Comprehensive Energy Audit
For
New Stuyahok Water Plant

Prepared For

City of New Stuyahok

February 14, 2017

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PREFACE

This energy audit was conducted using funds provided by the United States Department of Agriculture Rural Development, and the State of Alaska Department of Environmental Conservation. Coordination with the City of New Stuyahok has been undertaken to provide maximum accuracy in identifying facilities to audit and coordinating potential follow up retrofit activities.

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

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in January of 2016 by the Rural Energy Initiative of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy conservation measures. Discussions of site-specific concerns, non-recommended measures, and an energy conservation action plan are also included in this report.

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of Water Plant Operators Nick Epchook and Nick Suskuk, City of New Stuyahok Mayor Randy Hastings, City Clerk Anita Gust and Traditional Council Administrator William C. Peterson, Jr.

1. EXECUTIVE SUMMARY

This report was prepared for the City of New Stuyahok. The scope of the audit focused on New Stuyahok Water Plant and booster station. The water and sanitation system also includes an old lift station that is expected to go offline as a new one that is currently under construction comes online in spring or summer of 2017. Since the old lift station will soon be out of commission and isn't experiencing any outstanding issues, it has been excluded from the audit.

The scope of this report is a comprehensive energy study, which included an analysis of building shell, interior and exterior lighting systems, heating and ventilation systems, and plug loads.

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy costs are $59,814 per year. Electricity represents the largest portion with an annual cost of approximately $38,481. This includes about $12,616 paid by the village and about $25,865 paid by the Power Cost Equalization (PCE) program through the State of Alaska. Fuel represents the remaining portion, with an annual cost of approximately $21,333.

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 New Stuyahok, the current cost of electricity without PCE is $0.61/kWh and the cost of electricity with PCE is around $0.20/kWh, saving the village over $20,000 a year on electricity for the water plant and booster station.

Table 1.1 lists the total usage of electricity and #1 heating oil in the New Stuyahok Water Plant before and after the proposed retrofits.

Table 1.1: Predicted Annual Fuel Use for the Water Plant

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	63,084 kWh	48,565 kWh
#1 Oil	3,272 gallons	3,173 gallons

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

Table 1.2: Building Benchmarks for the Water Plant

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	825.5	73.02	$76.29
With Proposed Retrofits	745.7	65.95	$64.18
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 New Stuyahok Water Plant. 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 - Controls Retrofit: Booster Pump	Reduce the setpoint on the booster pumps from 63 psi down to 45 psi to reduce load and run time.	$4,963 / 27.8 MMBTU	$200	153.61	0.0	14,645.0
2	Setback Thermostat: New Stuyahok Water Plant	Implement a Heating Temperature Setback to 55.0 deg F when the water plant is unoccupied.	$489 / 8.8 MMBTU	$200	32.50	0.4	1,562.1
3	Other Electrical - Controls Retrofit: Well #3 Pump	Replace pressure transducer in the water storage tank, replace heat tape controls at WST to prevent freezing of transducer and incoming pipes. Control intake pump based upon water storage tank level rather than manual switching.	$1,539 + $250 Maint. Savings / 8.6 MMBTU	$2,200	6.86	1.2	4,540.2
4	Other Electrical - Controls Retrofit: Well #2 Pump	Replace pressure transducer in the water storage tank, replace heat tape controls at WST to prevent freezing of transducer and incoming pipes. Control intake pump based upon water storage tank level rather than manual switching.	$1,026 + $250 Maint. Savings / 5.7 MMBTU	$2,200	4.90	1.7	3,026.9
5	Lighting - Combined Retrofit: Main Room Lighting	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$266 / 0.9 MMBTU	$1,460	2.09	5.5	772.1

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR[1]**	**Simple Payback (Years)[2]**	**CO_2 Savings**
6	Other – Distribution Loop 1 (Lower Loop) Heat Load	Replace current heat exchangers with larger ones better able to meet heating demand, replace manual on/off switch with T775 and modulated Belimo valves	$0 + $500 Maint. Savings / 0.0 MMBTU	$3,500	1.22	7.0	0.0
7	Other – Distribution Loop 2 (Upper Loop) Heat Load	Replace current heat exchangers with larger ones better able to meet heating demand, replace manual on/off switch with T775 and modulated Belimo valves	$0 + $500 Maint. Savings / 0.0 MMBTU	$3,500	1.22	7.0	0.0
8	Lighting - Combined Retrofit: Office Lighting	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$79 / 0.3 MMBTU	$820	1.10	10.4	228.5
9	Other – Booster Station Heat Load	Replace water damaged section and insulate floor.	$183 / 3.6 MMBTU	$2,000	0.85	10.9	590.6
10	Water Plant Heating System	Replace controls with T775, replace limit switches (aquastat, hi temp shutoff), re-plumb boilers on nodes, install a circ pump on each node, replace boiler head or install genesis controller on boiler #2, tune and clean boilers, train operators in maintenance.	$184 + $500 Maint. Savings / 2.8 MMBTU	$18,000	0.58	26.3	579.3
11	Other Electrical - Power Retrofit: Lower Loop Circ Pump	Replace left hand lower loop circ pump motor, replace Victaulic valves on all four pumps, and replace flow meters.	$909 + $500 Maint. Savings / 4.7 MMBTU	$24,000	0.36	17.0	2,675.0
12	Air Tightening	Perform air sealing to reduce air leakage by 10 cfm at 50 Pascals.	$3 / 0.1 MMBTU	$500	0.06	156.7	10.2
13	Lighting - Combined Retrofit: Exterior Lighting	Replace with new energy-efficient LED lighting, replace manual switching with daylight sensor.	-$139 / -0.8 MMBTU	$580	-1.49	999.9	-410.9

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
	TOTAL, all measures		$9,500 + $2,500 Maint. Savings / 62.6 MMBTU	$59,160	1.62	4.9	28,218.9

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 $9,500 per year, or 15.9% of the buildings' total energy costs. These measures are estimated to cost $59,160, for an overall simple payback period of 4.9 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**	**Lighting**	**Other Electrical**	**Water Circulation Heat**	**Total Cost**
Existing Building	$1,636	$811	$36,914	$20,452	**$59,814**
With Proposed Retrofits	$1,078	$548	$28,443	$20,246	**$50,314**
Savings	$558	$263	$8,472	$206	**$9,500**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

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

2.2 Audit Description

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

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

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

Details collected from New Stuyahok Water 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.

