Comprehensive Energy Audit
For
Water Treatment Plant

Prepared For

City Of Brevig Mission

October 20, 2014

Prepared By:
ANTHC
3900 Ambassador Drive, Suite 301
Anchorage, AK 99508

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PREFACE

The Energy Projects Group at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for The City of Brevig Mission, Alaska. The authors of this report are Carl Remley, Certified Energy Auditor (CEA) and Certified Energy Manager (CEM) and Gavin Dixon.

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in February of 2014 by the Energy Projects Group 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.

This energy audit was conducted using funds from the United States Department of Agriculture Rural Utilities Service as well as the State of Alaska Department of Environmental Conservation. Coordination with the State of Alaska Remote Maintenance Worker (RMW) Program and the associated RMW for each community has been undertaken to provide maximum accuracy in identifying audits and coordinating potential follow up retrofit activities.

In the near future, a representative of ANTHC will be contacting both the city of Brevig Mission and the water treatment plant operator to follow up on the recommendations made in this audit report. A Rural Alaska Village Grant and funding from the Denali Commission has funded ANTHC to provide the city with assistance in understanding the report and implementing the recommendations.

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of Water Treatment Plant Operators Arnold Seetot and Carl Rock, and Brevig Mission Mayor Johnee Seetot.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Brevig Mission. The scope of the audit focused on the Water Treatment Plant (WTP). The scope of this report is a comprehensive energy study, which included an analysis of building shell, process heating loads, interior and exterior lighting systems, heating and ventilation systems, and plug loads.

The total predicted energy cost for the WTP is $109,295 per year. Electricity represents the largest piece with an annual cost of $58,050 per year. This includes $22,509 paid by the end-users and $35,541 paid by the Power Cost Equalization (PCE) program through the State of Alaska. The WTP is predicted to spend $51,244 for heating oil. These predictions are based on the electricity and fuel prices at the time of the audit.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower the electricity costs and make energy in rural Alaska affordable. In Brevig Mission, the cost of electricity without PCE is $0.49 /kWh, and the cost of electricity with PCE is $0.19/kWh. For the purposes of this report, electricity costs and savings are calculated using the $0.49 per kilowatt hour rate.

Table 1.1 below summarizes the energy efficiency measures analyzed for the Water Treatment Plant. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.1
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]
1	Ventilation	Reduce operating time of ventilation system and fans to a cycle of 20 minutes on and 40 minutes off.	$2,388	$1,500	17.50	0.6
2	Raw Water Heating: Reduce Temperature	Re-commission raw water heat add controls and lower set point to 40 degrees	$5,941	$5,000	16.08	0.8
3	Controls: Reduce CP-1 Pump Runtime	Shut off raw water heating during the summer months	$1,869	$1,000	11.57	0.5
4	Controls: Reduce CP-4 Pump Runtime	Shut off Loop B heating during the summer months	$3,327	$2,000	10.30	0.6
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7	Water Storage Tank Heating: Reduce Temperature	Re-commission tank heat add controls and lower temperature to 43 degrees	$2,376	$4,500	7.14	1.9
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9	Lighting: Mechanical Room	Replace lighting with new energy-efficient LED bulbs and improve controls.	$103 plus $60 Maintenance Savings	$360	2.78	2.2
10	Lighting: Office & Lab	Replace lighting with new energy-efficient LED bulbs and improve controls.	$91 plus $80 Maintenance Savings	$500	2.11	2.9
11	Lighting: WTP Fluorescent	Replace lighting with new energy-efficient LED bulbs and improve controls.	$203 plus $180 Maintenance Savings	$1,200	1.97	3.1
12	Lighting: Mezzanine	Replace lighting with new energy-efficient LED bulbs and improve controls.	$180 plus $160 Maintenance Savings	$1,100	1.91	3.2
13	Controls: Reduce Lift Station Electric Heat Usage	Add thermostat to lift station electric heater and set to 50 degrees F.	$318	$2,000	1.34	6.3
14	HVAC And DHW	Add a heat recovery system from the AVEC power plant to the water treatment plant	$28,649	$575,000	1.18	20.1
	TOTAL, all measures		**$53,581 plus $480 Maintenance Savings**	**$605,160**	**1.56**	**11.2**

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 $53,581 per year, or 49.0% of the buildings' total energy costs. These measures are estimated to cost $605,160, for an overall simple payback period of 11.2 years.

