Comprehensive Energy Audit
For

Shishmaref Pump House

Prepared For
City of Shishmaref

March 24, 2015

Prepared By:

ANTHC - DEHE
3900 Ambassador Drive, Suite 301
Anchorage, AK 99508

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PREFACE

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.

The Energy Projects Group at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for The City of Shishmaref, Alaska. The authors of this report are Carl Remley, Certified Energy Auditor (CEA) and Certified Energy Manager (CEM) and Kevin Ulrich. Energy Manager-in-Training (EMIT).

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in January of 2015 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.

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of Water Treatment Plant Operators Art Sheldon and Jeff Nayokpuk, Shishmaref Mayor Howard Weyiouanna Sr., Shishmaref Utilities Manager Bill Jones, and Shishmaref City Administrator Zena Barr.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Shishmaref. The scope of the audit focused on the Shishmaref Pump House. 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 systems, process loads, and plug loads. A separate report has been prepared for the Water Treatment Plant and Washeteria.

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy costs are $18,218 per year and the breakdown of the annual predicted energy costs and fuel use for the buildings analyzed are $9,900 for electricity and $8,318 for #1 Oil.

The total predicted energy cost for the pump house is $18,218 per year. Electricity represents the largest piece with an annual cost of $9,900 per year. This includes $3,617 paid by the end-users and $6,283 paid by the Power Cost Equalization (PCE) program through the State of Alaska. The pump house is predicted to spend $8,318 for #1 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 Shishmaref, the cost of electricity without PCE is $0.52/kWh, and the cost of electricity with PCE is $0.19/kWh.

The table below lists the total usage of electricity, #1 oil, and recovered heat in the WTP before and after the proposed retrofits.

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	17,727 kWh	9,224 kWh
#1 Oil	2,254 gallons	368 gallons
Recovered Heat	0.00 million Btu	188.77 million Btu

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

Building Benchmarks			
Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	403.2	25.54	$20.52
With Proposed Retrofits	302.7	19.17	$10.04
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 1.1 below summarizes the energy efficiency measures analyzed for the Shishmaref Pump House. Listed are the estimates of the annual savings, installed cost, 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]	CO_2 Savings
1	Other Electrical - Pressure Pump	Rewire pump to operate when pressure switch is on.	$3,438	$2,000	19.32	0.6	9,274.1
2	Other – Water Storage Tank	Repair tank heat-add controls.	$347	$1,000	4.70	2.9	1,981.4
3	Window: Boarded	Replace broken window with new, insulated window.	$58	$393	2.56	6.8	329.6
4	Lighting - Power Retrofit: Back Area 4 Foot	Replace with energy-efficient LED lighting.	$27	$136	2.33	5.0	16.8
5	Lighting - Power Retrofit: Main Area in Front	Replace with energy-efficient LED lighting.	$217	$1,088	2.33	5.0	134.0
6	Heating, Ventilation, and DHW	Implement a heat recovery system that recovers heat from the AVEC power plant and utilizes that heat the pump house.	$5,896	$100,000	1.41	17.0	32,464.9
	TOTAL, all measures		**$9,983**	**$104,617**	**1.80**	**10.5**	**44,200.9**

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 $9,303 per year, or 51.1% of the buildings' total energy costs. These measures are estimated to cost $104,617, for an overall simple payback period of 10.5 years. However, it should be noted that the heat recovery project listed in the above table has been funded by the renewable energy fund of the Alaska Energy Authority and will be implemented in the near future.

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.

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**	**Lighting**	**Other Electrical**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$5,980	$315	$5,598	$2,936	$3,328	**$18,218**
With Proposed Retrofits	$5,362	$240	$1,071	$1,135	$1,048	**$8,916**
Savings	$618	$76	$4,528	$1,801	$2,280	**$9,303**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Shishmaref Pump House. The scope of this project included evaluating building shell, lighting and other electrical systems, heating and ventilating equipment, and 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 Shishmaref Pump House 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.

Shishmaref Pump House is classified as being made up of the following activity areas:

1) Pump House: 888 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; heating and ventilation; 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. Shishmaref Pump House

3.1. Building Description

The 888 square foot Shishmaref Pump House was constructed in 1979, with a normal occupancy of one person. The number of hours of operation for this building average 3 hours per day, considering all seven days of the week.

