Comprehensive Energy Audit
For

Unalakleet Pump House

Prepared For
City of Unalakleet

March 9, 2017

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ANTHC-DEHE
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PREFACE

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

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

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

ACKNOWLEDGMENTS

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

1. EXECUTIVE SUMMARY

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

The City of Unalakleet is in the initial stages of developing a new water source for the community. This would include the construction of a new intake system. This facility will be replaced during the execution of this project.

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy costs are $63,084 per year. Fuel oil represents another main portion of energy costs with an annual cost of approximately $43,565. Electricity represents the remaining portion of the energy cost with an annual cost of approximately $19,518. This includes $8,732 paid by the City and $10,786 paid by the Power Cost Equalization (PCE) program through the State of Alaska.

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

Table 1.1 shows the predicted annual use of each fuel type for the Unalakleet Pump House

Table 1.1: Predicted Annual Fuel Use for the Unalakleet Pump House

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	46,725 kWh	45,054 kWh
#1 Oil	10,038 gallons	9,241 gallons

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 Unalakleet Pump House

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	3,865.9	277.74	$164.28
With Proposed Retrofits	3,576.9	256.98	$153.45
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

Table 1.3 below summarizes the energy efficiency measures analyzed for the Unalakleet Pump House. 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	Heating and Ventilation	Replace Broken Thermostat for the Unit heater, Clean and Tune boilers, Clean Hot Water Heaters	$4,142	$2,500	28.09	0.6	19,620.1
2	Lighting - Power Retrofit: Pump House Lights (T12)	Replace with LED-equivalent light bulbs	$14	$240	0.70	16.7	58.7
3	Lighting - Power Retrofit: Pump House Lights (T8)	Replace with LED-equivalent light bulbs	$1	$160	0.11	109.2	6.0
4	Setback Thermostat: Pump House	Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Pump House space.	$0	$500	0.00	999.9	0.0
5	Air Tightening	Weatherize around the doors and wall penetration, replace damaged insulation by the water intake wall penetration.	$0	$1,750	0.00	999.9	0.0
6	Window/Skylight: Window	Replace existing window with triple pane window.	$0	$1,708	0.00	999.9	0.0
	TOTAL, all measures		**$4,158**	**$6,858**	**10.27**	**1.6**	**19,684.7**

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 $4,158 per year, or 6.6% of the buildings' total energy costs. These measures are estimated to cost $6,858, for an overall simple payback period of 1.6 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**	**Total Cost**
Existing Building	$1,073	$47	$18,624	$43,292	**$63,084**
With Proposed Retrofits	$134	$31	$18,624	$40,090	**$58,926**
Savings	$939	$16	$0	$3,203	**$4,158**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

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

2.2 Audit Description

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

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

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

Details collected from Unalakleet 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.

Unalakleet Pump House is made up of the following activity areas:

1) Pump House: 384 square feet

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

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

2.3. Method of Analysis

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

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

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

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

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

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

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

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

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

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

2.4 Limitations of Study

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

3. Unalakleet Pump House

3.1. Building Description

The 384 square foot Unalakleet Pump House was constructed in 1965 and includes the building, water intake from Powers Creek, and large fuel storage tanks for use by the pump house and other barges and road maintenance equipment. The Unalakleet Pump House is the primary water intake of the City of Unalakleet. Water is pumped in from the intake gallery in Powers Creek and brought into the building. From there the water is heated by four indirect-fired hot water heaters, which are heated by two fuel-oil boilers, and sent through approximately 28,000 ft. of 4” buried pipe to the Unalakleet Water Treatment Plant.

Description of Building Shell

The exterior walls are standard 2x6 wood-framed construction with approximately 5.5 inches of fiberglass batt insulation. The insulation has been severely damaged in some locations where the outer sheathing of the wall has been exposed.

Figure 1: Damaged Wall Insulation in the Pump House

The building has a sloped roof with an attic and is constructed with 2x6 wood-framed construction. The roof is insulated with fiberglass batt insulation.

The building is constructed on pilings with a concrete floor.

There is one window in the pump house that is approximately 32”x39” in dimensions and has broken double-pane glass.

Figure 2: Broken Window in the Pump House

There are two entrances into the pump house. The front entrance is a set of metal double doors with no windows and significant air gaps around the door frame. The rear entrance is a single metal door.

