Comprehensive Energy Audit
For
Buckland Water Treatment Plant, Pump House and Lift Stations

Prepared For
City of Buckland

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Table of Contents

PREFACE 3
ACKNOWLEDGMENTS 3
1. EXECUTIVE SUMMARY 4
2. AUDIT AND ANALYSIS BACKGROUND 8
2.1 Program Description 8
2.2 Audit Description 8
2.3. Method of Analysis 9
2.4 Limitations of Study 10
3. BUCKLAND WATER TREATMENT PLANT, PUMP HOUSE AND LIFT STATIONS 11
3.1. Building Description 11
3.2 Predicted Energy Use 22
3.2.1 Energy Usage / Tariffs 22
3.2.2 Energy Use Index (EUI) 25
3.3 AkWarm© Building Simulation 27
4. ENERGY COST SAVING MEASURES 28
4.1 Summary of Results 28
4.2 Interactive Effects of Projects 29
Appendix A – Scanned Energy Billing Data 37
Appendix B – Energy Audit Report – Project Summary 38
Appendix C – Actual Fuel Use versus Modeled Fuel Use 40
Appendix D - Electrical Demands 42

PREFACE

This energy audit was conducted using funds provided by the Denali Commission. Coordination with the City of Buckland and Village Safe Water has been undertaken to provide maximum accuracy in identifying facilities to audit and coordinating potential follow up retrofit activities.

The Rural Energy Initiative at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for the City of Buckland, Alaska. The author of this report is Bailey Gamble, Mechanical Engineer I.

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in February of 2017 by the Rural Energy Initiative of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy conservation measures. Discussions of site-specific concerns, non-recommended measures, and an energy conservation action plan are also included in this report.

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of Water Plant Operators Erik Weber and Evan Thomas, Jr., City of Buckland Mayor Tim Gavin, City Administrator Cheryl Ticket and Village Safe Water Engineer Debra Addie.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Buckland. The scope of the audit focused on Buckland Water Treatment Plant, Pump House and Lift Stations. The Washeteria is assessed in a separate report.

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, and plug loads.

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy costs are $41,951 per year. Electricity represents the largest portion with an annual cost of approximately $31,780. This includes about $20,780 paid by the village and about $10,387 paid by the Power Cost Equalization (PCE) program through the State of Alaska. Fuel represents the remaining portion, with an annual cost of approximately $10,161. Recovered heat from the nearby power plant contributes to the heating demand in the water treatment plant as well and is currently provided free of charge.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower electricity costs and make energy affordable in rural Alaska. In Buckland, the current cost of electricity without PCE is $0.47/kWh and the cost of electricity with PCE is around $0.31/kWh, saving the village over $10,000 a year on electricity for the water treatment plant, pump house and lift stations.

Table 1.1 lists the total usage of electricity, #1 heating oil and recovered heat in the Buckland water treatment plant, pump house and lift stations before and after the proposed retrofits.

Table 1.1: Predicted Annual Fuel Use for the Water Plant, Pump House and Lift Stations

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	67,033 kWh	63,383 kWh
#1 Oil	1,494 gallons	1,300 gallons
Recovered Heat	1,057.98 million Btu	1,003.39 million Btu

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

Table 1.2: Building Benchmarks for the Water Plant, Pump House and Lift Stations

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	811.8	49.31	$22.95
With Proposed Retrofits	761.1	46.23	$21.28
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 Buckland Water Treatment Plant, Pump House and Lift Stations. 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	Raw Water Transmission Line Heat	Address suspected cold points in valves in underground vault so that heat trace setpoint may be reduced incrementally to 40 deg F if no issues with freezing are observed.	$615 / 39.6 MMBTU	$1,000	8.15	1.6	3,641.0
2	Heating System	Clean and tune boilers, train operators on boiler maintenance and optimization.	$817 / 14.1 MMBTU	$2,000	6.94	2.4	2,586.8
3	Lighting - Combined Retrofit: WTP Exterior Lighting	Replace with new energy-efficient LED lighting, replace manual switching with daylight sensor.	$552 / 4.0 MMBTU	$700	6.64	1.3	1,980.5
4	Pump House Space Heating	Air seal pump house door to reduce heat loss.	$68 / 1.3 MMBTU	$200	4.62	2.9	213.7
5	Backwash Tank Heat Trace	Verify temperature at bottom of backwash tank. Lower setpoint incrementally down to 40 deg F if temperatures below freezing are not observed.	$58 / 31.4 MMBTU	$200	3.90	3.5	1,932.2
6	Lighting - Combined Retrofit: WTP Mechanical Room Lighting (3 bulb)	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$577 / 1.3 MMBTU	$1,570	3.10	2.7	1,903.3
7	Lighting - Power Retrofit: WTP Boiler Room Lighting	Replace with new energy-efficient LED lighting.	$72 / 0.1 MMBTU	$320	1.90	4.4	237.2
8	Lighting - Combined Retrofit: WTP Office Lighting (2 bulb)	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$80 / 0.1 MMBTU	$410	1.64	5.1	261.2
9	Lighting - Power Retrofit: LS Wet Well Lighting (Ceiling)	Replace with new energy-efficient LED lighting.	$29 / 0.0 MMBTU	$150	1.62	5.2	93.8
10	Lighting - Combined Retrofit: WTP Mechanical Room Lighting (2 bulb)	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$71 / 0.1 MMBTU	$410	1.46	5.8	232.0

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
11	Lighting - Power Retrofit: Pump House Exterior Lighting	Replace with new energy-efficient LED lighting, replace manual switching with daylight sensor.	$39 / 0.3 MMBTU	$325	1.01	8.4	139.5
12	Lighting - Combined Retrofit: WTP Office Lighting (1 bulb)	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$21 / 0.0 MMBTU	$290	0.60	14.0	67.9
13	Lighting - Power Retrofit: WTP Bathroom Light	Replace with new energy-efficient LED lighting.	$3 / 0.0 MMBTU	$40	0.60	14.0	9.3
14	Lighting - Combined Retrofit: LS Exterior Lighting	Replace with new energy-efficient LED lighting, replace manual switching with daylight sensor.	$35 / 0.3 MMBTU	$1,000	0.30	28.3	126.8
15	Lighting - Power Retrofit: Pump House Interior Lighting	Replace with new energy-efficient LED lighting.	$2 / 0.0 MMBTU	$80	0.22	38.3	6.8
16	Lighting - Power Retrofit: LS Mechanical Room Lighting	Replace with new energy-efficient LED lighting.	$12 / 0.0 MMBTU	$480	0.22	39.1	39.9
	TOTAL, all measures		**$3,051 / 92.7 MMBTU**	**$9,175**	**3.96**	**3.0**	**13,471.8**

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 $3,051 per year, or 7.3% of the buildings' total energy costs. These measures are estimated to cost $9,175, for an overall simple payback period of 3.0 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**	**Water Heating**	**Ventilati on Fans**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$7,790	$2,197	$3	$2,356	$25,123	$1,659	$2,418	$406	**$41,951**
With Proposed Retrofits	$7,091	$2,020	$3	$858	$25,123	$991	$2,409	$406	**$38,900**
Savings	$699	$176	$0	$1,498	$0	$668	$10	$1	**$3,051**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

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

2.2 Audit Description

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

- Building envelope (roof, windows, etc.)
- Heating and ventilation equipment
- Lighting systems and controls
- Building-specific equipment
- Water treatment process and distribution

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 Buckland Water Treatment Plant, Pump House and Lift Stations 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.

