Comprehensive Energy Audit
For

Shageluk Water Treatment Plant & Washeteria

Prepared For
City of Shageluk

May 15, 2017

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PREFACE

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

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

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 Rural Energy Initiative gratefully acknowledges the assistance of Water Treatment Plant Operator John Hamilton, Mayor Chevie Roach, and City Administrator Scott Wolfershine.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Shageluk. The scope of the audit focused on the Shageluk Water Treatment Plant & Washeteria. The scope of this report is a comprehensive energy study, which included an analysis of building shell, interior and exterior lighting systems, HVAC 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 $39,270 per year. #1 Fuel oil represents the largest portion of energy use with an annual cost of approximately $18,199. Electricity is the remaining portion with an annual cost of approximately $15,294. This includes $7,477 paid by the City and $7,817 paid by the Power Cost Equalization program through the State of Alaska. There is a solar thermal water heater present in the system that is not in operation. With proper repairs and training, this could impact the heating fuel use.

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 Shageluk, the cost of electricity without PCE is $0.45/kWh and the cost of electricity with PCE is $0.22/kWh.

Table 1.1: Predicted Annual Fuel Use for the Shageluk Washeteria

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	33,986 kWh	15,187 kWh
#1 Oil	3,033 gallons	1,690 gallons
Solar Thermal	0.00 million Btu	36.03 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 Shageluk Washeteria

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	336.2	24.97	$21.80
With Proposed Retrofits	202.4	15.04	$11.05
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 Shageluk Water Treatment Plant & Washeteria. 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	Other Electrical: Septic Tank Heating (Controlled)	Shut off heat tape and use only for emergency thaw purposes. Lower electric heater settings.	$1,198	$500	28.14	0.4	4,790.9
2	Lighting: Exterior	Replace with new LED lights.	$122	$120	11.90	1.0	486.1
3	Lighting: Washeteria Hallway	Replace with new LED lights.	$254	$240	8.86	0.9	1,020.3
4	Dryers - Hydronic	Replace solenoid valves to prevent the dryers from constantly heating when not in use. Repair broken controls of dryer 2 to require coin-operation for use.	$3,043	$5,000	8.26	1.6	10,712.4
5	Other Electrical: Dryers - Electric	Repair hydronic dryers and convert dryer usage to hydronic units to take advantage of cheaper fuel costs.	$2,946	$5,000	6.85	1.7	11,878.2
6	Other Electrical: Raw Water Heat Tape	Shut off heat tape and use only for emergency thaw purposes.	$373	$500	6.27	1.3	1,490.0
7	Setback Thermostat: Washeteria	Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Washeteria space.	$463	$1,000	6.26	2.2	1,637.8
8	Lighting: Boiler Room	Replace with new LED lights.	$300	$400	6.20	1.3	1,225.1
9	Lighting: Process Room	Replace with new LED lights and add an occupancy sensor.	$678	$1,620	4.01	2.4	2,774.6
10	Other Electrical: Circulation Loop Heat Tape	Shut off heat tape and use only for emergency thaw purposes.	$223	$500	3.76	2.2	894.0
11	Lighting: Washeteria Room Lighting	Replace with new LED lights and add an occupancy sensor.	$478	$1,300	3.55	2.7	1,941.0
12	Setback Thermostat: Water Treatment Plant	Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Water Treatment Plant space.	$243	$1,000	3.28	4.1	859.5

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	Heating Systems and Domestic Hot Water	Replace Heat Loop Circulation Pumps with Grundfos Alpha models, Repair Solar Thermal Heater and train operator in proper use, Clean and tune boilers, replace guns, add tiger loops and fuel meters, insulate heating pipe (200 ft. approximately), Convert boiler system to a primary-secondary to allow boilers to operate independently and valve off when not in use, repair ceiling fan to improve space heat distribution in the water treatment plant space, Replace air relief valves throughout the plant (approx. 12), Add thermostats for the two bathrooms and create a separate heating zone such that bathroom heat can operate independently from the washeteria, Lower hot water heater temperature to 120F	$4,494	$25,000	3.01	5.6	14,227.0
14	Other Electrical: Clinic Circulation Pumps	Replace with Grundfos Alpha pumps	$173	$1,500	1.65	8.7	703.7
15	Lighting: Janitor Closet	Replace with new LED lights.	$15	$80	1.51	5.5	59.4
16	Air Tightening	Weatherize around the doors, replace door handles, and tighten the windows.	$656	$4,000	1.51	6.1	2,333.7
17	Lighting: Dryer Plenum	Replace with new LED lights.	$28	$160	1.43	5.8	113.6
18	Water Circulation Loop Heat-Add	Replace Heat Loop Heat Exchanger, Circulation Pumps, Lower Temperatures, Replace Flow Switches	$673	$14,000	0.83	20.8	2,387.0
19	Window: Broken Window (south)	Replace existing window with triple pane window.	$33	$1,016	0.56	30.9	117.3
20	Window: Broken Windows (3, not south)	Replace existing windows with triple pane windows.	$84	$3,056	0.47	36.2	300.6
21	Lighting: Sauna Lights	Replace with new LED lights.	$5	$120	0.34	24.4	19.9

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
22	Other Electrical: Well Pumps	Replace Pressure Switch, Clean Pipe interior, Replace Flow Meter	$24	$1,000	0.28	42.3	94.7
23	Lighting: Restroom Lights (2) - Fluor.	Replace with new LED lights.	$2	$80	0.20	41.2	8.0
24	Window: Window (not south)	Replace existing window with triple pane window.	$7	$1,016	0.12	144.3	25.0
25	Window: Window South	Replace existing window with triple pane window.	$6	$1,016	0.10	177.4	20.3
	TOTAL, all measures		**$16,519**	**$69,223**	**3.17**	**4.2**	**60,120.1**