Table 1.2 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 1.2

Annual Energy Cost Estimate										
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$6,709	$0	$87	$5,483	$9,077	$38,400	$19,047	$15,238	$15,193	**$109,295**
With Proposed Retrofits	$4,960	$0	$1,871	$1,842	$8,443	$29,481	$3,237	$2,589	$3,231	**$55,714**
Savings	$1,749	$0	-$1,784	$3,642	$634	$8,919	$15,810	$12,648	$11,962	**$53,581**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the 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 and ventilation equipment
- Lighting systems and controls
- Building-specific equipment
- Water consumption, treatment & 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 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.

Water Treatment Plant is classified as being made up of the following activity areas:

1) Water Treatment Plant: 2,000 square feet
2) Garage: 800 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. Water Treatment Plant

3.1. Building Description

The 2,800 square foot Water Treatment Plant was constructed in 2000 and has a normal occupancy of 2 people. The number of hours of operation for this building average 9.1 hours per day, considering all seven days of the week.

The Brevig Mission Water Treatment Plant houses a circulating water system with two loops that provide water to the residents of the community. One loop services the north end of town and the second loop serves the south side of town. Both loops are maintained at 45 degrees F.

The raw water is pumped from a well approximately 4400 feet from the water treatment plant. The raw water is treated with chlorine but does not require significant filtration. The chlorine is injected prior to entering a 100,000 gallon water storage tank. The water tank is maintained at 48 degrees F.

The sewer system is a gravity system that sends the waste to the sewage lagoon.

Description of Building Shell

The exterior walls are constructed with stressed skin panels with 5” of polyurethane insulation. There are 3960 square feet of wall space and the insulation is in good condition.

The roof of the building is constructed with steel I-beams at a standards 24” spacing and 6” polyurethane insulation. The ceiling is a cathedral ceiling with 2839 square feet.

The floor and foundation of the building is constructed with a 6” concrete slab with 8” of polyurethane insulation. There is 2800 square feet of floor space.

There are two windows in the building totaling 32 square feet of space. Each window is double-paned with wood framing. The windows are in good condition.

There are two metals doors with polyurethane cores that have a total of 63 square feet of space. There is also a metal garage door that covers 196 square feet of space.

Description of Heating Plants

The Heating Plants used in the building are:

Weil McLain

Fuel Type:	#1 Oil
Input Rating:	664,000 BTU/hr
Steady State Efficiency:	84 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol

Boiler Operation:	Oct - Jun
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Space Heating Distribution Systems

The main room of the building is heated with two Modine unit heaters that each put out 89.000 BTU/hr. The boiler room has a Modine unit heater that puts out 41,000 BTU/hr. The garage has two Modine unit heaters that each put out 89,000 BTU/hr.

Lighting

The water treatment plant has 9 fixtures with two T-8 fluorescent light bulbs in each fixture in the main room and 8 fixtures with two T-8 fluorescent light bulbs in each fixture. The mechanical room has three of these same fixtures and the office has four of the same fixtures. The water treatment plant also has 7 standard 250 watt light bulbs and the garage has 6 standard 250 watt light bulbs. A 40 watt incandescent light bulb is present in the restroom and a 75W incandescent light bulb is present in the entrance. There are three standard 70W light bulbs on the exterior of the building.

Plug Loads

The WTP has a variety of power tools, a telephone, and some other miscellaneous loads that require a plug into an electrical outlet. Additionally, the building is outfitted with a variety of controls used to operate the major components of the WTP. The total usage of these loads is estimated to be approximately 200W.

Major Equipment

There are four circulation pumps present in the water treatment system. All four pumps run constantly for eight months per year. One pump circulates raw water between the well house and the water treatment plant and uses 1320 watts.

Another pump circulates potable water between the water storage tank and the water treatment plant and uses 840 watts.

A third pump circulates water through circulation loop A and uses 1550 watts. A fourth pump circulates water through circulation loop B and uses 2350 watts.