Buckland Water Treatment Plant, Pump House and Lift Stations is classified as being made up of the following activity areas:

1) Water Treatment Plant: 1,828 square feet
2) Pump House: 120 square feet
3) Downtown Lift Station: 336 square feet
4) Midtown Lift Station: 224 square feet
5) Uptown Lift Station: 224 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. BUCKLAND WATER TREATMENT PLANT, PUMP HOUSE AND LIFT STATIONS

3.1. Building Description

The 1,828 square foot Buckland Water Treatment Plant went online in early 2016. The number of hours of operation for this building average 6.3 hours per day, considering all seven days of the week. Two operators currently share the responsibility of operating and maintaining the system, passing in and out of the water plant as they tend to various components of the system throughout the day.

The pump house and three lift stations were all constructed and put online between 2009-2016. The operator visits each lift station daily to record sewage pump start and run time data.

Two submersible pumps draw raw water from the river adjacent to town and send it to a 750,000 gallon raw water storage tank beside the water treatment plant. Glycol heat trace lines prevent freezing along the intake and the transmission line between the pump house and water treatment plant (WTP).

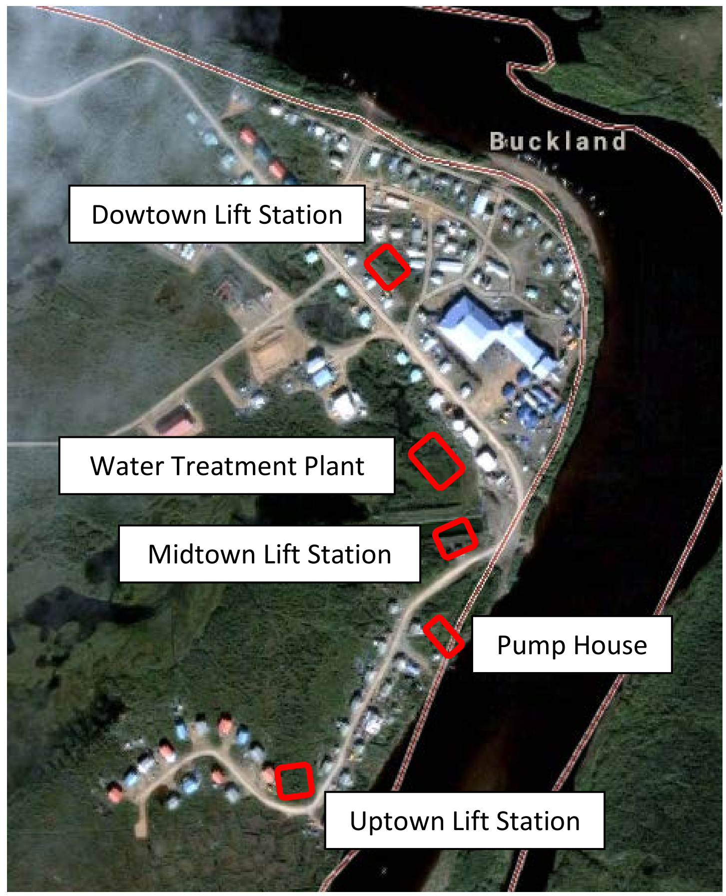


Figure 1: Aerial view of Buckland Water Treatment Plant, Pump House and Lift Station locations.

Heated water is injected into the raw water line as it enters the WTP to bring the temperature in the raw water storage tank (WST) up to 36°F. An automated treatment process runs continuously as long as the operator has not initiated the backwash process, the depth in the raw water storage tank remains between 4 and 22 feet and turbidity has not exceeded 0.3 ntu. The treatment flow rate is controlled by the operator through a set of process pumps typically sets to 35-37 gallons per minute. The raw water first passes through a magnetic ion exchange (MIEX) resin reactor vessel. The resin removes dissolved organic carbon which significantly reduces the quantity of the other chemicals that must be added during the remainder of the treatment process.

In order to retain its removal capacity, the MIEX resin must be regenerated. A fixed portion of the resin and water in the reactor vessel is pushed out of the reactor vessel into a regeneration tank where water is drained from the resin. Once enough resin has accumulated, the automated regeneration process is initiated and brine from the two adjacent reservoirs is pumped into the regeneration tank to reverse the ion exchange process. The resin is then rinsed and returned to the reactor vessel. The operator adds approximately 80 lbs of salt to the regeneration system each week and about 2 gallons of new resin to the reactor vessel each month.

After it exits the reactor vessel, potassium permanganate is added to the water and blended through a static mixer to oxidize iron and manganese. Polymer is then injected to coagulate and improve removal of particulates as the water passes through two 4 foot diameter pressurized media filters. After filtration, chlorine is injected for disinfection and fluoride is injected to prevent tooth decay. Once treated, the water is pumped to a 183,000 gallon treated water storage tank located across the street beside the washeteria.

Treated water quality is monitored by a turbidimeter and recorded for regulatory purpose. When the turbidity level exceeds allowable limits, a signal will automatically shut down treatment and stop flow to the treated WST. The operator will then initiate the filter backwash process to re-set the treatment system and re-establish flow to treated WST.

From the treated WST, water returns back to the WTP to be heated before distribution. Three pressure pumps charge a hydropneumatic tank that provide pressure to the three distribution loops. The 5396 foot downtown loop supplies water to 66 services and 11 hydrants, the 5274 foot uptown loop supplies 37 services and 7 hydrants and a 519 foot loop supplies the school. During the winter months, circulation pumps keep the water in the distribution lines moving and, along with dedicated heat add systems for each loop, prevent water in the lines from freezing. A glycol heat trace line runs along all distribution loops in case of the need for freeze-up recovery.

Wastewater flow is managed through three lift stations. The smaller uptown and midtown lift stations each contain two 3.8 hp sewage pumps and feed into the larger downtown lift station. The downtown lift station contains two 12 hp sewage pumps that transmit wastewater from the lift station to the sewage lagoon a little over a mile from the station. The boiler in the downtown lift station supplies heat to a glycol heat trace loop that runs along the sewer main to the lagoon.

Figure 2: Filters and the MIEX contactor tank in the main room of the Buckland Water Treatment Plant.

Description of Building Shell

The exterior walls of the water treatment plant are constructed with single stud 2x8 lumber construction with a 16-inch offset. The walls have approximately 7.25 inches of R-25 batt insulation in good condition. There is approximately 1,796 square feet of wall space in the WTP.

The WTP has an attic over the majority of the ceiling. The roof has standard framing and a 16-inch offset and approximately 6 inches of insulated polyurethane panels in good condition. There is additional 12 inches of R-38 batt insulation in the ceiling. There is approximately 1,921 square feet of roof space in the building.

The WTP is built on pilings with the floor constructed on I-joists. The floor is insulated with 6 inch polyurethane panels in good condition. There is approximately 1,828 square feet of floor space in the building.

