Comprehensive Energy Audit
For

Kotlik Water Treatment Plant

Prepared For
City of Kotlik

December 2, 2015

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PREFACE

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

The Energy Projects Group at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for The City of Kotlik, Alaska. The authors of this report are Kevin Ulrich, Energy Manager-in-Training (EMIT), and Max Goggin-Kehm, P.E.

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in October of 2015 by the Energy Projects Group of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy conservation measures. Discussions of site-specific concerns, non-recommended measures, and an energy conservation action plan are also included in this report.

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of Water Treatment Plant Operators Wilbur Tonuchuk and John Tonuchuk, and Kotlik City Administrator Flora Tonuchuk.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Kotlik and the Alaska Rural Utility Collaborative (ARUC). The scope of the audit focused on Kotlik Water Treatment Plant. 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 and distribution processes, and plug loads.

In the near future, a representative of ANTHC will be contacting both the City of Kotlik and the water treatment plant operators to follow up on the recommendations made in this audit report. Funding has been provided to ANTHC through a Rural Alaska Village Grant and the Denali Commission to provide the city with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations within the 2016 calendar year.

The total predicted energy cost for the Kotlik Water Treatment Plant is $77,536 per year. Electricity represents the largest portion with an annual cost of $63,592. This includes $23,997 paid by the city and $39,595 paid by the Power Cost Equalization (PCE) program through the State of Alaska. Heat recovery costs represent a portion of the total energy cost with an annual cost of $11,237. This includes the costs charged by the AVEC power plant for use of their heat. Fuel oil represents a small portion with an annual cost of $2,708.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower the electricity costs and make energy affordable in rural Alaska. In Kotlik, the cost of electricity without PCE is $0.53/KWH and the cost of electricity with PCE is $0.20/KWH.

There is a heat recovery project that transfers recovered heat from the generator cooling loop in the power plant to the water treatment plant and a community building. This project was constructed in 2003 during the construction of the power plant. The heat recovery system provides heating for all the heating loads in the water treatment plant and covers nearly the entire load on an annual basis. As a result, the Kotlik Water Treatment Plant uses less than 500 gallons of fuel per year.

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

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	121,213 kWh	89,645 kWh
#1 Oil	465 gallons	465 gallons
Heat Recovery	1,123.66 million Btu	1,123.66 million Btu

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

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	832.7	61.83	$40.38
With Proposed Retrofits	776.6	57.67	$31.88
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

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

Table 1.1 PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR[1]**	**Simple Payback (Years)[2]**	**CO_2 Savings**
1	Other Electrical - Raw Water Heat Tape	Turn off heat tape and use only for emergency that purposes.	$5,029	$10,000	5.91	2.0	28,200.8
2	Lighting - WTP Main Room	Replace with new energy-efficient LED lighting.	$528	$2,900	2.14	5.5	2,960.8
3	Lighting - Boiler Room	Replace with new energy-efficient LED lighting.	$113	$720	1.85	6.4	634.5
4	Other Electrical - WST Heat-Add Circulation Pump	Replace existing pump with new three-phase high efficiency pump.	$406	$3,000	1.59	7.4	2,275.4
5	Other Electrical - Main Transformer	Downsize transformer from the existing 30 kVA unit to a 20 kVa unit.	$2,753	$30,000	1.34	10.9	15,438.2
6	Other Electrical - Vacuum Sewer Pump	Replace vacuum pump with new modulating Mink pump.	$6,408	$75,000	1.25	11.7	35,926.5
7	Lighting - Arctic Entry	Replace with new energy-efficient LED lighting.	$16	$160	1.17	10.0	89.3
8	Other Electrical - Loop 1 Circulation Pumps	Replace existing pumps with new three-phase high efficiency pumps.	$587	$7,500	1.14	12.8	3,289.8
9	Other Electrical - Raw Water Heat-Add Circulation Pump	Replace existing pump with new three-phase high efficiency pump.	$146	$2,000	1.07	13.7	818.7
10	Other Electrical - Loop 2 Circulation Pumps	Replace existing pumps with new three-phase high efficiency pumps.	$287	$4,000	1.05	13.9	1,608.2
11	Lighting - Office	Replace with new energy-efficient LED lighting.	$19	$250	0.90	13.1	107.2
12	Setback Thermostat: Water Treatment Plant	Install a programmable thermostat and set temperature back to 60 deg. F when unoccupied.	$33	$1,000	0.42	30.4	186.2

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]**	**CO_2 Savings**
13	Lighting - Rest Room	Replace with new energy-efficient LED lighting.	$2	$120	0.23	50.9	13.2
14	Air Tightening: The entryway door and arctic entry area	Seal cracks around the entryway door.	$0	$2,000	0.00	999.9	0.0
	TOTAL, all measures		**$16,327**	**$138,650**	**1.59**	**8.5**	**91,548.6**

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 $16,327 per year, or 21.1% of the buildings' total energy costs. These measures are estimated to cost $138,650, for an overall simple payback period of 8.5 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**	**Water Heating**	**Lighting**	**Other Electrical**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$1,067	$1,114	$2,346	$60,296	$12,228	$427	**$77,536**
With Proposed Retrofits	$1,067	$1,118	$1,666	$44,644	$12,228	$427	**$61,209**
Savings	$0	-$4	$680	$15,651	$0	$0	**$16,327**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Kotlik Water Treatment Plant. The scope of this project included evaluating building shell, lighting and other electrical systems, and 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

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 Kotlik Water Treatment Plant enable a model of the building's energy usage to be developed, highlighting the building's total energy consumption, energy consumption by specific building component, and equivalent energy cost. The analysis involves distinguishing the different fuels used on site, and analyzing their consumption in different activity areas of the building.

