Comprehensive Energy Audit
For

Shungnak Water Treatment Plant

Prepared For

City of Shungnak

November 9, 2018

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ANTHC-DEHE
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Table of Contents

PREFACE

This energy audit was conducted using funds provided by the Denali Commission. Coordination with the City of Shungnak has been undertaken to provide maximum accuracy in identifying facilities to audit, and to facilitate energy efficiency project development after the audit process is complete.

The Rural Energy Initiative at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for the City of Shungnak, Alaska. The authors of this report are Kevin Ulrich, Assistant Engineering Project Manager, Mechanical Engineer in Training (EIT), and Certified Energy Manager (CEM); and Jonathon Pierson, Project Manager.

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in May of 2018 by the ANTHC Rural Energy Initiative. 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 Art Sheldon, Water Treatment Plant Operator; Gilbert Snell, Backup Water Plant Operator; and Helen Mitchell, City Administrator.

LIMITATIONS OF THIS STUDY

The building modeling software AkWarm© was used to create a virtual representation of the Shungnak Water Treatment Plant. The model is then used to test the cost effectiveness of different energy efficiency measures (EEMs) like LED lighting and pump improvements. The AkWarm© software calculates the annual cost savings and payback period for the investment, and then ranks all EEMs based on their payback period.

There are limitations using this software, which may affect the accuracy of the EEMs cost savings. This report should serve as a guide when deciding which EEMS to pursue further. All EEMs and installation costs should be verified with a certified professional in that field before construction begins.

1. EXECUTIVE SUMMARY

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy costs for the Shungnak Water Treatment Plant are $71,574 per year. Electricity is the largest expense, with the annual electricity usage estimated at $56,192 (before applying the PCE electricity subsidy) or 78.5% of the total energy cost for the facility. Heat recovery is the second highest expense, estimated at $9,170 per year or 12.8% of the total energy costs. Diesel (#1 fuel oil) comprises the remaining expense, estimated at $6,212 per year or 8.7% of the total energy costs.

The State of Alaska Power Cost Equalization (PCE) program provides a subsidy to rural communities across the state to lower electricity costs and make energy affordable in rural Alaska. In Shungnak, the cost of electricity without the PCE subsidy was approximately $0.66 per kilowatt-hour (kWh) and the cost with PCE was approximately $0.22 per kWh in 2018.

Table 1.1 lists the total usage of electricity in the Shungnak Water Treatment Plant before and after the proposed retrofits.

Table 1.1: Predicted Annual Use for the Shungnak Water Treatment Plant

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	85,140 kWh	52,554 kWh
#1 Oil	739 gallons	700 gallons
Heat Recovery	916.98 million Btu	750.44 million Btu

Benchmark figures facilitate comparing energy use between different buildings. Table 1.2 below lists several benchmarks for the audited building.

Table 1.2: Building Benchmarks for the Shungnak Water Treatment Plant

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	789.7	53.53	$43.31
With Proposed Retrofits	618.6	41.93	$29.09
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 Shungnak Water Treatment Plant. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return. The installed cost includes materials, 15% surcharge on materials for freight fees, local and specialist labor time, specialist travel, and indirect labor charges when applicable.

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: Raw Water Heat Tape	Shut off heat tape and use only for emergency thaw purposes and extreme cold weather events.	$13,858	$4,000	50.62	0.3	37,795.7
2	Lighting: Exterior	Replace with new, energy efficient, direct-wire LED lighting.	$215	$50	36.14	0.2	585.2
3	Lighting: Entryway Lights	Replace with new, energy efficient, direct-wire LED lighting.	$165	$50	27.74	0.3	435.6
4	Other Electrical: Back Loop Circulation Pumps	Shut down the water circulation loop pumps during the summer months.	$1,542	$1,000	18.09	0.6	4,157.6
5	Other Electrical: Well Pump	Replace the existing motor starter with a Variable Frequency Drive (VFD) and manually modulate the flow rate.	$4,050	$8,000	7.40	2.0	11,045.1
6	Back Loop	Lower the circulation loop temperatures to 40° F., Reduce flow rate to 70 GPM (1.8 ft/s) to reduce excess flow and heating loads.	$1,032	$2,000	6.72	1.9	5,196.7
7	Other Electrical: Front Loop Circulation Pumps	Shut down the water circulation loop pumps during the summer months.	$506	$1,000	5.92	2.0	1,350.4
8	Water Storage Tank	Lower the water storage tank temperature to 40° F.	$241	$1,000	3.14	4.1	1,214.9
9	Setback Thermostat: Water Treatment Plant	Install a new programmable thermostat and program a heating temperature setback to 60.0° F when the building is unoccupied.	$496	$2,000	3.07	4.0	2,064.5
10	Front Loop	Lower the circulation loop temperatures to 40° F.	$216	$1,000	2.82	4.6	1,089.5
11	Other Electrical: Middle Loop Circulation Pumps	Shut down the water circulation loop pumps during the summer months.	$238	$1,000	2.79	4.2	639.2
12	Middle Loop	Lower the circulation loop temperatures to 40° F.	$183	$1,000	2.38	5.5	922.1
13	Other Electrical: Chlorine Pump (Not Filling Tank)	Install controls to automatically turn off pump when not making water.	$115	$750	1.28	6.5	300.7

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
14	Air Tightening	Weatherize around shop door. Close the generator vent in winter to prevent cold air infiltration.	$121	$3,000	0.35	24.9	502.3
15	Heating, Ventilation, and Domestic Hot Water	Clean and tune boilers on an annual basis. (10% of total cost) Convert hot water heater to a hydronic unit. (50% of total cost) Address leaks and air in heat recovery pipe (40% of total cost)	$518	$25,000	0.32	48.3	1,824.8
TOTAL			**$23,496**	**$50,850**	**6.48**	**2.2**	**69,124.3**

