Comprehensive Energy Audit
For

Koyuk Water Treatment Plant & Washeteria

Prepared For
City of Koyuk

August 20, 2014

Prepared By:

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PREFACE

The Energy Projects Group at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for The City of Koyuk, Alaska. The authors of this report are Carl Remley, Certified Energy Auditor (CEA) and Certified Energy Manager (CEM) and Gavin Dixon. Pierre Costello and Kevin Ulrich participated in the on-site portion of this audit which was performed on April 8th and 9th of 2014.

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in April 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 Koyuk and the water treatment plant operator to follow up on the recommendations made in this audit report. A Rural Alaska Village Grant has funded ANTHC to provide the city with assistance in understanding the report and implementing the recommendations. Funding for implementation of the recommended retrofits is being partially provided for the above listed funding agencies, as well as the State of Alaska.

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of Water Treatment Plant Operator Steve Hoogendorn, City Utilities Manager Stephanie Anasogak, and City Clerk Tracy Kimoktoak.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Koyuk. The scope of the audit focused on Koyuk Water Treatment Plant & Washeteria. 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, water treatment energy use, and plug loads.

The total predicted energy cost for the WTP is $85,795 per year. This total compares favorably with the $92,490 actual cost for 2013. Fuel oil represents the largest component with an annual cost of $48,045. Electricity represents the next largest component with an annual cost of $37,750. This includes $13,468 paid by the City of Koyuk (end-user) and $24,282 paid by the Power Cost Equalization (PCE) program through the State of Alaska. This means that the city will experience approximately 30% of any electrical savings displayed in this report, the remainder will be saved by the State of Alaska PCE program. These predictions are based on 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 more affordable. In Koyuk, the cost of electricity without PCE is $0.52/kWh and the cost of electricity with PCE is $0.16/kWh. For the purposes of this report, electricity costs and savings are calculated using the full $0.52 per kilowatt hour cost to generate.

Table 1.1 below summarizes the energy efficiency measures analyzed for the Koyuk Water Treatment Plant & Washeteria. 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	Circulation Loop Heating: Reduce Heating Levels	Lower circulation loop temperatures from 50 to 40	$12,568	$250	680.02	0.0
2	Other Electrical – Only One Glycol Circulation Pump Required	At present, both glycol circulation pumps are operated, only one is required.	$2,257 plus $100 Maintenance Savings	$500	68.51	0.2

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]**
3	Water Storage Tank Heating	Lower water storage tank temperature from 50 to 40 degrees.	$1,752	$500	47.39	0.3
4	Other Electrical - Oksinulik Well Circulation Pump	Shut off pump during summer months	$385	$100	23.85	0.3
5	Other Electrical - Oksinulik Pump House Electric Heat	Add a thermostat to the electric heater in the pump house and set at 40 degrees	$829 plus $50 Maintenance Savings	$600	12.27	0.7
6	Other Electrical – Water Treatment Plant Well Pump	Repair well casing to eliminate 4 GPM leak to sewer	$2,139 plus $100 Maintenance Savings	$1,200	11.55	0.5
7	Lighting - Exterior Lighting Fuel Tank	Replace lighting with new direct wired energy efficient LED wall pack with photocell control	$140 plus $50 Maintenance Savings	$300	9.31	1.6
8	Lighting - Exterior Lighting Water Treatment Plant	Replace lighting with new direct wired energy efficient LED wall pack with photocell control	$73 plus $50 Maintenance Savings	$250	7.24	2.0
9	Lighting - Pump Area	Replace lighting with new direct wired energy efficient LED bulbs and remove the old fluorescent ballast.	$9	$20	6.49	2.3
10	Lighting - Exterior Lighting Washeteria	Replace lighting with new direct wired energy efficient LED wall pack with photocell control	$10 plus $50 Maintenance Savings	$200	4.45	3.3
11	Lighting – Water Treatment Plant	Replace lighting with new direct wired energy efficient LED bulbs and remove the old fluorescent ballast.	$751 plus $110 Maintenance Savings	$2,860	4.42	3.3
12	Lighting - Washeteria	Replace lighting with new direct wired energy efficient LED bulbs and remove the old fluorescent ballast.	$464 plus $80 Maintenance Savings	$2,080	3.82	3.8
13	Window/Skylight: Water Treatment Plant-Washeteria	Replace existing window with new energy efficient vinyl window	$60	$636	1.62	10.6
14	Other Electrical - Pressure Pumps	Repair expansion tanks to eliminate short cycling of pressure pumps	$131 plus $1,200 Maintenance Savings	$8,000	1.42	6.0
15	Heating and Ventilation and Domestic Hot Water	Add Heat Recovery from AVEC plant, shut off boilers in summer.	$17,026 plus $500 Maintenance Savings	$370,000	1.00	21.1