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

1) Water Treatment Plant: 1,920 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. Kotlik Water Treatment Plant

3.1. Building Description

The 1,920 square foot Kotlik Water Treatment Plant was constructed in 1998, with a normal occupancy of 1 person. The number of hours of operation for this building average 4 hours per day, considering all seven days of the week.

The Kotlik Water Treatment Plant serves as the water distribution center for the residents of the community and also houses the sewer system components.

The community of Kotlik was affected by a flood in the fall of 2013 that destroyed many of the existing utilidors. Currently there are two distribution loops working with a third loop that will be completed by the end of 2015. This report assumes that all the circulation loops are actively operational. Loop 1 serves the west side of town and are currently in operation. The loop has a length of approximately 7910 ft. Loop 2 serves the school buildings and is approximately 450 ft. long. Loop 3 will be operational by the end of 2015 and has a length of approximately 12,100 ft. Loops 1 and 2 use 4" arctic piping within a utilidor while Loop 2 uses 6" arctic piping within a utilidor.

Water is pumped into the water treatment plant from a raw water intake located in the Kotlik River approximately 450 ft. from the building. The water is pumped through an open-air filtration system where it receives a number of chemical injections before entering the 100,000 gallon water storage tank.

Description of Building Shell

The exterior walls are constructed from stressed skin panels with 7.5 inches of polyurethane foam insulation. The insulation is slightly damaged and there is 1,840 square feet of wall space in the building.

The roof of the building is has a cathedral ceiling with standard framing and 24-inch framing. There is 5.5 inches of polyurethane foam insulation in the roof that is slightly damaged and there is approximately 2,024 square feet of roof space in the building.

The building is built on pilings with approximately 48 inches of clearance between the pad and the ground. The floor is built with standard lumber and there is approximately 1,920 square feet of floor space in the building.

There are four windows in the building. All four windows are double-paned with wood framing and have 6 square feet of space each for a combined total of 24 square feet.

There are three total doors in the building. There is a set of double doors in the entryway and one single door as an emergency exit. The doors are all metal with an insulated core and there is approximately 63 square feet of door space in the building.

Description of Heating Plants

The Heating Plants used in the building are:

Boiler #1
Nameplate Information: Burnham Model V907
SN 64002977
Fuel Type: #1 Oil
Input Rating: 690,000 BTU/hr
Steady State Efficiency: 85 %
Idle Loss: 0.4 %
Heat Distribution Type: Glycol
Boiler Operation: All Year
Notes: The boilers are rarely operated because of the heat recovery system.

Boiler #2
Nameplate Information: Burnham Model V907
SN 64002978
Fuel Type: #1 Oil
Input Rating: 690,000 BTU/hr
Steady State Efficiency: 85 %
Idle Loss: 0.4 %

Heat Distribution Type: Glycol
Boiler Operation: All Year
Notes: The boilers are rarely operated because of the heat recovery system.

Heat Recovery
Fuel Type: Recovered Heat
Input Rating: 400,000 BTU/hr
Steady State Efficiency: 99 %
Idle Loss: 0.5 %
Heat Distribution Type: Glycol
Boiler Operation: All Year
Notes: Heat Recovery provided by AVEC power plant.
Winter Load: 280-300 KW (with school)
Summer Load: 200-220 KW

Space Heating Distribution Systems

There are two unit heaters in the building that are used to provide space heat. One is a small Dunham-Bush model with a 1/20 HP motor and is rated for 10,000 BTU/hr. The other is a larger Dunham-Bush model with a 1/10 HP motor and is rated for 15,000 BTU/hr.

Domestic Hot Water System

There are two hot water heaters in the WTP building. One is a Rheem model 81VP20S with a 2000W usage and a 19.9 gallon capacity. This unit only serves the restroom, shower, and utility sinks. The other is a Bradford White model with a 4500/3500 W usage and a 47 gallon storage capacity. This is used to heat water during the filtration process.

Heat Recovery Information

There is a heat recovery system that transfers heat from the power plant cooling loop to the water treatment plant that heats the glycol before going into the boilers. The heat recovery system also provides heat for the tribal office building. The system produces an average of 400,000 BTU/hr during the winter season and covers nearly all of the building heat loads except in extreme conditions. The winter power plant load is between 280-300 KW on average and the summer power plant load is between 200-220 KW on average.

Lighting

The main room has 28 fixtures with three T8 4-ft. fluorescent light bulbs in each fixture. These lights are on for four hours per day when the operator is on duty and consume approximately 3,481 KWH annually.

The boiler room has 6 fixtures with three T8 4-ft. fluorescent light bulbs in each fixture. These lights are on for four hours per day when the operator is on duty and consume approximately 746 KWH annually.

The office has two fixtures with three T8 4-ft. fluorescent light bulbs in each fixture. These lights are one for about half of the total time the operator is present in the building, or approximately two hours per day. The lights consume approximately 124 KWH annually.

