Comprehensive Energy Audit
For

Fort Yukon Water Treatment Plant

Prepared For

City of Fort Yukon

June 29, 2016

Prepared By:

ANTHC-DEHE
4500 Diplomacy Dr.,
Anchorage, AK 99508

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PREFACE

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

The Rural Energy Initiative at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for The City of Fort Yukon, Alaska. The authors of this report are Praveen KC, Professional Engineer (PE) and Kevin Ulrich, Energy Manager-in-Training (EMIT).

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in April 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 Treatment Plant Operator Eric Tremblay, Remote Maintenance Worker Fred Kameroff, and Fort Yukon City Manager Shawn Phillips.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Fort Yukon. The scope of the audit focused on the Fort Yukon Water Treatment Plant, Downtown Pumphouse, and Lift Stations. 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.

In the near future, a representative of ANTHC will be contacting the City of Fort Yukon to follow up on the recommendations made in this report. Funding has been provided by to ANTHC through a Rural Alaska Village Grant to provide the community with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations within the 2016 calendar year.

The total predicted energy cost for the Fort Yukon Water Treatment Plant and Lift Stations is $148,143 per year. Electricity represents the largest portion with an annual cost of approximately $86,986. This includes approximately $32,495 paid by the city and $55,491 paid by the Power Cost Equalization (PCE) program through the State of Alaska. Fuel oil represents the remaining portion with an annual cost of approximately $61,156.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower the electricity costs and make energy in rural Alaska affordable. In Fort Yukon, the cost of electricity without PCE is $0.58/kWh, and the cost of electricity with PCE is $0.21/kWh. For the purposes of this report, electricity costs and savings are calculated using the $0.58 per kilowatt hour rate.

The water treatment plant is the largest building of all the water and sewer facilities in the community. This building is estimated to consume approximately 94,957 kWh of electricity and 15,340 gallons of fuel annually. The electric billing indicates that the water treatment plant building was charged for an annual consumption of 33,674 kWh in 2015. The predicted energy usage does not align with energy usage measured by the electric meter. ANTHC is working with the City of Fort Yukon and the electric utility to identify solutions to the difference.

There is a small washeteria room located within the city multipurpose building. There are three electric clothes washers and two electric clothes dryers in the washeteria that are used for public laundry services. It was estimated by the community that the washeteria uses approximately 60,000 gallons of water per month, which is heated using a Toyotomi OM-148 water heater that is located within the mechanical space for the entire building. The washeteria generated an annual income of $11,730.75 from summer 2014 – summer 2015. This facility is small and does not require a full length energy audit report.

Table 1.1 lists the total usage of electricity and #1 heating in all buildings before and after the proposed retrofits.

Table 1.1: Predicted Annual Fuel Usage for Each Fuel Type

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	152,424 kWh	122,738 kWh

#1 Oil	17,473 gallons	14,437 gallons

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

Table 1.2: Building Benchmarks for the Fort Yukon Water Treatment Plant and Lift Stations

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	1,223.7	74.95	$64.13
With Proposed Retrofits	1,006.3	61.64	$52.30
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 Fort Yukon Water Treatment Plant. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.3: Summarized Priority List of All Energy Recommendations for the Fort Yukon Water Treatment Plant & Lift Stations

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: Well Pumps	Shut off one well pump and alternate the usage of the two pumps.	$2,209	$500	51.89	0.2	7,854.4
2	Other Electrical: Lift Station 3 Electric Heaters	Lower temperature set point in Lift Station 3 to 50 deg. F.	$1,552	$500	36.46	0.3	5,518.4
3	Other Electrical: Lift Station 2 Electric Heaters	Lower temperature set point in Lift Station 2 to 50 deg. F.	$1,034	$500	24.30	0.5	3,678.6
4	Other Electrical: Lift Station 4 Electric Heaters	Lower temperature set point in Lift Station 4 to 50 deg. F.	$1,035	$500	24.31	0.5	3,679.1
5	Other Electrical: Lift Station 5 Electric Heaters	Lower temperature set point in Lift Station 5 to 50 deg. F.	$1,003	$500	23.57	0.5	3,567.2
6	Other Electrical: Lift Station 6 Electric Heaters	Lower temperature set point in Lift Station 6 to 50 deg. F.	$846	$500	19.88	0.6	3,009.8

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**
7	Angel Pond Distribution Loop	Lower temperature settings to 41-39 deg. F. Reduce flow rate from 160 GPM to 120 GPM. Reduce temperature differential to 2 deg. F. Lower pump operating power in the summer months and use minimal heating when necessary in the warmer months. $3750 for remote monitoring efforts for certainty in operating margins	$9,096	$6,750	18.20	0.7	54,078.9
8	Lighting: Downtown Pump House Lights (4 T12 fixtures)	Replace with new energy-efficient LED lighting.	$382	$320	14.02	0.8	1,358.0
9	Lighting: Office/Lab Room	Replace with new energy-efficient LED lighting.	$535	$640	9.82	1.2	1,902.1
10	Lighting: Process Room	Replace with new energy-efficient LED lighting.	$1,871	$2,240	9.81	1.2	6,651.7
11	Lighting: Boiler Room	Replace with new energy-efficient LED lighting and add new occupancy sensor	$959	$1,460	7.71	1.5	3,409.1
12	Water Storage Tank Heat Add	Reduce flow rate to 60 GPM. Lower temperatures to 40-38 deg. F.	$1,593	$3,000	7.10	1.9	9,188.5
13	Lighting: Downtown Pump House Lights (2 T12 Fixtures)	Replace with new energy-efficient LED lighting.	$88	$240	4.28	2.7	311.2
14	Other Electrical: Transmission Loop Circulation Pump	Lower flow rate from 133 GPM to 120 GPM. Lower pump operating power in the summer months. $3750 for Remote Monitoring efforts that are required for certainty in operating margins.	$2,383	$9,750	2.87	4.1	8,473.3
15	Lighting: Lift Station 1 Exterior Light	Replace with new energy-efficient LED lighting.	$102	$500	2.39	4.9	361.4

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**
16	Lighting: Lift Station 2 Exterior Light	Replace with new energy-efficient LED lighting.	$102	$500	2.39	4.9	361.3
17	Lighting: Lift Station 3 Exterior Light	Replace with new energy-efficient LED lighting.	$102	$500	2.39	4.9	361.3
18	Lighting: Lift Station 4 Exterior Light	Replace with new energy-efficient LED lighting.	$102	$500	2.39	4.9	361.4
19	Lighting: Exterior Lights	Replace with new energy-efficient LED lighting.	$226	$1,500	1.77	6.6	803.4
20	Other Electrical: Angel Pond Loop Circulation Pump	Lower flow rate from 160 GPM to 120 GPM. Lower pump operating power in the summer months. $3750 for remote monitoring efforts that are required for certainty in operating margins.	$1,397	$9,750	1.68	7.0	4,967.7
21	Lighting: Lift Station 3 Interior Lights	Replace with new energy-efficient LED lighting.	$14	$100	1.61	7.3	48.8
22	Lighting: Restroom Lights	Replace with new energy-efficient LED lighting.	$9	$80	1.34	8.7	32.6
23	Transmission Distribution Loop	Lower flow rate from 133 GPM to 120 GPM. Reduce temperature differential to 2 deg. F. Lower pump operating power in the summer months and use minimal heating when necessary in the warmer months. $3750 for Remote Monitoring efforts that are required for certainty in operating margins.	$648	$6,750	1.24	10.4	3,364.1
24	Lighting: Lift Station 1 Wet Side Lights	Replace with new energy-efficient LED lighting.	$5	$50	1.07	10.9	16.3
25	Lighting: Lift Station 1 Dry Side Lights	Replace with new energy-efficient LED lighting.	$3	$100	0.38	30.9	11.5
26	Lighting: Chemical Storage - Incandescent	Replace with new energy-efficient LED lighting.	$1	$50	0.31	37.6	4.8