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]
	TOTAL, all measures		$38,594 plus $2,190 Maintenance Savings	$387,496	1.71	9.5

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 $38,594 per year, or 45.0% of the buildings' total energy costs. These measures are estimated to cost $387,496, for an overall simple payback period of 9.5 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	Clothes Drying	Lighting	Refrigeration	Other Electrical	Raw Water Heat Add	Water Circulation Heat	Tank Heat	Total Cost
Existing Building	$320	$0	$2,083	$0	$5,397	$3,910	$52	$31,845	$9,936	$25,782	$6,410	**$85,795**
With Proposed Retrofits	$1,310	$0	$1,589	$0	$2,303	$2,449	$52	$25,963	$5,022	$6,204	$2,249	**$47,201**
Savings	-$990	$0	$494	$0	$3,095	$1,461	$0	$5,883	$4,914	$19,578	$4,160	**$38,594**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Koyuk Water Treatment Plant & Washeteria. The scope of this project included evaluating building shell, lighting and other electrical systems, and heating and ventilating equipment, water process loads, 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, and disposal

The building site visit was performed to survey all major water plant 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 Koyuk Water Treatment Plant & Washeteria 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.

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

1) Water Treatment Plant: 943 square feet
2) Washeteria: 721 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, water treatment process 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. Koyuk Water Treatment Plant & Washeteria

3.1. Building Description

The 1,664 square foot Koyuk Water Treatment Plant & Washeteria was constructed in 1979 and had a significant upgrade in 1997. The normal occupancy is three people, the operator and a couple people in the washeteria. The facility is occupied approximately nine hours per day, seven days per week.

The Koyuk WTP includes a circulating water system with two loops that provide water to the residents of the community. One loop services the west end of town and is approximately 4000 ft. long. The other loop services the east end of town and is approximately 6000 ft. long. Both loops are maintained at a temperature of 50 degrees F.

The WTP has three wells, one at the WTP and two approximately 3000 feet away. The raw water is pumped through pressure filters and treated with chlorine before entering the 212,000 gallon water storage tank. The water tank is currently maintained at a year round temperature of 50 degrees. Significant damage to the storage tank roof reduces the insulation values.

The sewer system is a gravity fed system that leads to a sewage lagoon. The system includes one lift station with approximately 884 ft. of force main piping.

Description of Building Shell

The exterior walls are 2x6 frame with 5.5" of R-19 batt insulation. There is 1776 square feet of wall space and the insulation shows some limited damage from water and ice formation.

The roof of the building is 2x6 frame with 5.5" of polyurethane insulation. The roof has standard 24" of spacing and 1716 square feet.

The floor of the building is constructed with 2x6 lumber on pilings. The floor is insulated with 6" of R-19 batt insulation and shows some damage from water and ice formation. There is 1664 square feet of floor space.

There are multiple windows in various conditions throughout the building. There are six windows with double-paned glass and vinyl framing that have a combined surface area of 18 square feet. There are five windows with broken glass, wood or cardboard covers, and vinyl frames. These windows have a combined 27 square feet of surface area.

There are two entrances to the building; one in the water plant side and one in the washeteria side. The entrance in the water plant has a set of double doors while the washeteria entrance has a single door. All doors are metal with no glass or insulation.