The building has on one window located in the office facing southeast. The window is 4’ x 6’ with double glass and an aluminum frame.

There are three insulated metal exterior doors and one insulated sectional garage door on the WTP. The main entrance and chemical room doors measure 7’ x 3’. The boiler room door measures 7’ X 4’ and the garage door measures 8’ x 8’.

Description of Heating Plants

The Heating Plants used in these buildings are:

Water Treatment Plant Boiler # 1

Nameplate Information:	Burnham Boiler V904A
Fuel Type:	#1 Oil
Input Rating:	420,000 BTU/hr
Steady State Efficiency:	82 %
Idle Loss:	0.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	Oct – May
Input Rate:	4.2 gallons/hr

Water Treatment Plant Boiler # 2

Nameplate Information:	Burnham Boiler V904A
Fuel Type:	#1 Oil
Input Rating:	420,000 BTU/hr
Steady State Efficiency:	82 %
Idle Loss:	0.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	Oct – May
Input Rate:	4.2 gallons/hr

Water Treatment Plant Recovered Heat

Fuel Type:	Recovered Heat
Input Rating:	250,000 BTU/hr
Steady State Efficiency:	99 %
Idle Loss:	0 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Figure 3: The boilers and heat recovery heat exchanger in the Buckland Water Treatment Plant.

Pump House Boiler

Nameplate Information:	Burnham LEDV-1 (Pump House)
Fuel Type:	#1 Oil
Input Rating:	84,000 BTU/hr
Steady State Efficiency:	82 %
Idle Loss:	0.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	Oct – May
Input Rate:	0.6 GPH

Downtown Lift Station Boiler

Nameplate Information:	Burnham Boiler MPO-IQ84
Fuel Type:	#1 Oil
Input Rating:	84,000 BTU/hr
Steady State Efficiency:	78 %
Idle Loss:	0.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	Oct – May
Input Rate:	0.6 gallons/hr

Midtown Lift Station Boiler

Nameplate Information:	Burnham Boiler MPO-IQ84
Fuel Type:	#1 Oil
Input Rating:	84,000 BTU/hr

Steady State Efficiency:	78 %
Idle Loss:	0.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	Oct – May
Input Rate:	0.6 gallons/hr

Uptown Lift Station Boiler

Nameplate Information:	Burnham Boiler MPO-IQ84
Fuel Type:	#1 Oil
Input Rating:	84,000 BTU/hr
Steady State Efficiency:	78 %
Idle Loss:	0.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	Oct – May
Input Rate:	0.6 gallons/hr

Figure 4: The boilers in the Pump House and Downtown Lift Station.

The majority of the heating demand in the WTP is met by a heat recovery system. Two Burnham boilers are in place to supplement the heat recovery system when necessary. They were not observed to fire during the audit visit. The operator reports that they sometimes come on when the washeteria is experiencing high use.

The WTP hydronic heating system provides water heating and freeze-up protection through the eight heat add systems listed in the Table 3.1 below:

Table 3.1: Water Treatment Plant Heat Add Systems

Heat Add System	Outgoing Temperature Observed at time of Audit	Notes
Downtown distribution loop	40°F	Add heat set at 34°F, alarm at 32°F
Uptown distribution loop	40°F	Add heat set at 36°F, alarm at 34°F
School loop heat add	50°F	Add heat set at 36°F, alarm at 34°F
Raw water storage tank	40°F	Add heat set at 34°F, alarm at 32°F
Treated water storage tank	40°F	Add heat set at 34°F, alarm at 32°F
Raw water intake and transmission line heat trace	61°F	Issues with freeze-up along transmission line have prompted operators to raise this setpoint.
Distribution loop heat trace	off	Used only for freeze-up recovery. Not to be operated above 50°F due to ground thawing risk.
Backwash Tank Heat Trace	71°F	

Heat and flow in the raw water transmission line heat trace loop is maintained from the WTP, however, the loop is hydraulically connected through a "decouple" to the pump house's glycol heat loop in the intake building. This allows glycol fluid mixing and heating of both loops from the WTP heating system or the pump house boiler system.

There is an electric boiler present in the WTP intended to receive excess wind energy when it becomes available. It was not online at the time of the audit.

The pump house and lift stations are each equipped with a single boiler. The pump house is equipped to receive heat from the WTP through previously described "decouple" as well. The downtown lift station includes a heat add system for a glycol heat trace loop that runs along the sewer line heading out to the lagoon.

Figure 5: The "decouple" that hydraulically connects the heating lines in the WTP and pump house.

Space Heating Distribution Systems

Space heating in the WTP and lift stations is provided through radiant in-floor heating. The WTP contains a single unit heater located in the utilidor beside the raw WST. There is an electric heater located in the wet well room of each lift station to serve as a back-up to the boiler system.

Domestic Hot Water System

Hot water for the bathroom, office and mechanical room sinks is provided by a 5 gallon electric water heater.

Heat Recovery Information

A heat recovery system provides heat captured from the diesel generators at the Buckland power plant to a district heating loop that supplies the washeteria, WTP and city office. Heat is transferred from the district loop to the main WTP glycol heating loop via a heat exchanger in the WTP boiler room.

Description of Building Ventilation System

The existing building ventilation system consists of air make-up vents in the boiler room and exhaust fans in the bathroom and chemical room.

Lighting

There are a total of 40 light fixtures containing 81 bulbs in the five included buildings. The majority of fixtures contain 4' T8 fluorescent bulbs. Table 3.2 shows a breakdown of lighting by bulb type.

Table 3.2: Breakdown of Lighting by Bulb Type

Type of bulb	Total Number of Bulbs	Location(s)
32 W 4' T8 fluorescent	66	WTP plant mechanical room, boiler room, office, bathroom, pump house, lift station mechanical rooms
70 W high pressure sodium	2	WTP exterior
50 W high pressure sodium	4	Pump house and lift station exterior
60 W incandescent	6	Lift station wet well ceiling
100 W incandescent	3	Lift station wet well extension lights

Lighting in the in the WTP, pump house and lift stations consumes approximately 3,976 kWh annually constituting about 6% of the building's current electrical consumption.

Plug Loads

The water treatment plant contains a variety of electronics including a laptop, radios, coffee pot and mini fridge that require a plug into an electrical outlet. The use of these items consumes about 877 kWh annually.

Major Equipment

Tables 3.3-3.6 contain the details on each of the major electricity consuming mechanical components found in the water treatment plant and auxiliary buildings. Major equipment consumes approximately 51,626 kWh annually constituting about 77% of the building's current electrical consumption.