New Stuyahok Water Plant is classified as being made up of the following activity areas:

1) New Stuyahok Water Plant: 784 square feet

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

- Occupancy hours
- Local climate conditions

- Prices paid for energy

2.3. Method of Analysis

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

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

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

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

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

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

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

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

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

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

2.4 Limitations of Study

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

3. NEW STUYAHOK WATER PLANT

3.1. Building Description

The 784 square foot New Stuyahok Water Plant was constructed in 1984, with a normal occupancy of 1 people. The number of hours of operation for this building average about 2 hours per day, considering all seven days of the week. Two operators currently share the responsibility of operating and maintaining the system passing in and out of the water plant as they tend to various components of the system throughout the day.

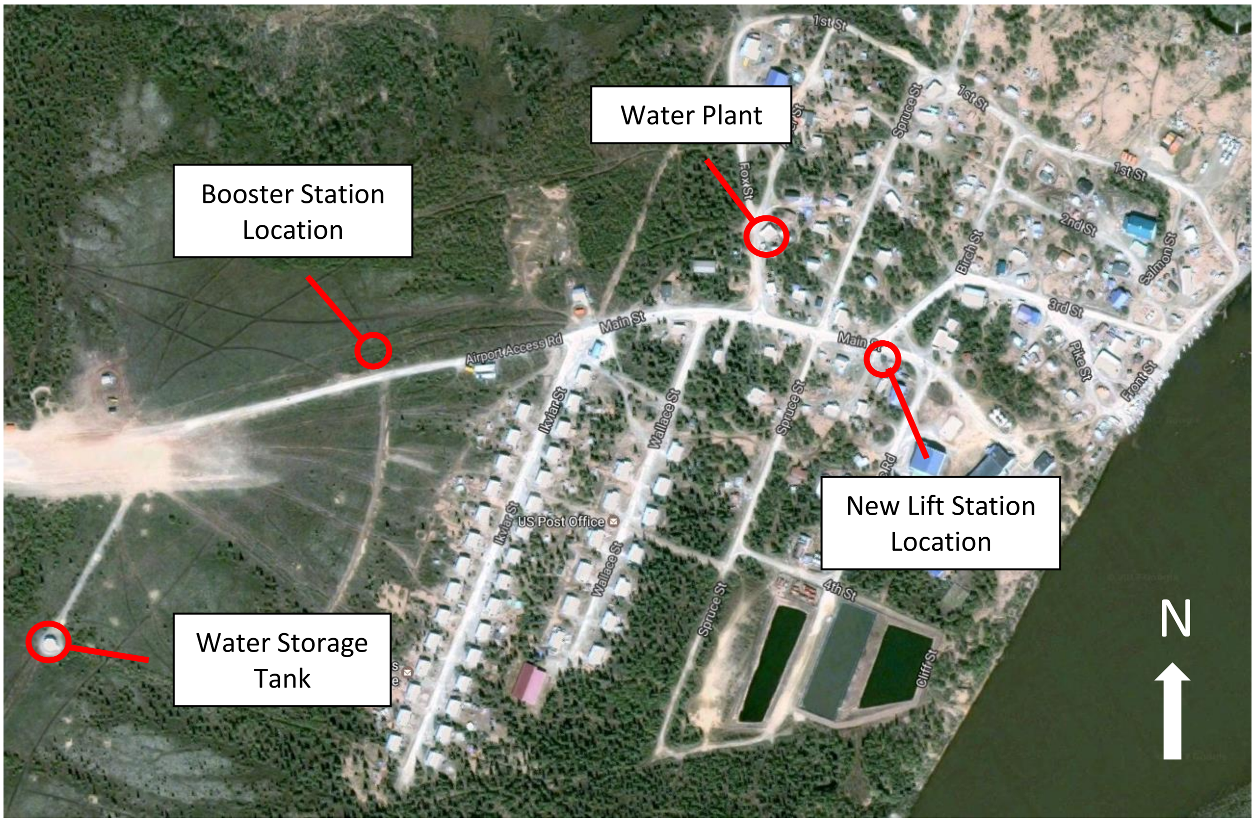


Figure 1: Aerial view of New Stuyahok, Water System Component Locations

Raw water is pumped from two 120 foot deep wells. Well #2 is located just southeast of the water plant and well #3 is located approximately 80 feet to the north of the building (well #1 is no longer in use). The well pumps are controlled manually by the operator to pump water every other two days (two days on, two days off) so are running approximately half the time.

The raw water in New Stuyahok is not treated – there are no chemicals added and no filtration process. After entering the water plant the raw water is diverted to one of two distribution loops. Prior to exiting the plant, during the winter months, heat add systems on each loop heat the water to 38°F. The lower loop (Loop 1) consists of 6000 feet of 4” PVC and 1200 feet of 4” HDPE pipe buried to an average depth of 3 feet. The upper loop (Loop 2) consists of 8300 feet of 4” arctic pipe buried to an average depth of 5 feet.

The upper loop delivers water to a 400,000 gallon water storage tank located behind the school. A pressure transducer in the tank is meant to read tank depth and control the raw water well pumps at the water plant via a telemetry system, however, the pressure transducer was not functioning at the time of the site visit. Water flows by gravity from the water storage tank to serve the homes along the upper loop before returning to the water plant. A booster station supplies the additional pressure needed to the branch of the upper loop that serves the highest elevation homes (primarily the teacher housing).