Description of Heating Plants

The Heating Plants used in the building are:

Weil McLean Boiler #1

Nameplate Information:	Weil McLean BL-876-WS
Fuel Type:	#1 Oil
Input Rating:	480,000 BTU/hr
Steady State Efficiency:	78 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Weil McLean Boiler #2

Nameplate Information:	Same as Boiler 1

Fuel Type:	#1 Oil
Input Rating:	480,000 BTU/hr
Steady State Efficiency:	78 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Space Heating Distribution Systems

The water treatment plant building is heated with one Modine unit heater with an output of 40,000 BTU/hour. Additional heat is provided by the boiler system. The heater has a thermostat that was set to 70 deg. F. A baseboard heating system is used in the washeteria. There is an electric heater present in the well house.

Lighting

There are 11 fixtures with 4 four foot F32T8 32 watt standard lamps each in the water plant section of the building. There are 4 four foot F32T8 32 watt standard lamps in the washeteria. In the alcove with the well pump there is a single 20 watt lamp. The exterior of the water plant section of the building has a 50 watt metal halide fixture. The exterior of the washeteria has a 20 watt CFL light bulb. The exterior of the water plant fuel tank has a 100 watt metal halide fixture.

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 4383 KWH.

Major Equipment

The boiler system has two glycol circulation pumps that circulate glycol throughout the water treatment system. Both pumps run year round and consume approximately KWH per year.

The expansion tanks have a pressure pump that keeps the tanks pressurized and allow the water to keep circulating. It operates year round and runs approximately 84% of the time. The pump starts approximately 25 times per hour with an average runtime of 27 seconds for each start. This indicates a problem exists with this system. The most likely issue is non-functional expansion tanks.

The circulation loops each have pumps that circulate the water through the loops in town. The pumps run one hour per day for three months per year, are shut off for three months per year and run constantly for six months during the winter. Each pump uses approximately 10,109 KWH per year for a combined usage of 20,219 KWH per year.

The water treatment plant building has a well pump that pumps water from a well beneath the plant into the building. This pump runs year round and uses approximately 8468 KWH per year.

The Oksinulik well house has a well pump that pumps water from the Oksinulik well to the water treatment plant building. The pump runs year round approximately 30% of the time and uses approximately 5891 KWH.

The Oksinulik pump house has an electric heater that is used to keep the building interior temperature above 32 degrees F. The heater runs approximately 20% of the time for eight months per year and uses approximately 4670 KWH per year.

The washeteria has an electric clothes washer that runs 12 hours per day year round and uses approximately 158 KWH per year.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

The electric usage profile charts (below) represent the predicted electrical usage for the building. Actual electricity usage records were available and 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-Koyuk - 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	$ 0.52/KWH
#1 Oil	$ 4.20/gallon

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Koyuk pays approximately $85,795 annually for electricity and fuel costs for the Water Treatment Plant & Washeteria.