Table 3.3: Intake and Distribution Equipment

Major Pumps + Motors	Purpose	Motor Size	Operating Schedule	Annual Energy Consumption (kWh)
Well Pump x 2	Draw raw water from river and transmit it to WST at WTP	1.5 HP	One runs 35% and the other runs 24% of the time.	5,787
Downtown Distribution Loop Circ Pump x 2	Prevent freezing by circulating water in downtown distribution loop	2.34 HP	Always on during winter heating season	8,312
Uptown Distribution Loop Circ Pump x 2	Prevent freezing by circulating water in uptown distribution loop	1.39 HP	Always on during winter heating season	4,948
School Loop Circ Pump x 2	Prevent freezing by circulating water in school delivery loop	1.29 HP	Always on during winter heating season	4,596
Pressure Pump x 3	Boost pressure to water services	2.37 HP	One pump running measured to run 11% of the time	1,705
High Demand Pump	Delivery water at a higher flow rate to flush system or provide fire flow	20 HP	Only used under special circumstance, unused to date	0
			Total Energy Consumption	25,348

Table 3.4: Treatment Process Equipment

Major Pumps + Motors	Purpose	Motor Size	Operating Schedule	Annual Energy Consumption (kWh)
Process Pump x 2	Pump and control flow of raw water through treatment process equipment	0.38 HP	Always on unless backwashing	2,348

Contactor Circulation Pump	Circulate contents of MIEX reactor vessel	0.45 HP	Always on unless backwashing	2,773
Chemical Pumps x 4	Inject potassium permanganate, polymer (coagulant), chlorine and fluoride into water	0.03 HP each	Always on unless	800
Chemical Mixers	Mix MIEX regeneration tank and batches of potassium permanganate, chlorine and dilute coagulant	0.05 – 0.25 HP	varies	19
Brine Pump	Pump brine solution into MIEX resin regeneration tank	0.5 HP	1 hour per day, 5 days per week	97
Filter Backwash Pump	Flush accumulated organics out of filters	5 HP	~ 15 minutes, once per week	49
Air Blower	Blow air into sand filters to increase effectiveness of backwash	3.4 HP	~ 10 minutes once per week	27
Air Compressor	Pressurize air for blower	5 HP	~ 10 minutes once per week	38.9
			Total Energy Consumption	6,152

Table 3.5: Heating System Equipment

Major Pumps + Motors	Purpose	Motor Size	Operating Schedule	Annual Energy Consumption (kWh)
Heat Recovery Circ Pump	Circulate heated glycol from power plant through WTP heat exchanger	0.33 HP	while pumping, ~ 24 hours per month	2,183
WTP Main Glycol Loop Circ Pump x 2	Circulate heated glycol in main water treatment plant hydronic heating loop	1 HP	Always on during winter heating season	3,191
Raw Water Storage Tank Heat Add Circ Pump x 2	Circulate heated glycol from the main heating line through the heat add heat exchanger	0.08 HP	Always on during winter heating season	265
Treated Water Storage Tank	Circulate heated glycol from the main heating	0.04 HP	Always on during winter heating season	128

Heat Add Circ Pump x 2	line through the heat add heat exchanger			
Backwash Tank Heat Trace Circ Pump x 2	Circulate heated glycol through the backwash tank heat trace loop	0.08 HP	Always on during winter heating season	265
Raw Water Transmission Line Heat Trace Circ Pump x 2	Circulate heating glycol in the heat trace running from the pump house to the WTP	0.33 HP	Always on during winter heating season	1,065
Raw Water Transmission Line Heat Trace Heat Add Circ Pump x 2	Circulate heated glycol from the main heating line through the heat add heat exchanger	0.04 HP	Always on during winter heating season	128
Distribution Loop Heat Trace Circ Pump x 2	Circulate heating glycol in the heat trace running along the distribution loops	0.33 HP	Used only for freeze-up recovery	22
Distribution Loop Heat Trace Heat Add Circ Pump	Circulate heated glycol from the main heating line through the heat add heat exchanger	0.08 HP	Used only for freeze-up recovery	5
Boiler Secondary Loop Circ Pumps x 2	Circulate glycol through boilers when running and into main heating loop	0.17 HP	Always on during winter heating season	27
Radiant Floor Heating Circ Pump x 2	Circulate glycol through radiant heat lines embedded in the floor	0.08 HP	Always on during winter heating season	265
Raw Water Storage Tank Mixer	Prevent freezing by keeping the water in the raw water tank moving	3 HP	Always on during winter heating season	1,752
			Total Energy Consumption	9,296

Table 3.6: Sewage Pumps

Major Pumps + Motors	**Purpose**	**Motor Size**	**Operating Schedule**	**Annual Energy Consumption (kWh)**
Downtown Sewage Pump x 2	Send sewage from community to the lagoon	12 HP	Both pumps run about 5% of the time	7,848
Midtown Sewage Pump x 2	Send sewage from midtown to downtown lift station	3.8 HP	Both pumps run about 1% of the time	497

Uptown Sewage Pump x 2	Send sewage from uptown to downtown lift station	3.8 HP	Both pumps run about 5% of the time	2,485
			Total Energy Consumption	10,830

<u>Heat Tape</u>

There are two 10 foot sections of heat tape in the WTP; one for each of two arctic boxes. There is a 10-15 foot section of heat tape in each lift station that runs through the water service line arctic box for a total of 5 sections of heat tape consuming an estimated 2,497 kWh per year, 4% of total electrical consumption

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 City of Buckland owns and operates the diesel power plant that provides electricity to the residents of public as well as all commercial and public facilities. Kotzebue Electric Association provides billing support. The power plant supplies heat recovered from the diesel generators to the washeteria, the City Office and the water treatment plant. Two 100 kW wind turbines were installed and integrated into Buckland's power production system in 2015. Two electric boilers, one in the power plant and one in the water treatment plant, are equipped to receive any energy produced by the wind turbines in excess of community demand. The boiler in the power plant adds additional heat to the heat recovery loop and the boiler in the water treatment plant adds additional heat to the raw water in the water treatment plant. The electric boiler in the water treatment plant was not in use at the time of the audit visit due to concern about potential damage to its power line.

The average cost for each type of fuel used in this building is shown below in Table 3.7. This figure includes all surcharges, subsidies, and utility customer charges:

Table 3.7: Energy Rates by Fuel Type in Buckland

Fuel Type	Average Energy Cost
Electricity	$ 0.4741/kWh
#1 Oil	$ 6.80/gallons
Recovered Heat	$ 0.00/million Btu

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Buckland pays approximately $41,951 annually for electricity and other fuel costs for the Buckland Water Treatment Plant, Pump House and Lift Stations.

Figure 6 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.

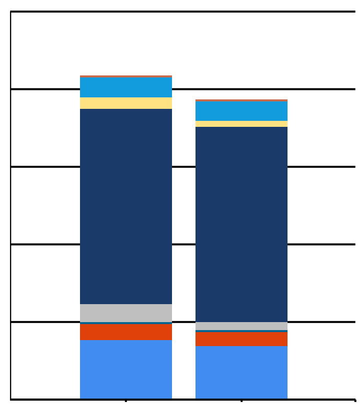


Figure 6: Annual energy costs by end use.

Figure 7 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.

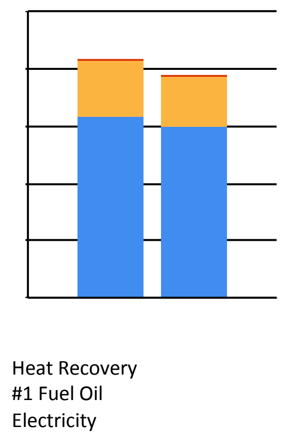


Figure 7: Annual energy costs by fuel type.

Figure 8 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.

