tank_Heat	11	11	11	7	1	0	0	0	0	4	7	11

Table 3.5: Fuel Oil Consumption Records by Category

Fuel Oil #2 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	168	160	148	81	0	0	0	0	0	40	108	170
Raw_Water_Heat_Add	152	138	152	149	160	0	0	0	94	156	148	152
Water_Circulation_Heat	0	0	0	0	0	0	0	0	0	0	0	0
Tank_Heat	80	79	79	51	10	0	0	0	0	29	54	84

Table 3.6: Recovered Heat Consumption Records by Category

Recovered Heat Consumption (Million Btu)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	0	0	0	0	0	0	0	0	0	0	0	0
Raw_Water_Heat_Add	0	0	0	0	0	0	0	0	0	0	0	0
Water_Circulation_Heat	111	101	111	108	111	0	0	0	61	111	108	111
Tank_Heat	0	0	0	0	0	0	0	0	0	0	0	0

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 3.4 for details):

$$\textit{Building Site EUI} = \frac{(\textit{Electric Usage in kBtu} + \textit{Fuel Usage in kBtu})}{\textit{Building Square Footage}}$$

$$\textit{Building Source EUI} = \frac{(\textit{Electric Usage in kBtu X SS Ratio} + \textit{Fuel Usage in kBtu X SS Ratio})}{\textit{Building Square Footage}}$$

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

Table 3.7: White Mountain 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	32,792 kWh	111,919	3.340	373,808
#2 Oil	2,641 gallons	364,472	1.010	368,117
Recovered Heat	933.20 million Btu	933,202	1.280	1,194,499
Total		**1,409,593**		**1,936,424**
BUILDING AREA		1,680	Square Feet	
BUILDING SITE EUI		839	kBTU/Ft^2/Yr	
BUILDING SOURCE EUI		1,153	**kBTU/Ft^2/Yr**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

Table 3.8: White Mountain Building Benchmarks

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	839.0	61.79	$16.86
With Proposed Retrofits	787.1	57.97	$13.58
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 White Mountain Water Treatment Plant was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from White Mountain 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 White Mountain. 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 - Controls Retrofit: Distribution Loop Circ Pump	Adjust controls on heat recovery system so that heat isn't added to the distribution loops during summer months. Turn circ pumps during summer months when ground temperature is above freezing.	$1,745 / 9.5 MMBTU	$900	22.77	0.5	7,874.0
2	Lighting - Combined Retrofit: Outdoor Lighting	Replace with new energy-efficient LED lighting, replace manual switching with daylight sensor.	$564 / 3.1 MMBTU	$860	5.52	1.5	2,547.9
3	Setback Thermostat: Water Treatment Plant	Install programmable thermostats and implement a heating setback to 50°F during WTP unoccupied hours.	$505 / 21.3 MMBTU	$2,000	3.38	4.0	3,591.3
4	Lighting - Combined Retrofit: Main Mechanical Room	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$470 / 0.6 MMBTU	$1,300	3.01	2.8	1,982.7
5	Other Electrical - Controls Retrofit: Pressure Pump	Replace pressure switches with more user friendly version so that operator may reduce system pressure as appropriate, reducing the run time of the pressure pumps.	$436 / 0.6 MMBTU	$1,300	2.79	3.0	1,838.7
6	Lighting - Combined Retrofit: Boiler Room	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$216 / 0.2 MMBTU	$860	2.09	4.0	904.7

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
7	Lighting - Combined Retrofit: Utility Room	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$193 / 0.2 MMBTU	$820	1.95	4.3	808.3
8	Air Tightening	Air seal exterior doors, old louvres, vents and old intake arctic box to reduce air leakage by 30%.	$750 / 31.8 MMBTU	$4,200	1.65	5.6	5,347.2
9	Heating and Ventilation	Clean and tune boilers, close the door to boiler room to reduce heating load. Move existing and add second temp sensor to water return and supply lines in city shop so that operators can easily gauge water temp. Replace broken flow indicators on WH line. Provide boiler cleaning and tuning training to operators.	$483 + $200 Maint. Savings / 14.9 MMBTU	$7,300	0.83	10.7	3,052.8
10	Lighting - Power Retrofit: Boiler Room	Replace with new energy-efficient LED lighting.	$32 / 0.1 MMBTU	$480	0.55	15.2	134.3
11	Lighting - Power Retrofit: Tank Corridor	Replace with new energy-efficient LED lighting.	$2 / 0.0 MMBTU	$80	0.22	37.0	9.0
12	Window/Skylight: Non-South Facing Windows	Replace windows with new, triple pane windows. Train operators in removal, installation and sealing. Window replacement is necessary to realize the benefits of air tightening retrofit.	$98 / 4.4 MMBTU	$9,612	0.18	98.0	716.8
13	Window/Skylight: South Facing Window	Replace windows with new, triple pane windows. Train operators in removal, installation and sealing. Window replacement is necessary to realize the benefits of air tightening retrofit.	$15 / 0.7 MMBTU	$1,602	0.17	104.9	111.6
14	Lighting - Power Retrofit: Hall	Replace with new energy-efficient LED lighting.	$3 / 0.0 MMBTU	$160	0.15	56.8	11.9