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**
27	Lighting: Lift Station 4 Interior Lights	Replace with new energy-efficient LED lighting.	$3	$160	0.26	45.9	12.3
28	Lighting: Lift Station 5 Interior Lights	Replace with new energy-efficient LED lighting.	$3	$160	0.25	46.2	12.4
29	Lighting: Lift Station 6 Interior Lights	Replace with new energy-efficient LED lighting.	$3	$160	0.25	46.2	12.3
30	Lighting: Lift Station 2 Interior Lights	Replace with new energy-efficient LED lighting.	$2	$100	0.25	46.5	7.7
31	Heating, Ventilation, and Domestic hot Water	Replace Glycol Circulation Pump with Grundfos Magna for improved efficiency and performance. This retrofit is necessary in order for the loop heat-add retrofits to be functionally dependable.	$17	$5,000	0.06	287.5	84.9
32	Lighting: Chemical Storage - T8's	Replace with new energy-efficient LED lighting.	$0	$80	0.04	284.4	1.0
	TOTAL, all measures		**$27,324**	**$53,440**	**6.37**	**2.0**	**123,505.0**

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 $27,324 per year, or 18.4% of the buildings' total energy costs. These measures are estimated to cost $53,440, for an overall simple payback period of 2.0 years.

Table 1.4 below is a breakdown of the annual energy cost across various energy end use types, such as space heating and water heating. The first row in the table shows the breakdown for the building as it is now. The second row shows the expected breakdown of energy cost for the building assuming all of the retrofits in this report are implemented. Finally, the last row shows the annual energy savings that will be achieved from the retrofits.

Table 1.4: Annual Energy Cost Estimate Broken Down by Category

Annual Energy Cost Estimate								
Description	**Space Heating**	**Ventilation Fans**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$4,469	$31	$7,507	$76,062	$5,873	$28,752	$25,350	**$148,143**
With Proposed Retrofits	$4,455	$31	$2,946	$64,662	$6,090	$18,756	$23,785	**$120,818**
Savings	$14	$0	$4,561	$11,399	-$217	$9,996	$1,565	**$27,324**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

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

2.2 Audit Description

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

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

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

Details collected from Fort Yukon 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 Fort Yukon Water Treatment Plant is made up of the following activity areas:

1) Water Treatment Plant: 2,160 square feet
2) Generator Room: 150 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 systems; 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. Fort Yukon Water Treatment Plant

3.1. Building Description

The 2,310 square foot Fort Yukon Water Treatment Plant was constructed in 2011, with a normal occupancy of one person. The number of hours of operation for this building average eight hours per day throughout the week.

The Fort Yukon Water Treatment Plant serves as the central location for the water intake, treatment, and distribution processes for the community. The water treatment plant has two distribution loops that are used to distribute water to each of the residences and other buildings. The Transmission Loop is 26,060 ft. long and supplies water to the western part of the town. The Angel Pond Loop is 23,200 ft. long and supplies water to the eastern part of the community. All loops use arctic pipe that is buried within the permafrost in the ground.

Water is pumped from two wells approximately 100 ft. from the facility that are influenced by the nearby Yukon River. The water is injected with polymer potassium permanganate before being pumped through two large sand filters. The water is then injected with chlorine and fluoride before being sent to the 350,000 gallon water storage tank. The water is allowed proper contact time within the water storage tank before getting pumped through the distribution loops.

There is an old pumphouse in the western side of town that is no longer actively used for water processing. The building is now used primarily for storage and is heated to prevent freezing in the equipment. There are also six lift stations throughout the town that are used to collect the sewage from the residents and pump it to the sewage lagoon outside of town.

Description of Building Shell

The exterior walls are constructed with 2x10 single stud framing with 16-inch offset and R-38 fiberglass batt insulation. The walls are 10 ft. tall and there is approximately 1920 square feet in the building.

The water treatment plant has a cathedral ceiling that is constructed with standard lumber framing and 24-inch spacing. There is approximately 9.5 inches of R-38 fiberglass batt insulation in the ceiling and there is a total of approximately 2,277 square feet of roof space in the building.

The water treatment plant is built on grade with a six-inch concrete slab and is framed with standard lumber. There is approximately 2,160 square feet of floor space in the building.

There is one triple-paned window in the office area that is 4ft x 3ft with wood framing.

The front entrance door is a standard 3ft x 7ft insulated metal door with a quarter-lite window. There is also a set of double doors on the northern wall that were previously used to move new equipment into the building. These doors are standard 3ft. x 7ft. insulated metal doors with no glass.

Description of Heating Plants

The Heating Plants used in the building are:

Boiler 1

Nameplate Information: Burnham Model MPC-4

Fuel Type: #1 Oil
Input Rating: 424,000 BTU/hr
Steady State Efficiency: 82 %
Idle Loss: 1.5 %
Heat Distribution Type: Glycol
Boiler Operation: All Year

Boiler 2

Fuel Type: #1 Oil
Input Rating: 424,000 BTU/hr
Steady State Efficiency: 83 %
Idle Loss: 1.5 %
Heat Distribution Type: Glycol
Boiler Operation: All Year

Figure 3.1: Burnham Boilers in the Mechanical Room

Upon arriving for the site visit, the heating system for the water treatment plant was unable to meet basic heating demands due to faulty programming with the VFD pump used for the glycol loop circulation. Additionally, the Tekmar boiler controller was unable to adjust its settings for the unexpected changes. As a result, the flow rate for glycol circulation was much lower than desired and the line did not have adequate pressure as well. These issues were addressed during the site visit and recommendations for the improvements have been included in this energy audit report. These recommendations are necessary in order for any heating recommendations to be effective.

Old Pumphouse Toyotomi Laser 73 Heaters

Fuel Type: #1 Oil
Input Rating: 40,000 BTU/hr
Steady State Efficiency: 80 %

Idle Loss: 1.5 %
Heat Distribution Type: Air

Figure 3.2: Toyotomi Stove in the Downtown Pumphouse

Electric heaters are present in each lift station that each are used to keep the sewage from freezing. Recommendations regarding the set points in the lift stations are included in this report but were modeled as electrical loads rather than heating plants. Additionally, Lift Station 1 has a Weil McLain Gold boiler rated for 75 MBH that is used for emergency purposes to keep the sewage from freezing in the sewer lines. This boiler uses less than 100 gallons of fuel per year.