A well pump is present that is manually controlled by the operators to be running during operator work hours. It runs for six hours every day and uses 3730 watts.

The lift station has an electric heater that 50% of the time for eight months per year that uses 450 watts.

Building controls for the water distribution system use 500 watts and are always in operation.

An exhaust fan and coffee pot combine to use 187 watts.

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).

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 following is a list of the utility companies providing energy to the building and the class of service provided:

Electricity: AVEC-Brevig Mission - Commercial - Sm

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 3.1 – Average Energy Cost

Description	Average Energy Cost
Electricity	$ 0.49/kWh
#1 Oil	$ 4.00/gallon

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, the WTP pays approximately $109,295 annually for electricity and other fuel costs.

Figure 3.1 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 3.1
Annual Energy Costs by End Use

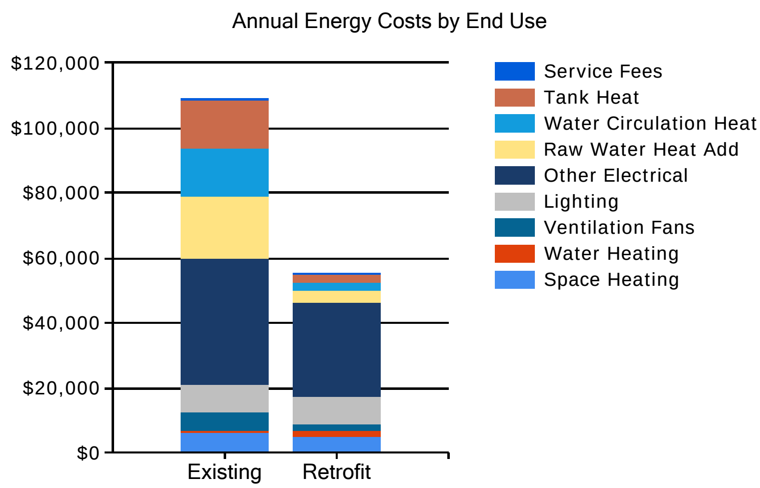


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

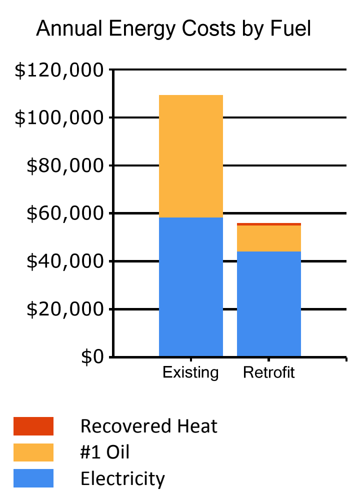
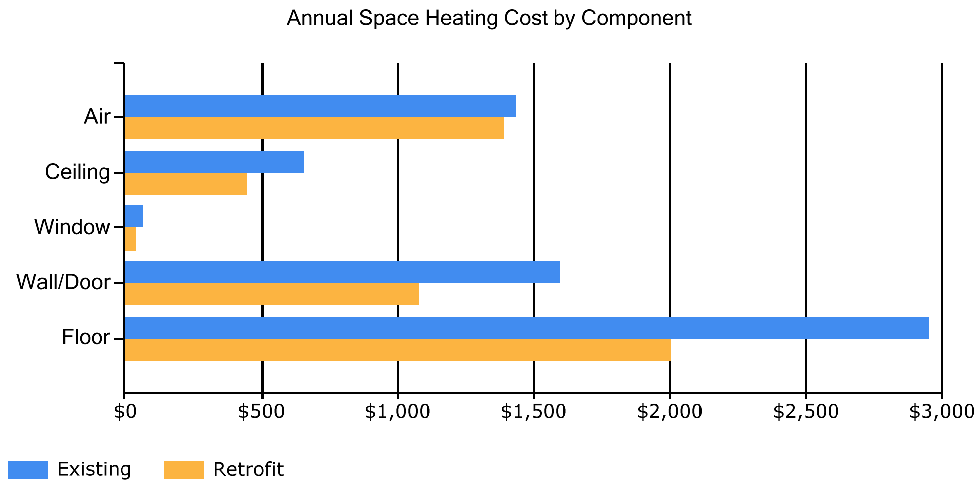


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing building is shown (blue bar) and the space heating cost assuming all retrofits are implemented (yellow bar) are shown.