The arctic entry has one fixture with four T8 4-ft. fluorescent light bulbs that are on approximately two hours per day during the heating months and consume approximately 103 KWH annually.

The rest room has one fixture with three T8 4-ft. fluorescent light bulbs in the fixture.

Plug Loads

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

Major Equipment

There are two vacuum pumps that are rated for 12 HP. One of the pumps runs approximately 71% of the time all year long. The pumps are used to collect all the sewage from throughout the vacuum sewer system. It was assumed that the pumps run at an average operating point of approximately 9 HP. Using this assumption, the vacuum sewer pumps are estimated to consume approximately 42,011 KWH annually.

There are two sewer discharge pumps that are rated for 7.5 HP. One of the pumps runs approximately 11% of the time all year long. The pumps are used to discharge the collected sewage to the sewage lagoon. It was assumed that the pumps run at an average operating point of approximately 5.6 HP. Using this assumption, the sewer discharge pumps are estimated to consume approximately 4,050 KWH annually.

There is a raw water intake pump that is used to pump intake water from the Kotlik River to the water treatment plant building. The pump is rated for 2 HP and runs 25% of the time all year long. The pump consumes approximately 3,287 KWH annually.

There are two circulation pumps on Loop 1 that are used to circulate the water throughout the loop. The pumps are rated for 1.5 HP and one pump is running constantly during the heating season from October – May. The pumps consume approximately 5,758 KWH annually.

There are two circulation pumps on Loop 2 that are used to circulate the water throughout the loop. The pumps are rated for ¾ HP and one pump is running constantly during the heating season from October – May. The pumps consume approximately 2,815 KWH annually.

There are two circulation pumps on Loop 3 that will be used to circulate the water throughout the loop. The pumps are rated for 3 HP and one pump will be running constantly during the heating season from October – May. The pumps consume approximately 11,516 KWH annually.

There are three pressure pumps that are used to pressurize the water distribution and allow for easier circulation. The pumps are rated for 3 HP and one pump is running 10% of the time all year long. The pumps consume approximately 1,972 KWH annually.

There is a backwash pump that is used to backwash the system and clean the pipes and filters throughout the year. The pump is rated for 3 HP and runs approximately 5 % of the time all year long. The pump consumes approximately 1,644 KWH annually.

There are two boiler circulation pumps that are used to circulate heated glycol throughout the hydronic heating system. These pumps are rated for ¾ HP and run constantly all year long. The pumps consume approximately 4,821 KWH annually.

There is a circulation pump for the water storage tank heat-add system that is used to circulate heated glycol from the hydronic heating system to the water storage tank heat exchanger. The pump is rated for 179 Watts and runs constantly all year long. It consumes approximately 1,569 KWH annually.

There is a circulation pump for the raw water intake heat-add system that is used to circulate heated glycol from the hydronic heating system to the raw water intake heat exchanger. The pump is rated for 65 Watts and runs constantly all year long. It consumes approximately 570 KWH annually.

There are two circulation pumps for the force main heat-add system that is used to circulate heated glycol from the hydronic heating system to the force main heat exchanger. The pumps are rated for 245 Watts each and run constantly all year long. They consume approximately 4,295 KWH annually.

There is a chemical pump that injects treatment chemicals into the water when it is being circulated. The pump is rated for 1/3 HP and runs approximately 10% of the time during the heating season from October - May.

There is a desludge pump that is used to keep the sewage from clumping in the sewer system. The pump is rated for 3 HP and runs 5% of the time all year long. The pump consumes approximately 986 KWH annually.

There is an effluent pump that is used to pump waste water from the treatment process away from the filtration system. The pump is rated for 2 HP and runs 5% of the time all year long. The pump consumes approximately 658 KWH annually.

There is an air compressor that is used to help the drainback of the raw water line and to clean the filters on a daily basis. The pump is rated for 5 HP and runs for 20 minutes per day. It consumes approximately 428 KWH annually.

There is a heat tape on the raw water line that is used to heat the raw water as it enters the building. The heat tape is used throughout the heating season from October-May and is estimated to use 2000 Watts of power. Using this estimate, the heat tape consumes approximately 10,236 KWH annually.

There is a main transformer present in the water treatment plant that transforms the 480V power distributed by the power plant into a single-phase 208V service that can be safely used to power the electrical equipment in the building. The transformer is rated for 30 kVA and can handle slightly more than 30 KW of power. The transformer uses 3000 Watts when in operation and approximately 10% of that power when in "OFF" mode during the summer months. Throughout the year, the main transformer consumes approximately 15,971 KWH annually.

There is a transformer present for the heat tape located on Loop 1 that transforms the 480V power distributed by the power plant into a single-phase 208V service that can be safely used to power the electrical equipment in the building. The transformer is not used over the course of the year and is constantly in "OFF" mode where it uses approximately 300 Watts. The transformer is completely shut down during the summer months and consumes approximately 1,535 KWH annually.

There is a transformer present for the heat tape located on the force main that transforms the 480V power distributed by the power plant into a single-phase 208V service that can be safely used to power the electrical equipment in the building. The transformer is not used over the course of the year and is constantly in "OFF" mode where it uses approximately 300 Watts. The transformer is completely shut down during the summer months and consumes approximately 799 KWH annually.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

The electric usage profile charts (below) represents the predicted electrical usage for the building. If actual electricity usage records were available, the model used to predict usage was calibrated to approximately match actual usage. The electric utility measures consumption in kilowatt-hours (kWh) and maximum demand in kilowatts (kW). One kWh usage is equivalent to 1,000 watts running for one hour. One KW of electric demand is equivalent to 1,000 watts running at a particular moment. The basic usage charges are shown as generation service and delivery charges along with several non-utility generation charges.