Space Heating Distribution Systems

There are five unit heaters and one baseboard heater that provide space heat to the water treatment plant. The heaters are listed below with information on heat output, operational status, and location.

Unit Heater 1: 31 MBH Rating, Process Room

Unit Heater 2: 31 MBH Rating, Process Room

Unit Heater 3: 31 MBH Rating, Process Room

Unit Heater 4: 10 MBH Rating, Boiler Room

Unit Heater 5: 20 MBH Rating, Generator Room

Baseboard Heater 1: 10 MBH, Restroom/Office

Electric heaters are present in each of the lift stations and are discussed in a later section.

Domestic Hot Water System

There are two large indirect-fired water heaters that are primarily used for lab sinks and the restroom. Each of the two tanks are 119 gallons but only one heater is in operation at a time. The tanks were sized to provide heat to the sewer lines during the construction phase of the project. These prevented the sewer lines freezing. This task is now performed by the heaters in each lift station and the hot water heaters in the water treatment plant are now used for emergency purposes only.

Description of Building Ventilation System

There is a ventilation fan in the chemical storage room that is used to remove contaminated air for safe usage by the operator. The fan is a Greenheck Model SQ-75-D-X and is rated for 50 CFM and 150 Watts.

Lighting

The process room has 14 fixtures with four T8 4ft. fluorescent light bulbs in each fixture. The lights are on approximately nine hours per day when the operator is working throughout the week and they consume approximately 5,184 kWh annually.

The office and lab room has four fixtures with four T8 4ft. fluorescent light bulbs in each fixture. The lights are on approximately nine hours per day when the operator is working throughout the week and they consume approximately 1,481 kWh annually.

The boiler room has six fixtures with four T8 4ft. fluorescent light bulbs in each fixture. The lights are on approximately nine hours per day when the operator is working throughout the week and they consume approximately 2,222 kWh annually.

There is one fixture with three T8 4ft. fluorescent lights in the restroom that uses approximately 31 kWh annually.

The chemical storage room has one fixture with two T8 4ft. fluorescent lights and one fixture with two 60 Watt incandescent light bulbs. The lights combine to use approximately 5 kWh annually.

The downtown pumphouse has lights that are used periodically throughout the winter when the operator needs to access the building to obtain equipment during the cold months. There are four fixtures with four T8 4ft. fluorescent light bulbs and three fixtures with two T8 4ft. fluorescent light bulbs. The lights combine to use approximately 1,317 kWh annually.

Lift Station 1 has three CFL 26 Watt light bulbs, one incandescent 60 Watt light bulb, and a metal halide 70 Watt exterior light that combine to consume approximately 471 kWh annually.

Lift Station 2 has two CFL 26 Watt light bulbs and a metal halide 70 Watt exterior light that combine to consume approximately 456 kWh annually.

Lift Station 3 has three incandescent 60 Watt light bulbs and a metal halide 70 Watt exterior light that combine to consume approximately 479 kWh annually.

Lift Station 4 has one fixture with two T8 4ft. fluorescent light bulbs in the fixture and a metal halide 70 Watt exterior light that combine to consume approximately 467 kWh annually.

Lift Station 5 and Lift Station 6 each have two fixtures with two T8 4ft. fluorescent light bulbs in each fixture. There are no exterior lights. The lights for each of the two lifty stations consumes approximately 21 kWh annually.

Plug Loads

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

Major Equipment

There are two distribution loops that are used to provide water to the residents in the community. Each loop has two 7.5 HP VFD circulation pumps that are used to pump water constantly throughout the year. These pumps operate constantly because the pipes are buried in continuous permafrost that always presents a threat of freezing the water. Angel Pond Loop is shorter and the circulation pumps for this loop consume approximately 20, 670 kWh annually. Transmission Loop is longer and consumes approximately 35,257 kWh annually.

There are two pressure pumps that are used to pressurize the water supply system for optimal distribution. One of the pumps operates approximately 8% of the time throughout the year and they pumps consume approximately 2,104 kWh annually.

There are heat tapes on the well line and along Well 1 and Well 2 that are used in emergency purposes to keep the water from freezing. The three heat tapes combine to use approximately 72 kWh annually.

There are two well pumps that are used to pump water from the wells to the water treatment plant approximately 100 feet away. Both pumps were operating constantly and are each rated for 0.75 HP. The two pumps combine to consume approximately 7,854 kWh annually.

There are four chemical injection pumps that operate constantly throughout the year. The pumps are used to inject fluoride, potassium permanganate, polymer, and chlorine respectively. Each of the pumps is rated for 0.5 HP and consumes approximately 3,287 kWh annually.

There are six lift stations in town that each have a pair of lift station pumps and electric heaters. In each lift station, the pumps alternate to run when necessary to pump the sewage to the sewage lagoon. The sewage travels in the order 6 -> 5 -> 4 -> 3 -> 2 -> 1 -> lagoon. The tables below show information on the lift station pumps and on the electric heaters.

Table 3.1: Lift Station Pump Information

Lift Station	Pump Rating (HP)	Approximate Runtime	kWh Consumption
1	18	14%	16,445
2	5	8%	2,630
3	3	10%	1,841
4	3.5	5%	1,159
5	3.5	3%	684
6	3	2%	368

Table 3.2: Lift Station Electric Heater Information

Lift Station	Electric Rating (Watts)	Approximate Runtime	kWh Consumption
2	3,300	35%	6,438
3	3,300	40%	7,358
4	3,300	35%	6,438
5	4,000	23%	5,128
6	3,000	34%	5,686

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

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

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

The Gwitchyaa Zhee Utility Company is a tribal utility that is locally owned and operated by the Gwitchyaa Zhee Corporation. The utility provides electricity to the residents of Fort Yukon as well as all 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: Average Energy Rates by Fuel Type

Average Energy Cost	
Description	Average Energy Cost
Electricity	$ 0.57/kWh
#1 Oil	$ 3.50/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Fort Yukon pays approximately $148,143 annually for electricity and other fuel costs for the Fort Yukon Water Treatment Plant.

Figure 3.3 below reflects the estimated distribution of costs across the primary end uses of energy based on the AkWarm© computer simulation.   Comparing the "Retrofit" bar in the figure to the "Existing" bar shows the potential savings from implementing all of the energy efficiency measures shown in this report.