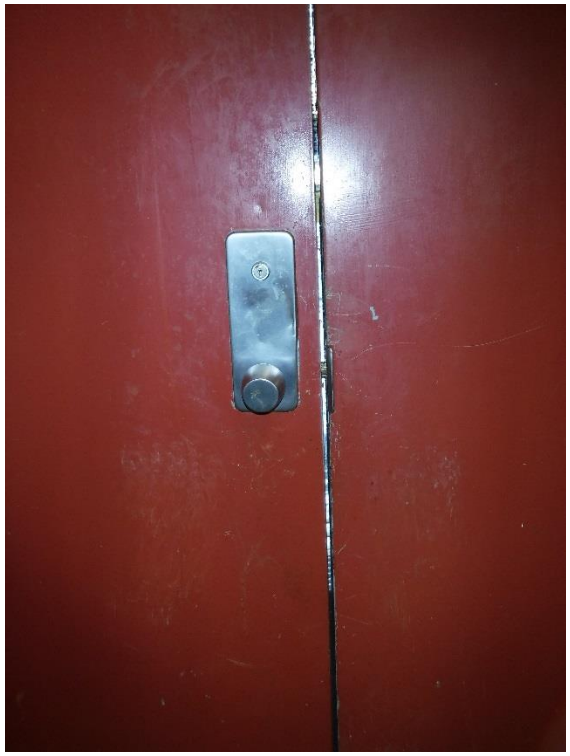

Figure 3: The Front Entrance of the Pump House with a Large Air Gap between the Doors.

Description of Heating Plants

The heating plants used in the building are:

Pump House Boiler 1

Nameplate Information:	Weil McLain Gold Model P-WTGO-6 Series 3
Fuel Type:	#1 Oil
Input Rating:	184,000 BTU/hr
Steady State Efficiency:	70 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year
Notes:	Grundfos UPS 15-58 FC

Pump House Boiler 2

Nameplate Information:	Weil McLain Gold Model P-WTGO-6 Series 3
Fuel Type:	#1 Oil

Input Rating:	184,000 BTU/hr
Steady State Efficiency:	70 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year
Notes:	Grundfos UPS 15-58 FC

Figure 4: Pump House Boilers

Space Heating Distribution Systems

There is a unit heater in the building that operates constantly with a broken thermostat. The thermostat had been set for 40 deg. F but did not react when the settings were adjusted. The unit heater is a Modine Model HS63S01 rated for 63,000 BTUh.

Figure 5: Unit Heater in the Pump House

Lighting

There are two fixtures with three T12 4ft. fluorescent light bulbs in each fixture. There are also two fixtures with two T8 4ft. fluorescent light bulbs in each fixture. These lights combine to use approximately 112 kWh annually.

Major Equipment

There are three intake pumps in the intake gallery that are used for pumping water from Powers Creek through the pump house and to the water treatment plant in the community. The pumps are rated for 5 HP, 7.5 HP, and 10 HP. The operators indicated that the 7.5 HP pump runs constantly.
There is a generator in the pump house that serves as an emergency backup if the power service from the community is not available. A large storm severed the electric line to the pump house during the summer and as a result the generator has been operating constantly since the summer months. The 10 HP intake pump cannot operate without overloading the breaker while the generator is in operation. The same problem occurs if the 7.5 HP and the 5 HP pumps operate together. The water intake pump consumes approximately 44,146 kWh annually.

Figure 6: Backup Electric Generator in the Pump House

There are four hot water heaters that are used to heat the intake water before being transported through the intake line to the community. Each of the hot water heaters is an Amtrol Model WH-7L with 41 gallons of storage. These are supplied heat by the fuel oil boilers, which operate freely because of a broken Tekmar temperature controller.

Figure 7: Hot Water Heaters for the Raw Water Supply in the Pump House

There is a fuel transfer pump that supplies the boilers with fuel when in operation. The pump is a Magnatek Cat. No. 934 rated for 0.33 HP. It consumes approximately 548 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) and maximum demand in kilowatts (kW). One kWh usage is equivalent to 1,000 watts running for one hour. One KW of electric demand is equivalent to 1,000 watts running at a particular moment. The basic usage charges are shown as generation service and delivery charges along with several non-utility generation charges.

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

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

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

Table 3.1: Energy Cost Rates for Each Fuel Type

Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.42/kWh
#1 Oil	$ 4.34/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Unalakleet pays approximately $63,084 annually for electricity and other fuel costs for the Unalakleet Pump House.