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
15	Lighting - Power Retrofit: Storage Room	Replace with new energy-efficient LED lighting.	$0 / 0.0 MMBTU	$30	0.11	79.2	1.6
16	Lighting - Power Retrofit: Bathroom	Replace with new energy-efficient LED lighting.	$1 / 0.0 MMBTU	$60	0.10	84.9	3.0
17	Lighting - Power Retrofit: Storage Room	Replace with new energy-efficient LED lighting.	$1 / 0.0 MMBTU	$80	0.06	137.9	2.5
18	Lighting - Power Retrofit: Bathroom	Replace with new energy-efficient LED lighting.	$0 / 0.0 MMBTU	$80	0.03	301.2	1.2
19	Lighting - Power Retrofit: False Wall/Corridor	Replace with new energy-efficient LED lighting.	$0 / 0.0 MMBTU	$90	0.01	658.3	0.6
	TOTAL, all measures		**$5,514 + $200 Maint. Savings / 87.3 MMBTU**	**$31,814**	**1.83**	**5.6**	**28,940.1**

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
12	Window/Skylight: Non-South Facing Windows	Glass: Single, Glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.94 Solar Heat Gain Coefficient including Window Coverings: 0.52	Replace windows with new, triple pain windows.

Installation Cost	$9,612	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$98
Breakeven Cost	$1,699	**Simple Payback (yrs)**	98	**Energy Savings (MMBTU/yr)**	4.4 MMBTU
		Savings-to-Investment Ratio	0.2		

Auditors Notes: There are seven total windows in the building. They are all double pane glass windows with wooden frames. Over time, the seals in the windows have become damaged causing them to function as single pane windows. Frost was present on the interior of all windows. Replace windows with new, triple pane windows. Train operators in removal, installation and sealing. Window replacement is necessary to realize the benefits of air tightening retrofit.

Rank	Location	Size/Type, Condition	Recommendation
13	Window/Skylight: South Facing Window	Glass: Single, Glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.94 Solar Heat Gain Coefficient including Window Coverings: 0.52	Replace windows with new, triple pain windows.

Installation Cost	$1,602	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$15
Breakeven Cost	$264	**Simple Payback (yrs)**	105	**Energy Savings (MMBTU/yr)**	0.7 MMBTU
		Savings-to-Investment Ratio	0.2		

Auditors Notes: See above table.

Figure 8: Left: Frost on the interior of the window in the WTP utility room. Right: Thermal image of same window.

4.3.4 Air Sealing Measures

Rank	Location	Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
8		Air Tightness estimated as: 5500 cfm at 50 Pascals		Air seal exterior doors, old louvres, vents and old intake arctic box to reduce air leakage by 30%.	
Installation Cost	$4,200	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$750
Breakeven Cost	$6,912	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	31.8 MMBTU
		Savings-to-Investment Ratio	1.6		
Auditors Notes: Significant air leakage puts creates extra space heating demand in the WTP. Air leakage can be reduced by keeping the doors to the boiler room closed, sealing holes above the door between the boiler and mechanical room and sealing un-needed old vents and louvres, door and window frames and a poorly insulated section around an old arctic box. See the photos below for detail. Note that the temperatures displayed on some photos are inaccurate. Outdoor temperature was -10°F and indoor temperature about 50°F when photos were taken.					