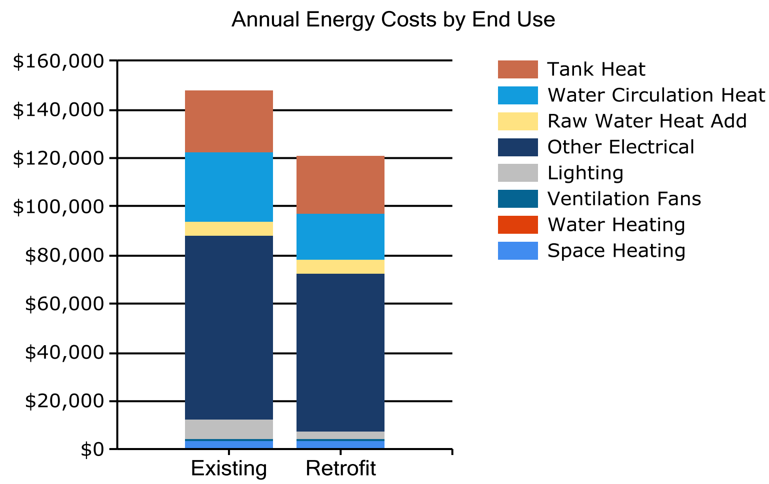


Figure 3.3: Annual Energy Costs by Building Category

Figure 3.4 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

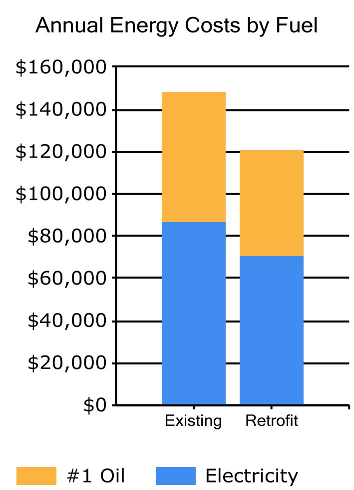


Figure 3.4: Annual Energy Costs by Fuel Type

Figure 3.5 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing building is shown (blue bar) and the space heating cost assuming all retrofits are implemented (yellow bar) are shown.

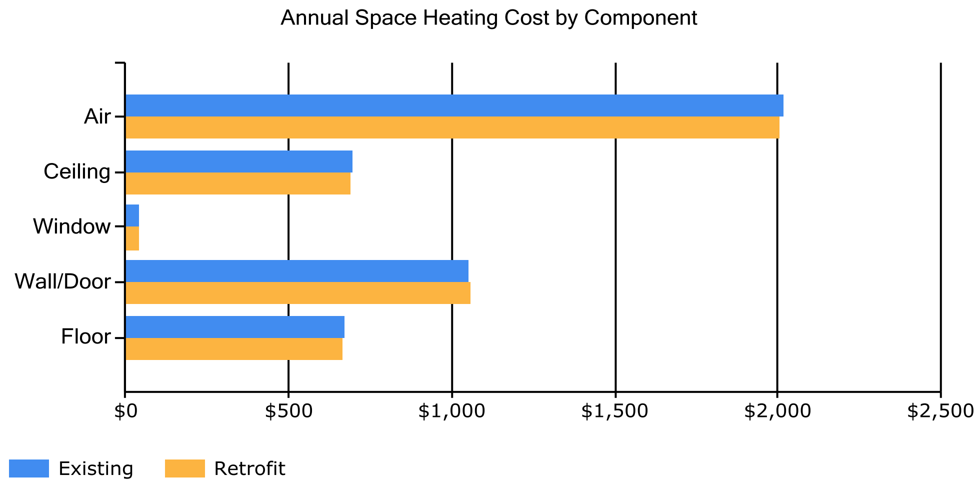


Figure 3.5: Annual Space Heating Cost by Component

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

Table 3.4: Electrical Consumption by Category

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	49	25	4	0	0	0	0	0	0	0	13	43
Domestic Hot Water	1	1	1	1	1	1	1	1	1	1	1	1
Ventilation Fans	5	4	5	4	5	4	5	5	4	5	4	5
Lighting	1299	1184	1299	1156	939	772	798	798	1055	1299	1257	1299
Other Electrical	12824	11687	12824	11573	9843	8391	8671	8671	10736	12824	12411	12824
Raw Water Heat Add	155	141	155	150	155	150	155	155	150	155	150	155
Water Circulation Heat	227	207	227	220	227	220	227	227	220	227	220	227
Tank Heat	175	145	136	92	63	61	63	63	66	105	140	170

Table 3.5: Fuel Oil Consumption by Category

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	236	187	163	86	28	3	3	3	38	107	173	227
Domestic Hot Water	2	2	2	2	2	2	2	2	2	2	2	2
Raw Water Heat Add	114	104	115	113	121	117	121	121	116	116	111	114
Water Circulation Heat	640	585	646	637	680	658	680	680	654	654	624	640
Tank Heat	1465	1144	956	416	0	0	0	0	62	558	1032	1401

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 3.6 for details):

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

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

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

Table 3.6: Fort Yukon Water Treatment Plant EUI Calculations

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	152,424 kWh	520,223	3.340	1,737,546
#1 Oil	17,473 gallons	2,306,461	1.010	2,329,526
Total		**2,826,684**		**4,067,071**
BUILDING AREA		2,310	Square Feet	
BUILDING SITE EUI		1,224	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		1,761	**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 3.7: Fort Yukon Water Treatment Plant Building Benchmarks

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	**1,223.7**	**74.95**	**$64.13**
With Proposed Retrofits	**1,006.3**	**61.64**	**$52.30**
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. **EUI/HDD: Energy Use Intensity per Heating Degree Day.** **ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.**			

3.3 AkWarm© Building Simulation

An accurate model of the building performance can be created by simulating the thermal performance of the walls, roof, windows and floors of the building. The heating and ventilation systems and central plant are modeled as well, accounting for the outside air ventilation required by the building and the heat recovery equipment in place.

The model uses local weather data and is trued up to historical energy use to ensure its accuracy. The model can be used now and in the future to measure the utility bill impact of all types of energy projects, including improving building insulation, modifying glazing, changing air handler schedules, increasing heat recovery, installing high efficiency boilers, using variable air volume air handlers, adjusting outside air ventilation and adding cogeneration systems.

For the purposes of this study, the Fort Yukon Water Treatment Plant was modeled using AkWarm© energy use software to establish a baseline space heating energy usage. Climate data from Fort Yukon 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 Fort Yukon. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the gas and electric profiles generated will not likely compare perfectly with actual energy billing information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.
• The heating load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in heating loads across different parts of the building.

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

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

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

Table 4.1: List of Energy Efficiency Measures by Economic Priority

Fort Yukon Water Treatment Plant, Fort Yukon, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)	CO_2 Savings
1	Other Electrical: Well Pumps	Shut off one well pump and alternate the usage of the two pumps.	$2,209	$500	51.89	0.2	7,854.4