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 $23,495 per year, or 32.8% of the buildings' total energy costs. These measures are estimated to cost $50,850, for an overall simple payback period of 2.2 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 Building

Annual Energy Cost Estimate								
Description	**Space Heating**	**Water Heating**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$5,021	$331	$6,210	$43,201	$1,793	$11,884	$3,134	**$71,574**
With Proposed Retrofits	$4,481	$20	$5,823	$22,809	$1,831	$10,255	$2,859	**$48,079**
Savings	$540	$311	$386	$20,393	-$38	$1,628	$274	**$23,495**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Shungnak 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% per 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

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 Shungnak 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.

The space heating load is based on an occupied space of 1,653 square feet in the water treatment plant facility.

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 systems; lighting, electrical loads, 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. SHUNGNAK WATER TREATMENT PLANT

3.1. Building Description

The 1,653 square foot Shungnak Water Treatment Plant was constructed in 2008 and houses the water intake, treatment, and distribution services for the community of Shungnak. The building has two operators with one operator working for eight hours each day. Figure 1 below shows an aerial view of the community with the water treatment plant and river intake.

Figure 1: An aerial view of the Shungnak water treatment system.

Water is pumped in from an intake in the nearby Kobuk River and transported approximately 1,100 feet to the water treatment plant. The raw water intake is heated by an electric heat trace, which is operated constantly during the winter months because of concern over permafrost in the buried ground where the water pipe is located.

Figure 2: Upper vault of river intake system.

Figure 3: Lower vault of river intake system.

Figure 4: Intake access of river intake system

When the water enters the plant, the raw water is injected with polymer coagulant and potassium permanganate, then filtered through two greensand filters, injected with chlorine, and stored in a 230,000-gallon water storage tank. The tank is filled in batches, and when the tank is not being actively filled the raw water is pumped directly to waste. The water storage tank is regularly dosed with chlorine because the stored water will dechlorinate over time.

The facility has three circulation loops that distribute water from the water storage tank to the individual services. These loops are the Front Loop, Middle Loop, and Back Loop. The Front Loop has approximately 3,310 feet of 4” high density polyethylene (HDPE) pipe and serves the eastern region of the community. The Middle Loop has approximately 980 feet of 4” HDPE pipe and serves the central region of the community. The Back Loop has approximately 1,600 feet of 4” HDPE pipe and 1,600 feet of 6” HDPE pipe and serves the western region of the community.

Figure 5: Shungnak Water Storage Tank

Figure 6: Water storage tank insulation

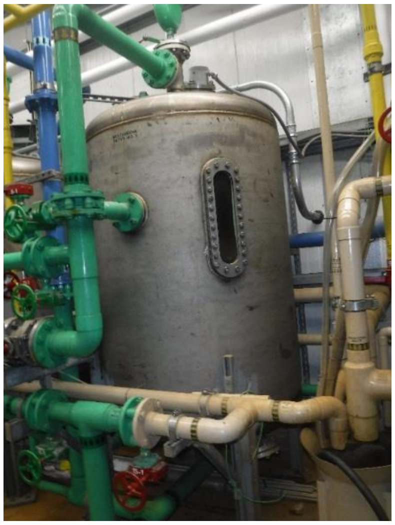


Figure 7: Greensand Filter

Figure 8: Water distribution loops

The building has an 11 kW solar photovoltaic system that produces electricity for the facility throughout the year. Data obtained from the Northwest Arctic Borough showed a production of approximately 6,064 kWh in 2017.

Figure 9: Solar photovoltaic system on the water treatment plant

Description of Building Shell

The water treatment plant shell consists of panelized construction with approximately 5" of polyurethane foam insulation for the walls and roof. The building is constructed on a gravel pad foundation with rigid foam insulation within the pad.

The building has two entrances, one as a main entrance and one in the shop. The main entrance has a single, insulated metal door with an arctic entry. The shop has a set of insulated metal double doors with no arctic entry.

There are five total windows in the building, two of which are facing south and three which are facing in other directions. All windows are approximately 32" x 32" with wood trim and triple-pane glass.

Description of Heating Plants

The heating plants used in the building are:

Boiler 1

Nameplate Information:	Weil-McLain 478 Commercial Boiler with a Becket Burner
Fuel Type:	#1 Oil
Input Rating:	348,000 BTU/hour
Steady State Efficiency:	82 %
Heat Distribution Type:	Glycol
Boiler Operation:	September through June

Boiler 2

Nameplate Information:	Weil-McLain 478 Commercial Boiler with a Becket Burner
Fuel Type:	#1 Oil
Input Rating:	348,000 BTU/hour
Steady State Efficiency:	82 %
Heat Distribution Type:	Glycol
Boiler Operation:	September through June

Figure 10: Boiler Room

Heat Recovery

Heat Exchanger Capacity:	335,000 BTU per hour
Steady State Efficiency:	95 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Electric Hot Water Heater

Fuel Type:	Electricity
Input Rating:	4.5 kW
Steady State Efficiency:	100 %
Heat Distribution Type:	Water
Boiler Operation:	All Year