Figure 3.3
Annual Space Heating Cost 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. Note, in the tables below "DHW" refers to Domestic Hot Water heating.

Electrical Consumption (kWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	971	901	948	810	715	660	175	178	196	776	847	984
Ventilation_Fans	949	864	949	918	949	918	949	949	918	949	918	949
Lighting	1570	1431	1570	1520	1570	1520	1570	1570	1520	1570	1520	1570
Other_Electrical	6699	6105	6699	6483	6699	6321	6531	6531	6321	6699	6483	6699
Raw_Water_Heat_Add	91	83	91	89	92	0	0	0	86	92	89	91
Water_Circulation_Heat	73	66	73	71	74	0	0	0	69	74	71	73
Tank_Heat	102	99	100	71	29	0	0	0	12	48	75	106

Fuel Oil #1 Consumption (Gallons)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	133	131	119	50	0	0	0	0	7	21	73	141
DHW	2	2	2	2	2	2	2	2	2	2	2	2
Raw_Water_Heat_Add	528	480	528	517	545	0	0	0	483	540	515	527
Water_Circulation_Heat	422	384	423	413	436	0	0	0	387	432	412	422
Tank_Heat	591	570	580	411	173	0	0	0	68	283	434	610

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):

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

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

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

Table 3.4
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	118,202 KWH	403,422	3.340	1,347,429
#1 Oil	12,811 gallons	1,691,063	1.010	1,707,974
Total		**2,094,485**		**3,055,402**
BUILDING AREA		2,800	Square Feet	
BUILDING SITE EUI		748	$kBTU/Ft^2/Yr$	
BUILDING SOURCE EUI		1,091	**$kBTU/Ft^2/Yr$**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

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 Water Treatment Plant was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Brevig Mission 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. Equipment cost estimate calculations are provided in Appendix D.

Limitations of AkWarm© Models

• The model is based on typical mean year weather data for Brevig Mission. 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 and cooling 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 cooling/heating loads across different parts of the building.
• The model does not model HVAC systems that simultaneously provide both heating and cooling to the same building space (typically done as a means of providing temperature control in the space).

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.

Table 4.1
Water Treatment Plant, Brevig Mission, Alaska
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5	Water Circulation Heating: Reduce Temperature	Recommission water circulation heat add controls and lower temperature to 40 degrees	$4,753	$8,000	8.04	1.7
6	Controls: Reduce CP-2 Pump Runtime	Shut off tank heating during the summer months	$1,189	$1,000	7.36	0.8
7	Water Storage Tank Heating: Reduce Temperature	Recommission tank heat add controls and lower temperature to 43 degrees	$2,376	$4,500	7.14	1.9
8	Controls: Reduce CP-3 Pump Runtime	Shut off Loop A heating during the summer months	$2,194	$2,000	6.79	0.9
9	Lighting: Mechanical Room	Replace lighting with new energy-efficient LED bulbs and improve controls.	$103 plus $60 Maintenance Savings	$360	2.78	2.2
10	Lighting: Office & Lab	Replace lighting with new energy-efficient LED bulbs and improve controls.	$91 plus $80 Maintenance Savings	$500	2.11	2.9
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12	Lighting: Mezzanine	Replace lighting with new energy-efficient LED bulbs and improve controls.	$180 plus $160 Maintenance Savings	$1,100	1.91	3.2
13	Controls: Reduce Lift Station Electric Heat Usage	Add thermostat to lift station electric heater and set to 50 degrees F.	$318	$2,000	1.34	6.3
14	HVAC And DHW	Add a heat recovery system from the AVEC power plant to the water treatment plant	$28,649	$575,000	1.18	20.1
	TOTAL, all measures		**$53,581 plus $480 Maintenance Savings**	**$605,160**	**1.56**	**11.2**

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. When the building is in cooling mode, these items contribute to the overall cooling demands of the building;

therefore, lighting efficiency improvements will reduce cooling requirements in air-conditioned buildings. Conversely, lighting-efficiency improvements are anticipated to slightly increase heating requirements. Heating penalties and cooling benefits were included in the lighting project analysis.