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 $16,519 per year, or 49.3% of the buildings' total energy costs. These measures are estimated to cost $69,223, for an overall simple payback period of 4.2 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 Shageluk Water Treatment Plant & Washeteria

Annual Energy Cost Estimate							
Description	Space Heating	Water Heating	Clothes Drying	Lighting	Other Electrical	Water Circulation Heat	Total Cost
Existing Building	$3,776	$8,619	$5,655	$3,217	$10,185	$2,039	**$33,492**
With Proposed Retrofits	$2,662	$5,195	$1,802	$1,067	$5,019	$1,229	**$16,973**
Savings	$1,115	$3,425	$3,854	$2,150	$5,166	$810	**$16,519**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

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

2.2 Audit Description

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

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

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

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

Shageluk Water Treatment Plant & Washeteria is made up of the following activity areas:

1) Washeteria: 674 square feet
2) Water Treatment Plant: 863 square feet

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

- Occupancy hours
- Local climate conditions

- Prices paid for energy

2.3. Method of Analysis

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

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

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

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

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

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

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

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

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

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

2.4 Limitations of Study

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

3. Shageluk Water Treatment Plant & Washeteria

3.1. Building Description

The 1,536 square foot Shageluk Water Treatment Plant & Washeteria was constructed in 1993. The building houses the central water intake and treatment systems along with a watering point for community access and a circulating loop to the clinic. Additionally, the building houses a washeteria with community access to community showers, rest rooms, a sauna, and laundromat services. The water treatment plant side of the building is occupied by the operator approximately six hours per day. The washeteria side is open 24 hours per day but is most frequently operated between the hours of 12-8pm by residents who are using the laundromat services.

Raw water is pumped into the building from a well located beneath the building. From there it is treated with chlorine and stored inside six 40-gallon pressure tanks. From this point it can be distributed through a circulating loop to the clinic or to the watering point for community access. Water is also used for the clothes washers, restrooms, and showers and is heated by an independent hot water heater. A solar thermal water heater is also plumbed in but not operational.

Figure 1: Pressure Tanks used for Water Storage

Figure 2 (Right): Wastewater Dosing Tank

There is a sauna in the building that is used occasionally by elders in the community. When in use the sauna space is heated to approximately 120 deg. F using a sauna heater, which produces steam inside the room by pouring water onto rocks that have been heated by a oil-fired burner to create a fire inside the heater.

Figure 3: Sauna Heater

Figure 4: Sauna Heater Blower Unit

All wastewater is transported through a storage tank in the mechanical space to a new septic tank by gravity and into a sewage lagoon. There is no moving equipment at the septic tank site except for two electric heaters and a heat tape for freeze protection.

Figure 5: Shageluk Septic Tank

Description of Building Shell

The exterior walls are 2 x 6 wood-framed construction with polyurethane foam insulation.

The building has a cathedral ceiling with a loft over the washeteria space. The roof has 2 x 6 construction with polyurethane foam insulation.

The building is built on piles with 2x10 lumber and foam insulation.

There are six windows in the building. All of the windows are measured at 22.5”x34.25” with wood framing and double-pane glass, though four of the six windows have broken glass. There is a broken window and a standard window that are south facing.

The washeteria entrance has an arctic entry with two insulated metal single doors. The water treatment plant entrance has a set of insulated-metal double-doors. The door handles on these were noted as needing replacements.

Description of Heating Plants

The heating plants used in the building are:

Boiler 1

Nameplate Information:	Burnham Model PV89WC-GBWN2S
Fuel Type:	#1 Oil
Input Rating:	260,000 BTU/hr

Steady State Efficiency:	83 %
Idle Loss:	1 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Boiler 2

Nameplate Information:	Burnham Model PV89WC-GBWN2S
Fuel Type:	#1 Oil
Input Rating:	260,000 BTU/hr
Steady State Efficiency:	83 %
Idle Loss:	1 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Figure 6: Fuel Oil Boilers

Solar Thermal Water Heater

Nameplate Information:	Heliodyne 3 Panels H-Pak 32?
Fuel Type:	Solar Thermal
Input Rating:	32,000 BTU/hr
Steady State Efficiency:	80 %
Idle Loss:	0 %
Heat Distribution Type:	Water
Operation:	All Year

The solar thermal water heater has not been actively used in years.

Figure 7: Solar Thermal Water Heater

Hot Water Heater

Fuel Type:	#1 Oil
Input Rating:	535,000 BTU/hr
Steady State Efficiency:	70 %
Idle Loss:	0.5 %
Heat Distribution Type:	Water
Operation:	All Year

Figure 8: Fuel Oil Hot Water Heater

Space Heating Distribution Systems

There are two space heaters in the building that distribute heat from the boilers through hydronic piping. Each of the unit heaters is rated for approximately 30,000 BTU/hr. The space heaters were functional but not operating during the site visit because of significant heat losses from exposed piping and the hydronic dryers.

Figure 9: Process Room Unit Heater

Figure 10: Washeteria Unit Heater

Domestic Hot Water System

Domestic hot water is used in the facility for clothes washers, showers, and restroom usage. The washeteria sees an average of six washer loads per day, and the showers see an average of 45 minutes of usage per day. This sums to an approximate total of 107.5 gallons of hot water usage per day. The water is heated to 138 deg. F by the hot water heater.