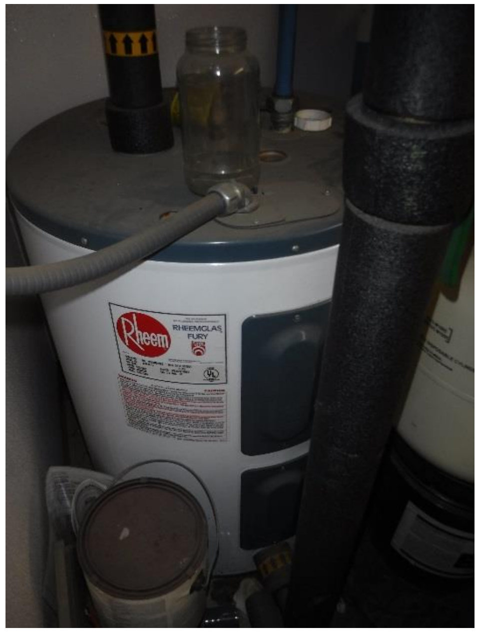


Figure 11: Electric hot water heater

Space Heating Distribution Systems

The building is heated by a combination of five unit heaters and baseboard distribution. Each of the unit heaters is a Modine model HS 24S01. Each of the unit heaters is estimated to distribute approximately 10,000 BTUs per hour of space heat. These units are in a hydronic heating loop with glycol circulated by a Grundfos UPS 50-80/2F circulation pump operating at 510 Watts. The hydronic circulation pump is not operated during the summer months when the water heating requirements are very low.

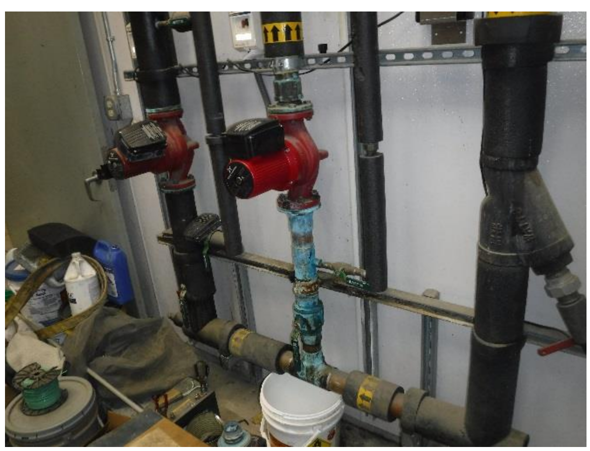


Figure 12: Hydronic circulation pumps

Domestic Hot Water System

There is a 30-gallon electric hot water heater that provides domestic hot water to the restroom, process room sink, and laboratory sink.

Heat Recovery Information

There is a heat recovery system that was installed in 2012 that transports heat from the power plant to the water treatment plant and the city office. The heat recovery system exchanges heat to the water treatment plant hydronic system through a heat exchanger rated for 335,000 BTU's/hr. There is a 260 Watt circulation pump that circulates the heated glycol through the heat recovery loop. This pump operates continuously throughout the year.

Lighting

Lighting in the water treatment plant consumes approximately 9,398 kWh annually and constitutes approximately 11.0% of the building's current electrical consumption.

Table 3.1: Breakdown of Lighting by Location and Bulb Type

Location	Bulb Type	Fixtures	Bulbs per Fixture	Annual Usage (kWh)
Process Rooms	LED 4ft. Tube (17 W)	37	4	8,604
Restroom	LED 4ft. Tube (17 W)	1	2	5
Generator Room	LED 4ft. Tube (17 W)	2	4	8
Entryway	Incandescent A Lamp (60 W)	2	1	351
Chemical Room	Fluorescent CFL A Lamp (13 W)	1	1	2
Exterior	Incandescent A Lamp (60 W)	2	1	438
			Total Energy Consumption	**9,398**

Major Equipment

Table 3.2 contains the details on each of the major electricity consuming mechanical components found in the raw water transmission line and water treatment plant. Major equipment consumes approximately 70,908 kWh annually, constituting about 83.3% of the building's current electrical consumption.

Table 3.2: Major Equipment List

Major Equipment	Purpose	Rating	Operating Schedule	Annual Energy Consumption (kWh)
Well Pump	Pump raw water from the intake to the water treatment plant.	2 HP	Constant	12,272
Backwash Pump	Clean sand filters after each water storage tank batch.	7.5 HP	Twice per week	438
Air Scour	Push air through filters to break up media and make backwashing easier.	5 HP	Twice per week	45

Pressure Pumps	Pressurize water distribution system	5 HP	Measured at approximately 9% of the time.	2,761
Front Loop Circulation Pumps	Circulates water in the Front Loop for distribution.	1 HP	Constant	5,246
Middle Loop Circulation Pumps	Circulates water in the Middle Loop for distribution.	0.5 HP	Constant	2,436
Back Loop Circulation Pumps	Circulates water in the Back Loop for distribution.	3 HP	Constant	15,737
Raw Water Heat Tape	Provide freeze protection to the raw water intake line.	7,500 W	Winter Months	26,247
Potassium Permanganate Pump	Injects water with potassium permanganate during the water treatment process.	180 W	Used during batch treatment each week.	9
Chlorine Pump 1	Injects chlorine in water storage tank during times with no active tank filling.	24	Approximately 30 minutes per day.	210
Chlorine Pump 2	Injects chlorine in filtered water during treatment.	24	Twice per week.	23
Polymer Pump	Injects water with polymer during treatment process.	24 W	Two days per week	23
Chemical Mixers (2)	Mixes chemicals to obtain proper chemical ratios for treatment.	70 W	Approximately 30 minutes per day.	9
Hydronic Circulation Pump	Circulates heated glycol from the boiler room to all the heat loads in the facility.	510 W	Winter Months	3,173
Heat Recovery Hydronic Pump	Circulates heated glycol in the heat recovery loop between the water treatment plant and the power plant.	260 W	Constant	2,279
			Total Energy Consumption	**70,908**

Figure 13: Heat-add circulation pumps with visible corrosion.