4.3 Mechanical Equipment Measures

4.3.1 Heating Domestic Hot Water Measure

Rank	Recommendation				
14	Add a heat recovery system from the AVEC power plant to the water treatment plant				
Installation Cost	$575,000	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$28,649
Breakeven Cost	$677,681	**Savings-to-Investment Ratio**	1.2	**Simple Payback yrs**	20
Auditors Notes: The AVEC plant is approximately 1,200 feet away from the water treatment plant building. The plant uses a Detroit Diesel Series 60 generator that could be outfitted with marine jacket manifolds to increase available recovered heat to supply the water treatment plant. Additionally the washeteria and city office could be included in a potential heat recovery project to make the project more economically feasible.					

4.3.2 Ventilation System Measures

Rank	Description			Recommendation	
1	Ventilation Controls			Change ventilation and fan operating time from constantly running to a cycle of 20 minutes on and 40 minutes off.	
Installation Cost	$1,500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$2,388
Breakeven Cost	$26,252	**Savings-to-Investment Ratio**	17.5	**Simple Payback yrs**	1
Auditors Notes: Change ventilation and fan operating time from constantly running to a cycle of 20 minutes on and 40 minutes off. This will properly ventilate the building but will reduce operating time and energy.					

4.4 Electrical & Appliance Measures

4.4.1 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 and cooling loads. The building cooling load will see a small decrease from an upgrade to more efficient bulbs and the heating load will see a small increase, as the more energy efficient bulbs give off less heat.

4.4.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	Location		Existing Condition		Recommendation	
9	Mechanical Room		3 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace lighting with new energy-efficient LED bulbs.	
Installation Cost		$360	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$103
					Maintenance Savings (/yr)	$60
Breakeven Cost		$1,002	**Savings-to-Investment Ratio**	2.8	**Simple Payback yrs**	2
Auditors Notes: Replace existing fixtures with direct wired 17 watt LED replacement bulbs. This includes removing the existing ballast. LED light bulbs use less energy, last longer, and do not contain harmful mercury.						

Rank	Location		Existing Condition		Recommendation	
10	Office & Lab		4 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace lighting with new energy-efficient LED bulbs.	
Installation Cost		$500	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$91
					Maintenance Savings (/yr)	$80
Breakeven Cost		$1,054	**Savings-to-Investment Ratio**	2.1	**Simple Payback yrs**	3
Auditors Notes: Replace existing fixtures with direct wired 17 watt LED replacement bulbs. This includes removing the existing ballast. LED light bulbs use less energy, last longer, and do not contain harmful mercury.						

Rank	Location		Existing Condition		Recommendation	
11	WTP Fluorescent		9 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace lighting with new energy-efficient LED bulbs.	
Installation Cost		$1,200	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$203
					Maintenance Savings (/yr)	$180
Breakeven Cost		$2,367	**Savings-to-Investment Ratio**	2.0	**Simple Payback yrs**	3
Auditors Notes: Replace existing fixtures with direct wired 17 watt LED replacement bulbs. This includes removing the existing ballast. LED light bulbs use less energy, last longer, and do not contain harmful mercury.						

Rank	Location		Existing Condition		Recommendation	
12	Mezzanine		8 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace lighting with new energy-efficient LED bulbs.	
Installation Cost		$1,100	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$180
					Maintenance Savings (/yr)	$160
Breakeven Cost		$2,101	**Savings-to-Investment Ratio**	1.9	**Simple Payback yrs**	3
Auditors Notes: Replace existing fixtures with direct wired 17 watt LED replacement bulbs. This includes removing the existing ballast. LED light bulbs use less energy, last longer, and do not contain harmful mercury.						

4.4.2 Other Electrical Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
3	CP-1		Raw Water Circulation Pump with Manual Switching		Improve Pump Controls	
Installation Cost		$1,000	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$1,869
Breakeven Cost		$11,568	**Savings-to-Investment Ratio**	11.6	**Simple Payback yrs**	1

Auditors Notes: Shut off the raw water circulation pump in the summer.