Fort Yukon Water Treatment Plant, Fort Yukon, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
2	Other Electrical: Lift Station 3 Electric Heaters	Lower temperature set point in Lift Station 3 to 50 deg. F.	$1,552	$500	36.46	0.3	5,518.4
3	Other Electrical: Lift Station 2 Electric Heaters	Lower temperature set point in Lift Station 2 to 50 deg. F.	$1,034	$500	24.30	0.5	3,678.6
4	Other Electrical: Lift Station 4 Electric Heaters	Lower temperature set point in Lift Station 4 to 50 deg. F.	$1,035	$500	24.31	0.5	3,679.1
5	Other Electrical: Lift Station 5 Electric Heaters	Lower temperature set point in Lift Station 5 to 50 deg. F.	$1,003	$500	23.57	0.5	3,567.2
6	Other Electrical: Lift Station 6 Electric Heaters	Lower temperature set point in Lift Station 6 to 50 deg. F.	$846	$500	19.88	0.6	3,009.8
7	Angel Pond Distribution Loop	Lower temperature settings to 41-39 deg. F. Reduce flow rate from 160 GPM to 120 GPM. Reduce temperature differential to 2 deg. F. Lower pump operating power in the summer months and use minimal heating when necessary in the warmer months. $3750 for remote monitoring efforts that are required for certainty in operating margins..	$9,096	$6,750	18.20	0.7	54,078.9
8	Lighting: Downtown Pump House Lights (4 T12 fixtures)	Replace with new energy-efficient LED lighting.	$382	$320	14.02	0.8	1,358.0
9	Lighting: Office/Lab Room	Replace with new energy-efficient LED lighting.	$535	$640	9.82	1.2	1,902.1
10	Lighting: Process Room	Replace with new energy-efficient LED lighting.	$1,871	$2,240	9.81	1.2	6,651.7

Fort Yukon Water Treatment Plant, Fort Yukon, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
11	Lighting: Boiler Room	Replace with new energy-efficient LED lighting and add new occupancy sensor	$959	$1,460	7.71	1.5	3,409.1
12	Water Storage Tank Heat Add	Reduce flow rate to 60 GPM. Lower temperatures to 40-38 deg. F.	$1,593	$3,000	7.10	1.9	9,188.5
13	Lighting: Downtown Pump House Lights (2 T12 Fixtures)	Replace with new energy-efficient LED lighting.	$88	$240	4.28	2.7	311.2
14	Other Electrical: Transmission Loop Circulation Pump	Lower flow rate from 133 GPM to 120 GPM. Lower pump operating power in the summer months. $3750 for Remote Monitoring efforts that are required for certainty in operating margins.	$2,383	$9,750	2.87	4.1	8,473.3
15	Lighting: Lift Station 1 Exterior Light	Replace with new energy-efficient LED lighting.	$102	$500	2.39	4.9	361.4
16	Lighting: Lift Station 2 Exterior Light	Replace with new energy-efficient LED lighting.	$102	$500	2.39	4.9	361.3
17	Lighting: Lift Station 3 Exterior Light	Replace with new energy-efficient LED lighting.	$102	$500	2.39	4.9	361.3
18	Lighting: Lift Station 4 Exterior Light	Replace with new energy-efficient LED lighting.	$102	$500	2.39	4.9	361.4
19	Lighting: Exterior Lights	Replace with new energy-efficient LED lighting.	$226	$1,500	1.77	6.6	803.4
20	Other Electrical: Angel Pond Loop Circulation Pump	Lower flow rate from 160 GPM to 120 GPM. Lower pump operating power in the summer months. $3750 for remote monitoring efforts that are required for certainty in operating margins.	$1,397	$9,750	1.68	7.0	4,967.7
21	Lighting: Lift Station 3 Interior Lights	Replace with new energy-efficient LED lighting.	$14	$100	1.61	7.3	48.8
22	Lighting: Restroom Lights	Replace with new energy-efficient LED lighting.	$9	$80	1.34	8.7	32.6

Fort Yukon Water Treatment Plant, Fort Yukon, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
23	Transmission Distribution Loop	Lower flow rate from 133 GPM to 120 GPM. Reduce temperature differential to 2 deg. F. Lower pump operating power in the summer months and use minimal heating when necessary in the warmer months. $3750 for Remote Monitoring efforts that are required for certainty in operating margins..	$648	$6,750	1.24	10.4	3,364.1
24	Lighting: Lift Station 1 Wet Side Lights	Replace with new energy-efficient LED lighting.	$5	$50	1.07	10.9	16.3
25	Lighting: Lift Station 1 Dry Side Lights	Replace with new energy-efficient LED lighting.	$3	$100	0.38	30.9	11.5
26	Lighting: Chemical Storage - Incandescent	Replace with new energy-efficient LED lighting.	$1	$50	0.31	37.6	4.8
27	Lighting: Lift Station 4 Interior Lights	Replace with new energy-efficient LED lighting.	$3	$160	0.26	45.9	12.3
28	Lighting: Lift Station 5 Interior Lights	Replace with new energy-efficient LED lighting.	$3	$160	0.25	46.2	12.4
29	Lighting: Lift Station 6 Interior Lights	Replace with new energy-efficient LED lighting.	$3	$160	0.25	46.2	12.3
30	Lighting: Lift Station 2 Interior Lights	Replace with new energy-efficient LED lighting.	$2	$100	0.25	46.5	7.7
31	Heating, Ventilation, and Domestic hot Water	Replace Glycol Circulation Pump with Grundfos Magna for improved efficiency and performance. This retrofit is necessary in order for the loop heat-add retrofits to be functionally dependable.	$17	$5,000	0.06	287.5	84.9
32	Lighting: Chemical Storage - T8's	Replace with new energy-efficient LED lighting.	$0	$80	0.04	284.4	1.0
	TOTAL, all measures		**$27,324**	**$53,440**	**6.37**	**2.0**	**123,505.0**

4.2 Interactive Effects of Projects

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

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

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

4.3 Mechanical Equipment Measures

4.3.1 Heating/ Domestic Hot Water Measure

Rank	**Recommendation**				
31	Replace Glycol Circulation Pump with Grundfos Magna for improved efficiency and performance. This retrofit is necessary in order for the loop heat-add retrofits to be functionally dependable.				
Installation Cost	$5,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$17
Breakeven Cost	$280	**Savings-to-Investment Ratio**	0.1	**Simple Payback yrs**	288

Auditors Notes: The glycol circulation pump in place is an Armstrong brand that was not operating at the proper flow rate and pressure for system operations. As a result, the boilers were operating more because of a call for heat that could not be met by the glycol circulation loop. Part of the problem was also that the boiler controller attempted to compensate for summer conditions by lowering the glycol circulation rate, but with the loops buried in continuous permafrost this adjustment did not help with system performance. This recommendation is to replace the current pump with a Grundfos Magna model because this is a pump that we are familiar with and that has a record of success in other plants. Although this is primarily an operational concern, this is an important task that will allow the building to handle any efficiency improvements to the heating system.

Figure 4.1: Glycol Circulation Pump

4.4 Electrical & Appliance Measures

4.4.1 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.

4.4.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	**Location**	**Existing Condition**		**Recommendation**	
8	Downtown Pump House Lights (4 T12 fixtures)	4 FLUOR (4) T12 4' F40T12 40W Standard StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$320	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$382
Breakeven Cost	$4,486	**Savings-to-Investment Ratio**	14.0	**Simple Payback yrs**	1
Auditors Notes: The room has four fixtures with four light bulbs to be replaced with two new light bulbs in each fixture for a total of eight light bulbs to replace.					

Rank	**Location**	**Existing Condition**		**Recommendation**	
9	Office/Lab Room	4 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$640	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$535
Breakeven Cost	$6,283	**Savings-to-Investment Ratio**	9.8	**Simple Payback yrs**	1
Auditors Notes: The room has four fixtures with four light bulbs to be replaced with two new light bulbs in each fixture for a total of eight light bulbs to replace.					