Figure 14: Pressure pumps

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 138,000 BTUs of energy.

The Alaska Village Electric Cooperative (AVEC) owns and operates a power plant that provides electricity to the community of Shungnak, including all residential and commercial services. Additionally, the Shungnak power plant also provides electricity to the community of Kobuk, approximately 11 miles away via intertie.

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	$ 0.66/kWh
#1 Oil	$ 8.41/gallons
Heat Recovery	$ 10.00/million Btu

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Shungnak pays approximately $71,574 annually for electricity and other fuel costs for the Shungnak Water Treatment Plant.

Figure 15 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.

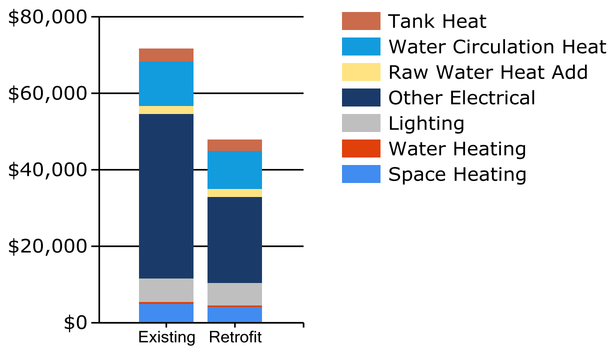


Figure 15: Annual energy costs by end use.

Figure 16 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.

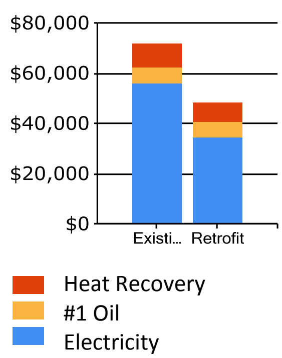


Figure 16: Annual energy costs by fuel type.

Figure 17 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 and 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.

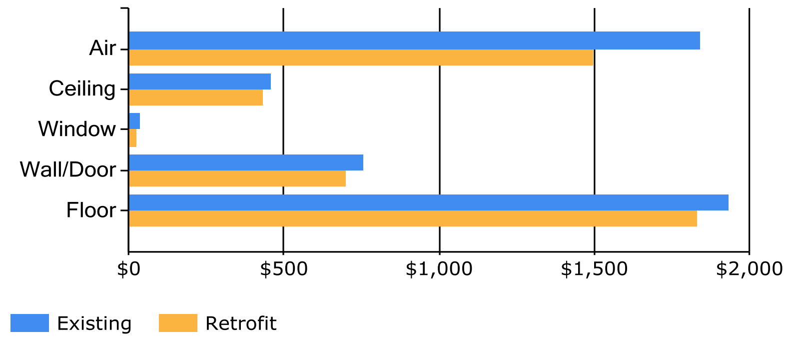


Figure 17: Annual space heating costs.

Tables 3.4.1, 3.4.2, and 3.4.3 below show the model's estimate of the monthly use for the electricity, fuel oil, and heat recovery sources used in the building. The fuel use is broken down across the energy end uses.

Table 3.4.1: Estimated Electrical Consumption by Category

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	926	795	848	315	218	192	196	213	233	543	809	876
DHW	43	39	43	41	43	41	43	43	41	43	41	43
Lighting	825	751	825	769	778	737	761	761	769	810	798	825
Other Electrical	8501	7747	8501	3547	3665	2422	2503	2503	3022	6317	8227	8501
Raw Water Heat Add	160	146	160	155	160	0	0	0	83	160	155	160
Water Circulation Heat	99	90	99	96	99	0	0	0	51	99	96	99
Tank Heat	184	164	178	162	154	0	0	0	80	167	171	180

Table 3.4.2: Estimated #1 Fuel Oil Consumption by Category

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Raw Water Heat Add	5	5	5	5	6	0	0	0	5	5	5	5
Water Circulation Heat	63	58	64	66	74	0	0	0	62	69	63	64
Tank Heat	20	16	17	10	1	0	0	0	1	10	15	18

Table 3.4.3: Estimated Heat Recovery Consumption by Category

Heat Recovery Consumption (Million Btu)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	19	14	14	7	1	0	0	1	2	7	13	16
Raw Water Heat Add	6	6	6	6	6	0	0	0	3	6	6	6
Water Circulation Heat	77	70	77	74	77	0	0	0	40	77	74	77
Tank Heat	24	19	20	11	1	0	0	0	1	11	18	21

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 U.S. Environmental Protection Agency (US EPA) has determined that source energy is the most comparable unit for evaluation purposes and overall global impact. Both the site and source EUI ratings for the building are provided to understand and compare the differences in energy use.

The site and source EUIs for this building are calculated as follows. (See Table 3.4 for details):

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

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

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

Table 3.5: Building EUI Calculations for the Shungnak Water Treatment Plant

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	85,140 kWh	290,582	3.340	970,545
#1 Oil	739 gallons	97,498	1.010	98,473
Heat Recovery	916.98 million Btu	916,981	1.280	1,173,736
Total		**1,305,061**		**2,242,753**
BUILDING AREA		1,653	Square Feet	
BUILDING SITE EUI		790	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		1,357	**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 3.6: Building Benchmarks for the Shungnak Water Treatment Plant

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	789.7	53.53	$43.31
With Proposed Retrofits	618.6	41.93	$29.09
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 exhaust fans, boilers, and heat recovery system 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 Shungnak Water Treatment Plant was modeled using AkWarm© energy use software to establish a baseline space heating energy usage. Climate data from Shungnak was used for analysis. From this, the model was 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

1. The model is based on typical mean year weather data for Shungnak. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the fuel 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.