The Shishmaref Pump House serves as the water distribution center for the school, clinic, and city office building. There are three individual distribution lines for the three buildings. One line serves the school and is approximately 285ft. long. A second line circulates water to the city office and is approximately 115ft. long. A third line circulates water to the clinic and is approximately 455ft. long.

Water is pumped to the water tank associated this building from the water treatment plant/washeteria. The treated water is stored in 300,000 gallon water storage tank. A pressure pump is used to keep maintain pressure.

Description of Building Shell

The exterior walls are constructed with single stud 2x8 construction and plywood sheathing. There is approximately 6¾” of R-22 batt insulation in the walls. There is a total of 1471 square feet of wall space and the insulation is in fair condition.

The roof of the building is constructed with standard framing with 16” spacing. There is a dropped ceiling with 6” of R-19 batt insulation that is in poor condition and needs repair. There is a total of 888 square feet of roof space.

The building has a slab foundation with 6¾” of R-22 batt insulation that has some damage. There is a total of 888 square feet of floor space.

There is one window in the building that has been broken and replaced with a plywood cover. The window has an area of approximately 6 square feet.

There is one door in the building. The door is made of metal with a fiberglass core. There is 21 square feet of door space.

Description of Heating Plants

The Heating Plants used in the building are:

Burnham V 37 -1

Fuel Type:	#1 Oil
Input Rating:	370,000 BTU/hr
Steady State Efficiency:	75 %
Idle Loss:	2 %
Heat Distribution Type:	Glycol
Boiler Operation:	Sep – Jun

Burnham V 37 -2

Fuel Type:	#1 Oil
Input Rating:	370,000 BTU/hr
Steady State Efficiency:	75 %
Idle Loss:	2 %
Heat Distribution Type:	Water
Boiler Operation:	Sep - Jun

Space Heating Distribution Systems

The building is heated with an old baseboard heating system with no controls. The baseboard has an average heat output of 300 Btu/hr and operates at 80% efficiency.

Lighting

The main area of the pump house has eight fixtures with two T8 fluorescent light bulbs in each fixture. The back area of the pump house has one fixture with two T8 fluorescent bulbs.

Plug Loads

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

Major Equipment

There is a pressure pump in the water distribution system. This pump operates constantly for the entire year and consumes approximately 9,204 KWH annually.

There is a circulation pump that circulates water to the city building. The pump consumes approximately 435 KWH annually.

There is a circulation pump that circulates glycol through a line that is in contact with the city line to keep the water from freezing. The pump consumes approximately 445 KWH annually.

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). One KWH usage is equivalent to 1,000 watts running for one hour. The basic usage charges are shown as generation service and delivery charges along with several non-utility generation charges.

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

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

Electricity: AVEC-Shishmaref - 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 and utility customer charges but not the PCE subsidy:

Table 3.1 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.52/kWh
#1 Oil	$ 3.69/gallon

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, the City of Shishmaref pays approximately $18,218 annually for electricity and other fuel costs for the Shishmaref Pump House.