Figure 2: Main room in New Stuyahok Water Plant

Description of Building Shell

The exterior walls of the water treatment plant are constructed with single stud 2x6 lumber construction with a 16-inch offset. The average wall height is approximately 10 ft. The walls have approximately 5.5 inches of batt insulation damaged due to age. There is approximately 1,120 square feet of wall space in the WTP.

The WTP has a cathedral ceiling with 2x6 lumber construction. The roof has standard framing and a 24-inch offset. The peak ceiling height is approximately 13'6". The ceiling has approximately 5.5 inches of insulated polyurethane panels with damage due to age. There is approximately 808 square feet of roof space in the building.

The WTP is built on grade on a gravel pad. The concrete floor contains an insulated layer of 6 inch polyurethane panels significantly damaged by age. There is approximately 784 feet of floor space in the building. Differential movement has allowed the floor to separate from the wall which is especially noticeable on the northeast side of the building. The operators have used spray foam to fill the gaps. Thermal photos show lower temperatures along this section, however, nothing unusual for a building joint.

There are three windows located throughout the building. All windows are the same size, approximately 26" x 30". All windows are double-pane glass with vinyl frames in fairly good condition.

Figure 3: Evidence of differential movement between the floor and wall, thermal image.

There is a 3' x 6'8" metal door with an arctic entry on the front (southwestern) side of the building. There is some damage to the outer frame causing air leakage into the arctic entry.

<u>Description of Heating Plants</u>

The Heating Plants used in the building are:

Boiler 1

Nameplate Information:	Burnham Low Pressure Boiler Model V8H5
Fuel Type:	#1 Oil
Input Rating:	172,000 BTU/hour
Steady State Efficiency:	74 %
Idle Loss:	0 %
Heat Distribution Type:	Water
Boiler Operation:	Nov – May
Fire Rate:	1.65 gallons/hour

Boiler 2

Nameplate Information:	Burnham Low Pressure Boiler Model V8H6
Fuel Type:	#1 Oil
Input Rating:	172,000 BTU/hour
Steady State Efficiency:	82 %
Idle Loss:	2 %
Heat Distribution Type:	Water
Boiler Operation:	Nov – May
Fire Rate:	1.65 gallons/hour

Space Heater

Nameplate Information:	MPI Monitor 422
Fuel Type:	#1 Oil
Input Rating:	17,400 BTU/hr
Steady State Efficiency:	88 %
Idle Loss:	0 %

Heat Distribution Type: Air
Fire Rate: 0.13 gallons/hour

The demand for heat in the water plant is seasonal and includes space heating and two heat-add systems; one for each distribution loop. Two Burnham boilers serve to meet the heating demand of the water plant. At the time of this audit, only Boiler 2 was in use. Combustion test results show that in their current conditions, Boiler 2 is running more efficiently than Boiler 1 (84% vs 72% efficiency) and that the temperature in the stack of Boiler 1 was nearly twice that of Boiler 2 (1029°F vs 503°F) suggesting for cleaning and tuning. The boilers are turned on and off manually. A manually controlled circulating pump circulates heated water through the boilers and into the main hydronic loop.

Figure 4: Boilers in the water plant.

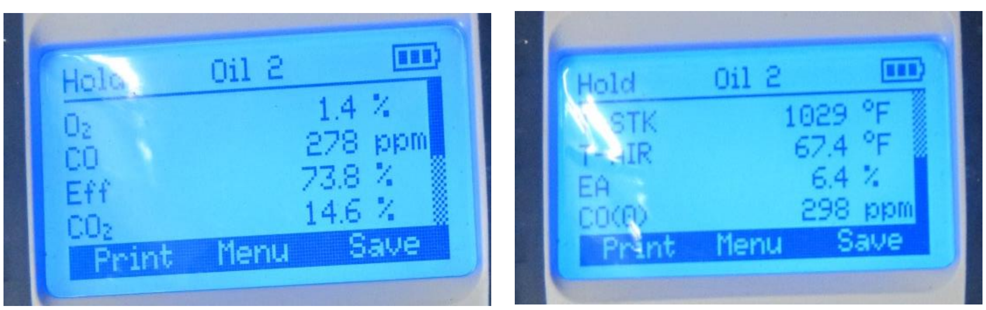


Figure 5: Boiler 1 combustion test results.

Figure 6: Boiler 2 combustion test results.

The booster station is heated by an MPI Monitor oil-burning space heater.

Figure 7: Inside the booster station, Monitor 422 on the left.

Space Heating Distribution Systems

Space heating is provided by a hydronic loop. A circulating pump circulates heated water through the hydronic loop. The heat is distributed by a 1/25 HP unit heater in the office and a 1/20 HP heater in the main room of the water plant.

Description of Building Ventilation System

Ventilation in the building is achieved through an air make-up vent.

Lighting

Lighting in the water plant consumes approximately 1,329 kWh annually constituting about 2% of the building's current electrical consumption.

Table 3.1: Breakdown of Lighting by Bulb Type

Type of bulb	Total Number of Bulbs	kWh/year	Location(s)
32 W, 4' T8 fluorescent	32	1,329	Boiler room, main mechanical room, tank corridor, hall, storage room, bathroom, utility room
100 W incandescent	1	0	Exterior

Major Equipment

Table 3.2 contains the details on each of the major electricity consuming mechanical components found in the water treatment plant. Major equipment consumes approximately 57,076 kWh annually constituting about 91% of the system's current electrical consumption. The booster pumps are the single largest electrical consuming components in the system, constituting 35% of the total electrical consumption.