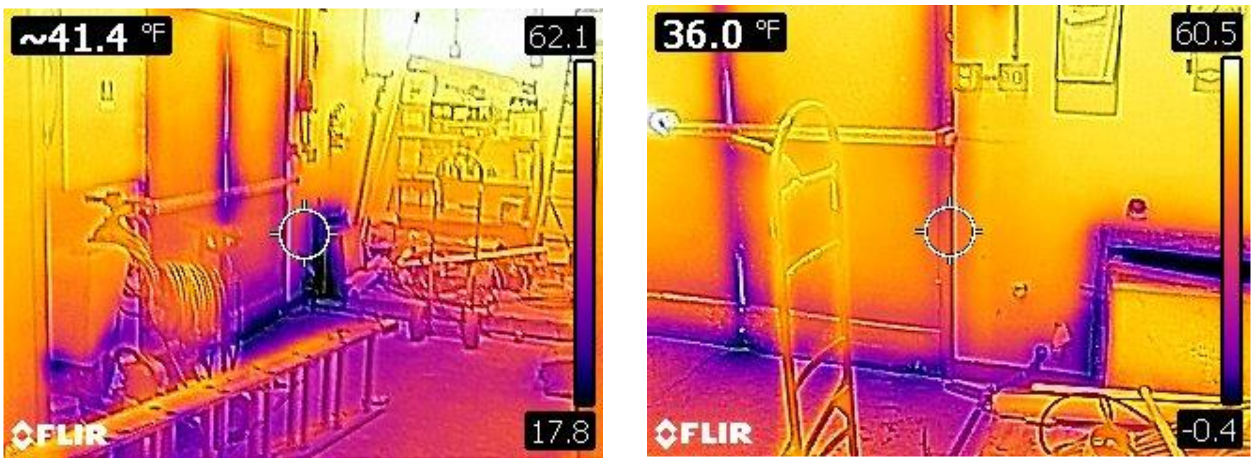


Figure 9: Thermal image of the boiler room double doors and louvre to the right of the door. The dark colors indicate low temperatures and air leakage.

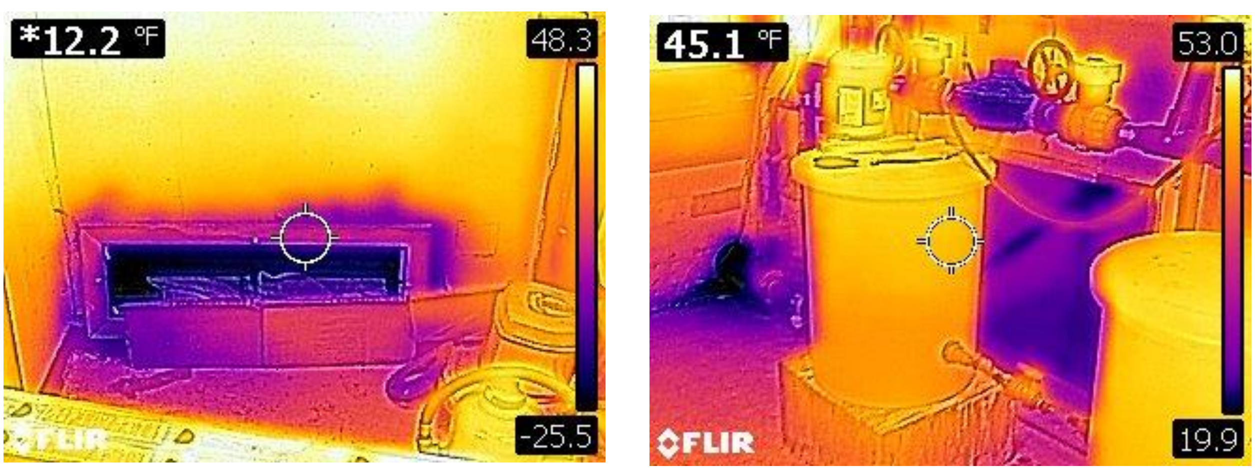


Figure 10: Left: An old air make-up vent now blocked with cardboard. Right: Behind an old chemical tank, dark colors indicate poorly isolated areas surrounding the raw water intake and an old arctic box.

4.4 Mechanical Equipment Measures

4.4.1 Heating

Rank	Recommendation				
9	Clean and tune boilers, improve temperature readings on recovered heat				
Installation Cost	$7,300	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$483
Breakeven Cost	$6,038	**Simple Payback (yrs)**	11	**Energy Savings (MMBTU/yr)**	14.9 MMBTU
		Savings-to-Investment Ratio	0.8	**Maintenance Savings ($/yr)**	$200

Auditors Notes: Clean and tune boilers in water treatment plant, train operators in cleaning and tuning, closing the door to boiler room to reduce heating load.

In the city shop, near the distribution loop heat-add system, there is one temperature gauge on the water supply line located near the heat exchanger. Move the temp sensor/gauge on the supply line to the point where the line enters the building to get a more accurate reading. Add a temp gauge to the return line near the point where it exits the building so that the operator can easily gauge temperature and assess heat added via heat recovery as well as heat loss along the distribution loop. Replace broken paddles in flow indicators on heat recovery glycol and water line.

4.4.3 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
3	Water Treatment Plant			Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Water Treatment Plant space.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$505
Breakeven Cost	$6,754	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	21.3 MMBTU
		Savings-to-Investment Ratio	3.4		

Auditors Notes: Install programmable thermostats to implement a heating setback when the WTP is unoccupied.

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	Outdoor Lighting		3 MH 100 Watt		Replace with new, energy efficient LED lighting and add a daylight sensor.	
Installation Cost		$860	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$564
Breakeven Cost		$4,751	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	3.1 MMBTU
			Savings-to-Investment Ratio	5.5		
Auditors Notes: Outdoor lighting on the water treatment plant includes three single bulb wall-pack fixtures.						