Lighting

Table 3.1: Lighting Details for the Shageluk Water Treatment Plant & Washeteria

Room	Bulb Type	Fixtures	Bulbs per Fixture	Annual Usage (kWh)
Boiler Room	Fluorescent T8 4ft.	5	4	1,234
Process Room	Fluorescent T8 4ft.	14	3	2,611
Dryer Plenum	Fluorescent T8 4ft.	2	2	252
Washeteria Room	Fluorescent T8 4ft.	10	3	1,557
Washeteria Hallway	Fluorescent T12 4ft.	3	3	946
Janitor Closet	Fluorescent T12 4ft.	1	4	53
Restroom Lights (2)	Fluorescent T12 4ft.	2	1	13
Restroom Lights (2)	CFL Plug-In Quad-Tube 13W	2	1	5

Sauna Lights	Incandescent 60W	3	1	19
Exterior	Incandescent 60W	3	1	459

Plug Loads

The Shageluk Water Treatment Plant & Washeteria 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

Table 3.2: Major Electrical Equipment Information for the Shageluk Water Treatment Plant & Washeteria

Equipment	Rating (Watts)	Annual Usage (kWh)
Well Pumps	1,500	526
Raw Water Heat Tape	250	853
Clinic Circulation Pumps	85	745
Chlorine Pump	180	63
Circulation Loop Heat Tape	150	512
Clothes Washers	1,176	2,864
Electric Dryers	5,750	14,004
Battery Charger - ATV	3,500	265
Septic Tank Heat Tape	550	2,801

There are two well pumps that are used to pump water from the well beneath the building into the pressure tanks. The well pumps are controlled by a pressure switch that activates the pumps when the water pressure has dropped below 18 PSI and stops the pumps at 36 PSI. This yields a pump runtime of approximately 4% of the time according to measurements taken during the site visit. During the months of December 2016 and January 2017, the pressure switch malfunctioned and the pumps ran constantly, causing a massive increase in the plant electric load. This issue was resolved prior to the site visit for this audit.

There are two heat tapes on the raw water and clinic loop that are used in the cold periods of winter when the temperature drops below 0 deg. F. These heat tapes are labeled incorrectly with the raw water heat taped labeled "Clinic" and the Clinic Loop heat tape labeled "Raw Water". This was the result of emergency repairs that switched the heat tapes to prevent freezing during a cold stretch.

There approximately six clothes washer loads daily in the washeteria. This uses 2,864 kWh annually. There are also six dryer loads daily in the washeteria. Currently, the electric dryers are primarily used because of controls problems with the coin-operation of the hydronic dryers. Repairs of the coin-operations and of the solenoid valves that are causing constant heating for the hydronic dryers will allow the community to switch operations to the cheaper hydronic units.

Figure 11: Hydronic Dryers

Figure 12: Electric Washers and Dryers

The septic tank has a two electric resistance heaters that are controlled by a thermostat that regulates according to the inside temperature. There is also a small heat tape that runs from the septic tank to the sewage lagoon discharge. This was installed as a separate electric meter in November 2016 following the conclusion of a large sanitation project to repair the sewage lagoon and install the new septic tank. The sewer tank heating is expected to consume approximately 2,801 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 services to all residential, commercial, and public facilities in Shageluk.

The average cost for each type of fuel used in this building is shown below in Table 3.3. This figure includes all surcharges, subsidies, and utility customer charges:

Table 3.3: Energy Cost Rates for Each Fuel Type

Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.4500/kWh
#1 Oil	$ 6.00/gallons

Solar Thermal	$ 0.00/million Btu

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, the City of Shageluk pays approximately $33,492 annually for electricity and other fuel costs for the Shageluk Water Treatment Plant & Washeteria.

Figure 13 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.

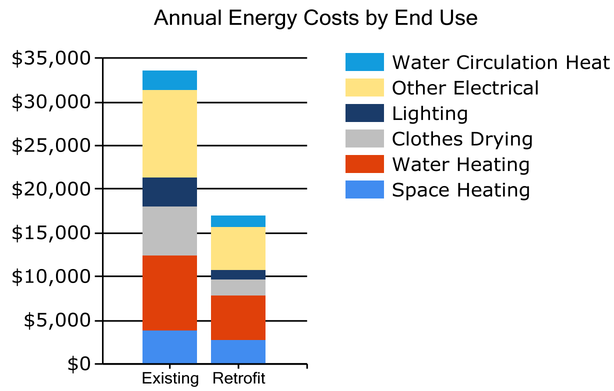


Figure 13: Annual Energy Costs by End Use

Figure 14 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.

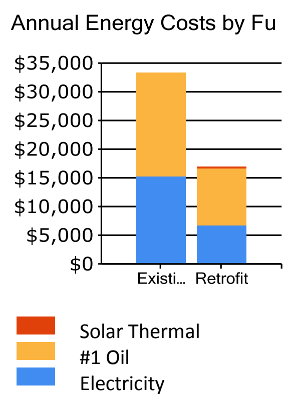


Figure 14: Annual Energy Costs by Fuel Type

Figure 15 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.

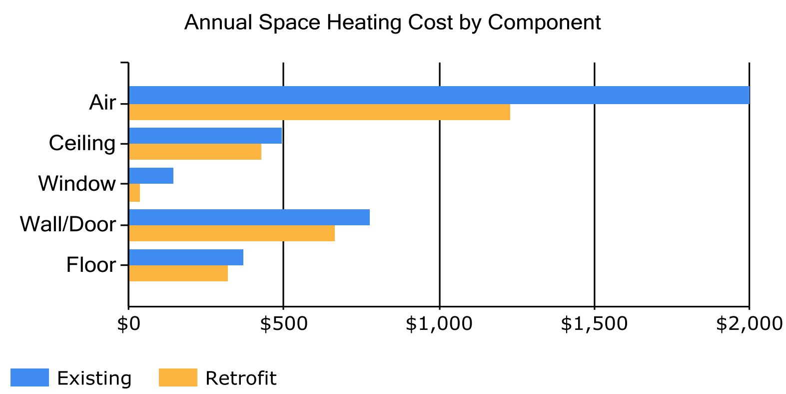


Figure 15: Annual Space Heating Costs

Tables 3.4, 3.5, and 3.6 below show AkWarm's estimate of the monthly usage for each energy source used in the building. For each energy source, the use is broken down across the energy end uses. Note, in the tables below "DHW" refers to Domestic Hot Water heating.