2. 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.

3. The data and inputs used to model the building are adjusted until the model is within 5-10% of the reported fuel and electric use. As such, the predicted cost savings for the recommended energy efficiency measures (EEMs) are reasonable approximations, but not assurances. All EEMs should be verified with a certified professional in that field before any measures are pursued.

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: Raw Water Heat Tape	Shut off heat tape and use only for emergency thaw purposes and extreme cold weather events.	$13,858	$4,000	50.62	0.3	37,795.7
2	Lighting: Exterior	Replace with new, energy efficient, direct-wire LED lighting.	$215	$50	36.14	0.2	585.2
3	Lighting: Entryway Lights	Replace with new, energy efficient, direct-wire LED lighting.	$165	$50	27.74	0.3	435.6
4	Other Electrical: Back Loop Circulation Pumps	Shut down the water circulation loop pumps during the summer months.	$1,542	$1,000	18.09	0.6	4,157.6

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
5	Other Electrical: Well Pump	Replace the existing motor starter with a Variable Frequency Drive (VFD) and manually modulate the flow rate.	$4,050	$8,000	7.40	2.0	11,045.1
6	Back Loop	Lower the circulation loop temperatures to 40° F., Reduce flow rate to 70 GPM (1.8 ft/s) to reduce excess flow and heating loads.	$1,032	$2,000	6.72	1.9	5,196.7
7	Other Electrical: Front Loop Circulation Pumps	Shut down the water circulation loop pumps during the summer months.	$506	$1,000	5.92	2.0	1,350.4
8	Water Storage Tank	Lower the water storage tank temperature to 40° F.	$241	$1,000	3.14	4.1	1,214.9
9	Setback Thermostat: Water Treatment Plant	Install a new programmable thermostat and program a heating temperature setback to 60.0° F when the building is unoccupied.	$496	$2,000	3.07	4.0	2,064.5
10	Front Loop	Lower the circulation loop temperatures to 40° F.	$216	$1,000	2.82	4.6	1,089.5
11	Other Electrical: Middle Loop Circulation Pumps	Shut down the water circulation loop pumps during the summer months.	$238	$1,000	2.79	4.2	639.2
12	Middle Loop	Lower the circulation loop temperatures to 40° F.	$183	$1,000	2.38	5.5	922.1
13	Other Electrical: Chlorine Pump (Not Filling Tank)	Install controls to automatically turn off pump when not making water.	$115	$750	1.28	6.5	300.7
14	Air Tightening	Weatherize around shop door. Close the generator vent in winter to prevent cold air infiltration.	$121	$3,000	0.35	24.9	502.3

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
15	Heating, Ventilation, and Domestic Hot Water	Clean and tune boilers on an annual basis. (10% of total cost) Convert hot water heater to a hydronic unit. (50% of total cost) Address leaks and air in heat recovery pipe (40% of total cost)	$518	$25,000	0.32	48.3	1,824.8
TOTAL			**$23,496**	**$50,850**	**6.48**	**2.2**	**69,124.3**

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.

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		Air Tightness estimated as: 3451 cfm at 75 Pascals		Weatherize around shop door. Close the generator vent in winter to prevent cold air infiltration.	
Installation Cost	$3,000	**Estimated Life of Measure (yrs.)**	10	**Energy Savings ($/yr.)**	$121
Breakeven Cost	$1,051	**Simple Payback (yrs.)**	25	**Energy Savings (MMBTU/yr.)**	6.0 MMBTU
		Savings-to-Investment Ratio	0.4		
Auditors Notes: Weatherize around shop door, close generator vent in winter to prevent col air infiltration					

4.4 Mechanical Equipment Measures

4.4.1 Heating /Domestic Hot Water Measure

Rank	Recommendation				
15	Clean and Tune boilers on a monthly basis, convert hot water heater to a hydronic unit, address leaks and air in heat recovery pipe				
Installation Cost	$25,000	**Estimated Life of Measure (yrs.)**	20	**Energy Savings ($/yr.)**	$518
Breakeven Cost	$7,941	**Simple Payback (yrs.)**	48	**Energy Savings (MMBTU/yr.)**	16.0 MMBTU
		Savings-to-Investment Ratio	0.3		

Auditors Notes: Boilers should be cleaned regularly (approximately once per year) to improve efficiency in heat transfer.

The current hot water heater is an electric unit. Connecting the hydronic heating system to a hydronic hot water heater will allow the heat recovery system to supplement the energy load for the hot water system.

The heat recovery loop is leaking glycol and air is getting caught in the line, which impedes performance and presents operations and maintenance concerns with the equipment. Fixing the leaks will help the heat recovery system operate better for the long term.

Boiler Maintenance: $2,500
Hot Water Heater Conversion: $12,500
Heat Recovery Pipe Leaks: $10,000

Total Cost: $25,000

4.4.2 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
9	Water Treatment Plant			Install a new programmable thermostat and program a heating temperature setback to 60.0° F when the building is unoccupied.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs.)**	15	**Energy Savings ($/yr.)**	$496
Breakeven Cost	$6,131	**Simple Payback (yrs.)**	4	**Energy Savings (MMBTU/yr.)**	24.6 MMBTU
		Savings-to-Investment Ratio	3.1		
Auditors Notes: Lowering the thermostat to 60 deg. F when the operators are not present will reduce the space heating costs and lower the fuel use without affecting the comfort of the operators.					