Rank	**Location**	**Existing Condition**		**Recommendation**	
10	Process Room	14 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$2,240	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,871
Breakeven Cost	$21,972	**Savings-to-Investment Ratio**	9.8	**Simple Payback yrs**	1
Auditors Notes: The room has 14 fixtures with four light bulbs to be replaced with two new light bulbs in each fixture for a total of 28 light bulbs to replace.					

Rank	**Location**	**Existing Condition**		**Recommendation**	
11	Boiler Room	6 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting and Add new Occupancy Sensor	
Installation Cost	$1,460	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$959
Breakeven Cost	$11,261	**Savings-to-Investment Ratio**	7.7	**Simple Payback yrs**	2
Auditors Notes: The room has six fixtures with four light bulbs to be replaced with two new light bulbs in each fixture for a total of 12 light bulbs to replace.					

Rank	Location	Existing Condition	Recommendation
13	Downtown Pump House Lights (2 T12 Fixtures)	3 FLUOR (2) T12 4' F40T12 40W Standard StdElectronic	Replace with new energy-efficient LED lighting.

Installation Cost	$240	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$88
Breakeven Cost	$1,028	**Savings-to-Investment Ratio**	4.3	**Simple Payback yrs**	3

Auditors Notes: The room has three fixtures with four light bulbs in each fixture for a total of six light bulbs to replace.

Rank	Location	Existing Condition	Recommendation
15	Lift Station 1 Exterior Light	MH 70 Watt StdElectronic	Replace with new energy-efficient LED lighting.

Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$102
Breakeven Cost	$1,194	**Savings-to-Investment Ratio**	2.4	**Simple Payback yrs**	5

Auditors Notes: The lift station has one metal halide 70 Watt light bulb on the exterior of the building to be replaced.

Rank	Location	Existing Condition	Recommendation
16	Lift Station 2 Exterior Light	MH 70 Watt StdElectronic	Replace with new energy-efficient LED lighting.

Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$102
Breakeven Cost	$1,194	**Savings-to-Investment Ratio**	2.4	**Simple Payback yrs**	5

Auditors Notes: The lift station has one metal halide 70 Watt light bulb on the exterior of the building to be replaced.

Rank	Location	Existing Condition	Recommendation
17	Lift Station 3 Exterior Light	MH 70 Watt StdElectronic	Replace with new energy-efficient LED lighting.

Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$102
Breakeven Cost	$1,193	**Savings-to-Investment Ratio**	2.4	**Simple Payback yrs**	5

Auditors Notes: The lift station has one metal halide 70 Watt light bulb on the exterior of the building to be replaced.

Rank	Location	Existing Condition	Recommendation
18	Lift Station 4 Exterior Light	MH 70 Watt StdElectronic	Replace with new energy-efficient LED lighting.

Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$102
Breakeven Cost	$1,194	**Savings-to-Investment Ratio**	2.4	**Simple Payback yrs**	5

Auditors Notes: The lift station has one metal halide 70 Watt light bulb on the exterior of the building to be replaced.

Rank	Location	Existing Condition	Recommendation
19	Exterior Lights	3 HPS 70 Watt StdElectronic	Replace with new energy-efficient LED lighting.

Installation Cost	$1,500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$226
Breakeven Cost	$2,654	**Savings-to-Investment Ratio**	1.8	**Simple Payback yrs**	7

Auditors Notes: The water treatment plant has three exterior fixtures with a high pressure sodium 70 Watt light bulb in each fixture for a total of three light bulbs to be replaced.

Rank	Location		Existing Condition		Recommendation	
21	Lift Station 3 Interior Lights		3 INCAN A Lamp, Std 60W		Replace with new energy-efficient LED lighting.	
Installation Cost	$100	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$14	
Breakeven Cost	$161	**Savings-to-Investment Ratio**	1.6	**Simple Payback yrs**	7	
Auditors Notes: The room has three fixtures with a single incandescent 60 Watt light bulb in each fixture for a total of three light bulbs to be replaced.						

Rank	Location		Existing Condition		Recommendation	
22	Restroom Lights		FLUOR (3) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$80	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$9	
Breakeven Cost	$108	**Savings-to-Investment Ratio**	1.3	**Simple Payback yrs**	9	
Auditors Notes: The room has three fixtures with four light bulbs to be replaced with two new light bulbs in each fixture for a total of six light bulbs to replace.						

Rank	Location		Existing Condition		Recommendation	
24	Lift Station 1 Wet Side Lights		INCAN A Lamp, Halogen 60W		Replace with LED 12W Module StdElectronic	
Installation Cost	$50	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$5	
Breakeven Cost	$54	**Savings-to-Investment Ratio**	1.1	**Simple Payback yrs**	11	
Auditors Notes: The lift station has one incandescent 60 Watt light bulb on the wet side of the building to be replaced.						

Rank	Location		Existing Condition		Recommendation	
25	Lift Station 1 Dry Side Lights		3 FLUOR CFL, Spiral 26 W		Replace with new energy-efficient LED lighting.	
Installation Cost	$100	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$3	
Breakeven Cost	$38	**Savings-to-Investment Ratio**	0.4	**Simple Payback yrs**	31	
Auditors Notes: The lift station has three CFL 26 Watt light bulbs on the dry side of the building to be replaced.						

Rank	Location		Existing Condition		Recommendation	
26	Chemical Storage - Incandescent		INCAN (2) A Lamp, Std 60W		Replace with new energy-efficient LED lighting.	
Installation Cost	$50	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1	
Breakeven Cost	$16	**Savings-to-Investment Ratio**	0.3	**Simple Payback yrs**	38	
Auditors Notes: The chemical storage room has two incandescent 60 Watt light bulbs to be replaced.						

Rank	Location	Existing Condition		Recommendation	
27	Lift Station 4 Interior Lights	2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$3
Breakeven Cost	$41	**Savings-to-Investment Ratio**	0.3	**Simple Payback yrs**	46

Auditors Notes: The lift station has two fixtures with two T8 4ft. fluorescent light bulbs in each fixture for a total of four light bulbs to be replaced.

Rank	Location	Existing Condition		Recommendation	
28	Lift Station 5 Interior Lights	2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$3
Breakeven Cost	$41	**Savings-to-Investment Ratio**	0.3	**Simple Payback yrs**	46

Auditors Notes: The lift station has two fixtures with two T8 4ft. fluorescent light bulbs in each fixture for a total of four light bulbs to be replaced.

Rank	Location	Existing Condition		Recommendation	
29	Lift Station 6 Interior Lights	2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$3
Breakeven Cost	$41	**Savings-to-Investment Ratio**	0.3	**Simple Payback yrs**	46

Auditors Notes: The lift station has two fixtures with two T8 4ft. fluorescent light bulbs in each fixture for a total of four light bulbs to be replaced.