Table 3.4: Estimated Electrical Consumption by Category

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	213	186	192	170	166	157	162	162	162	179	188	212
DHW	138	125	138	133	138	133	138	138	133	138	133	138
Lighting	635	578	635	614	568	549	568	568	549	635	614	635
Other Electrical	2064	1881	2064	1945	1401	1772	1831	1831	1772	2010	1998	2064
Water Circulation Heat	63	58	63	61	0	0	0	0	0	63	61	63

Table 3.5: Estimated Fuel Oil Consumption by Category

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	112	83	59	15	0	0	0	0	0	23	65	111
DHW	112	102	112	108	112	108	112	112	108	112	108	112
Clothes Drying	69	64	73	77	90	87	90	90	87	78	70	69
Water Circulation Heat	59	48	43	26	0	0	0	0	0	29	44	58

Table 3.6: Estimated Solar Thermal Consumption

Solar Thermal Consumption (Million Btu)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
DHW	0	0	0	0	0	0	0	0	0	0	0	0

.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 3.8 for details):

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

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

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

Table 3.7: Building EUI Calculations for the Shageluk Water Treatment Plant & Washeteria

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	33,986 kWh	115,994	3.340	387,420
#1 Oil	3,033 gallons	400,372	1.010	404,376
Solar Thermal	0.00 million Btu	0	1.280	0
Total		**516,366**		**791,796**
BUILDING AREA		1,536	Square Feet	
BUILDING SITE EUI		336	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		515	**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 3.8: Building Benchmarks for the Shageluk Water Treatment Plant & Washeteria

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	336.2	24.97	$21.80
With Proposed Retrofits	202.4	15.04	$11.05
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 Shageluk Water Treatment Plant & Washeteria was modeled using AkWarm© energy use software to establish a baseline space heating energy usage. Climate data from Shageluk 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 Shageluk. 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: Summary List of Recommended Energy Efficiency Measures Ranked by Economic Priority

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: Septic Tank Heating (Controlled)	Shut off heat tape and use only for emergency thaw purposes. Lower electric heater settings.	$1,198	$500	28.14	0.4	4,790.9
2	Lighting: Exterior	Replace with new LED lights.	$122	$120	11.90	1.0	486.1
3	Lighting: Washeteria Hallway	Replace with new LED lights.	$254	$240	8.86	0.9	1,020.3
4	Dryers - Hydronic	Replace solenoid valves to prevent the dryers from constantly heating when not in use. Repair broken controls of dryer 2 to require coin-operation for use.	$3,043	$5,000	8.26	1.6	10,712.4
5	Other Electrical: Dryers - Electric	Repair hydronic dryers and convert dryer usage to hydronic units to take advantage of cheaper fuel costs.	$2,946	$5,000	6.85	1.7	11,878.2
6	Other Electrical: Raw Water Heat Tape	Shut off heat tape and use only for emergency thaw purposes.	$373	$500	6.27	1.3	1,490.0
7	Setback Thermostat: Washeteria	Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Washeteria space.	$463	$1,000	6.26	2.2	1,637.8
8	Lighting: Boiler Room	Replace with new LED lights.	$300	$400	6.20	1.3	1,225.1
9	Lighting: Process Room	Replace with new LED lights and add an occupancy sensor.	$678	$1,620	4.01	2.4	2,774.6
10	Other Electrical: Circulation Loop Heat Tape	Shut off heat tape and use only for emergency thaw purposes.	$223	$500	3.76	2.2	894.0
11	Lighting: Washeteria Room Lighting	Replace with new LED lights and add an occupancy sensor.	$478	$1,300	3.55	2.7	1,941.0
12	Setback Thermostat: Water Treatment Plant	Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Water Treatment Plant space.	$243	$1,000	3.28	4.1	859.5

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	Heating Systems and Domestic Hot Water	Replace Heat Loop Circulation Pumps with Grundfos Alpha models, Repair Solar Thermal Heater and train operator in proper use, Clean and tune boilers, replace guns, add tiger loops and fuel meters, insulate heating pipe (200 ft. approximately), Convert boiler system to a primary-secondary to allow boilers to operate independently and valve off when not in use, repair ceiling fan to improve space heat distribution in the water treatment plant space, Replace air relief valves throughout the plant (approx. 12), Add thermostats for the two bathrooms and create a separate heating zone such that bathroom heat can operate independently from the washeteria, Lower hot water heater temperature to 120F	$4,494	$25,000	3.01	5.6	14,227.0
14	Other Electrical: Clinic Circulation Pumps	Replace with Grundfos Alpha pumps	$173	$1,500	1.65	8.7	703.7
15	Lighting: Janitor Closet	Replace with new LED lights.	$15	$80	1.51	5.5	59.4
16	Air Tightening	Weatherize around the doors, replace door handles, and tighten the windows.	$656	$4,000	1.51	6.1	2,333.7
17	Lighting: Dryer Plenum	Replace with new LED lights.	$28	$160	1.43	5.8	113.6
18	Water Circulation Loop Heat-Add	Replace Heat Loop Heat Exchanger, Circulation Pumps, Lower Temperatures, Replace Flow Switches	$673	$14,000	0.83	20.8	2,387.0
19	Window: Broken Window (south)	Replace existing window with triple pane window.	$33	$1,016	0.56	30.9	117.3
20	Window: Broken Windows (3, not south)	Replace existing windows with triple pane windows.	$84	$3,056	0.47	36.2	300.6
21	Lighting: Sauna Lights	Replace with new LED lights.	$5	$120	0.34	24.4	19.9