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	2 Incandescent 60-Watt A-Lamp units		Replace with new, energy efficient, direct-wire LED lighting.	
Installation Cost	$50	**Estimated Life of Measure (yrs.)**	10	**Energy Savings ($/yr.)**	$215
Breakeven Cost	$1,807	**Simple Payback (yrs.)**	0	**Energy Savings (MMBTU/yr.)**	1.1 MMBTU
		Savings-to-Investment Ratio	36.1		
Auditors Notes: There are two incandescent A-lamps to be replaced with LED equivalents.					

Rank	Location	Existing Condition		Recommendation	
3	Entryway Lights	2 Incandescent 60-Watt A-Lamp units		Replace with new, energy efficient, direct-wire LED lighting.	
Installation Cost	$50	**Estimated Life of Measure (yrs.)**	10	**Energy Savings ($/yr.)**	$164
Breakeven Cost	$1,387	**Simple Payback (yrs.)**	0	**Energy Savings (MMBTU/yr.)**	0.5 MMBTU
		Savings-to-Investment Ratio	27.7	**Maintenance Savings ($/yr.)**	$1
Auditors Notes: There are two incandescent A-lamps to be replaced with LED equivalents.					

4.5.2 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
1	Raw Water Heat Tape	Heat Tape		Shut off heat tape and use only for emergency thaw purposes and extreme cold weather events.	
Installation Cost	$4,000	**Estimated Life of Measure (yrs.)**	20	**Energy Savings ($/yr.)**	$13,858
Breakeven Cost	$202,473	**Simple Payback (yrs.)**	0	**Energy Savings (MMBTU/yr.)**	71.7 MMBTU
		Savings-to-Investment Ratio	50.6		
Auditors Notes: The well pump operates constantly and the constant water flow is used to prevent freezing incidents. The heat tape is not needed in addition to the water flow and can be shut off throughout the year except for emergency thaw purposes and extreme cold weather events to reduce electricity usage.					

Rank	Location	Description of Existing		Efficiency Recommendation	
4	Back Loop Circulation Pumps	Circulation Pumps		Shut down water circulation loop pumps during the summer months.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs.)**	15	**Energy Savings ($/yr.)**	$1,542
Breakeven Cost	$18,090	**Simple Payback (yrs.)**	1	**Energy Savings (MMBTU/yr.)**	6.4 MMBTU
		Savings-to-Investment Ratio	18.1		
Auditors Notes: Shutting down the circulation pumps will reduce the excess pump usage and lower electricity usage in the facility. The pumps serve as freeze protection and likely do not need to be operated during the summer months.					

Rank	Location	Description of Existing		Efficiency Recommendation	
5	Well Pump	Well Pump		Replace with a Variable Frequency Drive (VFD) modulating smart pump.	
Installation Cost	$8,000	**Estimated Life of Measure (yrs.)**	20	**Energy Savings ($/yr.)**	$4,050
Breakeven Cost	$59,169	**Simple Payback (yrs.)**	2	**Energy Savings (MMBTU/yr.)**	20.9 MMBTU
		Savings-to-Investment Ratio	7.4		
Auditors Notes: Manually modulating the flow will allow the operator to flow in the pipe without using more electricity than required for the operation. This will reduce excess water flow and pump electricity usage.					

Rank	Location	Description of Existing		Efficiency Recommendation	
7	Front Loop Circulation Pumps	Circulation Pumps		Shut down water circulation loop pumps during the summer months.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs.)**	15	**Energy Savings ($/yr.)**	$506
Breakeven Cost	$5,925	**Simple Payback (yrs.)**	2	**Energy Savings (MMBTU/yr.)**	1.7 MMBTU
		Savings-to-Investment Ratio	5.9		
Auditors Notes: Shutting down the circulation pumps will reduce the excess pump usage and lower electricity usage in the facility. The pumps serve as freeze protection and likely do not need to be operated during the summer months.					

Rank	Location	Description of Existing		Efficiency Recommendation	
11	Middle Loop Circulation Pumps	Circulation Pumps		Shut down water circulation loop pumps during the summer months.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs.)**	15	**Energy Savings (\$/yr.)**	$238
Breakeven Cost	$2,787	**Simple Payback (yrs.)**	4	**Energy Savings (MMBTU/yr.)**	0.9 MMBTU
		Savings-to-Investment Ratio	2.8		
Auditors Notes: Shutting down the circulation pumps will reduce the excess pump usage and lower electricity usage in the facility. The pumps serve as freeze protection and likely do not need to be operated during the summer months.					

Rank	Location	Description of Existing		Efficiency Recommendation	
13	Chlorine Pump (Not Filling Tank)	Chemical Pump		Reconfigure pump to not run constantly.	
Installation Cost	$750	**Estimated Life of Measure (yrs.)**	10	**Energy Savings (\$/yr.)**	$115
Breakeven Cost	$963	**Simple Payback (yrs.)**	7	**Energy Savings (MMBTU/yr.)**	0.2 MMBTU
		Savings-to-Investment Ratio	1.3		
Auditors Notes: Pump is currently plugged into the wall with no controls. Install new controls and hardwire the pump into the building so that the pump can be controlled by required dosing instead of manually by the operator.					