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

The Alaska Village Electric Cooperative (AVEC) provides electricity to the residents of Kotlik as well as all the commercial and public facilities.

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	$ 0.53/kWh
#1 Oil	$ 5.82/gallons
Heat Recovery	$ 10.00/million Btu

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, ARUC pays approximately $77,536 annually for electricity and other fuel costs for the Kotlik Water Treatment Plant.

Figure 3.1 below reflects the estimated distribution of costs across the primary end uses of energy based on the AkWarm© computer simulation. Comparing the "Retrofit" bar in the figure to the "Existing" bar shows the potential savings from implementing all of the energy efficiency measures shown in this report.

Figure 3.1
Annual Energy Costs by End Use

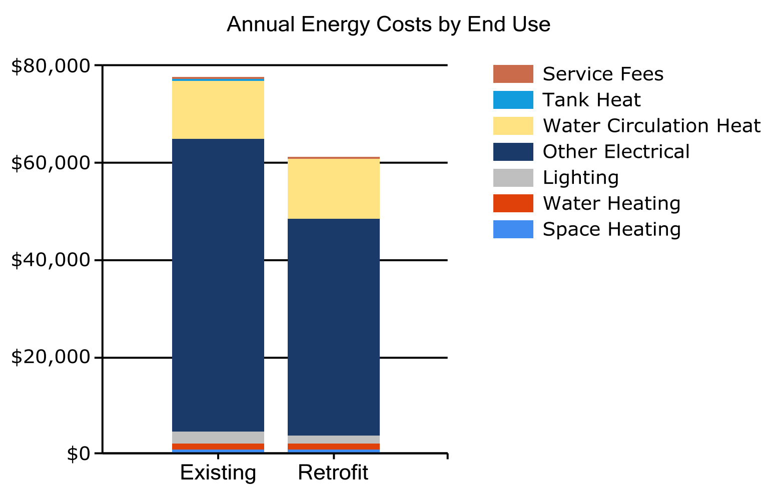


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

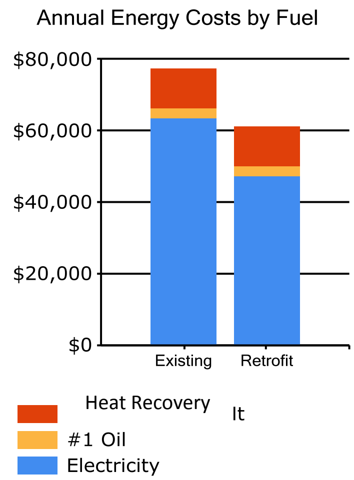
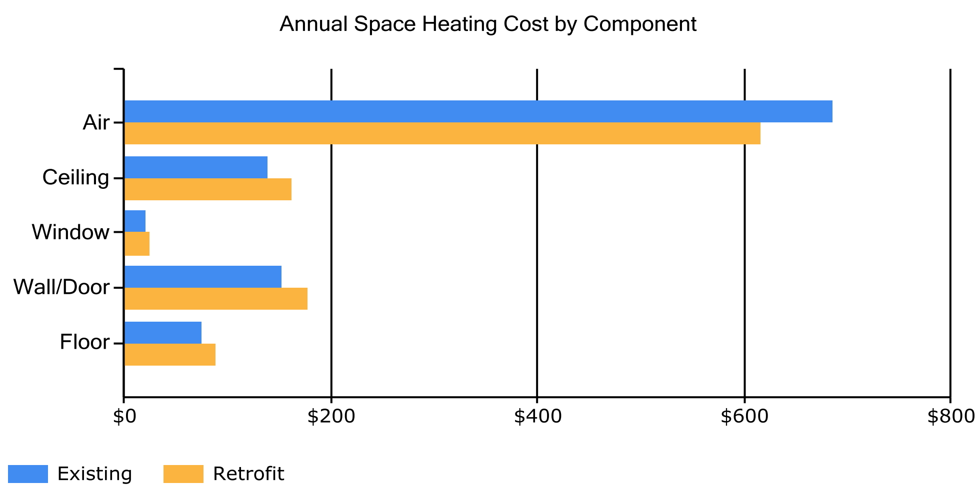


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing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

Figure 3.3
Annual Space Heating Cost by Component



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

Heat Recovery

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
DHW	144	131	144	139	144	139	144	144	139	144	139	144
Lighting	385	350	385	372	371	359	371	371	366	385	372	385
Other Electrical	12620	11500	12620	12213	8023	5587	5773	5773	5587	10520	12213	12620

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	16	14	16	15	16	15	16	16	15	16	15	16
DHW	0	0	0	0	0	0	16	16	0	0	0	0
Water Circulation Heat	30	28	30	25	19	15	0	0	17	22	26	31
Tank Heat	1	1	1	1	0	0	0	0	0	1	1	1