Table 3.2: Major Equipment List

Major Pumps + Motors	Purpose	Motor Size	Operating Schedule	Annual Energy Consumption (kWh)
Well #2 Pump	Draw raw water from well number 2.	2 HP	pumping approximately half the time	8,408
Well #3 Pump	Draw raw water from well number 3.	3 HP	pumping approximately half the time	12,611
Upper Loop Circ Pump x 2	Circulate water in distribution loop to prevent freezing, deliver water to water storage tank. One pump runs at a time.	2 HP	always on during winter heating months	5,332
Lower Loop Circ Pump x 2	Circulate water in distribution loop to prevent freezing. One pump runs at a time.	2 HP	always on during winter heating months	7,484
Booster Pump x 2	Boost pressure in distribution loop branch serving teacher housing. One pump was in operation.	7 HP	operating about 65% of the time	21,926
Control panel x 3	Controlling various system components.	50 W	always on	1,315
			Total Energy Consumption	57,076

Heat Tape

There is approximately 100 feet of manually controlled heat tape on the portion of pipeline that runs from well #2 over to the water plant. The heat tape is always on during the winter heating months and consumes approximately 3,061 kWh annually or about 5% of total electrical consumption. There is a heat tape meant to prevent freezing of the pressure transducer and inlet piping on the water storage tank as well. This heat is designed to be controlled by a thermostat, but does not currently appear to be turning on when it should.

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 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.

Alaska Village Electric Cooperative (AVEC) runs the power plant in the city of New Stuyahok. The utility provides electricity to the residents of New Stuyahok as well as commercial and public facilities.

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 Rates by Fuel Type in New Stuyahok

Table 3.3 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.61/kWh
#1 Oil	$ 6.52/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of New Stuyahok pays approximately $59,814 annually for electricity and other fuel costs for the New Stuyahok Water Plant.

Figure 8 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.

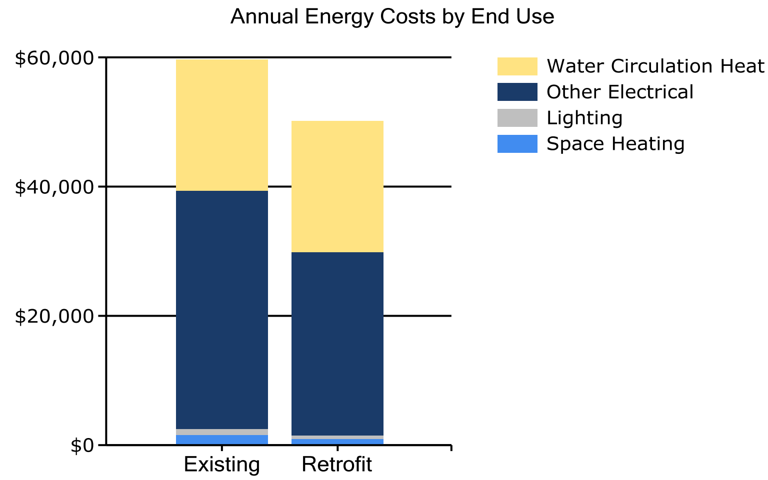


Figure 8: Annual energy costs by end use.

Figure 9 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.

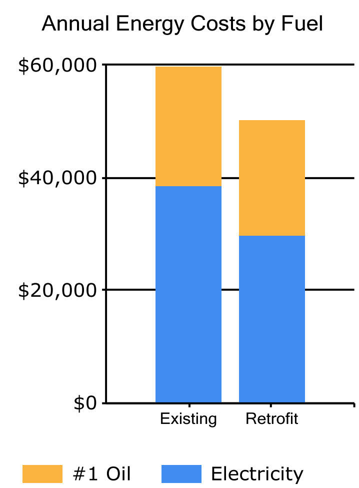


Figure 9: Annual energy costs by fuel type.

Figure 10 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. Note that many components are related – poorly sealed doors and windows contribute to air leakage, increasing space heating demand. 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.

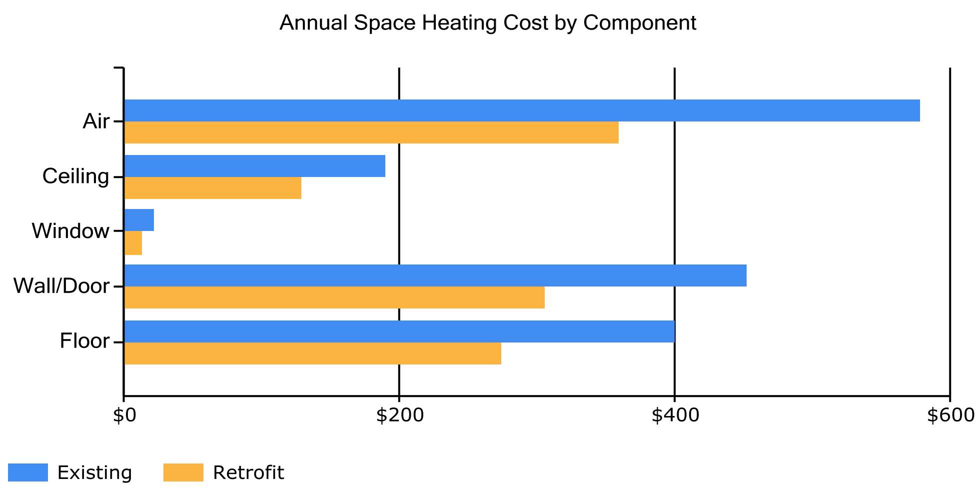


Figure 10: Annual space heating costs by component.

The tables below show AkWarm's estimate of the monthly fuel use for each of the fuels used in the building. For each fuel, the fuel use is broken down across the energy end uses.