Rank	**Location**		**Existing Condition**		**Recommendation**	
4	Main Mechanical Room		5 FLUOR (4) T8 4' F32T8 25W Energy-Saver		Replace with new, energy efficient LED lighting and add an occupancy sensor.	
Installation Cost		$1,300	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$470
Breakeven Cost		$3,918	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	0.6 MMBTU
			Savings-to-Investment Ratio	3.0		
Auditors Notes: There are five fixtures with four bulbs each so a total of 20 4’ T8 fluorescent bulbs to be replaced with their LED equivalent.						

Rank	**Location**		**Existing Condition**		**Recommendation**	
6	Boiler Room		3 FLUOR (3) T8 4' F32T8 25W Energy-Saver		Replace with new, energy efficient LED lighting and add an occupancy sensor.	
Installation Cost		$860	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$216
Breakeven Cost		$1,797	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	0.2 MMBTU
			Savings-to-Investment Ratio	2.1		
Auditors Notes: There are three fixtures with three bulbs each so a total of 9 4’ T8 fluorescent bulbs to be replaced with their LED equivalent.						

Rank	Location	Existing Condition		Recommendation	
7	Utility Room	4 FLUOR (2) T8 4' F32T8 25W Energy-Saver		Replace with new, energy efficient LED lighting and add an occupancy sensor.	
Installation Cost	$820	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$193
Breakeven Cost	$1,603	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	0.2 MMBTU
		Savings-to-Investment Ratio	2.0		
Auditors Notes: There are four fixtures with two bulbs each so a total of 8 4’ T* fluorescent bulbs to be replaced with their LED equivalent.					

Rank	Location	Existing Condition		Recommendation	
10	Boiler Room	3 FLUOR (4) T8 4' F32T8 25W Energy-Saver		Replace with new, energy efficient LED lighting.	
Installation Cost	$480	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$32
Breakeven Cost	$264	**Simple Payback (yrs)**	15	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	0.5		
Auditors Notes: There are three fixtures with four bulbs each so a total of 12 4’ T8 fluorescent bulbs to be replaced with their LED equivalent. These would be controlled by the boiler room occupancy sensor assigned to the other boiler room lights.					

Rank	Location	Existing Condition		Recommendation	
11	Tank Corridor	FLUOR (2) T8 4' F32T8 25W Energy-Saver		Replace with new, energy efficient LED lighting.	
Installation Cost	$80	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$2
Breakeven Cost	$18	**Simple Payback (yrs)**	37	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.2		
Auditors Notes: There are two fixtures with four bulbs each so a total of 8 4’ T8 fluorescent bulbs to be replaced with their LED equivalent.					

Rank	Location	Existing Condition		Recommendation	
14	Hall	2 FLUOR (2) T8 4' F32T8 25W Energy-Saver		Replace with new, energy efficient LED lighting.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$3
Breakeven Cost	$24	**Simple Payback (yrs)**	57	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.1		
Auditors Notes: There are two fixtures with two bulbs each so a total of 4 4’ T8 fluorescent bulbs to be replaced with their LED equivalent.					

Rank	Location	Existing Condition		Recommendation	
15	Storage Room	2 FLUOR CFL, Spiral 15 W		Replace with new, energy efficient LED lighting.	
Installation Cost	$30	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$
Breakeven Cost	$3	**Simple Payback (yrs)**	79	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.1		
Auditors Notes: There are two compact fluorescent spiral bulbs to be replaced with their LED equivalent.					

Rank	Location	Existing Condition		Recommendation	
16	Bathroom	4 FLUOR CFL, Spiral 15 W		Replace with new, energy efficient LED lighting.	
Installation Cost	$60	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$1
Breakeven Cost	$6	**Simple Payback (yrs)**	85	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.1		
Auditors Notes: There are four compact fluorescent spiral bulbs to be replaced with their LED equivalent.					

Rank	Location	Existing Condition		Recommendation	
17	Storage Room	2 FLUOR T8 4' F32T8 25W Energy-Saver		Replace with new, energy efficient LED lighting.	
Installation Cost	$80	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$1
Breakeven Cost	$5	**Simple Payback (yrs)**	138	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.1		
Auditors Notes: There are two fixtures with one bulb each so a total of 2 4’ T8 fluorescent bulbs to be replaced with their LED equivalent.					

Rank	Location	Existing Condition		Recommendation	
18	Bathroom	FLUOR (2) T8 4' F32T8 25W Energy-Saver		Replace with new, energy efficient LED lighting.	
Installation Cost	$80	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$
Breakeven Cost	$2	**Simple Payback (yrs)**	301	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.0		
Auditors Notes: There are two fixtures with one bulb each so a total of 2 4’ T8 fluorescent bulbs to be replaced with their LED equivalent.					