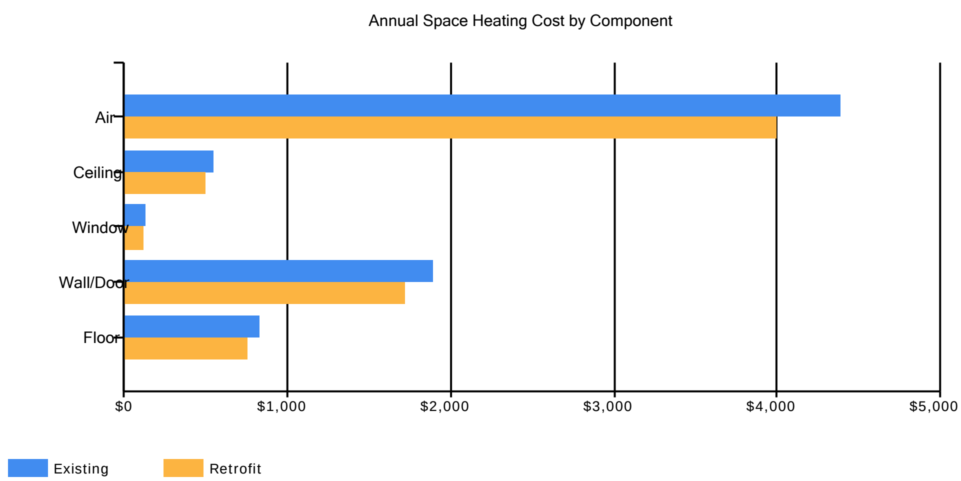


Figure 8: Annual space heating costs by component.

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

Table 3.8: Electrical Consumption Records by Category

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	865	792	861	817	632	191	193	195	193	220	721	867
DHW	86	79	86	84	60	1	4	2	0	8	70	86
Ventilation Fans	1	0	1	1	1	1	1	1	1	1	1	1
Lighting	435	396	422	408	401	388	401	421	408	435	421	435
Other Electrical	6314	5754	6314	6110	5160	2266	2341	2341	2266	2341	5469	6314
Raw Water Heat Add	226	206	226	219	159	0	0	0	0	0	183	226
Water Circulation Heat	11	10	11	11	4	0	0	0	0	0	10	11
Tank Heat	69	63	69	67	49	0	0	0	0	0	56	69

Table 3.9: Fuel Oil Consumption Records by Category

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	122	117	117	86	29	1	0	0	1	9	80	125
DHW	41	37	41	40	27	0	0	0	0	24	33	41
Raw Water Heat Add	22	20	23	22	15	0	0	0	0	0	19	22
Water Circulation Heat	56	51	56	55	26	0	0	0	0	0	49	56
Tank Heat	5	5	5	3	1	0	0	0	0	0	4	6

Table 3.10: Recovered Heat Consumption Records by Category

Recovered Heat Consumption (Million Btu)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	4	4	1	0	0	0	0	0	1	8	3	6
DHW	8	7	8	7	6	0	0	0	0	0	6	8
Raw Water Heat Add	8	7	8	8	6	0	0	0	0	0	6	8
Water Circulation Heat	130	119	130	126	92	0	0	0	0	0	105	130
Tank Heat	12	12	12	8	2	0	0	0	0	0	8	13

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 3.11 for details):

Building Site EUI = (Electric Usage in kBtu + Fuel Usage in kBtu) / Building Square Footage

Building Source EUI = (Electric Usage in kBtu X SS Ratio + Fuel Usage in kBtu X SS Ratio) / Building Square Footage

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

Table 3.11: Buckland Water Treatment Plant, Pump House and Lift Stations 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	67,033 kWh	228,782	3.340	764,132
#1 Oil	1,494 gallons	197,233	1.010	199,206
Recovered Heat	1,057.98 million Btu	1,057,977	1.280	1,354,210
Total		**1,483,992**		**2,317,548**
BUILDING AREA		1,828	Square Feet	
BUILDING SITE EUI		812	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		**1,268**	**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 3.12: Buckland Building Benchmarks

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	811.8	49.31	$22.95
With Proposed Retrofits	761.1	46.23	$21.28
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 Buckland Water Treatment Plant, Pump House and Lift Stations was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Buckland 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 Buckland. 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	Raw Water Transmission Line Heat	Address suspected cold points in valves in underground vault so that heat trace setpoint may be reduced incrementally to 40 deg F if no issues with freezing are observed.	$615 / 39.6 MMBTU	$1,000	8.15	1.6	3,641.0
2	Heating System	Clean and tune boilers, train operators on boiler maintenance and optimization.	$817 / 14.1 MMBTU	$2,000	6.94	2.4	2,586.8
3	Lighting - Combined Retrofit: WTP Exterior Lighting	Replace with new energy-efficient LED lighting, replace manual switching with daylight sensor.	$552 / 4.0 MMBTU	$700	6.64	1.3	1,980.5
4	Pump House Space Heating	Air seal pump house door to reduce heat loss.	$68 / 1.3 MMBTU	$200	4.62	2.9	213.7
5	Backwash Tank Heat Trace	Verify temperature at bottom of backwash tank. Lower setpoint incrementally down to 40 deg F if temperatures below freezing are not observed.	$58 / 31.4 MMBTU	$200	3.90	3.5	1,932.2
6	Lighting - Combined Retrofit: WTP Mechanical Room Lighting (3 bulb)	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$577 / 1.3 MMBTU	$1,570	3.10	2.7	1,903.3
7	Lighting - Power Retrofit: WTP Boiler Room Lighting	Replace with new energy-efficient LED lighting.	$72 / 0.1 MMBTU	$320	1.90	4.4	237.2
8	Lighting - Combined Retrofit: WTP Office Lighting (2 bulb)	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$80 / 0.1 MMBTU	$410	1.64	5.1	261.2

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
9	Lighting - Power Retrofit: LS Wet Well Lighting (Ceiling)	Replace with new energy-efficient LED lighting.	$29 / 0.0 MMBTU	$150	1.62	5.2	93.8
10	Lighting - Combined Retrofit: WTP Mechanical Room Lighting (2 bulb)	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$71 / 0.1 MMBTU	$410	1.46	5.8	232.0
11	Lighting - Power Retrofit: Pump House Exterior Lighting	Replace with new energy-efficient LED lighting, replace manual switching with daylight sensor.	$39 / 0.3 MMBTU	$325	1.01	8.4	139.5
12	Lighting - Combined Retrofit: WTP Office Lighting (1 bulb)	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$21 / 0.0 MMBTU	$290	0.60	14.0	67.9
13	Lighting - Power Retrofit: WTP Bathroom Light	Replace with new energy-efficient LED lighting.	$3 / 0.0 MMBTU	$40	0.60	14.0	9.3
14	Lighting - Combined Retrofit: LS Exterior Lighting	Replace with new energy-efficient LED lighting, replace manual switching with daylight sensor.	$35 / 0.3 MMBTU	$1,000	0.30	28.3	126.8
15	Lighting - Power Retrofit: Pump House Interior Lighting	Replace with new energy-efficient LED lighting.	$2 / 0.0 MMBTU	$80	0.22	38.3	6.8
16	Lighting - Power Retrofit: LS Mechanical Room Lighting	Replace with new energy-efficient LED lighting.	$12 / 0.0 MMBTU	$480	0.22	39.1	39.9
	TOTAL, all measures		**$3,051 / 92.7 MMBTU**	**$9,175**	**3.96**	**3.0**	**13,471.8**

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 Mechanical Equipment Measures

4.3.1 Heating Measure

Rank	Recommendation				
2	Clean and tune boilers, train operators on boiler maintenance and optimization.				
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$817
Breakeven Cost	$13,873	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	14.1 MMBTU
		Savings-to-Investment Ratio	6.9		
Auditors Notes: Clean boilers in the WTP, pump house and lift stations, tune boiler heads and train operators in maintenance, troubleshooting and optimization of boilers for energy efficiency.					