Rank	Location	Existing Condition		Recommendation	
30	Lift Station 2 Interior Lights	2 FLUOR CFL, Spiral 26 W		Replace with new energy-efficient LED lighting.	
Installation Cost	$100	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$2
Breakeven Cost	$25	**Savings-to-Investment Ratio**	0.3	**Simple Payback yrs**	47

Auditors Notes: The lift station has two CFL 26 Watt light bulbs to be replaced.

Rank	Location	Existing Condition		Recommendation	
32	Chemical Storage - T8's	FLUOR (2) T8 4' F32T8 32W Standard Program StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$80	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$
Breakeven Cost	$3	**Savings-to-Investment Ratio**	0.0	**Simple Payback yrs**	284

Auditors Notes: The chemical storage room has one fixture with two T8 4ft. fluorescent light bulbs to be replaced.

4.4.2 Other Electrical Measures

Rank	Location	Description of Existing			Efficiency Recommendation
1	Well Pumps	1 Well Pumps			Shut off one well pump and alternate the usage of the two pumps.
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$2,209
Breakeven Cost	$25,945	**Savings-to-Investment Ratio**	51.9	**Simple Payback yrs**	0
Auditors Notes: Both pumps are in constant operation throughout the year but the design calls for only one pump to operate at a time. Doing this will increase the life of the pumps and lower the electricity consumption.					

Rank	Location	Description of Existing			Efficiency Recommendation
2	Lift Station 3 Electric Heaters	Electric Heaters			Lower temperature set point in Lift Station 3 to 50 deg. F.
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,552
Breakeven Cost	$18,229	**Savings-to-Investment Ratio**	36.5	**Simple Payback yrs**	0
Auditors Notes: The temperature set point was 58 deg. F during the site visit. The lift station needs to only be heated to keep the sewage from freezing. A temperature set point of 50 deg. F is acceptable for this task.					

Rank	Location	Description of Existing			Efficiency Recommendation
3	Lift Station 2 Electric Heaters	Electric Heaters			Lower temperature set point in Lift Station 2 to 50 deg. F.
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,034
Breakeven Cost	$12,151	**Savings-to-Investment Ratio**	24.3	**Simple Payback yrs**	0
Auditors Notes: The temperature set point was 59 deg. F during the site visit. The lift station needs to only be heated to keep the sewage from freezing. A temperature set point of 50 deg. F is acceptable for this task.					

Rank	Location	Description of Existing			Efficiency Recommendation
4	Lift Station 4 Electric Heaters	Electric Heaters			Lower temperature set point in Lift Station 4 to 50 deg. F.
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,035
Breakeven Cost	$12,153	**Savings-to-Investment Ratio**	24.3	**Simple Payback yrs**	0
Auditors Notes: The temperature set point was 58 deg. F during the site visit. The lift station needs to only be heated to keep the sewage from freezing. A temperature set point of 50 deg. F is acceptable for this task.					

Rank	Location	Description of Existing			Efficiency Recommendation
5	Lift Station 5 Electric Heaters	Electric Heaters			Lower temperature set point in Lift Station 5 to 50 deg. F.
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,003
Breakeven Cost	$11,784	**Savings-to-Investment Ratio**	23.6	**Simple Payback yrs**	0
Auditors Notes: The temperature set point was 54 deg. F during the site visit. The lift station needs to only be heated to keep the sewage from freezing. A temperature set point of 50 deg. F is acceptable for this task.					

Rank	Location		Description of Existing		Efficiency Recommendation	
6	Lift Station 6 Electric Heaters		Electric Heaters		Lower temperature set point in Lift Station 6 to 50 deg. F.	
Installation Cost		$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$846
Breakeven Cost		$9,942	**Savings-to-Investment Ratio**	19.9	**Simple Payback yrs**	1
Auditors Notes: The temperature set point was 54 deg. F during the site visit. The lift station needs to only be heated to keep the sewage from freezing. A temperature set point of 50 deg. F is acceptable for this task.						

Rank	Location		Description of Existing		Efficiency Recommendation	
14	Transmission Loop Circulation Pump		Circulation Pump		Lower flow rate and run time for the circulation pump.	
Installation Cost		$9,750	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$2,383
Breakeven Cost		$27,990	**Savings-to-Investment Ratio**	2.9	**Simple Payback yrs**	4
Auditors Notes: Lower flow rate from 133 GPM to 120 GPM. Lower pump operating power in the summer months. $3750 for Remote Monitoring efforts that are required for certainty in operating margins.						

Rank	Location		Description of Existing		Efficiency Recommendation	
20	Angel Pond Loop Circulation Pump		Circulation Pump		Lower flow rate and run time for the circulation pump.	
Installation Cost		$9,750	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,397
Breakeven Cost		$16,410	**Savings-to-Investment Ratio**	1.7	**Simple Payback yrs**	7
Auditors Notes: Lower flow rate from 160 GPM to 120 GPM. Lower pump operating power in the summer months. $3750 for Remote Monitoring efforts that are required for certainty in operating margins.						

4.4.3 Other Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
7			Angel Pond Loop		Lower temperature settings to 41-39 deg. F. Reduce flow rate from 160 GPM to 120 GPM. Reduce temperature differential to 2 deg. F. Lower pump operating power in the summer months and use minimal heating when necessary in the warmer months. $3750 for Remote Monitoring efforts that are required for safety concerns with the changes in operations.	
Installation Cost		$6,750	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$9,096
Breakeven Cost		$122,828	**Savings-to-Investment Ratio**	18.2	**Simple Payback yrs**	1
Auditors Notes: The loop is running at a higher flow rate than necessary and has a set point that is higher than necessary to prevent the water from freezing. Lowering these, especially in the summer, will prevent unnecessary heating and save on heating costs. Adding a remote monitoring system to the building can give confidence to the operator that any signs of freezing will be identified before they become major problems.						

Rank	Location	Description of Existing	Efficiency Recommendation
12		Water Storage Tank Heat Load	Reduce flow rate to 60 GPM. Lower temperatures to 40-38 deg. F.

Installation Cost	$3,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,593
Breakeven Cost	$21,301	**Savings-to-Investment Ratio**	7.1	**Simple Payback yrs**	2

Auditors Notes: The flow rate through the heat exchanger was very high and the temperature had to be set high in order to compensate for the lack of time spent within the heat exchanger by the hot water. High temperatures and low flow rates are ideal for heat transfer through a heat exchanger. As a result, the heating demands were unable to be met despite a high set point. Additionally, the high flow rate on the water side has created holes in the turns of the heat exchanger that have leaked water into the water treatment plant building. The pictures below show the leaky heat exchanger and the holes in the pipe. The heat exchanger was repaired and a balance valve was installed on the water storage tank line during the site visit.