Table 3.4: Electrical Consumption Records by Category

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	30	23	17	4	5	22	14	16	29	57	35	32
Lighting	113	103	113	109	113	109	113	113	109	113	109	113
Other Electrical	6489	5914	6489	6280	5095	3666	3789	3789	3666	3789	5060	6489
Water Circulation Heat	162	148	162	157	79	0	0	0	0	0	84	162

Table 3.5: Fuel Oil Consumption Records by Category

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	21	15	15	9	2	18	12	14	24	49	22	23
Water Circulation Heat	518	472	518	501	246	0	0	0	0	0	275	518

3.2.2 Energy Use Index (EUI)

Energy Use Index (EUI) is a measure of a building's annual energy utilization per square foot of building. This calculation is completed by converting all utility usage consumed by a building for one year, to British Thermal Units (Btu) or kBtu, and dividing this number by the building square footage. EUI is a good measure of a building's energy use and is utilized regularly for comparison of energy performance for similar building types. The Oak Ridge National Laboratory (ORNL) Buildings Technology Center under a contract with the U.S. Department of Energy maintains a Benchmarking Building Energy Performance Program. The ORNL website determines how a building's energy use compares with similar facilities throughout the U.S. and in a specific region or state.

Source use differs from site usage when comparing a building's energy consumption with the national average. Site energy use is the energy consumed by the building at the building site only. Source energy use includes the site energy use as well as all of the losses to create and distribute the energy to the building. Source energy represents the total amount of raw fuel that is required to operate the building. It incorporates all transmission, delivery, and production losses, which allows for a complete assessment of energy efficiency in a building. The type of utility purchased has a substantial impact on the source energy use of a building. The EPA has determined that source energy is the most comparable unit for evaluation purposes and overall global impact. Both the site and source EUI ratings for the building are provided to understand and compare the differences in energy use.
The site and source EUIs for this building are calculated as follows. (See Table 3.4 for details):

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

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

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

Table 3.7: New Stuyahok Water Plant EUI Calculations

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	63,084 kWh	215,304	3.340	719,115
#1 Oil	3,272 gallons	431,898	1.010	436,217
Total		**647,202**		**1,155,332**
BUILDING AREA		784	Square Feet	
BUILDING SITE EUI		826	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		**1,474**	**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: New Stuyahok Building Benchmarks

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	825.5	73.02	$76.29
With Proposed Retrofits	745.7	65.95	$64.18
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 New Stuyahok Water Plant was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from New Stuyahok 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 New Stuyahok. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the gas and electric profiles generated will not likely compare perfectly with actual energy billing information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.
• The heating load model is a simple two-zone model consisting of the building’s core interior spaces and the building’s perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in heating loads across different parts of the building.

The energy balances shown in Section 3.1 were derived from the output generated by the AkWarm© simulations.

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

The energy saving measures are summarized in Table 4.1. Please refer to the individual measure descriptions later in this report for more detail.

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR[1]**	**Simple Payback (Years)[2]**	**CO_2 Savings**
1	Other Electrical - Controls Retrofit: Booster Pump	Reduce the setpoint on the booster pumps from 63 psi down to 45 psi to reduce load and run time.	$4,963 / 27.8 MMBTU	$200	153.61	0.0	14,645.0
2	Setback Thermostat: New Stuyahok Water Plant	Implement a Heating Temperature Setback to 55.0 deg F when the water plant is unoccupied.	$489 / 8.8 MMBTU	$200	32.50	0.4	1,562.1
3	Other Electrical - Controls Retrofit: Well #3 Pump	Replace pressure transducer in the water storage tank, replace heat tape controls at WST to prevent freezing of transducer and incoming pipes. Control intake pump based upon water storage tank level rather than manual switching.	$1,539 + $250 Maint. Savings / 8.6 MMBTU	$2,200	6.86	1.2	4,540.2
4	Other Electrical - Controls Retrofit: Well #2 Pump	Replace pressure transducer in the water storage tank, replace heat tape controls at WST to prevent freezing of transducer and incoming pipes. Control intake pump based upon water storage tank level rather than manual switching.	$1,026 + $250 Maint. Savings / 5.7 MMBTU	$2,200	4.90	1.7	3,026.9
5	Lighting - Combined Retrofit: Main Room Lighting	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$266 / 0.9 MMBTU	$1,460	2.09	5.5	772.1

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
6	Other – Distribution Loop 1 (Lower Loop) Heat Load	Replace current heat exchangers with larger ones better able to meet heating demand, replace manual on/off switch with T775 and modulated Belimo valves	$0 + $500 Maint. Savings / 0.0 MMBTU	$3,500	1.22	7.0	0.0
7	Other – Distribution Loop 2 (Upper Loop) Heat Load	Replace current heat exchangers with larger ones better able to meet heating demand, replace manual on/off switch with T775 and modulated Belimo valves	$0 + $500 Maint. Savings / 0.0 MMBTU	$3,500	1.22	7.0	0.0
8	Lighting - Combined Retrofit: Office Lighting	Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	$79 / 0.3 MMBTU	$820	1.10	10.4	228.5
9	Other – Booster Station Heat Load	Replace water damaged section and insulate floor.	$183 / 3.6 MMBTU	$2,000	0.85	10.9	590.6
10	Water Plant Heating System	Replace controls with T775, replace limit switches (aquastat, hi temp shutoff), re-plumb boilers on nodes, install a circ pump on each node, replace boiler head or install genesis controller on boiler #2, tune and clean boilers, train operators in maintenance.	$184 + $500 Maint. Savings / 2.8 MMBTU	$18,000	0.58	26.3	579.3
11	Other Electrical - Power Retrofit: Lower Loop Circ Pump	Replace left hand lower loop circ pump motor, replace Victaulic valves on all four pumps, and replace flow meters.	$909 + $500 Maint. Savings / 4.7 MMBTU	$24,000	0.36	17.0	2,675.0
12	Air Tightening	Perform air sealing to reduce air leakage by 10 cfm at 50 Pascals.	$3 / 0.1 MMBTU	$500	0.06	156.7	10.2
13	Lighting - Combined Retrofit: Exterior Lighting	Replace with new energy-efficient LED lighting, replace manual switching with daylight sensor.	-$139 / -0.8 MMBTU	$580	-1.49	999.9	-410.9

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
	TOTAL, all measures		$9,500 + $2,500 Maint. Savings / 62.6 MMBTU	$59,160	1.62	4.9	28,218.9

4.2 Interactive Effects of Projects

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

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

Interior lighting, plug loads, facility equipment, and occupants generate heat within the building. When the building is in cooling mode, these items contribute to the overall cooling demands of the building; therefore, lighting efficiency improvements will reduce cooling requirements in air-conditioned buildings. Conversely, lighting-efficiency improvements are anticipated to slightly increase heating requirements. Heating penalties and cooling benefits were included in the lighting project analysis.