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
22	Other Electrical: Well Pumps	Replace Pressure Switch, Clean Pipe interior, Replace Flow Meter	$24	$1,000	0.28	42.3	94.7
23	Lighting: Restroom Lights (2) - Fluor.	Replace with new LED lights.	$2	$80	0.20	41.2	8.0
24	Window: Window (not south)	Replace existing window with triple pane window.	$7	$1,016	0.12	144.3	25.0
25	Window: Window South	Replace existing window with triple pane window.	$6	$1,016	0.10	177.4	20.3
	TOTAL, all measures		**$16,519**	**$69,223**	**3.17**	**4.2**	**60,120.1**

4.2 Interactive Effects of Projects

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

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

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

4.3 Building Shell Measures

4.3.1 Window Measures

Rank	Location	Size/Type, Condition	Recommendation
19	Window: Broken Window (south)	Glass: No glazing - broken, missing Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.94 Solar Heat Gain Coefficient including Window Coverings: 0.11	Replace existing window with triple pane window.

Installation Cost	$1,016	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$33
Breakeven Cost	$565	**Simple Payback (yrs)**	31	**Energy Savings (MMBTU/yr)**	0.7 MMBTU
		Savings-to-Investment Ratio	0.6		

Auditors Notes: Replacing the windows will improve the total wall insulation and air leakage of the building.

Rank	Location	Size/Type, Condition	Recommendation
20	Window: Broken Windows (3, not south)	Glass: No glazing - broken, missing Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.94 Solar Heat Gain Coefficient including Window Coverings: 0.11	Replace existing windows with triple pane windows.

Installation Cost	$3,056	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$84
Breakeven Cost	$1,448	**Simple Payback (yrs)**	36	**Energy Savings (MMBTU/yr)**	1.7 MMBTU
		Savings-to-Investment Ratio	0.5		

Auditors Notes: Replacing the windows will improve the total wall insulation and air leakage of the building.

Rank	Location	Size/Type, Condition	Recommendation
24	Window: Window (not south)	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46	Replace existing window with triple pane window.

Installation Cost	$1,016	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$7
Breakeven Cost	$121	**Simple Payback (yrs)**	144	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	0.1		

Auditors Notes: Replacing the windows will improve the total wall insulation and air leakage of the building.

Rank	Location	Size/Type, Condition	Recommendation
25	Window: Window South	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46	Replace existing window with triple pane window.

Installation Cost	$1,016	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$6
Breakeven Cost	$99	**Simple Payback (yrs)**	177	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	0.1		

Auditors Notes: Replacing the windows will improve the total wall insulation and air leakage of the building.

4.3.2 Air Sealing Measures

Rank	Location		Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
16			Air Tightness from Blower Door Test: 3000 cfm at 50 Pascals		Weatherize around the doors, replace door handles, and tighten the windows	
Installation Cost	$4,000	**Estimated Life of Measure (yrs)**	10		**Energy Savings ($/yr)**	$656
Breakeven Cost	$6,047	**Simple Payback (yrs)**	6		**Energy Savings (MMBTU/yr)**	13.6 MMBTU
		Savings-to-Investment Ratio	1.5			
Auditors Notes: Adding weather stripping to the doors, caulking windows, and replacing the door handles in the water treatment plant entrance will reduce the amount of heat loss through those penetrations and lower the heating load for the building.						

4.4 Mechanical Equipment Measures

4.4.1 Heating /Domestic Hot Water Measure

Rank	Recommendation				
13	Replace Heat Loop Circulation Pumps with Grundfos Alpha models, Repair Solar Thermal Heater and train operator in proper use, Clean and tune boilers, replace guns, add tiger loops and fuel meters, insulate heating pipe (200 ft. approximately), Convert boiler system to a primary-secondary to allow boilers to operate independently and valve off when not in use, repair ceiling fan to improve space heat distribution in the water treatment plant space, Replace air relief valves throughout the plant (approx. 12), Add thermostats for the two bathrooms and create a separate heating zone such that restroom heat can operate independently from the washeteria, Lower hot water heater temperature to 120F				
Installation Cost	$25,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$4,494
Breakeven Cost	$75,372	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	47.9 MMBTU
		Savings-to-Investment Ratio	3.0		

Auditors Notes: Auditors Notes: The heating circulation pumps can be replaced with Grundfos Alpha models to modulate the flow control and reduce excess electricity usage.

The solar water heater has not been in use because of a lack of training in solar thermal heating for the community and water plant operator. Additionally, the solar thermal water heater should be inspected to verify proper heating function. This retrofit is to train the community in the system use and use the solar thermal water heater to supplement the domestic hot water loads in the washeteria. This estimates that the solar heating can displace 33% of the domestic water heating costs.

Cleaning and tuning the boilers will improve the overall maintenance of the boilers and eliminate soot from the combustion chambers. Replacing the guns and adding tiger loops and fuel meters will provide high-efficiency operations with additional safeties to increase the life of the boilers.

There is approximately 200 ft. of pipe related to the hydronic heating system that is uninsulated. This causes excess loss to the atmosphere that could be of more efficient use in the hydronic systems. Insulate the pipes to reduce the heat loss.