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

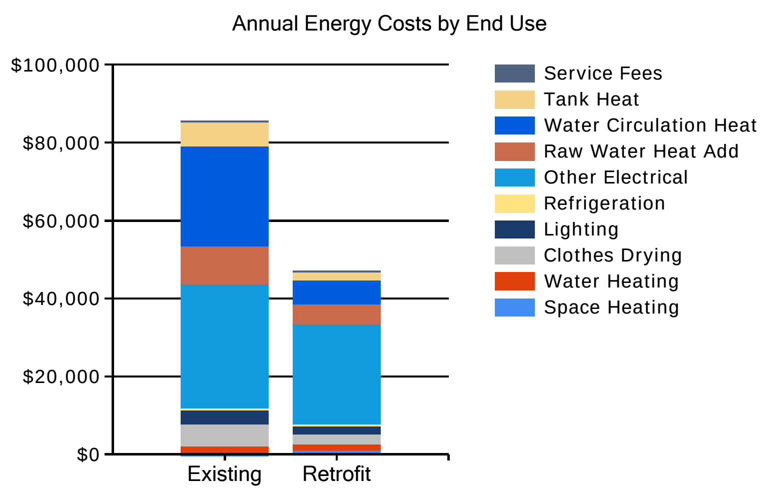


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

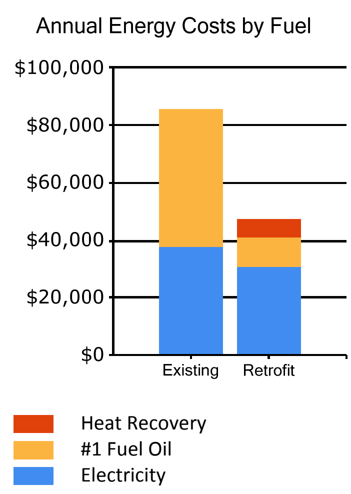
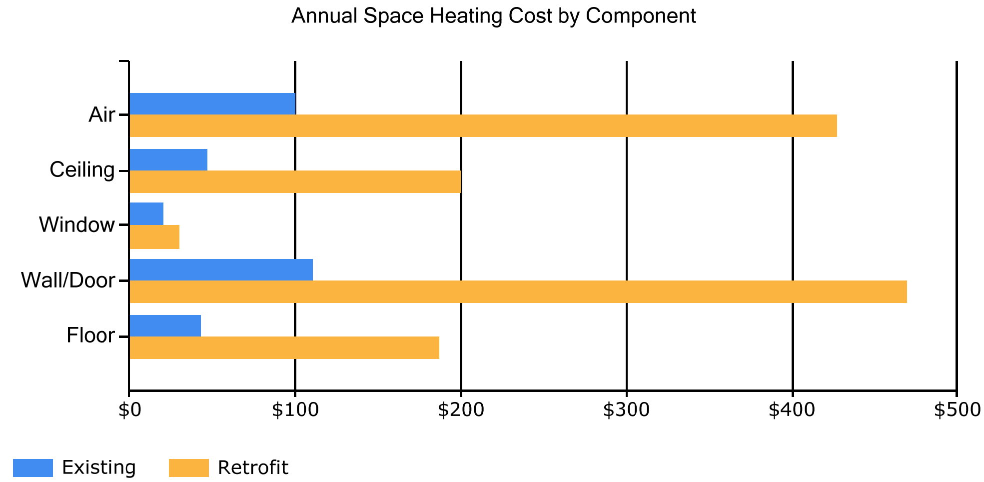


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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



It should be noted that building heating costs will go up in the building because the amount of electric heat generated by the other loads will decrease.

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	23	21	19	10	5	4	5	5	5	9	15	24
DHW	112	102	112	108	112	111	114	114	108	112	108	112
Clothes_Drying	18	16	18	17	19	28	29	29	18	18	17	18
Lighting	695	633	695	568	587	568	587	587	568	695	672	695
Refrigeration	8	8	8	8	8	8	8	8	8	8	8	8
Other_Electrical	7399	6743	7399	5452	3868	3024	3120	3120	3093	3868	7161	7399
Raw_Water_Heat_Add	58	52	58	56	30	0	0	0	31	58	56	58
Water_Circulation_Heat	149	136	149	145	77	0	0	0	81	150	145	149
Tank_Heat	48	46	47	33	7	0	0	0	4	23	35	49

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	15	14	8	0	0	0	0	0	0	0	5	16
DHW	24	22	24	23	26	38	40	40	25	24	23	24
Clothes_Drying	91	83	91	88	97	145	150	150	93	91	88	91
Raw_Water_Heat_Add	292	266	292	283	150	0	0	0	160	293	283	292
Water_Circulation_Heat	757	689	757	735	390	0	0	0	414	761	734	756
Tank_Heat	243	234	238	169	38	0	0	0	20	118	179	251

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
Koyuk Water Treatment Plant & Washeteria 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	72,942 kWh	248,949	3.340	831,491
#1 Oil	11,439 gallons	1,509,998	1.010	1,525,098
Total		**1,758,947**		**2,356,588**
BUILDING AREA		1,664	Square Feet	
BUILDING SITE EUI		1,057	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		1,416	**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.				