4.5 Electrical & Appliance Measures

4.5.1 Lighting Measures

The goal of this section is to present any lighting energy conservation measures that may also be cost beneficial. It should be noted that replacing current bulbs with more energy-efficient equivalents will have a small effect on the building heating loads. The 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	
3	WTP Exterior Lighting	2 HPS 70 Watt StdElectronic with Manual Switching		Replace two exterior light fixtures with new energy efficient LED lighting with built in daylight sensors.	
Installation Cost	$700	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$552
Breakeven Cost	$4,651	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	4.0 MMBTU
		Savings-to-Investment Ratio	6.6		
Auditors Notes: Replace the two high pressure sodium bulb exterior light fixtures on the WTP with two energy efficient LED fixtures with built in daylight sensors.					

Rank	Location	Existing Condition		Recommendation	
6	WTP Mechanical Room Lighting (3 bulb)	11 FLUOR (3) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with energy efficient LED lighting and install an occupancy sensor.	
Installation Cost	$1,570	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$577
Breakeven Cost	$4,860	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	1.3 MMBTU
		Savings-to-Investment Ratio	3.1		
Auditors Notes: Replace a total of 33 4' T8 fluorescent bulbs in the WTP mechanical room with their energy efficient LED equivalents and install a motion sensor control to reduce time on.					

Rank	Location		Existing Condition		Recommendation	
7	WTP Boiler Room Lighting		4 FLUOR (2) T8 4' F32T8 32W Standard Instant EfficMagnetic with Manual Switching		Replace with energy efficient LED lighting.	
Installation Cost		$320	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$72
Breakeven Cost		$610	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
			Savings-to-Investment Ratio	1.1		
Auditors Notes: Replace a total of 8 4’ T8 fluorescent bulbs in the WTP boiler room with their energy efficient LED equivalents.						

Rank	Location		Existing Condition		Recommendation	
8	WTP Office Lighting (2 bulb)		2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with energy efficient LED lighting and install a motion sensor.	
Installation Cost		$410	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$80
Breakeven Cost		$671	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
			Savings-to-Investment Ratio	1.6		
Auditors Notes: Replace a total of 4 4’ T8 fluorescent bulbs in the WTP office with their energy efficient LED equivalents and install a motion sensor control to reduce time on.						

Rank	Location		Existing Condition		Recommendation	
9	LS Wet Well Lighting (Ceiling)		6 INCAN A Lamp, Std 60W with Manual Switching		Replace with energy efficient LED lighting.	
Installation Cost		$150	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$29
Breakeven Cost		$243	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	1.6		
Auditors Notes: Replace a total of six incandescent light bulbs, two in each lift station wet well, with their energy efficient LED equivalents.						

Rank	Location		Existing Condition		Recommendation	
10	WTP Mechanical Room Lighting (2 bulb)		2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with energy efficient LED lighting and control using motion sensor.	
Installation Cost		$410	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$71
Breakeven Cost		$597	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
			Savings-to-Investment Ratio	1.5		
Auditors Notes: Replace a total of 4 4’ T8 fluorescent bulbs in the WTP mechanical room with their energy efficient LED equivalents. These fixtures will be controlled by the same motion sensor described in the other Mechanical Room (3 bulb fixtures) recommendation. Occupancy sensor cost is split between both mechanical room lighting recommendations.						

Rank	Location		Existing Condition		Recommendation	
11	Pump House Exterior Lighting		HPS 50 Watt StdElectronic with Manual Switching		Replace with energy efficient LED lighting with daylight sensor.	
Installation Cost		$325	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$39
Breakeven Cost		$328	**Simple Payback (yrs)**	8	**Energy Savings (MMBTU/yr)**	0.3 MMBTU
			Savings-to-Investment Ratio	1.0		
Auditors Notes: Replace the high pressure sodium bulb fixture on the exterior of the pump house with an energy efficient LED fixture with built in daylight sensor.						

Rank	Location	Existing Condition		Recommendation	
12	WTP Office Lighting (1 bulb)	FLUOR T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with LED 17W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	
Installation Cost	$290	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$21
Breakeven Cost	$175	**Simple Payback (yrs)**	14	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.6		
Auditors Notes:					

Rank	Location	Existing Condition		Recommendation	
13	WTP Bathroom Light	FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with energy efficient LED lighting.	
Installation Cost	$40	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$3
Breakeven Cost	$24	**Simple Payback (yrs)**	14	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.6		
Auditors Notes: Replace a total of two 4' T8 fluorescent bulbs in the WTP bathroom with their energy efficient LED equivalents.					

Rank	Location	Existing Condition		Recommendation	
14	LS Exterior Lighting	3 HPS 50 Watt StdElectronic with Manual Switching		Replace with energy efficient LED lighting with daylight sensor.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$35
Breakeven Cost	$298	**Simple Payback (yrs)**	28	**Energy Savings (MMBTU/yr)**	0.3 MMBTU
		Savings-to-Investment Ratio	0.3		
Auditors Notes: Replace the high pressure sodium bulb exterior fixtures on each of the three lift stations with energy efficient LED fixtures with built in daylight sensors.					

Rank	Location	Existing Condition		Recommendation	
15	Pump House Interior Lighting	FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with energy efficient LED lighting.	
Installation Cost	$80	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$2
Breakeven Cost	$18	**Simple Payback (yrs)**	38	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.2		
Auditors Notes: Replace a total of two 4' T8 fluorescent bulbs in the pump house with their energy efficient LED equivalents.					

Rank	Location		Existing Condition		Recommendation	
16	LS Mechanical Room Lighting		3 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with energy efficient LED lighting.	
Installation Cost		$480	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$12
Breakeven Cost		$104	**Simple Payback (yrs)**	39	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.2		
Auditors Notes: Replace a total of 12 4’ T8 fluorescent bulbs, four in each lift station mechanical room, with their energy efficient LED equivalents.						

4.5.2 Other Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
1			Raw Water Transmission Line Heat Add		Address suspected cold points in valves in underground vault so that heat trace setpoint may be reduced incrementally to 40 deg F if no issues with freezing are observed.	
Installation Cost		$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$615
Breakeven Cost		$8,150	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	39.6 MMBTU
			Savings-to-Investment Ratio	8.2		
Auditors Notes: Operators have encountered issues with freeze-ups along the raw water transmission line. At the time of the audit visit, the transmission line heat trace was returning at 61 deg F. Operators suspect cold points may be present in the valve vaults along this line. Access valve vaults and increase insulation on valves and plumbing so that the heat trace setpoint may be reduced incrementally to 40 deg F if no issues with freezing are observed.						