4.3 Building Shell Measures

4.3.1 Air Sealing Measures

Rank	Location	Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
12		Air Tightness estimated as: 1176 cfm at 50 Pascals		Perform air sealing to reduce air leakage by 10 cfm at 50 Pascals.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$3
Breakeven Cost	$29	**Simple Payback (yrs)**	157	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	0.1		
Auditors Notes: There is some damage visible to the front entry door jam. Repair the damaged section so that the door may better seal and reduce air leakage.					

4.4 Mechanical Equipment Measures

4.4.1 Heating/ Domestic Hot Water Measure

Rank	Recommendation				
10	Replace controls with T775, replace limit switches (aquastat, hi temp shutoff), replumb boilers on nodes, install a circ pump on each node, replace boiler head or install genesis controller on boiler #2, tune and clean boilers, train operators in maintenance.				
Installation Cost	$18,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$184
Breakeven Cost	$10,477	**Simple Payback (yrs)**	26	**Energy Savings (MMBTU/yr)**	2.8 MMBTU
		Savings-to-Investment Ratio	0.6	**Maintenance Savings ($/yr)**	$500
Auditors Notes: The aquastat and high temperature cutoff switch on boiler #2 were not working properly at the time of the audit, therefore replacement is recommended. In order to reduce heat lost to idle loss, replace the manual control switch with a Tekmar T775 controller, replumb boilers off nodes and install a circ pump on each node. Combustion test results show that boiler #1 is operating at low efficiency (72%), confirming a need for tuning, cleaning and training in set-up and maintenance. The maintenance savings here represent extended boiler/boiler component life when boilers are regularly rotated, cleaned and tuned as well as the risks and damage associated with boiling water release that occasionally results from the current aquastat and hi-temp cutoff dysfunction.					

4.4.2 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
2	New Stuyahok Water Plant			Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the New Stuyahok Water Plant space.	
Installation Cost	$200	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$489
Breakeven Cost	$6,499	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	8.8 MMBTU
		Savings-to-Investment Ratio	32.5		
Auditors Notes: The water plant is currently heated to 72°F at all times. Install a programmable thermostat and program a setback to 55°F during hours when the plant is unoccupied to save on space heating demand.					

4.5 Electrical & Appliance Measures

4.5.1 Lighting Measures

The goal of this section is to present any lighting energy conservation measures that may also be cost beneficial. It should be noted that replacing current bulbs with more energy-efficient equivalents will have a small effect on the building heating and cooling loads. The building cooling load will see a small decrease from an upgrade to more efficient bulbs and the heating load will see a small increase, as the more energy efficient bulbs give off less heat.

4.5.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	**Location**	**Existing Condition**		**Recommendation**	
5	Main Room Lighting	6 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	
Installation Cost	$1,460	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$266
Breakeven Cost	$3,047	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	0.9 MMBTU
		Savings-to-Investment Ratio	2.1		
Auditors Notes: There are six fixtures with four bulbs each so a total of 24 4’ T8 fluorescent bulbs to be replaced with their LED equivalent.					

Rank	**Location**	**Existing Condition**		**Recommendation**	
8	Office Lighting	2 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with new energy-efficient LED lighting, replace manual switching with occupancy sensor.	
Installation Cost	$820	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$79
Breakeven Cost	$901	**Simple Payback (yrs)**	10	**Energy Savings (MMBTU/yr)**	0.3 MMBTU
		Savings-to-Investment Ratio	1.1		
Auditors Notes: There are two fixtures with four bulbs each so a total of 8 4’ T8 fluorescent bulbs to be replaced with their LED equivalent.					

Rank	**Location**	**Existing Condition**		**Recommendation**	
13	Exterior Lighting	INCAN A Lamp, Std 100W with Manual Switching		Replace with new energy-efficient LED lighting, replace manual switching with daylight sensor.	
Installation Cost	$580	**Estimated Life of Measure (yrs)**	7	**Energy Savings ($/yr)**	-$139
Breakeven Cost	-$862	**Simple Payback (yrs)**	1000	**Energy Savings (MMBTU/yr)**	-0.8 MMBTU
		Savings-to-Investment Ratio	-1.5		
Auditors Notes: Outdoor lighting on the water treatment plant includes one single bulb wall-pack fixture. At the time of the audit the exterior light was not in use. Install an LED equivalent with more protective fixture and daylight sensor to provide exterior lighting for the facility.					

4.5.2 Other Electrical Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
1	Booster Pump		Pump with Other Controls		Reduce the setpoint on the booster pumps from 63 psi down to 45 psi to reduce load and run time.	
Installation Cost	$200		**Estimated Life of Measure (yrs)**	7	**Energy Savings ($/yr)**	$4,963
Breakeven Cost	$30,722		**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	27.8 MMBTU
			Savings-to-Investment Ratio	153.6		
Auditors Notes: The booster pumps are the single largest electricity consumers in the water system. They add the pressure needed to properly serve the higher elevation teacher housing. At the time of the audit, they were measured to be running 87% of the time. They are currently set to boost pressure to 63 psi. The acceptable design range for pressure at home connections is 20-80 psi. The setpoint on the booster pumps could be lowered and still provide sufficient pressure to the higher elevation homes. Lower the setpoint to 45 psi to reduce the load and run time for the pumps.						