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 Koyuk Water Treatment Plant & Washeteria was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Koyuk 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 Koyuk. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the oil 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 cooling/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.

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]
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2	Other Electrical – Only One Glycol Circulation Pump Required	At present, both glycol circulation pumps are operated, only one is required.	$2,257 plus $100 Maintenance Savings	$500	68.51	0.2
3	Water Storage Tank Heating	Lower water storage tank temperature from 50 to 40 degrees.	$1,752	$500	47.39	0.3
4	Other Electrical - Oksinulik Well Circulation Pump	Shut off pump during summer months	$385	$100	23.85	0.3
5	Other Electrical - Oksinulik Pump House Electric Heat	Add a thermostat to the electric heater in the pump house and set at 40 degrees	$829 plus $50 Maintenance Savings	$600	12.27	0.7
6	Other Electrical – Water Treatment Plant Well Pump	Repair well casing to eliminate 4 GPM leak to sewer	$2,139 plus $100 Maintenance Savings	$1,200	11.55	0.5
7	Lighting - Exterior Lighting Fuel Tank	Replace lighting with new direct wired energy efficient LED wall pack with photocell control	$140 plus $50 Maintenance Savings	$300	9.31	1.6
8	Lighting - Exterior Lighting Water Treatment Plant	Replace lighting with new direct wired energy efficient LED wall pack with photocell control	$73 plus $50 Maintenance Savings	$250	7.24	2.0
9	Lighting - Pump Area	Replace lighting with new direct wired energy efficient LED bulbs and remove the old fluorescent ballast.	$9	$20	6.49	2.3
10	Lighting - Exterior Lighting Washeteria	Replace lighting with new direct wired energy efficient LED wall pack with photocell control	$10 plus $50 Maintenance Savings	$200	4.45	3.3

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]
11	Lighting – Water Treatment Plant	Replace lighting with new direct wired energy efficient LED bulbs and remove the old fluorescent ballast.	$751 plus $110 Maintenance Savings	$2,860	4.42	3.3
12	Lighting - Washeteria	Replace lighting with new direct wired energy efficient LED bulbs and remove the old fluorescent ballast.	$464 plus $80 Maintenance Savings	$2,080	3.82	3.8
13	Window/Skylight: Water Treatment Plant-Washeteria	Replace existing window with new energy efficient vinyl window	$60	$636	1.62	10.6
14	Other Electrical - Pressure Pumps	Repair expansion tanks to eliminate short cycling of pressure pumps	$131 plus $1,200 Maintenance Savings	$8,000	1.42	6.0
15	Heating and Ventilation and Domestic Hot Water	Add Heat Recovery from AVEC plant, shut off boilers in summer.	$17,026 plus $500 Maintenance Savings	$370,000	1.00	21.1
	TOTAL, all measures		**$38,594 plus $2,190 Maintenance Savings**	**$387,496**	**1.71**	**9.5**

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 Building Shell Measures

4.3.1 Window Measures

Rank	Location	Size/Type, Condition	Recommendation
13	Window/Skylight: WTP-Washeteria	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 vinyl window

Installation Cost	$636	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$60
Breakeven Cost	$1,029	**Savings-to-Investment Ratio**	1.6	**Simple Payback yrs**	11
Auditors Notes: The current window is damaged and is missing a pane. Consider replacing with U-0.22 window.					

4.4 Mechanical Equipment Measures

4.4.1 Heating /Domestic Hot Water Measure

Rank	Recommendation
15	Add Heat Recovery from AVEC plant, shut off boilers in summer.

Installation Cost	$370,000	**Estimated Life of Measure (yrs)**	25	**Energy Savings (/yr)**	$17,026
				Maintenance Savings (/yr)	$500
Breakeven Cost	$370,934	**Savings-to-Investment Ratio**	1.0	**Simple Payback yrs**	21
Auditors Notes: The AVEC power plant is approximately 850ft. from the WTP building and was built in 2011. They use a Detroit Diesel Series 60 generator that could be outfitted with marine jacket manifolds to increase available recovered heat to supply the WTP.					