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

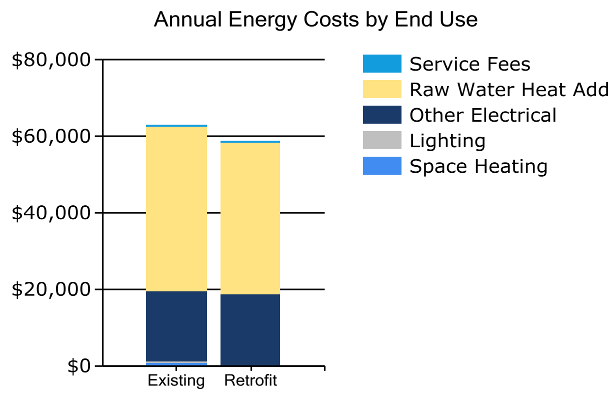

Figure 8: Annual Energy Costs by End Use

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

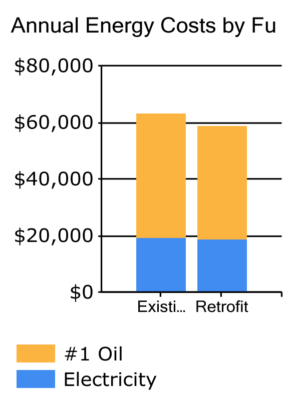

Figure 9: Annual Energy Costs by Fuel Type

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

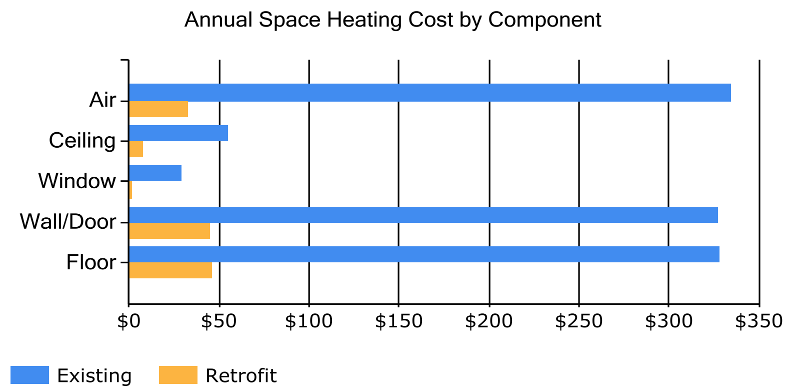

Figure 10: Annual Space Heating Costs

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

Table 3.2: Estimated Electrical Consumption by Category

Electrical Consumption (kWh)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Space Heating	137	125	137	132	137	132	137	137	132	137	132	137
Lighting	10	9	10	9	10	9	10	10	9	10	9	10
Other Electrical	3793	3457	3793	3671	3793	3671	3793	3793	3671	3793	3671	3793
Raw Water Heat Add	51	50	50	34	11	0	0	0	2	21	36	53

Table 3.3: Estimated Fuel Oil Consumption by Category

Fuel Oil #1 Consumption (Gallons)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Space Heating	0	0	0	0	0	30	31	31	0	0	0	0
Raw Water Heat Add	1643	1594	1608	1090	368	0	0	0	84	696	1160	1702

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):

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

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

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

Table 3.4: Unalakleet 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	46,725 kWh	159,473	3.340	532,639
#1 Oil	10,038 gallons	1,325,025	1.010	1,338,275
Total		**1,484,498**		**1,870,914**
BUILDING AREA		384	Square Feet	
BUILDING SITE EUI		3,866	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		4,872	**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 for the Unalakleet Pump House

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	3,865.9	277.74	$164.28
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EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

3.3 AkWarm© Building Simulation

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

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

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

Limitations of AkWarm© Models

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

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

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

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

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
1	Heating and Ventilation	Replace Broken Thermostat for the Unit heater, Clean and Tune boilers	$4,142	$2,500	28.09	0.6	19,620.1
2	Lighting - Power Retrofit: Pump House Lights (T12)	Replace with LED-equivalent light bulbs	$14	$240	0.70	16.7	58.7
3	Lighting - Power Retrofit: Pump House Lights (T8)	Replace with LED-equivalent light bulbs	$1	$160	0.11	109.2	6.0
4	Setback Thermostat: Pump House	Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Pump House space.	$0	$500	0.00	999.9	0.0

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
5	Air Tightening	Weatherize around the doors and wall penetration, replace damaged insulation by the water intake wall penetration.	$0	$1,750	0.00	999.9	0.0
6	Window/Skylight: Window	Replace existing window with triple pane window.	$0	$1,708	0.00	999.9	0.0
	TOTAL, all measures		**$4,158**	**$6,858**	**10.27**	**1.6**	**19,684.7**

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
6	Window/Skylight: Window	Glass: No glazing - broken, missing Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.94 Solar Heat Gain Coefficient including Window Coverings: 0.11	Replace existing window with triple pane window.