Recovered Heat Consumption (Million Btu)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
DHW	0	0	0	0	0	0	2	2	0	0	0	0
Water Circulation Heat	173	167	170	118	46	7	0	0	19	79	125	179
Tank Heat	7	7	7	4	0	0	0	0	0	2	4	7

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
Kotlik Water Treatment Plant EUI Calculations

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	121,213 kWh	413,701	3.340	1,381,762
#1 Oil	465 gallons	61,415	1.010	62,029
Heat Recovery	1,123.66 million Btu	1,123,663	1.280	1,438,289
Total		**1,598,779**		**2,882,080**
BUILDING AREA		1,920	Square Feet	
BUILDING SITE EUI		833	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		1,501	**kBTU/Ft²/Yr**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

Table 3.5

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	**832.7**	**61.83**	**$40.38**
With Proposed Retrofits	**776.6**	**57.67**	**$31.88**
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

3.3 AkWarm© Building Simulation

An accurate model of the building performance can be created by simulating the thermal performance of the walls, roof, windows and floors of the building. The heating and ventilation systems 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 Kotlik Water Treatment Plant was modeled using AkWarm© energy use software to establish a baseline space heating energy usage. Climate data from Kotlik 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 Kotlik. 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.

Table 4.1
Kotlik Water Treatment Plant, Kotlik, Alaska
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)	CO_2 Savings
1	Other Electrical - Raw Water Heat Tape	Turn off heat tape and use only for emergency that purposes.	$5,029	$10,000	5.91	2.0	28,200.8
2	Lighting - WTP Main Room	Replace with new energy-efficient LED lighting.	$528	$2,900	2.14	5.5	2,960.8
3	Lighting - Boiler Room	Replace with new energy-efficient LED lighting.	$113	$720	1.85	6.4	634.5
4	Other Electrical - WST Heat-Add Circulation Pump	Replace existing pump with new three-phase high efficiency pump.	$406	$3,000	1.59	7.4	2,275.4
5	Other Electrical - Main Transformer	Downsize transformer from the existing 30 kVA unit to a 20 kVa unit.	$2,753	$30,000	1.34	10.9	15,438.2
6	Other Electrical - Vacuum Sewer Pump	Replace vacuum pump with new modulating Mink pump.	$6,408	$75,000	1.25	11.7	35,926.5
7	Lighting - Arctic Entry	Replace with new energy-efficient LED lighting.	$16	$160	1.17	10.0	89.3
8	Other Electrical - Loop 1 Circulation Pumps	Replace existing pumps with new three-phase high efficiency pumps.	$587	$7,500	1.14	12.8	3,289.8

Table 4.1 Kotlik Water Treatment Plant, Kotlik, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
9	Other Electrical - Raw Water Heat-Add Circulation Pump	Replace existing pump with new three-phase high efficiency pump.	$146	$2,000	1.07	13.7	818.7
10	Other Electrical - Loop 2 Circulation Pumps	Replace existing pumps with new three-phase high efficiency pumps.	$287	$4,000	1.05	13.9	1,608.2
11	Lighting - Office	Replace with new energy-efficient LED lighting.	$19	$250	0.90	13.1	107.2
12	Setback Thermostat: Water Treatment Plant	Install a programmable thermostat and set temperature back to 60 deg. F when unoccupied.	$33	$1,000	0.42	30.4	186.2
13	Lighting - Rest Room	Replace with new energy-efficient LED lighting.	$2	$120	0.23	50.9	13.2
14	Air Tightening: The entryway door and arctic entry area	Seal cracks around the entryway door.	$0	$2,000	0.00	999.9	0.0
	TOTAL, all measures		**$16,327**	**$138,650**	**1.59**	**8.5**	**91,548.6**

4.2 Interactive Effects of Projects

The savings for a particular measure are calculated assuming all recommended EEMs coming before that measure in the list are implemented. If some EEMs are not implemented, savings for the remaining EEMs will be affected. For example, if ceiling insulation is not added, then savings from a project to replace the heating system will be increased, because the heating system for the building supplies a larger load.

In general, all projects are evaluated sequentially so energy savings associated with one EEM would not also be attributed to another EEM. By modeling the recommended project sequentially, the analysis accounts for interactive affects among the EEMs and does not “double count” savings.

Interior lighting, plug loads, facility equipment, and occupants generate heat within the building. Lighting-efficiency improvements are anticipated to slightly increase heating requirements. Heating penalties were included in the lighting project analysis

4.3 Building Shell Measures

4.3.1 Air Sealing Measures

Rank	Location	Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
14	The entryway door and arctic entry area	Air Tightness estimated as: 4000 cfm at 50 Pascals		Seal cracks around the entryway door.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$
Breakeven Cost	$	**Savings-to-Investment Ratio**	0.0	**Simple Payback yrs**	
Auditors Notes: There are large cracks around the connection between the arctic entry and the entryway door. Daylight is visible and the main part of the building appears to be slowly settling into the ground. Insulate the cracks to reduce air penetration. Additionally, the doors do not properly close and should be repaired in order to effectively seal the entryway when closed.					

4.4 Mechanical Equipment Measures

4.4.1 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
12	Water Treatment Plant			Install a programmable thermostat and set temperature back to 60 deg. F when unoccupied.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$33
Breakeven Cost	$415	**Savings-to-Investment Ratio**	0.4	**Simple Payback yrs**	30
Auditors Notes: The building air temperature is currently set at 70 deg. F during all times of the day. Setting the temperature back to 60 deg. F when it is unoccupied will reduce the space heating load and save on fuel and recovered heat costs. This can be accomplished by installing a programmable thermostat and having the unoccupied temperature set point programmed to automatically take effect.					