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

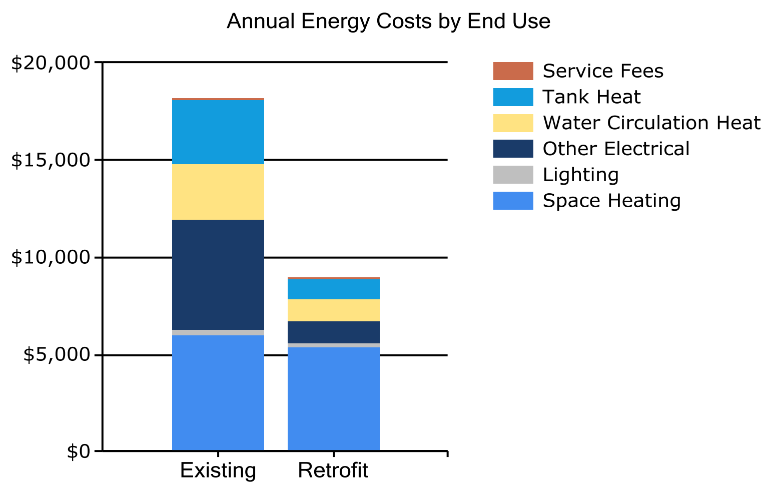


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

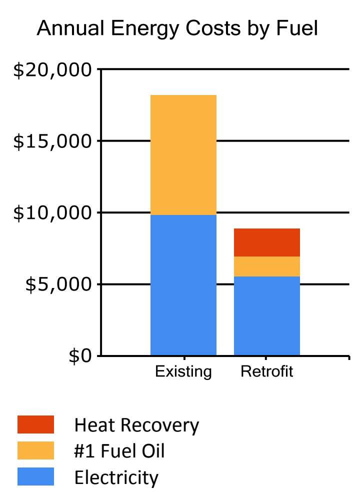
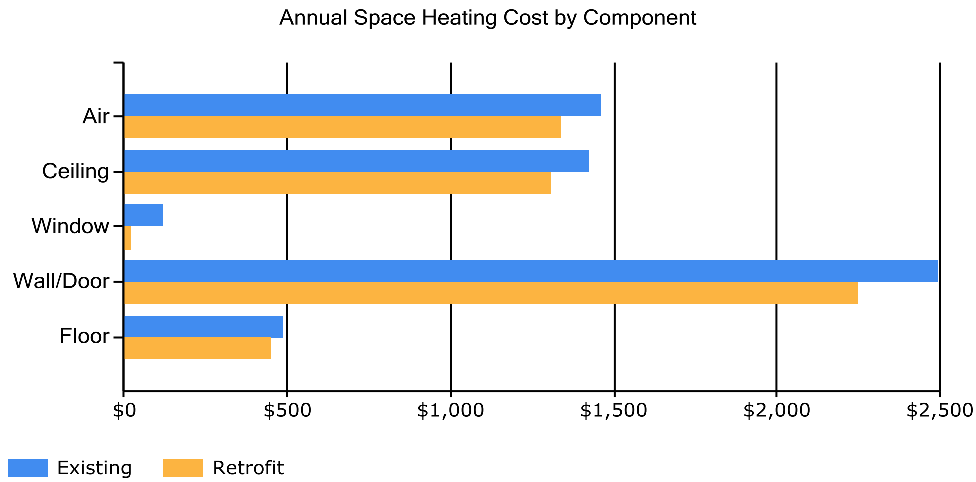


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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	476	434	475	459	472	454	469	469	457	474	460	476
Lighting	48	44	48	47	48	47	48	48	47	48	47	48
Other_Electrical	909	829	909	880	843	756	781	781	756	851	880	909
Water_Circulation_Heat	68	62	68	66	68	63	65	65	66	68	66	68
Tank_Heat	143	130	143	137	140	0	0	0	1	3	4	5

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	121	113	109	77	42	0	0	0	40	64	95	122
Water_Circulation_Heat	79	75	78	65	56	21	21	21	55	59	67	81
Tank_Heat	123	118	118	87	47	1	0	0	14	66	95	126

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
Shishmaref Pump House 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	17,727 KWH	60,502	3.340	202,078
#1 Oil	2,254 gallons	297,557	1.010	300,533
Total		**358,060**		**502,610**
BUILDING AREA		888	Square Feet	
BUILDING SITE EUI		403	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		566	**kBTU/Ft²/Yr**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

Table 3.5

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	**403.2**	**25.54**	**$20.52**
With Proposed Retrofits	**302.7**	**19.17**	**$10.04**
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 heating and ventilation systems as well as the 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 Shishmaref Pump House was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Shishmaref 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 Shishmaref. 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 heating and ventilation 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 Shishmaref Pump House, Shishmaref, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)	CO_2 Savings

Table 4.1 Shishmaref Pump House, Shishmaref, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
1	Other Electrical - Pressure Pump	Rewire pump to operate when pressure switch is on..	$3,438	$2,000	19.32	0.6	9,274.1
2	Other – Water Storage Tank	Repair tank heat-add controls.	$347	$1,000	4.70	2.9	1,981.4
3	Window: Boarded	Replace broken window with new, insulated window.	$58	$393	2.56	6.8	329.6
4	Lighting - Power Retrofit: Back Area 4 Foot	Replace with energy-efficient LED lighting.	$27	$136	2.33	5.0	16.8
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6	Heating, Ventilation, and DHW	Implement a heat recovery system that recovers heat from the AVEC power plant and utilizes that heat the pump house.	$5,896	$100,000	1.41	17.0	32,464.9
	TOTAL, all measures		**$9,983**	**$104,617**	**1.80**	**10.5**	**44,200.9**

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. Therefore, 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
3	Window/Skylight: Window – Boarded	Glass: No glazing - broken, missing Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.94 Solar Heat Gain Coefficient including Window Coverings: 0.11	Replace broken window with new, insulated window.