Rank	Location	Existing Condition		Recommendation	
19	False Wall/Corridor	6 FLUOR CFL, Spiral 15 W		Replace with new, energy efficient LED lighting.	
Installation Cost	$90	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$
Breakeven Cost	$1	**Simple Payback (yrs)**	658	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.0		
Auditors Notes: There are six compact fluorescent spiral bulbs to be replaced with their LED equivalent.					

4.5.3 Other Electrical Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
1	Distribution Loop Circ Pump		Pump with Manual Switching		Adjust heat recovery controls so that distribution loop circ pumps can be turned off during summer.	
Installation Cost		$900	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$1,745
Breakeven Cost		$20,494	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	9.5 MMBTU
			Savings-to-Investment Ratio	22.8		
Auditors Notes: Distribution loop circ pumps are currently run year round to prevent houses nearest the city shop heat-add from experiencing excessively high temperatures in their water. Reprogram controls on the heat recovery system so that heat is not demanded and added to water during the summer months. Turn circ pumps off during summer months.						

Rank	Location		Description of Existing		Efficiency Recommendation	
5	Pressure Pump		Pump with Other Controls		Improve Other Controls	
Installation Cost		$1,300	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$436
Breakeven Cost		$3,633	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	0.6 MMBTU
			Savings-to-Investment Ratio	2.8		
Auditors Notes: Replace pressure switches with more user friendly version that operator feels comfortable adjusting as appropriate, reduce system pressure from 95 psi down to design pressure (70-90 psi) to reduce pressure pump run time by 5-10%. Reducing pressure in the distribution loop may also reduce leakage.						

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.

ANTHC is currently working with the City of White Mountain in an effort to realize the retrofits identified in this report through funding from the Rural Alaskan Village Grant (RAVG) program. ANTHC will continue to work with White Mountain to secure any additional funding necessary to implement the recommended energy efficiency measures.

APPENDICES

Appendix A – Scanned Energy Billing Data

White Mountain Utilities – Water Treatment Plant Fuel Records for 12/16/2013-07/09/2016

Type	Date	Num	Memo	Item	Qty	Sales Price	Amount
Invoice	01/03/2014	11044	529.2 gallons delivered on 12/16/13	Fuel Sales	529.20	3.6584	1,936.03
Invoice	06/03/2014	11694	838.9 gallons delivered on 05/29/14	Fuel Sales	838.90	3.6584	3,069.03
Invoice	04/01/2014	11439	945.5 gallons delivered on 03/07/14	Fuel Sales	945.50	3.6584	3,459.02
Invoice	12/02/2015	14174	941.8 gallons delivered on 11/23/15	Fuel Sales	941.80	2.9807	2,807.22
Invoice	12/07/2015	14242	100 gallons delivered 2/12/2015	Fuel Sales	100.00	2.9807	298.07
Invoice	12/07/2015	14242	722 gallons delivered 1/13/2015	Fuel Sales	722.00	2.9807	2,152.07
Invoice	12/07/2015	14242	929.8 gallons delivered 4/23/2015	Fuel Sales	929.80	2.9807	2,771.45
Invoice	02/05/2016	14409	895.3 gallons delivered 1/4/16	Fuel Sales	895.30	2.9807	2,668.62
Invoice	03/01/2016	14517	470 gallons delivered 2/12/16	Fuel Sales	470.00	2.9807	1,400.93
Invoice	04/04/2016	15043	719.7 gallons delivered 3/29/16	Fuel Sales	719.70	2.9807	2,145.21
Invoice	08/01/2016	15483	1004 gallons 7/19/16	Fuel Sales	1,004.00	2.9807	2,992.62
				Total Fuel	8,096.20		$ 25,700.27

White Mountain Utilities – Water Treatment Plant Electrical Records for 01/03/2014-11/01/2016