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 building heating load will see a small increase, as the more energy efficient bulbs give off less heat.

4.5.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	Location	Existing Condition		Recommendation	
2	WTP Main Room	28 FLUOR (3) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$2,900	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$528
Breakeven Cost	$6,202	**Savings-to-Investment Ratio**	2.1	**Simple Payback yrs**	5
Auditors Notes: Replace existing fluorescent light fixtures with 17Watt 4-ft. LED equivalents. This room has 28 fixtures with three bulbs per fixture for a total of 84 light bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
3	Boiler Room	6 FLUOR (3) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$720	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$113
Breakeven Cost	$1,329	**Savings-to-Investment Ratio**	1.8	**Simple Payback yrs**	6
Auditors Notes: Replace existing fluorescent light fixtures with 17Watt 4-ft. LED equivalents. This room has 6 fixtures with three bulbs per fixture for a total of 18 light bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
7	Arctic Entry	FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$16
Breakeven Cost	$188	**Savings-to-Investment Ratio**	1.2	**Simple Payback yrs**	10
Auditors Notes: Replace existing fluorescent light fixtures with 17Watt 4-ft. LED equivalents. This room has one fixture with four bulbs in the fixture for a total of 4 light bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
11	Office	2 FLUOR (3) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$250	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$19
Breakeven Cost	$225	**Savings-to-Investment Ratio**	0.9	**Simple Payback yrs**	13
Auditors Notes: Replace existing fluorescent light fixtures with 17Watt 4-ft. LED equivalents. This room has one fixture with four bulbs in the fixture for a total of 4 light bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
13	Rest Room	FLUOR (3) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$120	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$2
Breakeven Cost	$28	**Savings-to-Investment Ratio**	0.2	**Simple Payback yrs**	51
Auditors Notes: Replace existing fluorescent light fixtures with 17Watt 4-ft. LED equivalents. This room has one fixture with four bulbs in the fixture for a total of 4 light bulbs to be replaced.					

4.5.2 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
1	Raw Water Heat Tape	Raw Water Line Heat Tape		Shut off heat tape and use only for emergency thaw purposes.	
Installation Cost	$10,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$5,029
Breakeven Cost	$59,079	**Savings-to-Investment Ratio**	5.9	**Simple Payback yrs**	2

Auditors Notes: The raw water heat tape is used to heat the intake water as it travels from the intake structure to the water treatment plant building. This task should be accomplished by using the drainback system and through a glycol heat trace that can be heated by the existing heat recovery system. Turn off the heat tape and use these methods, limiting the total KWH consumed so that the plant does not violate PCE requirements and reducing the consumption and total electricity costs.

Rank	Location	Description of Existing		Efficiency Recommendation	
4	WST Heat-Add Circulation Pump	Heat-Add Pump		Replace existing pumps with new three-phase high efficiency pumps.	
Installation Cost	$3,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$406
Breakeven Cost	$4,767	**Savings-to-Investment Ratio**	1.6	**Simple Payback yrs**	7

Auditors Notes: The current pumps are single-phase and don't operate as efficiently as many newer models. Switching these pumps to three-phase models will improve the electric distribution, operating efficiency, and balance of the existing three-phase service in the building. Replacing these pumps will require rewiring of the building in conjunction with the main transformer replacement to distribute three-phase power and provide adequate safety measures.

Rank	Location	Description of Existing		Efficiency Recommendation	
5	Main Transformer	30 kVA Transformer with Control Panel		Downsize transformer from the existing 30 kVA unit to a 20 kVa unit.	
Installation Cost	$30,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$2,753
Breakeven Cost	$40,226	**Savings-to-Investment Ratio**	1.3	**Simple Payback yrs**	11

Auditors Notes: The current transformer is used to convert the existing 480V service to single-phase 208V that can be used to safely power electrical equipment in the building. Upgrading existing circulation pumps to three-phase high efficiency pumps will allow for more efficient plant operation and will also reduce the use of the existing transformer that is rated for 30 kVA and can handle a power load of slightly more than 30 KW. If the pumps are replaced and the proper rewiring done to service those pumps, the main transformer can be downsized to a 20 kVa unit so that the unit is not consuming as much electricity. This work will require electrical design work from a licensed Professional Engineer and will need to be completed by a licensed Journeyman Electrician or higher.

Rank	Location	Description of Existing		Efficiency Recommendation	
6	Vacuum Sewer Pump	Vacuum Sewer Pump		Replace existing vacuum pump with new modulating Mink pump.	
Installation Cost	$75,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$6,408
Breakeven Cost	$93,588	**Savings-to-Investment Ratio**	1.2	**Simple Payback yrs**	12

Auditors Notes: The existing vacuum pump has no modulating controls and must run at a high power load even when it is more than necessary to complete the task. Replace the pump with a Mink brand Vacuum pump with modulating controls that will operate more efficiently and reduce run-time of the pumps.