Rank	Location		Description of Existing		Efficiency Recommendation	
3	Well #3 Pump		Pump with Manual Switching		Repair pressure transducer at WST, replace heat tape controls to prevent freezing, control intake pump based upon water storage tank level rather than manually.	
Installation Cost	$2,200		**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$1,539
Breakeven Cost	$15,089		**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	8.6 MMBTU
			Savings-to-Investment Ratio	6.9	**Maintenance Savings ($/yr)**	$250
Auditors Notes: A pressure transducer in the water storage tank is meant to read the depth of water in the tank and then send that reading to the water plant via a telemetry system. Although the telemetry system appears to be functioning properly, the pressure transducer was not. The heat tape meant to prevent freezing of the pressure transducer and inlet piping was also non-functional. Replace the pressure transducer and install it such that it extends farther into the tank, eliminating the need for freeze protection. Control the intake pumps based upon the storage tank level rather than manually to prevent tank overflow and slightly reduce intake pump run time. The maintenance savings shown here represent the extended pump life due to lower pump run time and the elimination of issues associated with tank overflow and ice build-up on and around the water tank.						

Rank	Location		Description of Existing		Efficiency Recommendation	
4	Well #2 Pump		Pump with Manual Switching		Control intake pump based upon water storage tank level rather than manually.	
Installation Cost	$2,200		**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$1,026
Breakeven Cost	$10,771		**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	5.7 MMBTU
			Savings-to-Investment Ratio	4.9	**Maintenance Savings ($/yr)**	$250
Auditors Notes: Same as above solution for Well #3 pump.						

Rank	Location	Description of Existing		Efficiency Recommendation	
11	Lower Loop Circ Pump	Pump with Manual Switching		Replace with Pump	
Installation Cost	$24,000	**Estimated Life of Measure (yrs)**	7	**Energy Savings ($/yr)**	$909
Breakeven Cost	$8,732	**Simple Payback (yrs)**	17	**Energy Savings (MMBTU/yr)**	4.7 MMBTU
		Savings-to-Investment Ratio	0.4	**Maintenance Savings ($/yr)**	$500

Auditors Notes: There is a set of circ pumps serving each of the two distribution loops. One circ pump runs at a time. They are meant to be rotated manually on a regular basis, however, the victaulic valves that allow for rotation are very difficult open. Replace all four victaulic valves to that circ pumps may be more easily rotated/isolated and receive more even wear.

The left hand pump (when looking toward the front of the building) on the lower circ loop is being run at a lower frequency than the other pumps to run at full load and exhibits some imbalance in the three phase power legs, suggesting that the motor may need replacement. Replace motor Replace inoperable flow meters on both loops.

The maintenance savings shown here represent extended pump life associated with the ability to regularly rotate pumps and the reduced risk of failure at the victaulic valves currently requiring excessive force to open or close.

4.5.3 Other Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
6		Distribution Loop 1 (Lower Loop) Heat Load		Replace current heat exchangers with larger ones better able to meet heating demand, replace manual on/off switch with T775 and modulated Belimo valves	
Installation Cost	$3,500	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$
Breakeven Cost	$4,265	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.2	**Maintenance Savings ($/yr)**	$500

Auditors Notes: Each distribution loop has its own heat add system. The water system has had issues with freezing which may be tied to undersized heat exchangers in the heat add systems. Replace current heat exchangers with higher heat transfer capacity, brazed plate, double wall heat exchangers. Replace manual on/off heat add valves with T775 controller and modulated Belimo valves.

The maintenance savings represented here represent the potential reduction in service line and branch freeze-ups with heat exchangers better sized to meet current and future heating demand.

Rank	Location	Description of Existing		Efficiency Recommendation	
7		Distribution Loop 2 (Upper Loop) Heat Load		Replace current heat exchangers with larger ones better able to meet heating demand, replace manual on/off switch with T775 and modulated Belimo valves	
Installation Cost	$3,500	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$
Breakeven Cost	$4,265	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.2	**Maintenance Savings ($/yr)**	$500

Auditors Notes: Same as above notes for Distribution Loop 1.

Rank	Location	Description of Existing		Efficiency Recommendation	
9		Booster Pump House Heat Load		Replace water damaged section and insulate floor.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$183
Breakeven Cost	$1,695	**Simple Payback (yrs)**	11	**Energy Savings (MMBTU/yr)**	3.6 MMBTU
		Savings-to-Investment Ratio	0.8		
Auditors Notes: The booster station floor shows major deterioration. Replace damaged flooring and insulate floor with foam panels to reduce heat loss.					

Figure 11: Deteriorating floor in booster station.

5. ENERGY EFFICIENCY ACTION PLAN

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

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

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

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: New Stuyahok Water Plant	**Auditor Company:** Alaska Native Tribal Health Consortium
Address: PO Box 10	**Auditor Name:** Bailey Gamble
City: New Stuyahok	**Auditor Address:** 4500 Diplomacy Dr., Suite 454 Anchorage, AK 99508
Client Name: Nick Epchook	
Client Address: PO Box 10 New Stuyahok, AK 99636	**Auditor Phone:** (907) 729-4501
	Auditor FAX:
Client Phone: (907) 693-6085	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 784 square feet	**Design Space Heating Load:** Design Loss at Space: 11,051 Btu/hour with Distribution Losses: 11,051 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 16,846 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 1 people	**Design Indoor Temperature:** 72 deg F (building average)
Actual City: New Stuyahok	**Design Outdoor Temperature:** -19.3 deg F
Weather/Fuel City: New Stuyahok	**Heating Degree Days:** 11,306 deg F-days
Utility Information	
Electric Utility: AVEC-New Stuyahok - Commercial - Lg	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.610/kWh	**Average Annual Cost/ccf:** $0.000/ccf