Currently, the boilers operate in parallel with hot glycol flowing through both boilers. This causes the boiler not currently in use to act as a heat sink, storing heat that could be used elsewhere. Adding a check valve and providing boiler controls can prevent heat losses from a boiler not in use.

The ceiling fan is not currently functioning and could be used to improve the space heat distribution so that the high-ceilings and lofted areas are not heated more than necessary.

The air relief valves are not installed properly and should be replaced for optimal operations of the hydronic heating system.

The restrooms are currently zoned into the same heating loop as the washeteria but often do not need to be heated at the same levels. Adding a zone valve and providing an additional thermostat can reduce the heat going to the restrooms when they are unoccupied..

The independent hot water heater is set to 138 deg. F, which is above the necessary temperature of 120 deg. F for domestic hot water needs.

Heating Circulation Pumps Replacement	$2500
Solar Thermal Water Heater Training	$500
Boiler Cleaning, Tuning, and Adjustments	$5000
Pipe Insulation	$1000
Valve off Boilers	$5000
Ceiling Fan Repair	$500
Air Relief Valve Replacement	$6000
Restroom Heating Zone	$4000
Hot Water Heater Set Point Adjustment	$500
Total	**$25,000**

4.4.2 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
7	Washeteria			Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Washeteria space.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$463
Breakeven Cost	$6,258	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	10.0 MMBTU
		Savings-to-Investment Ratio	6.3		
Auditors Notes: Lowering the temperature when not occupied can prevent the building from using more heat than necessary. This will only be effective with a repair of the dryer heating.					

Rank	Building Space			Recommendation	
12	Water Treatment Plant			Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Water Treatment Plant space.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$243
Breakeven Cost	$3,284	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	5.2 MMBTU
		Savings-to-Investment Ratio	3.3		
Auditors Notes: Lowering the temperature when not occupied can prevent the building from using more heat than necessary. This will only be effective with a repair of the dryer heating.					

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	Exterior	3 INCAN A Lamp, Std 60W		Replace with new LED lights.	
Installation Cost	$120	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$122
Breakeven Cost	$1,428	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.9 MMBTU
		Savings-to-Investment Ratio	11.9		
Auditors Notes: There are three single light bulbs on the building exterior to be replaced.					

Rank	Location	Existing Condition		Recommendation	
3	Washeteria Hallway	3 FLUOR (3) T12 4' F40T12 40W Standard StdElectronic		Replace with new LED lights.	
Installation Cost	$240	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$254
Breakeven Cost	$2,127	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	1.8 MMBTU
		Savings-to-Investment Ratio	8.9		
Auditors Notes: There are three fixtures with three light bulbs in each fixture to be replaced with two light bulbs per fixture for a total of six replacement light bulbs.					

Rank	Location	Existing Condition		Recommendation	
8	Boiler Room	5 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new LED lights.	
Installation Cost	$400	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$300
Breakeven Cost	$2,479	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	1.5 MMBTU
		Savings-to-Investment Ratio	6.2		
Auditors Notes: There are five fixtures with four light bulbs in each fixture to be replaced with two light bulbs per fixture for a total of ten replacement light bulbs.					

Rank	Location	Existing Condition		Recommendation	
9	Process Room	14 FLUOR (3) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new LED lights and add an occupancy sensor.	
Installation Cost	$1,620	**Estimated Life of Measure (yrs)**	12	**Energy Savings ($/yr)**	$678
Breakeven Cost	$6,491	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	3.3 MMBTU
		Savings-to-Investment Ratio	4.0		
Auditors Notes: There are 14 fixtures with three light bulbs in each fixture to be replaced with two light bulbs per fixture for a total of 28 replacement light bulbs. Add an occupancy sensor to reduce excess lighting usage when unoccupied.					

Rank	Location	Existing Condition		Recommendation	
11	Washeteria Room Lighting	10 FLUOR (3) T8 4' F32T8 32W Standard Program StdElectronic		Replace with new LED lights and add an occupancy sensor.	
Installation Cost	$1,300	**Estimated Life of Measure (yrs)**	12	**Energy Savings ($/yr)**	$478
Breakeven Cost	$4,610	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	2.8 MMBTU
		Savings-to-Investment Ratio	3.5		
Auditors Notes: There are ten fixtures with three light bulbs in each fixture to be replaced with two light bulbs per fixture for a total of 20 replacement light bulbs. Add an occupancy sensor to reduce excess lighting usage when unoccupied.					

Rank	Location	Existing Condition		Recommendation	
15	Janitor Closet	FLUOR (4) T12 4' F40T12 40W Standard StdElectronic		Replace with new LED lights.	
Installation Cost	$80	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$15
Breakeven Cost	$121	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	1.5		
Auditors Notes: There is one fixture with four light bulbs in each fixture to be replaced with two light bulbs per fixture for a total of two replacement light bulbs.					

Rank	Location	Existing Condition		Recommendation	
17	Dryer Plenum	2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new LED lights.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$28
Breakeven Cost	$230	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	1.4		
Auditors Notes:					

Rank	Location	Existing Condition		Recommendation	
21	Sauna Lights	3 INCAN A Lamp, Std 60W		Replace with new LED lights.	
Installation Cost	$120	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$5
Breakeven Cost	$41	**Simple Payback (yrs)**	24	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.3		
Auditors Notes: There are three single light bulbs in the sauna to be replaced.					