Rank	Location		Description of Existing		Efficiency Recommendation	
8	Loop 1 Circulation Pumps		Circulation Pumps		Replace existing pumps with new three-phase high efficiency pumps.	
Installation Cost		$7,500	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$587
Breakeven Cost		$8,561	**Savings-to-Investment Ratio**	1.1	**Simple Payback yrs**	13

Auditors Notes: The current pumps are single-phase and don't operate as efficiently as many newer models. Switching these pumps to three-phase models will improve the electric distribution, operating efficiency, and balance of the existing three-phase service in the building. Replacing these pumps will require rewiring of the building in conjunction with the main transformer replacement to distribute three-phase power and provide adequate safety measures.

Rank	Location		Description of Existing		Efficiency Recommendation	
9	Raw Water Heat-Add Circulation Pump		Heat-Add Pump		Replace existing pumps with new three-phase high efficiency pumps.	
Installation Cost		$2,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$146
Breakeven Cost		$2,132	**Savings-to-Investment Ratio**	1.1	**Simple Payback yrs**	14

Auditors Notes: The current pumps are single-phase and don't operate as efficiently as many newer models. Switching these pumps to three-phase models will improve the electric distribution, operating efficiency, and balance of the existing three-phase service in the building. Replacing these pumps will require rewiring of the building in conjunction with the main transformer replacement to distribute three-phase power and provide adequate safety measures.

Rank	Location		Description of Existing		Efficiency Recommendation	
10	Loop 2 Circulation Pumps		Circulation Pumps with Manual Switching		Replace existing pumps with new three-phase high efficiency pumps.	
Installation Cost		$4,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$287
Breakeven Cost		$4,185	**Savings-to-Investment Ratio**	1.0	**Simple Payback yrs**	14

Auditors Notes: The current pumps are single-phase and don't operate as efficiently as many newer models. Switching these pumps to three-phase models will improve the electric distribution, operating efficiency, and balance of the existing three-phase service in the building. Replacing these pumps will require rewiring of the building in conjunction with the main transformer replacement to distribute three-phase power and provide adequate safety measures.

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 Kotlik and the water treatment plant operator to follow up on the recommendations made in this audit report. Funding has been provided to ANTHC through a Rural Alaska Village Grant and the Denali Commission to provide the city with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations within the 2016 calendar year.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Kotlik Water Treatment Plant	**Auditor Company:** ANTHC
Address: Water Treatment Plant	**Auditor Name:** Kevin Ulrich & Max Goggin-Kehm
City: Kotlik	**Auditor Address:** 4500 Diplomacy Dr. Anchorage, AK 99508
Client Name: Wilbur Tonuchuk & John Tonuchuk	
Client Address:	**Auditor Phone:** (907) 729-3237
	Auditor FAX: (907) 729-4049
Client Phone: (907) 899-4035	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 1,920 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: 1 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Kotlik	**Design Outdoor Temperature:** -20.1 deg F
Weather/Fuel City: Kotlik	**Heating Degree Days:** 13,467 deg F-days
Utility Information	
Electric Utility: AVEC-Kotlik - Commercial - Sm	**Average Annual Cost/kWh:** $0.53/kWh

Annual Energy Cost Estimate							
Description	**Space Heating**	**Water Heating**	**Lighting**	**Other Electrical**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$1,067	$1,114	$2,346	$60,296	$12,228	$427	**$77,536**
With Proposed Retrofits	$1,067	$1,118	$1,666	$44,644	$12,228	$427	**$61,209**
Savings	$0	-$4	$680	$15,651	$0	$0	**$16,327**

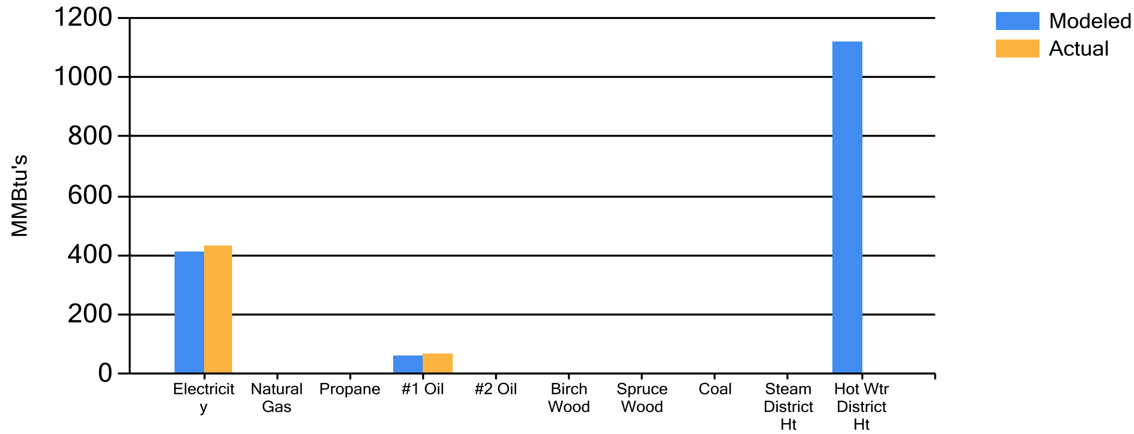
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	832.7	61.83	$40.38
With Proposed Retrofits	776.6	57.67	$31.88