Installation Cost	$393	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$58
Breakeven Cost	$1,004	**Savings-to-Investment Ratio**	2.6	**Simple Payback yrs**	7
Auditors Notes: Replace existing windows with low-e/argon fiberglass or insulated vinyl windows					

4.4 Mechanical Equipment Measures

4.4.1 Heating/ Domestic Hot Water Measure

Rank	Recommendation
6	Implement a heat recovery system that recovers heat from the AVEC power plant and utilizes that heat the pump house.

Installation Cost	$100,000	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$5,596
				Maintenance Savings (/yr)	$300
Breakeven Cost	$141,014	**Savings-to-Investment Ratio**	1.4	**Simple Payback yrs**	17
Auditors Notes: Implement a heat recovery system that recovers heat from the AVEC power plant and utilizes that heat to essentially eliminate the need for oil at the pump house. This includes replacing one of the existing boilers and insulating the uninsulated heating distribution lines.					

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 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.

4.5.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	Location	Existing Condition	Recommendation
4	Back Area 4 Foot	FLUOR (2) T8 4' F32T8 32W standard electronic light bulbs.	Replace with energy-efficient LED lighting.

Installation Cost	$136	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$7
				Maintenance Savings (/yr)	$20
Breakeven Cost	$317	**Savings-to-Investment Ratio**	2.3	**Simple Payback yrs**	5
Auditors Notes: Convert fluorescent fixture to LED. Replace current lighting with LED (2) 17 Watt module standard electronic light bulbs.					

Rank	Location	Existing Condition		Recommendation	
5	Main Area in Front	8 FLUOR (2) T8 4' F32T8 32W 32W standard electronic light bulbs.		Replace with energy-efficient LED lighting.	
Installation Cost	$1,088	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$57
				Maintenance Savings (/yr)	$160
Breakeven Cost	$2,536	**Savings-to-Investment Ratio**	2.3	**Simple Payback yrs**	5
Auditors Notes: Convert fluorescent fixtures to LED. Replace current lighting with 8 LED (2) 17 Watt module standard electronic light bulbs.					

4.5.2 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
1	Pressure Pump	Pressure Pump with Manual Switching		Rewire pump to operate when pressure switch is on.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$3,238
				Maintenance Savings (/yr)	$200
Breakeven Cost	$38,636	**Savings-to-Investment Ratio**	19.3	**Simple Payback yrs**	1
Auditors Notes: The pressure pump is presently wired to run 24 hours per day 365 days per year. It should be controlled off the existing pressure switch. This retrofit can be easily implemented when at the same time as other recommendations.					

4.5.3 Other Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
2		Tank Heat Load		Repair tank heat add controls.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$347
Breakeven Cost	$4,703	**Savings-to-Investment Ratio**	4.7	**Simple Payback yrs**	3
Auditors Notes: Repair tank heat add controls to operate at proper temperatures and appropriate run times.					

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 Shishmaref and the water treatment plant operator to follow up on the recommendations made in this audit report. Funding has been provided to ANTHC through a Rural Alaska Village Grant and the Denali Commission to provide the city with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations within the 2015 calendar year.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Shishmaref Pump House	**Auditor Company:** ANTHC - DEHE
Address: P O box 83	**Auditor Name:** Carl Remley and Kevin Ulrich
City: Shishmaref	**Auditor Address:** 3900 Ambassador Drive, Suite 301 Anchorage, AK 99508
Client Name: Art Sheldon and Jeff Nayokpuk	
Client Address: P O Box 83 Shishmaref, AK 99772	**Auditor Phone:** (907) 729-3543
	Auditor FAX:
Client Phone: (907) 649-3781	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 888 square feet	**Design Space Heating Load:** Design Loss at Space: 16,740 Btu/hour with Distribution Losses: 20,925 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 31,897 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 0 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Shishmaref	**Design Outdoor Temperature:** -35.6 deg F
Weather/Fuel City: Shishmaref	**Heating Degree Days:** 15,790 deg F-days
Utility Information	
Electric Utility: AVEC-Shishmaref - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.558/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate						
Description	**Space Heating**	**Lighting**	**Other Electrical**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$5,980	$315	$5,598	$2,936	$3,328	**$18,218**
With Proposed Retrofits	$5,362	$240	$1,071	$1,135	$1,048	**$8,916**
Savings	$618	$76	$4,528	$1,801	$2,280	**$9,303**