Type	Date	Num	Memo	Item	Qty	Sales Price	Amount
Invoice	01/03/2014	11044	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	3,104.00	0.62	1,924.48
Invoice	02/03/2014	11175	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,253.00	0.62	1,396.86
Invoice	03/03/2014	11307	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,272.00	0.62	1,408.64
Invoice	04/01/2014	11439	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,375.00	0.62	1,472.50
Invoice	05/01/2014	11567	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,318.00	0.62	1,437.16
Invoice	06/03/2014	11694	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,350.00	0.62	1,457.00
Invoice	07/01/2014	11824	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	1,884.00	0.62	1,168.08
Invoice	08/01/2014	11957	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,103.00	0.62	1,303.86
Invoice	09/02/2014	12083	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,087.00	0.62	1,293.94
Invoice	10/01/2014	12210	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,006.00	0.62	1,243.72
Invoice	11/03/2014	12338	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,340.00	0.62	1,450.80
Invoice	12/02/2014	12465	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	3,417.00	0.62	2,118.54
Invoice	01/06/2015	12639	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,094.00	0.62	1,298.28
Invoice	02/05/2015	12738	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,373.00	0.62	1,471.26
Invoice	03/02/2015	12826	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,289.00	0.62	1,419.18
Invoice	04/01/2015	12955	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,554.00	0.62	1,583.48
Invoice	05/01/2015	13080	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,820.00	0.62	1,748.40
Invoice	06/01/2015	13323	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,616.00	0.62	1,621.92
Invoice	07/01/2015	13442	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,165.00	0.62	1,342.30
Invoice	08/01/2015	13566	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,064.00	0.62	1,279.68
Invoice	09/01/2015	13699	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	1,986.00	0.62	1,231.32
Invoice	10/01/2015	13936	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	1,930.00	0.62	1,196.60
Invoice	11/02/2015	14057	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	1,974.00	0.62	1,223.88
Invoice	12/02/2015	14174	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,054.00	0.62	1,273.48
Invoice	01/04/2016	14295	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,193.00	0.62	1,359.66
Invoice	02/02/2016	14409	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,347.00	0.62	1,455.14
Invoice	03/01/2016	14517	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,303.00	0.62	1,427.86
Invoice	04/01/2016	15043	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,391.00	0.62	1,482.42
Invoice	05/02/2016	15148	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,373.00	0.62	1,471.26
Invoice	06/01/2016	15254	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,474.00	0.62	1,533.88
Invoice	07/01/2016	15372	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	1,924.00	0.62	1,192.88
Invoice	08/01/2016	15483	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	1,865.00	0.62	1,156.30
Invoice	09/01/2016	15594	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	1,600.00	0.55	880.00
Invoice	10/03/2016	15704	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,198.00	0.55	1,208.90
Invoice	11/01/2016	15817	Kilowatt Hours Consumed	Elec.-Sales:Electricity (Kilowatt Hours Consumed)	2,214.00	0.55	1,217.70
				Total Electrcity	79,310.00		$ 48,751.36

White Mountain Utilities – Lift Station Electrical Records for 01/03/2014 – 11/01/2016

Type	Date	Num	Memo	Item	Qty	Sales Price	Amount
Invoice	01/03/2014	11037	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	878.00	-0.3437	-301.77
Invoice	02/03/2014	11168	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	2,383.00	-0.3437	-819.04
Invoice	03/03/2014	11300	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	1,439.00	-0.3437	-494.58
Invoice	04/01/2014	11431	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	717.00	-0.3437	-246.43
Invoice	05/01/2014	11560	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	1,640.00	-0.3437	-563.67
Invoice	06/03/2014	11687	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	1,441.00	-0.3437	-495.27
Invoice	07/01/2014	11817	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	2,161.00	-0.3365	-727.18
Invoice	08/01/2014	11950	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	1,188.00	-0.3365	-399.76
Invoice	09/02/2014	12076	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	943.00	-0.3365	-317.32
Invoice	10/01/2014	12203	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	142.00	-0.3365	-47.78
Invoice	11/03/2014	12329	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	2,583.00	-0.3389	-875.38
Invoice	12/02/2014	12457	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	801.00	-0.3389	-271.46
Invoice	01/06/2015	12635	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	1,555.00	-0.3437	-534.45
Invoice	02/02/2015	12735	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	2,840.00	-0.3437	-976.11
Invoice	03/02/2015	12819	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	1,721.00	-0.3389	-583.25
Invoice	04/01/2015	12947	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	1,863.00	-0.3389	-631.37
Invoice	05/01/2015	13072	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	2,017.00	-0.3389	-683.56
Invoice	06/01/2015	13316	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	574.00	-0.3389	-194.53
Invoice	07/01/2015	13435	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	1,344.00	-0.3389	-455.48
Invoice	08/01/2015	13559	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	1,004.00	-0.3294	-330.72
Invoice	09/01/2015	13692	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	671.00	-0.2674	-179.43
Invoice	10/01/2015	13929	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	1,469.00	-0.2674	-392.81
Invoice	11/02/2015	14121	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	439.00	-0.2674	-117.39
Invoice	12/02/2015	14238	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	646.00	-0.2674	-172.74
Invoice	01/04/2016	14287	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	567.00	-0.2674	-151.62
Invoice	02/02/2016	14401	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	645.00	-0.2674	-172.47
Invoice	03/01/2016	14508	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	502.00	-0.2674	-134.23
Invoice	04/01/2016	15034	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	377.00	-0.2674	-100.81
Invoice	05/02/2016	15140	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	1,202.00	-0.2674	-321.41
Invoice	06/01/2016	15247	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	698.00	-0.2674	-186.65
Invoice	07/01/2016	15365	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	475.00	-0.2593	-123.17
Invoice	08/01/2016	15477	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	836.00	-0.2593	-216.77
Invoice	09/01/2016	15588	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	609.00	-0.2223	-135.38
Invoice	10/03/2016	15699	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	675.00	-0.2223	-150.05
Invoice	11/01/2016	15811	Community Facility PCE Credit	Commercial PCE (Community Facility PCE Credit)	1,578.00	-0.2223	-350.79
							-12,854.83