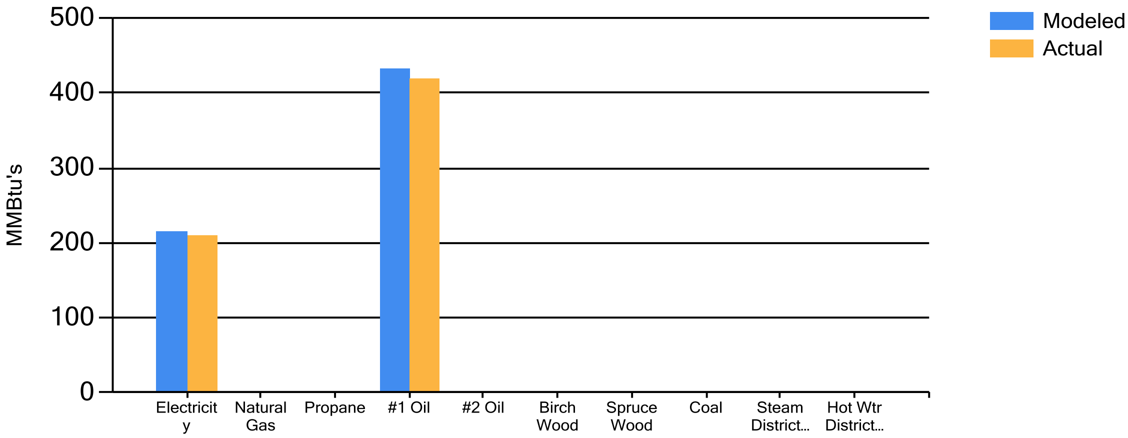
Annual Energy Cost Estimate					
Description	**Space Heating**	**Lighting**	**Other Electrical**	**Water Circulation Heat**	**Total Cost**
Existing Building	$1,636	$811	$36,914	$20,452	**$59,814**
With Proposed Retrofits	$1,078	$548	$28,443	$20,246	**$50,314**
Savings	$558	$263	$8,472	$206	**$9,500**

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	825.5	73.02	$76.29
With Proposed Retrofits	745.7	65.95	$64.18
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

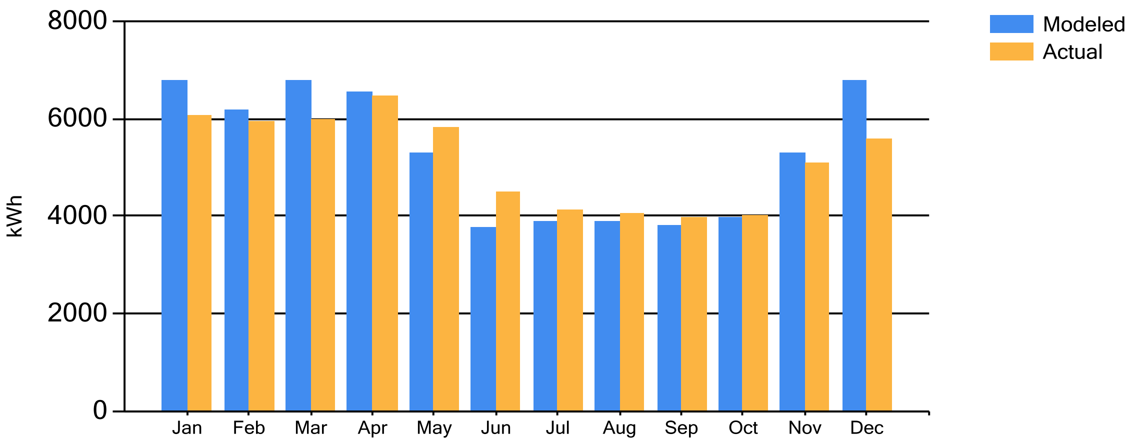
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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

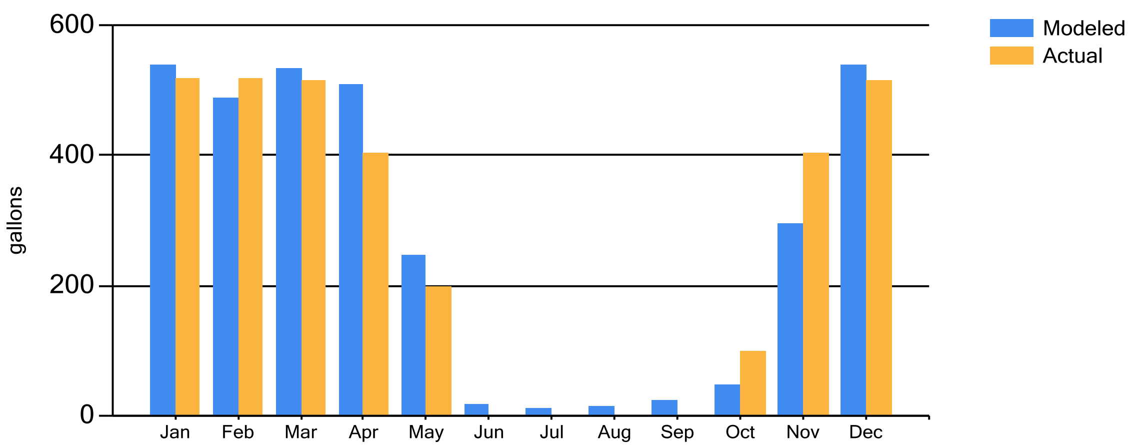
Annual Energy Use



Electricity Use



#1 Fuel Oil Use



Appendix C - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	11.4	11.4	11.4	11.3	9.5	7.7	7.7	7.7	7.8	7.8	9.7	11.4
As Proposed	9.1	9.1	9.1	9.0	7.4	5.8	5.8	5.8	5.8	5.9	7.6	9.1

AkWarmCalc Ver 2.6.1.0, Energy Lib 8/9/2016