4.5.3 Other Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
6		Back Loop Circulation Heat Load		Lower the circulation loop temperatures to 40° F., Reduce flow rate to 70 GPM (1.8 ft./s) to reduce excess flow and heating loads.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs.)**	15	**Energy Savings (\$/yr.)**	$1,032
Breakeven Cost	$13,435	**Simple Payback (yrs.)**	2	**Energy Savings (MMBTU/yr.)**	81.9 MMBTU
		Savings-to-Investment Ratio	6.7		
Auditors Notes: Lower the operation temperature of the circulation loops to minimize excess heating usage. Lower the circulation rate to the minimum flow rate required to meet the freeze protection demands of the back loop. The homes on this loop have individual circulation pumps that circulate water through the service lines to keep them from freezing. This allows the mainline to circulate slower, as flow does not need to be induced through the service lines (if there were pit orifice). Lowering the flow rate will reduce the excess electricity usage and heating demand of the loop.					

Rank	Location	Description of Existing		Efficiency Recommendation	
8		Water Storage Tank Heat Load		Lower the water storage tank temperature to 40° F.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs.)**	15	**Energy Savings (\$/yr.)**	$241
Breakeven Cost	$3,141	**Simple Payback (yrs.)**	4	**Energy Savings (MMBTU/yr.)**	19.1 MMBTU
		Savings-to-Investment Ratio	3.1		
Auditors Notes: Lower the operation temperature of the water storage tank to minimize excess heating usage.					

Rank	Location	Description of Existing		Efficiency Recommendation	
10		Front Loop Circulation Heat Load		Lower Circulation Loop Temperatures to 40 Deg. F.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs.)**	15	**Energy Savings ($/yr.)**	$216
Breakeven Cost	$2,817	**Simple Payback (yrs.)**	5	**Energy Savings (MMBTU/yr.)**	17.2 MMBTU
		Savings-to-Investment Ratio	2.8		
Auditors Notes: Lower the operation temperature of the circulation loops to minimize excess heating usage.					

Rank	Location	Description of Existing		Efficiency Recommendation	
12		Middle Loop Circulation Heat Load		Lower the circulation loop temperatures to 40° F.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs.)**	15	**Energy Savings ($/yr.)**	$183
Breakeven Cost	$2,384	**Simple Payback (yrs.)**	5	**Energy Savings (MMBTU/yr.)**	14.5 MMBTU
		Savings-to-Investment Ratio	2.4		
Auditors Notes: Lower the operation temperature of the circulation loops to minimize excess heating usage.					

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.

APPENDICES

Appendix A – Scanned Energy Billing Data

1. Electricity Billing Data

Utility: Alaska Village Electric Cooperative
Reading: Monthly
Units: kWh

Month	Shungak Water Treatment Plant
January 2017	11,961
February 2017	11,091
March 2017	11,540
April 2017	3,323
May 2017	2,847
June 2017	2,326
July 2017	1,905
August 2017	1,328
September 2017	1,959
October 2017	5,593
November 2017	10,853
December 2017	11,737

2. #1 Fuel Oil Billing Data

Utility Data: Alaska Rural Utility Collaborative
Quantity: 780 gallons is the two-year average between 2017 and 2018 numbers.

Note: Fuel oil is purchased infrequently so the exact usage is difficult to determine. The two-year average was used to provide a more accurate estimate in annual usage.

3. Heat Recovery Billing Data

Data Source: ANTHC Remote Monitoring
Reading: Monthly
Units: Million BTU

Month	Shungak Water Treatment Plant
January 2017	135
February 2017	124
March 2017	103
April 2017	99
May 2017	103
June 2017	9
July 2017	0
August 2017	0
September 2017	54
October 2017	112
November 2017	162
December 2017	155

Note: Data was collected from the remote monitoring sensors installed by ANTHC. The data is collected and communicated to an online source, where data can be downloaded. Monthly averages in operational temperature differences and an assumption of a heat recovery flow rate of approximately 15 GPM were used to calculate the total heat recovery benefit in Million BTU units. Data can be seen at http://rm.anthc.webfactional.com/map/.

Appendix B – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Shungnak Water Treatment Plant	**Auditor Company:** ANTHC-DEHE
Address: Water Treatment Plant	**Auditor Name:** Kevin Ulrich & Jonathon Pierson
City: Shungnak	**Auditor Address:** 4500 Diplomacy Dr., Anchorage, AK 99508
Client Name: Art Sheldon	
Client Address:	**Auditor Phone:** (907) 729-3237
	Auditor FAX:
Client Phone: (907) 437-5073	**Auditor Comment:** Kevin Ulrich is a CEM Jonathon Pierson is a Project Manager. Contact Info is for Kevin Ulrich
Client FAX:	
Design Data	
Building Area: 1,653 square feet	**Design Space Heating Load:** Design Loss at Space: 41,958 Btu/hour with Distribution Losses: 41,958 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 63,960 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 1 person	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Shungnak	**Design Outdoor Temperature:** -39.1 deg F
Weather/Fuel City: Shungnak	**Heating Degree Days:** 14,754 deg F-days
Utility Information	
Electric Utility: Alaska Village Electric Cooperative	**Average Annual Cost/kWh:** $0.66/kWh

Annual Energy Cost Estimate

Description	Space Heating	Water Heating	Lighting	Other Electrical	Raw Water Heat Add	Water Circulation Heat	Tank Heat	Total Cost
Existing Building	$5,021	$331	$6,210	$43,201	$1,793	$11,884	$3,134	**$71,574**
With Proposed Retrofits	$4,481	$20	$5,823	$22,809	$1,831	$10,255	$2,859	**$48,079**
Savings	$540	$311	$386	$20,393	-$38	$1,628	$274	**$23,495**