Appendix B – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: White Mountain Water Treatment Plant	**Auditor Company:** ANTHC
Address: PO Box 150	**Auditor Name:** Bailey Gamble
City: White Mountain	**Auditor Address:** 4500 Diplomacy Dr. Anchorage, AK 99508
Client Name: Yvonne Galsy Gregg	
Client Address: PO Box 150 White Mountain, AK 99784	**Auditor Phone:** (907) 729-4501
	Auditor FAX:
Client Phone: (907) 638-2230	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 1,680 square feet	**Design Space Heating Load:** Design Loss at Space: 46,175 Btu/hour with Distribution Losses: 46,175 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 70,389 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 0 people	**Design Indoor Temperature:** 55 deg F (building average)
Actual City: White Mountain	**Design Outdoor Temperature:** -22.2 deg F
Weather/Fuel City: White Mountain	**Heating Degree Days:** 13,578 deg F-days
Utility Information	
Electric Utility: White Mountain– Utilities	**Average Annual Cost/kWh:** $0.62/kWh

Annual Energy Cost Estimate								
Description	**Space Heating**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Service Fees**	**Total Cost**
Existing Building	$2,897	$2,120	$17,776	$3,983	$9	$1,425	$120	**$28,331**
With Proposed Retrofits	$1,484	$530	$15,541	$3,780	$9	$1,352	$120	**$22,817**
Savings	$1,414	$1,590	$2,235	$203	$0	$72	$0	**$5,514**

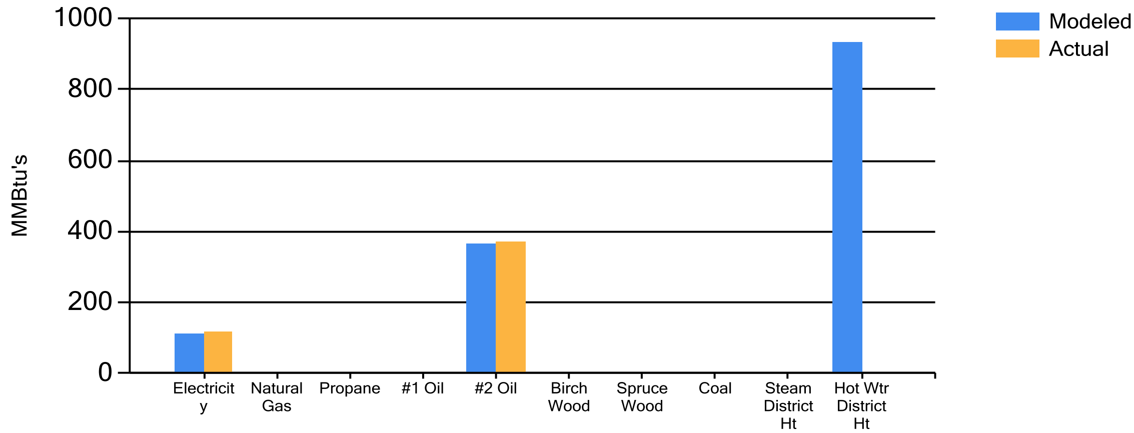
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	839.0	61.79	$16.86
With Proposed Retrofits	787.1	57.97	$13.58

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.

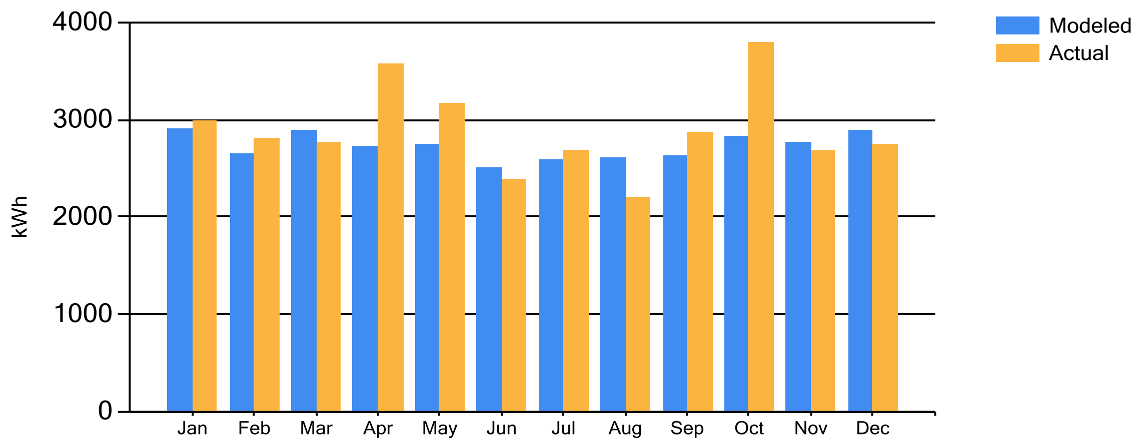
Appendix C – Actual Fuel Use versus Modeled Fuel Use