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	
7	Exterior Lighting Fuel Tank	MH 100 Watt Magnetic with Manual Switching		Replace lighting with new energy-efficient LED bulbs and improve controls.	
Installation Cost	$300	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$140
				Maintenance Savings (/yr)	$50
Breakeven Cost	$2,794	**Savings-to-Investment Ratio**	9.3	**Simple Payback yrs**	2
Auditors Notes: Replace with LED replacement bulbs. LED's use less energy and last significantly longer than the existing bulbs.					

Rank	Location	Existing Condition		Recommendation	
8	Exterior Lighting WTP	MH 50 Watt Magnetic with Manual Switching		Replace lighting with new energy-efficient LED bulbs and improve controls.	
Installation Cost	$250	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$73
				Maintenance Savings (/yr)	$50
Breakeven Cost	$1,809	**Savings-to-Investment Ratio**	7.2	**Simple Payback yrs**	2
Auditors Notes: Replace the existing high pressure sodium fixtures with new LED wall packs. The LED wall packs consist of with 3 LED 17 watt electronic fixtures with a photo cell control to ensure lights only function when it is dark outside.					

Rank	Location	Existing Condition		Recommendation	
9	Pump Area	FLUOR CFL, A Lamp 20W with Manual Switching		Replace lighting with new energy-efficient LED bulbs and improve controls.	
Installation Cost	$20	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$9
Breakeven Cost	$130	**Savings-to-Investment Ratio**	6.5	**Simple Payback yrs**	2
Auditors Notes: Replace with LED replacement bulbs. LED's use less energy and last significantly longer than the existing bulbs.					

Rank	Location	Existing Condition		Recommendation	
10	Exterior Lighting Washeteria	FLUOR CFL, A Lamp 20W with Manual Switching		Replace lighting with new energy-efficient LED bulbs and improve controls.	
Installation Cost	$200	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$10
				Maintenance Savings (/yr)	$50
Breakeven Cost	$890	**Savings-to-Investment Ratio**	4.4	**Simple Payback yrs**	3
Auditors Notes: Replace with LED replacement bulbs. LED's use less energy and last significantly longer than the existing bulbs.					

Rank	Location	Existing Condition		Recommendation	
11	WTP	11 FLUOR (4) T8 4' F32T8 32W Standard Instant EfficMagnetic with Manual Switching		Replace lighting with new energy-efficient LED bulbs and improve controls.	
Installation Cost	$2,860	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$751
				Maintenance Savings (/yr)	$110
Breakeven Cost	$12,634	**Savings-to-Investment Ratio**	4.4	**Simple Payback yrs**	3
Auditors Notes: Replace with LED replacement bulbs. LED's use less energy and last significantly longer than the existing bulbs.					

Rank	Location	Existing Condition		Recommendation	
12	Washeteria	8 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace lighting with new energy-efficient LED bulbs and improve controls.	
Installation Cost	$2,080	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$464
				Maintenance Savings (/yr)	$80
Breakeven Cost	$7,954	**Savings-to-Investment Ratio**	3.8	**Simple Payback yrs**	4
Auditors Notes: Replace with LED replacement bulbs. LED's use less energy and last significantly longer than the existing bulbs.					

4.5.2 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
2	Glycol Circulation Pumps	2Glycol Circulation Pumps with Manual Switching		Operate one pump only and leave other pump as backup.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$2,257
				Maintenance Savings (/yr)	$100
Breakeven Cost	$34,255	**Savings-to-Investment Ratio**	68.5	**Simple Payback yrs**	0
Auditors Notes: The system is designed to use one circulation pump only and operating two pumps is unnecessary. Consider shutting one pump off and running one pump at a time.					

Rank	Location	Description of Existing		Efficiency Recommendation	
4	Oksinulik Well Circulation Pump	Oksinulik Well Circulation Pump with Manual Switching		Shut off pump during summer months.	
Installation Cost	$100	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$385
Breakeven Cost	$2,385	**Savings-to-Investment Ratio**	23.8	**Simple Payback yrs**	0
Auditors Notes: The pump does not need to run in the summer and should be shut off during those months.					