Rank	Location	Description of Existing		Efficiency Recommendation	
4	CP-4	Loop B Circulation Pump with Manual Switching		Improve Pump Controls	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$3,327
Breakeven Cost	$20,594	**Savings-to-Investment Ratio**	10.3	**Simple Payback yrs**	1
Auditors Notes: Shut off loop B circulation pump in summer.					

Rank	Location	Description of Existing		Efficiency Recommendation	
6	CP-2	Tank Circulation Pump with Manual Switching		Improve Pump Controls	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$1,189
Breakeven Cost	$7,361	**Savings-to-Investment Ratio**	7.4	**Simple Payback yrs**	1
Auditors Notes: Shut off tank heat add circulation pump in summer.					

Rank	Location	Description of Existing		Efficiency Recommendation	
8	CP-3	Loop A Circulation Pump with Manual Switching		Improve Pump Controls	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$2,194
Breakeven Cost	$13,583	**Savings-to-Investment Ratio**	6.8	**Simple Payback yrs**	1
Auditors Notes: Shut off loop A circulation pump in summer.					

Rank	Location	Description of Existing		Efficiency Recommendation	
13	Lift Station Electric Heat	Electric Heat with Manual Switching		Improve electric heater controls	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$318
Breakeven Cost	$2,674	**Savings-to-Investment Ratio**	1.3	**Simple Payback yrs**	6
Auditors Notes: Add thermostat to control electric heater in lift station and set it to 50F.					

4.4.3 Other Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
2		Raw Water Heat Add Load		Recommission raw water heat add controls and lower set point to 40 degrees F	
Installation Cost	$5,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$5,941
Breakeven Cost	$80,379	**Savings-to-Investment Ratio**	16.1	**Simple Payback yrs**	1
Auditors Notes: Reset the raw water heat add control from a set point of 45 to 40 degrees F.					

Rank	Location	Description of Existing		Efficiency Recommendation	
5		Water Circulation Heat Load		Recommission water circulation heat add controls and lower temperature to 40 degrees F	
Installation Cost	$8,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$4,753
Breakeven Cost	$64,304	**Savings-to-Investment Ratio**	8.0	**Simple Payback yrs**	2
Auditors Notes: Reset the water circulation heat add control from a set point of 45 to 40 degrees F.					

Rank	Location	Description of Existing		Efficiency Recommendation	
7		Tank Heat Load		Recommission tank heat add controls and lower temperature to 43 degrees F	
Installation Cost	$4,500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$2,376
Breakeven Cost	$32,152	**Savings-to-Investment Ratio**	7.1	**Simple Payback yrs**	2
Auditors Notes: Reset the tank heat add control from a set point of 48 to 43 degrees F.					

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 both the city of Brevig Mission and the water treatment plant operator to follow up on the recommendations made in this audit report. A Rural Alaska Village Grant and funding from the Denali Commission has funded ANTHC to provide the city with assistance in understanding the report and implementing the recommendations. This will include in facility training for the operator. Field training and retrofit implementation should take between one and two weeks of field time to implement.