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

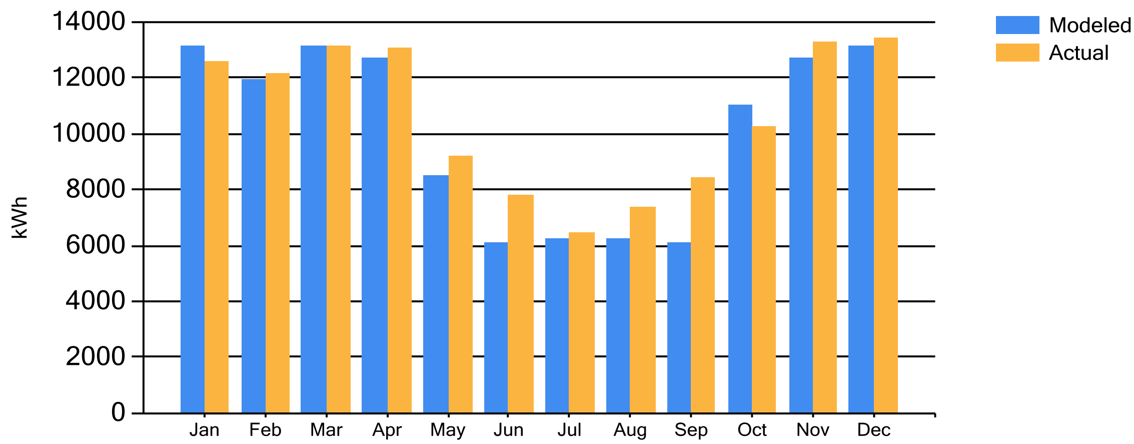
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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

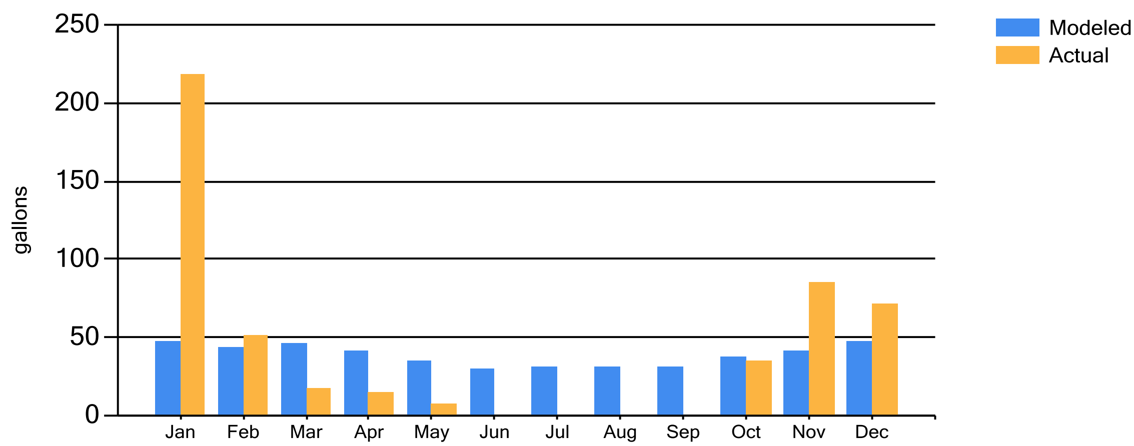
Annual Fuel Use



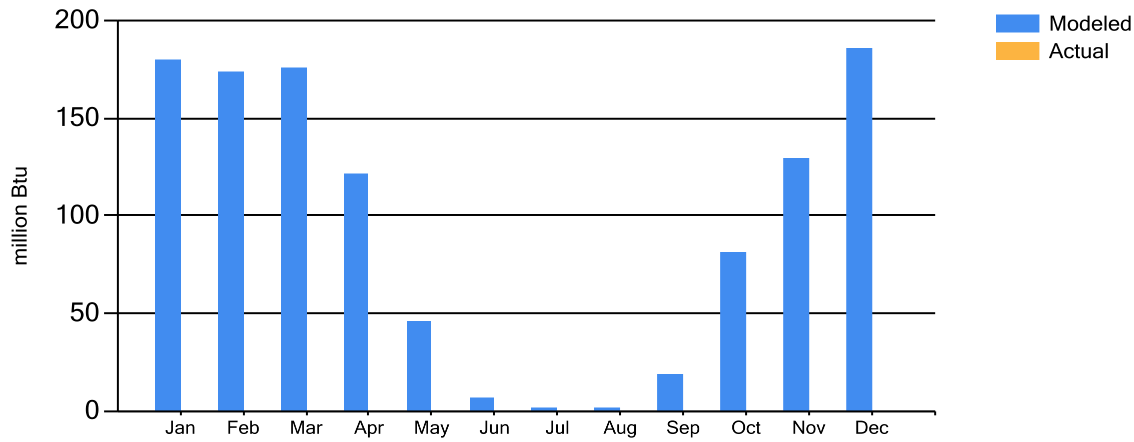
Electricity Fuel Use



#1 Fuel Oil Fuel Use



Recovered Heat Fuel Use



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

Appendix C - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	24.6	24.6	24.6	24.6	18.1	15.1	15.1	15.1	15.2	21.8	24.6	24.6
As Proposed	18.9	18.9	18.9	18.9	14.6	12.7	12.7	12.7	12.7	17.1	18.9	18.9

AkWarmCalc Ver 2.4.1.0, Energy Lib 3/30/2015