Rank	Location	Existing Condition		Recommendation	
23	Restroom Lights (2) - Fluor.	2 FLUOR T12 3' Standard StdElectronic		Replace with new LED lights.	
Installation Cost	$80	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$2
Breakeven Cost	$16	**Simple Payback (yrs)**	41	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.2		
Auditors Notes: There are two fixtures with two light bulbs in each fixture for a total of four light bulbs to be replaced. These are 3ft. light bulb models.					

4.5.3 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
1	Septic Tank Heating (Controlled)	Electric Heating and Heat Tape		Shut off heat tape and use only for emergency thaw purposes. Lower electric heater settings.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$1,198
Breakeven Cost	$14,069	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	9.1 MMBTU
		Savings-to-Investment Ratio	28.1		
Auditors Notes: Shutting off the heat tape except for extreme conditions will allow the system to operate with just enough heat to prevent freezing without using excess power. Lower the electric heater settings so that the sewage is protected from freezing without using excess energy. This would involve using a set point of 40 deg. F for the inside of the septic tank and sewage lines.					

Rank	Location	Description of Existing		Efficiency Recommendation	
5	Dryers - Electric	Dryers		Repair hydronic dryers and convert dryer usage to hydronic units to take advantage of cheaper fuel costs.	
Installation Cost	$5,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$2,946
Breakeven Cost	$34,236	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	19.5 MMBTU
		Savings-to-Investment Ratio	6.8		

Auditors Notes: As the hydronic dryers get repaired, use them more instead of the electric dryers to take advantage of cheaper fuel over electricity costs.

Rank	Location	Description of Existing		Efficiency Recommendation	
6	Raw Water Heat Tape	Heat Tape		Shut off heat tape and use only for emergency thaw purposes.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$373
Breakeven Cost	$3,137	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	2.8 MMBTU
		Savings-to-Investment Ratio	6.3		

Auditors Notes: Shutting off the heat tape except for extreme conditions will allow the system to operate with just enough heat to prevent freezing without using excess power.

Rank	Location	Description of Existing		Efficiency Recommendation	
10	Circulation Loop Heat Tape	Heat Tape		Shut off heat tape and use only for emergency thaw purposes.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$223
Breakeven Cost	$1,882	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	1.7 MMBTU
		Savings-to-Investment Ratio	3.8		

Auditors Notes: Shutting off the heat tape except for extreme conditions will allow the system to operate with just enough heat to prevent freezing without using excess power.

Rank	Location	Description of Existing		Efficiency Recommendation	
14	Clinic Circulation Pumps	Circulation Pump		Replace with Grundfos Alpha pumps	
Installation Cost	$1,500	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$173
Breakeven Cost	$2,469	**Simple Payback (yrs)**	9	**Energy Savings (MMBTU/yr)**	1.0 MMBTU
		Savings-to-Investment Ratio	1.6		

Auditors Notes: Replace with Grundfos Alpha models (2 pumps). These pumps will modulate the flow and provide the clinic loop with enough pressure to maintain service while minimizing electric usage. Shut off pumps during the summer months when freeze protection is not needed. Pumps can then operate as needed.

Rank	Location	Description of Existing		Efficiency Recommendation	
22	Well Pumps	Well Pump		Replace Pressure Switch, Clean Pipe interior, Replace Flow Meter	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$24
Breakeven Cost	$278	**Simple Payback (yrs)**	42	**Energy Savings (MMBTU/yr)**	0.2 MMBTU
		Savings-to-Investment Ratio	0.3		

Auditors Notes: These repairs will allow the well pumps to operate within optimal system parameters of 18-36 psi and improve the interior flow of the pipe. Replacing the flow meter will allow the operator to safely monitor the water system performance in order to improve the efficiency of the operations.

4.5.4 Other Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
4		Clothes Dryers		Replace solenoid valves to prevent the dryers from constantly heating when not in use. Repair broken controls of dryer 2 to require coin-operation for use.	
Installation Cost	$5,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$3,043
Breakeven Cost	$41,293	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	67.0 MMBTU
		Savings-to-Investment Ratio	8.3		

Auditors Notes: Adding solenoid valves and repairing the controls will make the dryer operate only when user begins a load. The controls will then call for heat that will be supplied by the boilers. Currently, the dryers are constantly heated to a temperature of 160 deg. F and the system is experiencing massive heat loss.

Rank	Location	Description of Existing		Efficiency Recommendation	
18		Water Circulation Loop Heat		Replace Heat Loop Heat Exchanger, Circulation Pumps, Lower Temperatures, Replace Flow Switches	
Installation Cost	$14,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$673
Breakeven Cost	$11,623	**Simple Payback (yrs)**	21	**Energy Savings (MMBTU/yr)**	14.3 MMBTU
		Savings-to-Investment Ratio	0.8		

Auditors Notes: The existing heat exchanger is old and the transfer of heat is not efficient. Replacing the heat exchanger will also provide the system with the security of a double-wall heat exchanger, which prevents any glycol from entering the water system.

The circulation pumps can be replaced with Grundfos Alpha models to modulate the flow control and reduce excess electricity usage.

The water circulation loop temperatures can be lowered to 40 deg. F to provide freeze protection while reducing excess heating loads.

Replace the flow switches to insure proper controls of the circulation flow rates.