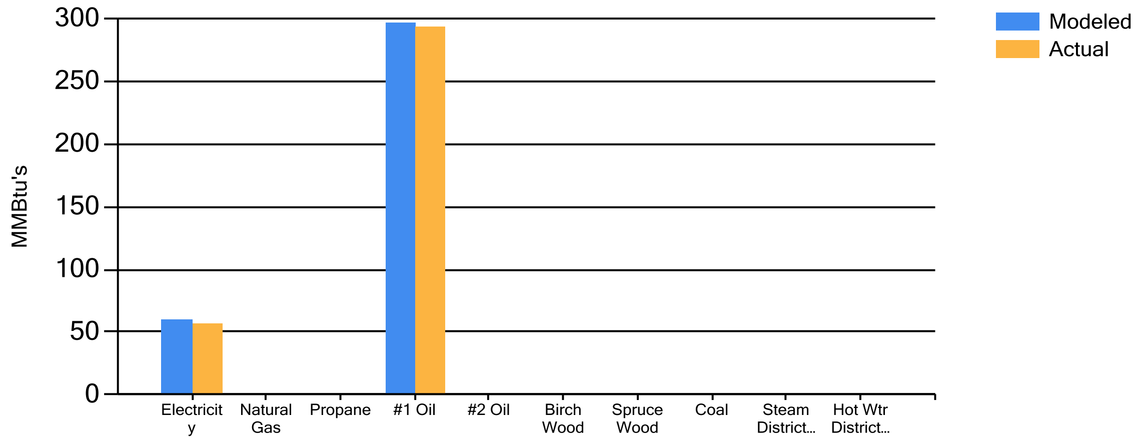
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	403.2	25.54	$20.52
With Proposed Retrofits	302.7	19.17	$10.04

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

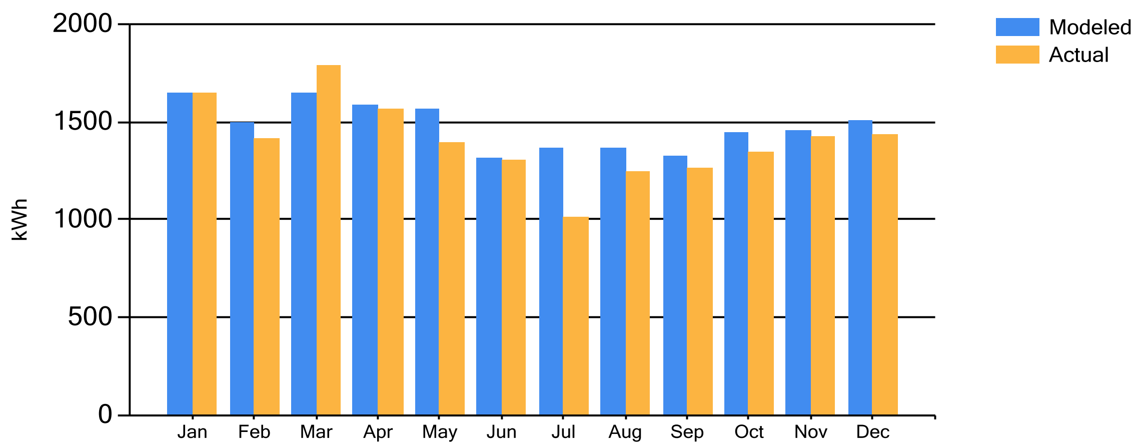
Appendix B – Actual Fuel Use versus Modeled Fuel Use

The 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