Appendix A – Energy Audit Report – Project Summary

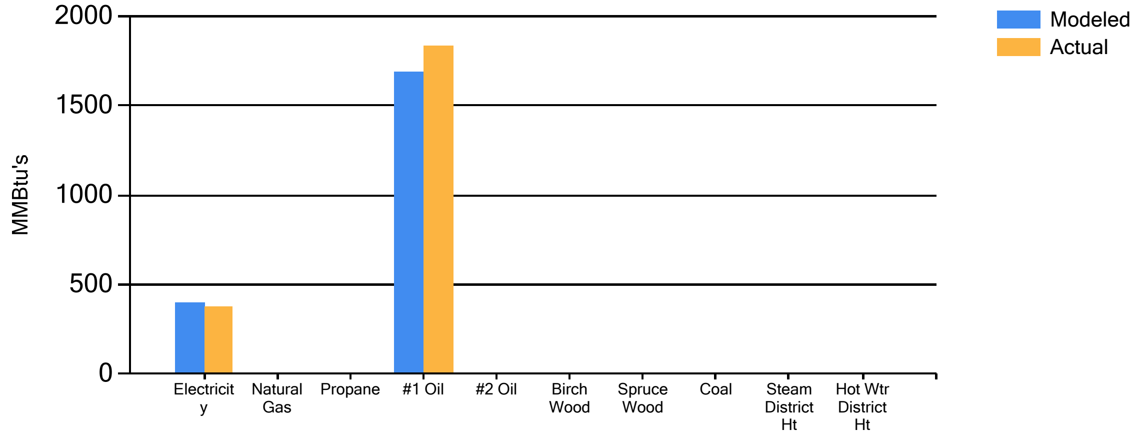
ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Water Treatment Plant	**Auditor Company:** ANTHC
Address: P O Box 8501	**Auditor Name:** Carl Remley, Eric Hanssen, Martin Wortman
City: Brevig Mission **Client Name:** Arnold Seetot & Carl Rock	**Auditor Address:** 3900 Ambassador Drive, Suite 301 Anchorage, AK 99508
Client Address: P O Box 85021 Brevig Mission, AK 99785	**Auditor Phone:** (907) 632-7075 **Auditor FAX:**
Client Phone: (907) 642-2278 **Client FAX:**	**Auditor Comment:**
Design Data	
Building Area: 2,800 square feet	**Design Space Heating Load:** Design Loss at Space: 43,591 Btu/hour with Distribution Losses: 45,886 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 69,948 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 2 people	**Design Indoor Temperature:** 58.6 deg F (building average)
Actual City: Brevig Mission	**Design Outdoor Temperature:** -28 deg F
Weather/Fuel City: Brevig Mission	**Heating Degree Days:** 14,138 deg F-days
Utility Information	
Electric Utility: AVEC-Brevig Mission - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.491/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate											
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Service Fees**	**Total Cost**
Existing Building	$6,709	$0	$87	$5,483	$9,077	$38,400	$19,047	$15,238	$15,193	$60	**$109,295**
With Proposed Retrofits	$4,960	$0	$1,871	$1,842	$8,443	$29,481	$3,237	$2,589	$3,231	$60	**$55,714**
Savings	$1,749	$0	-$1,784	$3,642	$634	$8,919	$15,810	$12,648	$11,962	$0	**$53,581**

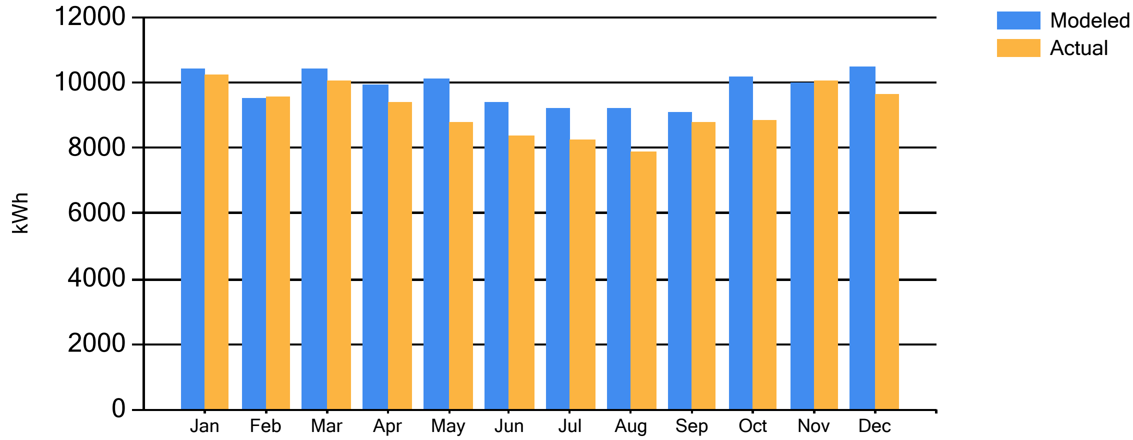
Appendix B – Actual Fuel Use versus Modeled Fuel Use

The Orange bars show Actual fuel use, and the Blue bars are AkWarm's prediction of fuel use.

Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use