Heat Exchanger Replacement	$10,750
Circulation Pumps Replacement	$2000
Lower Circulation Loop Temperatures	$250
Flow Switch Replacement	$1000
Total	**$14000**

5. ENERGY EFFICIENCY ACTION PLAN

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

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

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

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Shageluk Water Treatment Plant & Washeteria	**Auditor Company:** ANTHC-DEHE
Address: PO Box 110	**Auditor Name:** Kevin Ulrich
City: Shageluk	**Auditor Address:** 4500 Diplomacy Drive Anchorage, AK 99508
Client Name: John Hamilton	
Client Address: PO Box 110 Shageluk, AK 99665	**Auditor Phone:** (907) 729-3237
	Auditor FAX:
Client Phone: (907) 310-1819	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 1,536 square feet	**Design Space Heating Load:** Design Loss at Space: 2,912 Btu/hour with Distribution Losses: 3,066 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 4,673 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 2 people	**Design Indoor Temperature:** 64.4 deg F (building average)
Actual City: Shageluk	**Design Outdoor Temperature:** -39.2 deg F
Weather/Fuel City: Shageluk	**Heating Degree Days:** 13,462 deg F-days
Utility Information	
Electric Utility: Alaska Village Electric Cooperative	**Average Annual Cost/kWh:** $0.45/kWh

Annual Energy Cost Estimate							
Description	**Space Heating**	**Water Heating**	**Clothes Drying**	**Lighting**	**Other Electrical**	**Water Circulation Heat**	**Total Cost**
Existing Building	$3,776	$8,619	$5,655	$3,217	$10,185	$2,039	**$33,492**
With Proposed Retrofits	$2,662	$5,195	$1,802	$1,067	$5,019	$1,229	**$16,973**
Savings	$1,115	$3,425	$3,854	$2,150	$5,166	$810	**$16,519**

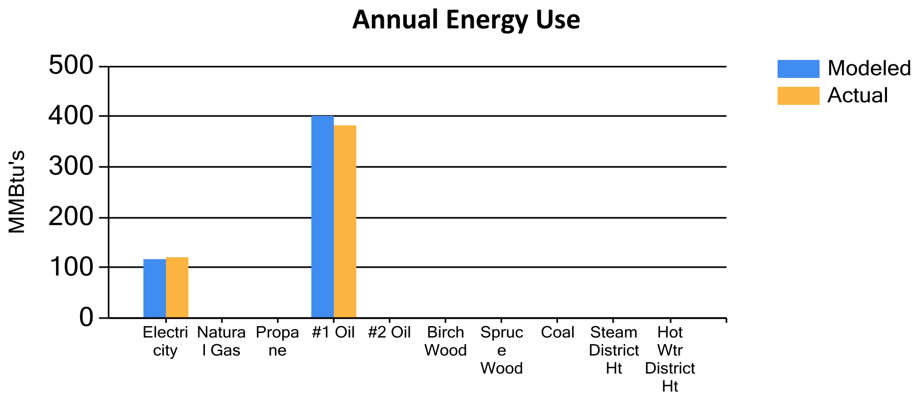
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	336.2	24.97	$21.80
With Proposed Retrofits	202.4	15.04	$11.05

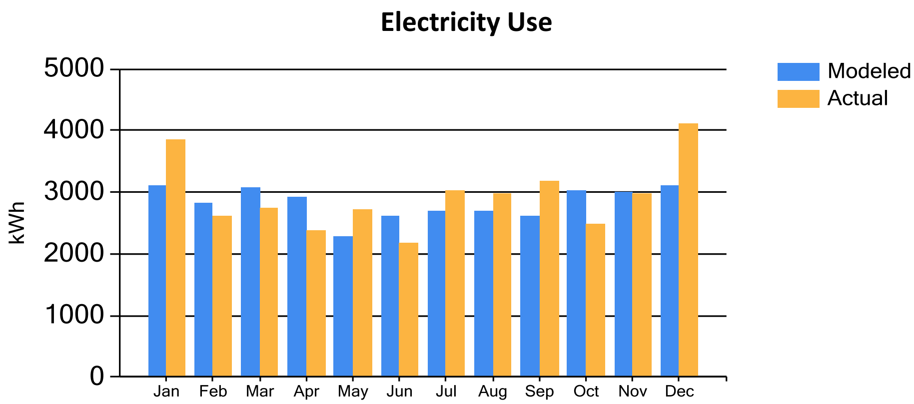
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure’s conditioned area.
EUI/HDD: Energy Use Intensity per Heating Degree Day.

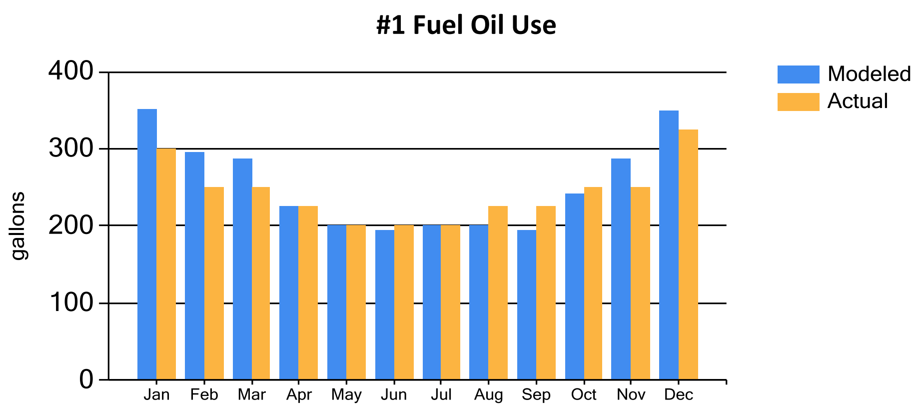
ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.

Appendix B – Actual Fuel Use versus Modeled Fuel Use

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







Appendix C - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	11.6	11.5	11.5	11.5	10.5	10.5	10.5	10.5	10.5	11.5	11.5	11.6
As Proposed	5.8	5.8	5.7	5.6	5.4	5.4	5.4	5.4	5.4	5.6	5.7	5.8

AkWarmCalc Ver 2.6.1.0, Energy Lib 8/9/2016