Rank	Location	Description of Existing		Efficiency Recommendation	
5	Oksinulik Pump House Electric Heat	Oksinulik Pump House Electric Heat with Manual Switching		Replace electric heater and control system in Oksinulik well house	
Installation Cost	$600	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$829
				Maintenance Savings (/yr)	$50
Breakeven Cost	$7,362	**Savings-to-Investment Ratio**	12.3	**Simple Payback yrs**	1
Auditors Notes: The electric heater in the Oksinulik well house is not presently controlled by a thermostat that allow accurately setting the temperature. Add a thermostat and set it at 40 degrees.					

Rank	Location	Description of Existing		Efficiency Recommendation	
6	WTP Well Pump	WTP Well Pump with Manual Switching		Replace WTP well pump.	
Installation Cost	$1,200	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$2,139
				Maintenance Savings (/yr)	$100
Breakeven Cost	$13,864	**Savings-to-Investment Ratio**	11.6	**Simple Payback yrs**	1
Auditors Notes: The well pump is presently wasting 4 GPM to the lift station due to a pump casing leak. The leak should be repaired. This will reduce both the cost of pumping the raw water and the cost of pumping it from the lift station to the lagoon.					

Rank	Location	Description of Existing		Efficiency Recommendation	
14	Pressure Pumps	Pressure Pumps with Manual Switching		Replace pressure pumps in the WTP.	
Installation Cost	$8,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$131
				Maintenance Savings (/yr)	$1,200
Breakeven Cost	$11,334	**Savings-to-Investment Ratio**	1.4	**Simple Payback yrs**	6
Auditors Notes: The pressure pumps currently start 25 times per hour for runtime intervals of approximately 25-30 seconds. This will result in a shorter pump life and result in excessive electricity consumption due to excessive starts. The expansion tanks need to be repaired or replaced.					

4.5.3 Other Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
1		Water Circulation & Force Main Heat Load		Lower circulation temperatures from 50 to 40	
Installation Cost	$250	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$12,568
Breakeven Cost	$170,005	**Savings-to-Investment Ratio**	680.0	**Simple Payback yrs**	0
Auditors Notes: Reset the circulation loop temperature controller from 50 to 40 degrees. This will reduce the amount of heat used to maintain loop temperature.					

Rank	Location	Description of Existing		Efficiency Recommendation	
3		Tank Heat Load		Lower Storage Tank Temperature to 40	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,752
Breakeven Cost	$23,697	**Savings-to-Investment Ratio**	47.4	**Simple Payback yrs**	0
Auditors Notes: Reset the water storage tank heat load to 40 degrees . This will reduce the amount of heat used to heat the raw water from the wells.					

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 Koyuk and the water plant operator to follow-up on the recommendations made in this audit report. A Rural Alaska Village Grant has funded ANTHC to provide the City with assistance in understanding the report and implementing the recommendations

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Koyuk Water Treatment Plant & Washeteria	**Auditor Company:** ANTHC-DEHE
Address: PO Box 53029	**Auditor Name:** Carl Remley, Kevin Ulrich, and Pierre Costello
City: Koyuk	**Auditor Address:** 3900 Ambassador Drive, Suite 301 Anchorage, AK 99508
Client Name: Steve Hoogendorn	
Client Address: PO Box 53029 Koyuk, AK 99753	**Auditor Phone:** (907) 729-3543
	Auditor FAX:
Client Phone: (907) 963-8274	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 1,664 square feet	**Design Space Heating Load:** Design Loss at Space: 0 Btu/hour with Distribution Losses: 0 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 0 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 3 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Koyuk	**Design Outdoor Temperature:** -24.3 deg F
Weather/Fuel City: Koyuk	**Heating Degree Days:** 13,943 deg F-days
Utility Information	
Electric Utility: AVEC-Koyuk - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.518/kWh	**Average Annual Cost/ccf:** $0.000/ccf