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.

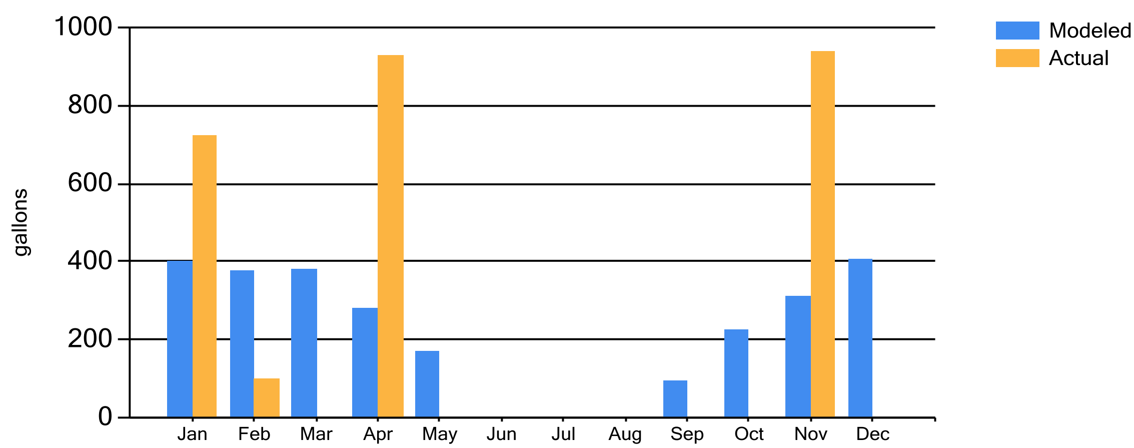
Annual Fuel Use



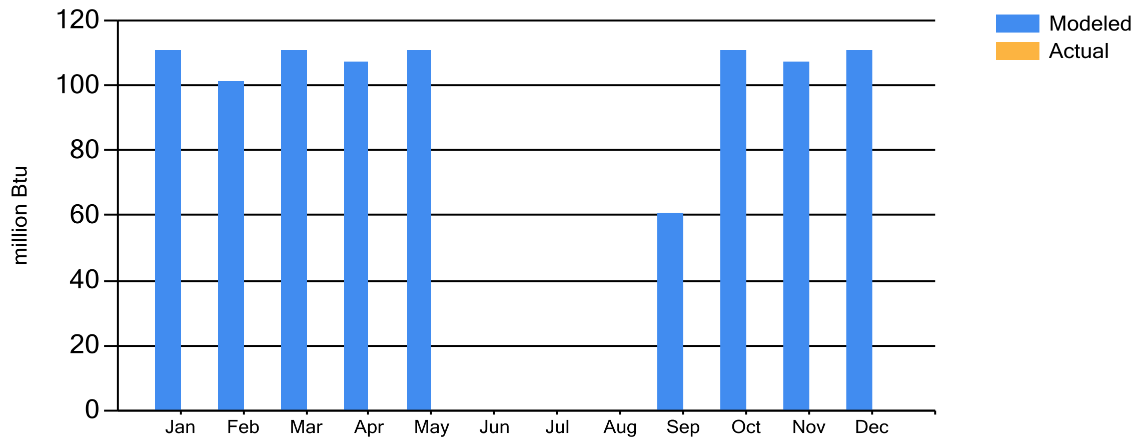
Electricity Fuel Use



#2 Fuel Oil Fuel Use



Recovered Heat Fuel Use


120
100
80
60
40
20
0
million Btu
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Modeled
Actual

Appendix D - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Current	4.9	4.9	4.8	4.6	4.5	4.3	4.3	4.3	4.4	4.5	4.6	4.6
As Proposed	4.1	4.1	4.1	4.0	4.0	2.7	2.7	2.7	3.4	4.0	4.0	4.0

AkWarmCalc Ver 2.6.1.0, Energy Lib 8/9/2016