Installation Cost	$1,708	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$
Breakeven Cost	$	**Simple Payback (yrs)**	1000	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.0		

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

4.3.2 Air Sealing Measures

Rank	Location	Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
5		Air Tightness estimated as: 800 cfm at 50 Pascals		Weatherize around the doors and wall penetration, replace damaged insulation by the water intake wall penetration.	
Installation Cost	$1,750	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$
Breakeven Cost	$	**Simple Payback (yrs)**	1000	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.0		
Auditors Notes: Sealing the cracks around the doors and replacing the insulation in the wall, while combined with the replacement of the broken window, will significantly reduce the space heating load and prevent cold air from penetrating the building.					

4.4 Mechanical Equipment Measures

4.4.1 Heating Measure

Rank	Recommendation				
1	Replace Broken Thermostat for the Unit heater, Clean and Tune boilers, Clean Hot Water Heaters				
Installation Cost	$2,500	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$4,142
Breakeven Cost	$70,231	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	110.8 MMBTU
		Savings-to-Investment Ratio	28.1		
Auditors Notes: The thermostat was set for 40 deg. F but was not working properly when adjusted. This caused the unit heater to operate constantly and call for heat from the boiler. Replacing the thermostat will reduce the runtime of the unit heater and boilers. Additionally, cleaning and tuning the boilers as well replacing the Tekmar temperature controller will allow for more efficient boiler operations. Cleaning the hot water heaters will improve the heat transfer between the boilers and the water intake.					

4.4.2 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
4	Pump House			Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Pump House space.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$
Breakeven Cost	$	**Simple Payback (yrs)**	1000	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.0		
Auditors Notes: This is the retrofit for replacing the pump house thermostat, which will affect the Heating Measure previously listed.					

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	
2	Pump House Lights (T12)	3 FLUOR (2) T12 4' F40T12 40W Standard StdElectronic		Replace with LED-equivalent light bulbs	
Installation Cost	$240	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$14
Breakeven Cost	$169	**Simple Payback (yrs)**	17	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	0.7		
Auditors Notes: There are three fixtures with two light bulbs in each fixture for a total of six light bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
3	Pump House Lights (T8)	2 FLUOR (2) T8 4' F32T8 25W Energy-Saver Instant StdElectronic		Replace with LED-equivalent light bulbs	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$1
Breakeven Cost	$17	**Simple Payback (yrs)**	109	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.1		
Auditors Notes: There are two fixtures with two light bulbs in each fixture for a total of four light bulbs to be replaced.					

5. ENERGY EFFICIENCY ACTION PLAN

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

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

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

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Unalakleet Pump House	**Auditor Company:** ANTHC-DEHE
Address: P.O. Box 28	**Auditor Name:** Kevin Ulrich, Martin Wortman
City: Unalakleet	**Auditor Address:** 4500 Diplomacy Dr. Anchorage, AK 99508
Client Name: Dwayne Johnson, Roger Nichols	
Client Address: P.O. Box 28	**Auditor Phone:** (907) 729-3237
	Auditor FAX:
Client Phone: (907) 624-3531	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 384 square feet	**Design Space Heating Load:** Design Loss at Space: 5,379 Btu/hour with Distribution Losses: 5,379 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 8,200 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 1 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Unalakleet	**Design Outdoor Temperature:** -34 deg F
Weather/Fuel City: Unalakleet	**Heating Degree Days:** 13,919 deg F-days
Utility Information	
Electric Utility: Unalakleet Valley Elec. Coop.	**Average Annual Cost/kWh:** $0.42/kWh

Annual Energy Cost Estimate

Description	Space Heating	Lighting	Other Electrical	Raw Water Heat Add	Total Cost
Existing Building	$1,073	$47	$18,624	$43,292	**$63,084**
With Proposed Retrofits	$134	$31	$18,624	$40,090	**$58,926**
Savings	$939	$16	$0	$3,203	**$4,158**

Building Benchmarks

Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	3,865.9	277.74	$164.28
With Proposed Retrofits	3,576.9	256.98	$153.45

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

Appendix B – Actual Fuel Use versus Modeled Fuel Use

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