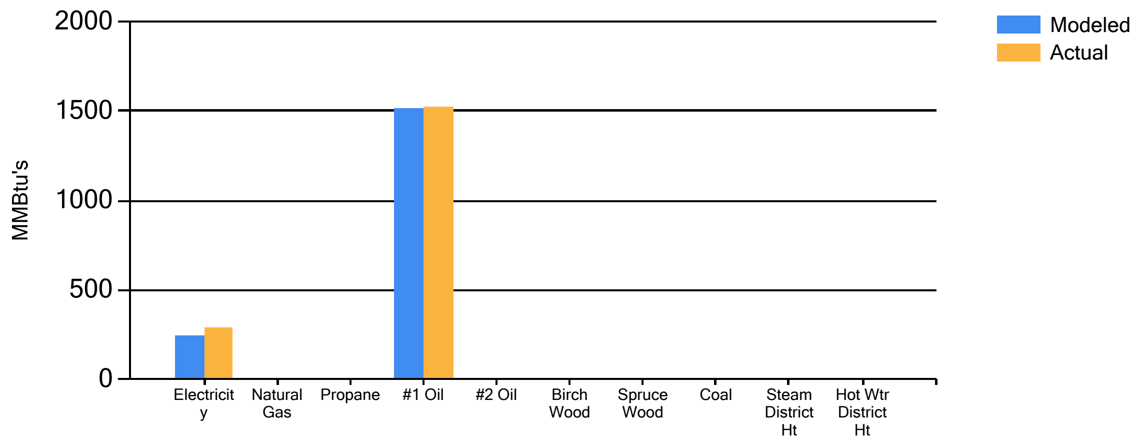
Annual Energy Cost Estimate

Description	Space Heating	Space Cooling	Water Heating	Ventilation Fans	Clothes Drying	Lighting	Refrigeration	Other Electrical	Raw Water Heat Add	Water Circulation Heat	Tank Heat	Service Fees	Total Cost
Existing Building	$320	$0	$2,083	$0	$5,397	$3,910	$52	$31,845	$9,936	$25,782	$6,410	$60	**$85,795**
With Proposed Retrofits	$1,310	$0	$1,589	$0	$2,303	$2,449	$52	$25,963	$5,022	$6,204	$2,249	$60	**$47,201**
Savings	-$990	$0	$494	$0	$3,095	$1,461	$0	$5,883	$4,914	$19,578	$4,160	$0	**$38,594**

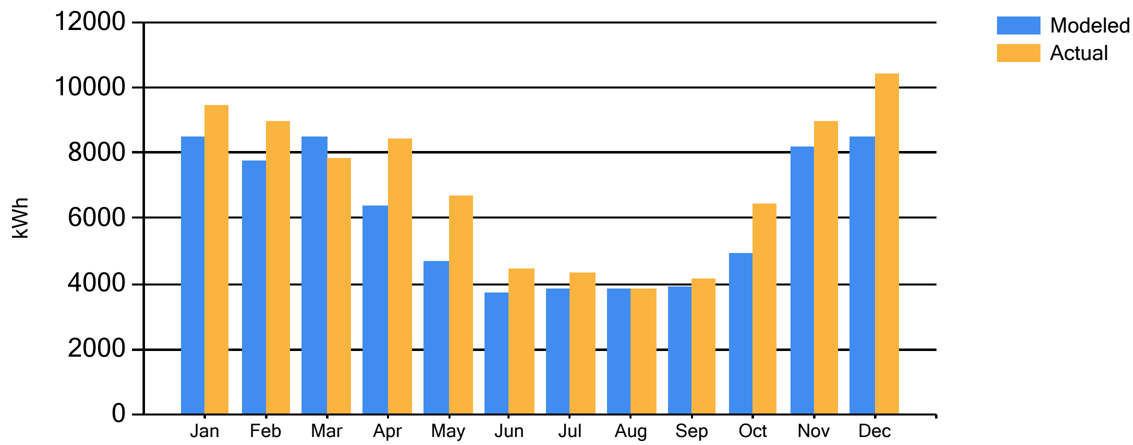
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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