Rank	Location		Description of Existing		Efficiency Recommendation	
4			Pump House Space Heating		Air seal door	
Installation Cost		$200	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$68
Breakeven Cost		$925	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	1.3 MMBTU
			Savings-to-Investment Ratio	4.6		
Auditors Notes: There is a visible space between the bottom of the pump house door and the door frame. Air seal this door to reduce air leakage and heat loss.						

Rank	Location		Description of Existing		Efficiency Recommendation	
5			Backwash Line Heat Trace		Verify temperature at bottom of backwash tank. Lower setpoint incrementally down to 40 deg F if temperatures below freezing are not observed.	
Installation Cost		$200	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$58
Breakeven Cost		$779	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	31.4 MMBTU
			Savings-to-Investment Ratio	3.9		
Auditors Notes:						

5. ENERGY EFFICIENCY ACTION PLAN

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

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

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

APPENDICES

Appendix A – Scanned Energy Billing Data

1. Electricity Billing Data

11:05 AM
02/28/17
Cash Basis

City of Buckland
Transaction Detail By Account
January through December 2016

kwh $0.47/kwh

Type	Date	Num	Na...	Memo	Original A...	Paid Amount	Balance
Electricity							
Check	02/25/2016	35729	KO...	Account 2230	66.38	66.38	66.38
Check	02/25/2016	35729	KO...	Account 4160	631.12	631.12	697.50
Check	02/25/2016	35729	KO...	Account 4182	2,095.80	2,095.80	2,793.30
Check	02/25/2016	35729	KO...	Account 4224	6.84	6.84	2,800.14
Check	03/10/2016	35759	KO...	Acct 2230 - R...	151.23	151.23	2,951.37
Check	03/10/2016	35759	KO...	Acct 4182 - N...	2,667.40	2,667.40	5,618.77
Check	03/10/2016	35759	KO...	Acct 4160 - U...	703.10	703.10	6,321.87
Check	04/21/2016	35838	KO...	Acct # 4224	0.89	0.89	6,322.76
Check	04/21/2016	35838	KO...	Acct # 4182	2,095.80	2,095.80	8,418.56
Check	04/21/2016	35838	KO...	Acct # 4160	293.74	293.74	8,712.30
Check	04/21/2016	35838	KO...	Acct # 2230	145.28	145.28	8,857.58
Check	05/09/2016	35872	KO...	ACCT #4224	8.94	8.94	8,866.52
Check	05/09/2016	35872	KO...	ACCT #4182	1,690.94	1,690.94	10,557.46
Check	05/09/2016	35872	KO...	ACCT #4160	457.00	457.00	11,014.46
Check	05/09/2016	35872	KO...	ACCT #2230	119.68	119.68	11,134.14
Check	06/02/2016	35929	KO...	ACCT #2230	73.53	73.53	11,207.67
Check	06/02/2016	35929	KO...	ACCT #4160	479.19	479.19	11,686.86
Check	06/02/2016	35929	KO...	ACCT #4182	1,286.06	1,286.06	12,972.92
Check	06/02/2016	35929	KO...	ACCT #4224	5.06	5.06	12,977.98
Check	08/15/2016	36104	KO...	Acct #4224	6.84	6.84	12,984.82
Check	08/15/2016	36104	KO...	Acct #4182	381.06	381.06	13,365.88
Check	08/15/2016	36104	KO...	Acct #4160	279.77	279.77	13,645.65
Check	08/15/2016	36104	KO...	Acct #2230	150.34	150.34	13,795.99
Check	08/15/2016	36104	KO...	Acct #2090	4.17	4.17	13,800.16
Check	08/17/2016	36120	KO...	ACCT #2080	645.85	645.85	14,446.01
Check	08/17/2016	36120	KO...	ACCT #4160	269.46	269.46	14,715.47
Check	08/17/2016	36120	KO...	ACCT #4182	342.49	342.49	15,057.96
Check	08/17/2016	36120	KO...	ACCT #4224	3.67	3.67	15,061.63
Check	09/09/2016	36170	KO...	Acct #2080	242.20	242.20	15,303.83
Check	09/09/2016	36170	KO...	Acct #2090	4.90	4.90	15,308.73
Check	09/09/2016	36170	KO...	Acct #2230	156.57	156.57	15,465.30
Check	09/09/2016	36170	KO...	Acct #4160	314.25	314.25	15,779.55
Check	09/09/2016	36170	KO...	Acct #4182	464.81	464.81	16,244.36
Check	09/09/2016	36170	KO...	Acct #4224	5.51	5.51	16,249.87
Check	11/07/2016	36295	KO...	ACCT #2080	211.92	211.92	16,461.79
Check	11/07/2016	36295	KO...	ACCT #2230	170.94	170.94	16,632.73
Check	11/07/2016	36295	KO...	ACCT #4160	404.93	404.93	17,037.66
Check	11/07/2016	36295	KO...	ACCT #4182	464.81	464.81	17,502.47
Check	11/07/2016	36295	KO...	ACCT #4224	13.77	13.77	17,516.24
Check	12/06/2016	36360	KO...	ACCT #2080	280.96	280.96	17,797.20
Check	12/06/2016	36360	KO...	ACCT #4160	467.68	467.68	18,264.88
Check	12/06/2016	36360	KO...	ACCT #4182	1,328.40	1,328.40	19,593.28
Check	12/06/2016	36360	KO...	ACCT #4224	5.65	5.65	19,598.93
Total Electricity						19,598.93	19,598.93
TOTAL						19,598.93	19,598.93

4224 New lift Station 3 — 300 – 206
4182 New Water Plant – 500 gal tank – 300
4160 Lift Station 1 — 300 – 206
2330 Raw Water Pump — 300 – Ø
2080 Washeteria — 500 – 53
2090 City Fuel Farm
LS 2 — 300 – 206

Page 1

Appendix B – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Buckland Water Treatment Plant, Pump House and Lift Stations	**Auditor Company:** Alaska Native Tribal Health Consortium
Address: PO Box 49	**Auditor Name:** Bailey Gamble
City: Buckland	**Auditor Address:** 4500 Diplomacy Dr., Suite 454 Anchorage, AK 99508
Client Name: Erik Weber	
Client Address: PO Box 49 Buckland, AK 99272	**Auditor Phone:** (907) 729-4501
	Auditor FAX:
Client Phone: (907) 494-2152	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 1,828 square feet	**Design Space Heating Load:** Design Loss at Space: 26,043 Btu/hour with Distribution Losses: 26,043 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 39,700 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: Buckland	**Design Outdoor Temperature:** -40 deg F
Weather/Fuel City: Buckland	**Heating Degree Days:** 16,462 deg F-days
Utility Information	
Electric Utility: Buckland, City of - Commercial - Sm	**Average Annual Cost/kWh:** $0.474/kWh

Annual Energy Cost Estimate											
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Service Fees**	**Total Cost**
Existing Building	$7,217	$0	$3,808	$3	$1,888	$25,065	$1,656	$2,399	$405	$0	**$42,441**
With Proposed Retrofits	$7,014	$0	$3,564	$3	$814	$25,065	$991	$2,409	$406	$0	**$40,264**
Savings	$203	$0	$245	$0	$1,075	$0	$666	-$9	-$1	$0	**$2,177**