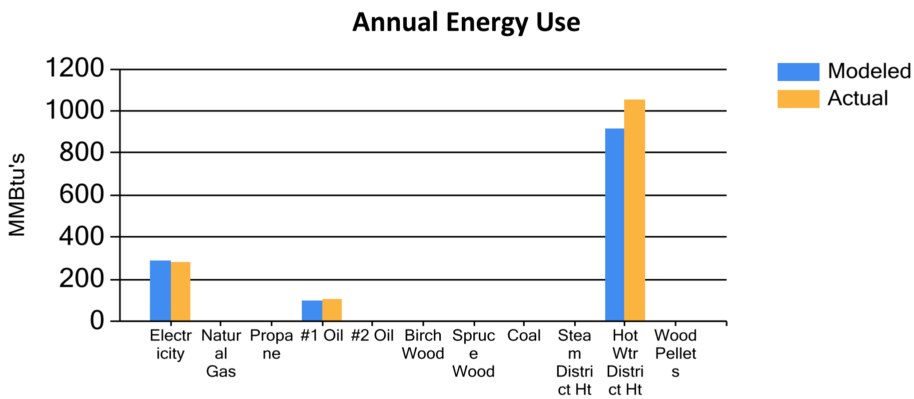
Building Benchmarks

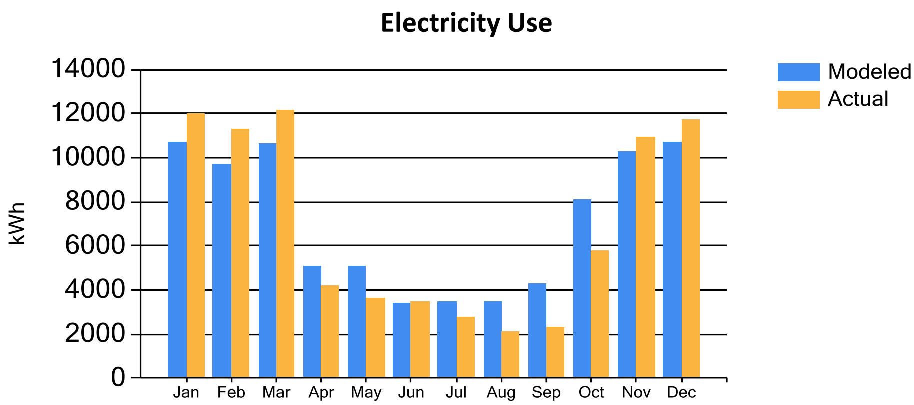
Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	789.7	53.53	$43.31
With Proposed Retrofits	618.6	41.93	$29.09

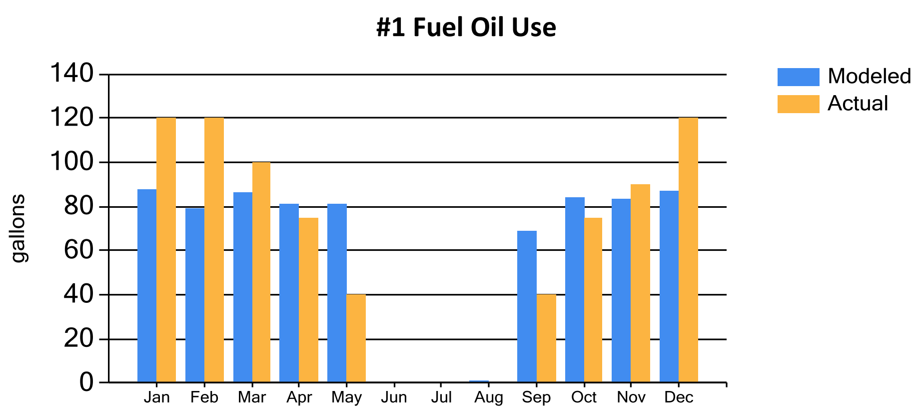
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area.
EUI/HDD: Energy Use Intensity per Heating Degree Day.
ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.

Appendix C – Actual Fuel Use versus Modeled Fuel Use

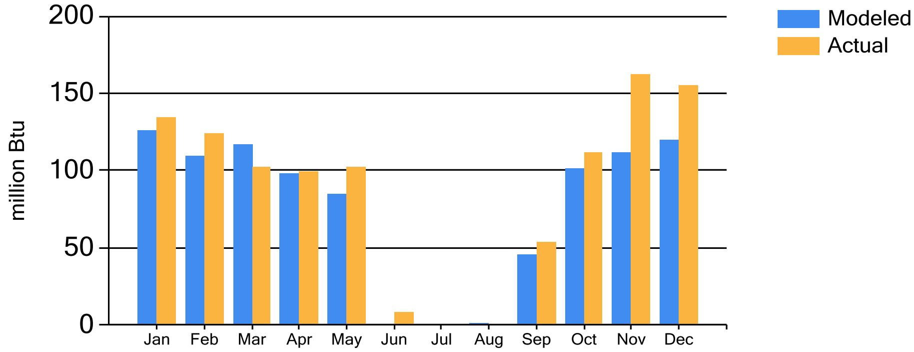
The graphs below show the modeled energy usage results of the energy audit process compared to the actual energy usage report data. The model was completed using AkWarm modeling software. The orange bars show actual fuel use, and the blue bars are AkWarm's prediction of fuel use.







Heat Recovery Use



Appendix D - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	21.3	21.1	21.0	13.7	13.4	11.3	11.2	11.2	12.2	17.1	20.4	20.4
As Proposed	14.3	14.2	14.1	12.1	11.9	8.6	8.6	8.6	10.4	13.1	14.1	14.2

AkWarmCalc Ver 2.9.0.0, Energy Lib 4/4/2018