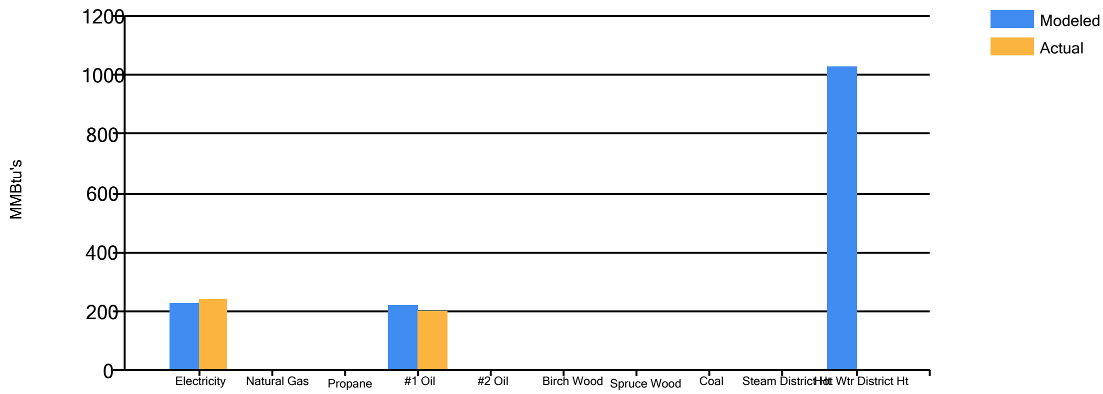
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	804.1	48.85	$23.22
With Proposed Retrofits	757.1	45.99	$22.03
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area.			

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

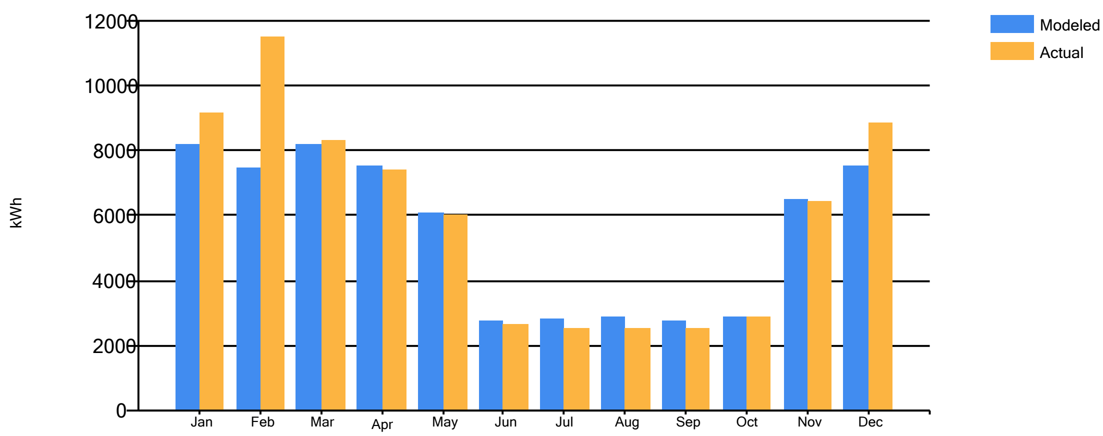
Appendix C – Actual Fuel Use versus Modeled Fuel Use

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

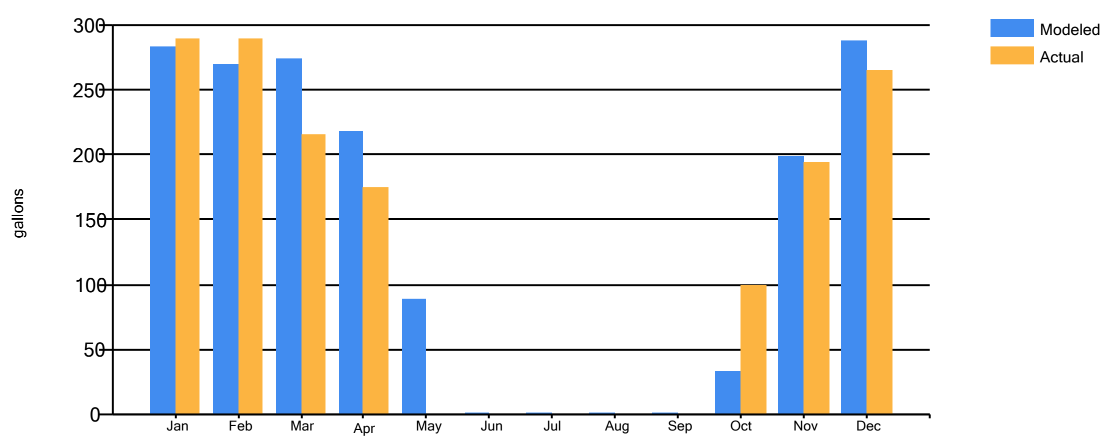
Annual Fuel Use



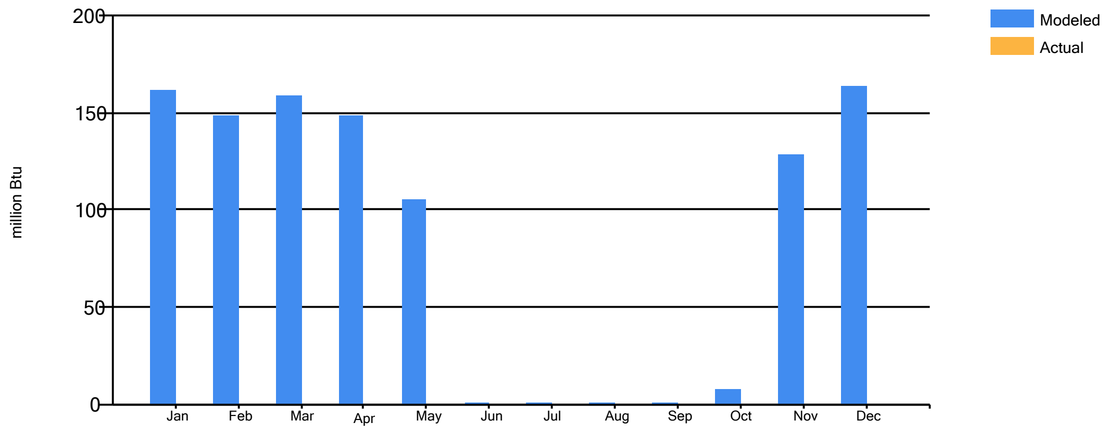
Electricity Fuel Use



#1 Fuel Oil Fuel Use



Hot Wtr District Ht Fuel Use



200
150
100
50
0
million Btu
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Modeled
Actual

Appendix D - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	16.0	16.0	16.0	15.4	13.2	8.9	8.9	8.9	8.9	8.9	14.0	15.0
As Proposed	15.3	15.3	15.3	14.8	12.6	8.3	8.3	8.3	8.3	8.3	13.4	14.4

AkWarmCalc Ver 2.6.1.0, Energy Lib 8/9/2016