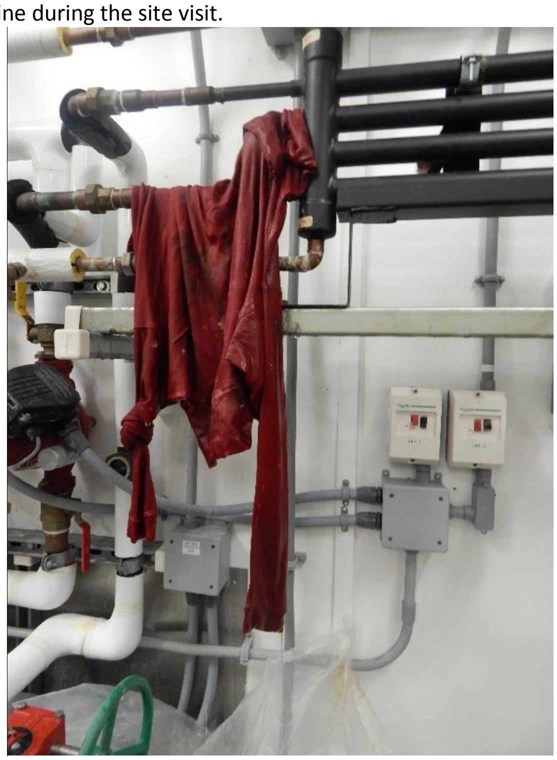


Figure 4.2: Leaks from the Water Storage Tank Heat Exchanger

Figure 4.3: Hole in the Heat Exchanger Turn

Rank	Location	Description of Existing	Efficiency Recommendation
23		Transmission Loop	Lower flow rate from 133 GPM to 120 GPM. Reduce temperature differential to 2 deg. F. Lower pump operating power in the summer months and use minimal heating when necessary in the warmer months. $3750 for Remote Monitoring efforts that are required for safety concerns with the changes in operations.

Installation Cost	$6,750	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$648
Breakeven Cost	$8,393	**Savings-to-Investment Ratio**	1.2	**Simple Payback yrs**	10

Auditors Notes: The loop is running at a higher flow rate than necessary and has a set point that is higher than necessary to prevent the water from freezing. Lowering these, especially in the summer, will prevent unnecessary heating and save on heating costs. Adding a remote monitoring system to the building can give confidence to the operator that any signs of freezing will be identified before they become major problems.

5. ENERGY EFFICIENCY ACTION PLAN

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

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

In the near future, a representative of ANTHC will be contacting the City of Fort Yukon to follow up on the recommendations made in this report. Funding has been provided by to ANTHC through a Rural Alaska Village Grant to provide the community with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations within the 2016 calendar year.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Fort Yukon Water Treatment Plant	**Auditor Company:** ANTHC-DEHE
Address: Fort Yukon	**Auditor Name:** Kevin Ulrich and Praveen KC
City: Fort Yukon	**Auditor Address:** 4500 Diplomacy Dr., Anchorage, AK 99508
Client Name: Eric Tremblay	
Client Address:	**Auditor Phone:** (907) 729-3237
	Auditor FAX:
Client Phone: (907) 662-4339	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 2,310 square feet	**Design Space Heating Load:** Design Loss at Space: 15,449 Btu/hour with Distribution Losses: 15,449 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 23,550 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 1 people	**Design Indoor Temperature:** 60 deg F (building average)
Actual City: Fort Yukon	**Design Outdoor Temperature:** -57 deg F
Weather/Fuel City: Fort Yukon	**Heating Degree Days:** 16,326 deg F-days
Utility Information	
Electric Utility: Gwitchyaa Zhee Utility Co - Commercial - Sm	**Average Annual Cost/kWh:** $0.57/kWh

Annual Energy Cost Estimate									
Description	**Space Heating**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$4,469	$99	$31	$7,507	$76,062	$5,873	$28,752	$25,350	**$148,143**
With Proposed Retrofits	$4,455	$92	$31	$2,946	$64,662	$6,090	$18,756	$23,785	**$120,818**
Savings	$14	$6	$0	$4,561	$11,399	-$217	$9,996	$1,565	**$27,324**

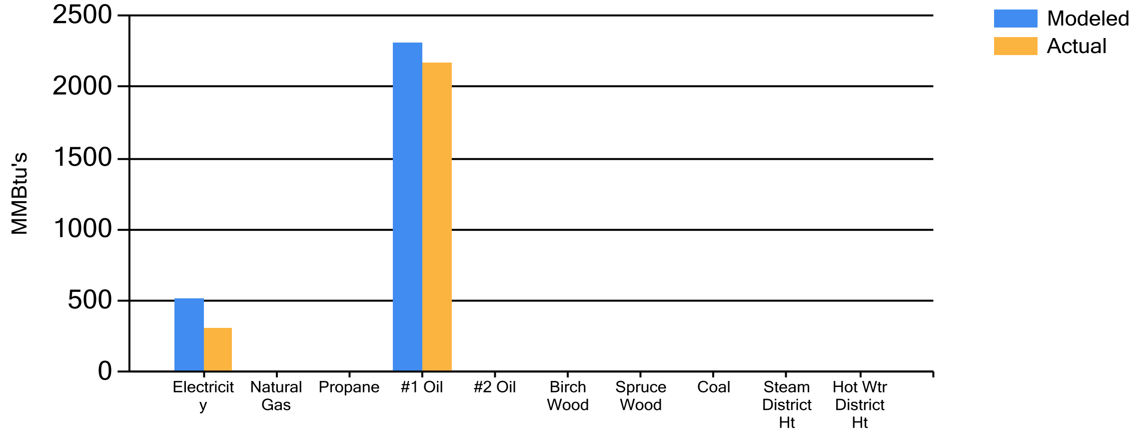
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	1,223.7	74.95	$64.13
With Proposed Retrofits	1,006.3	61.64	$52.30
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day.			

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

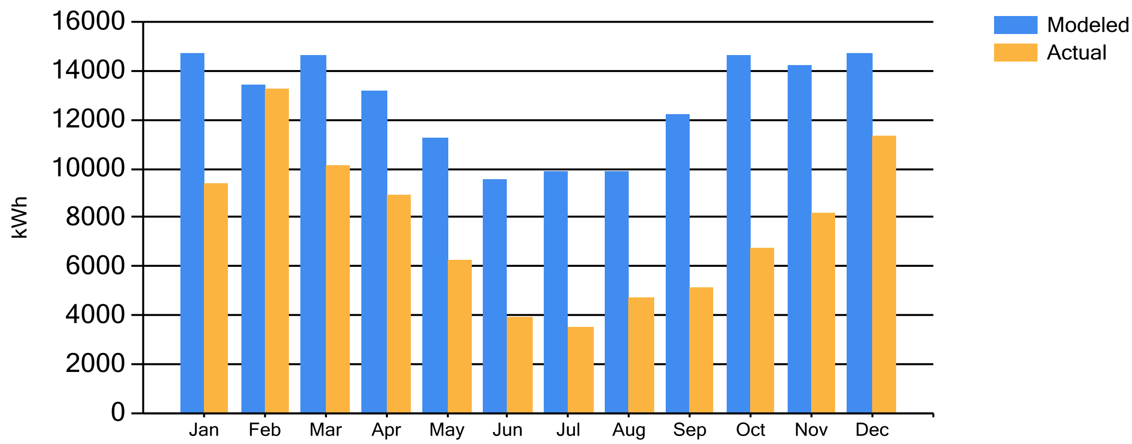
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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

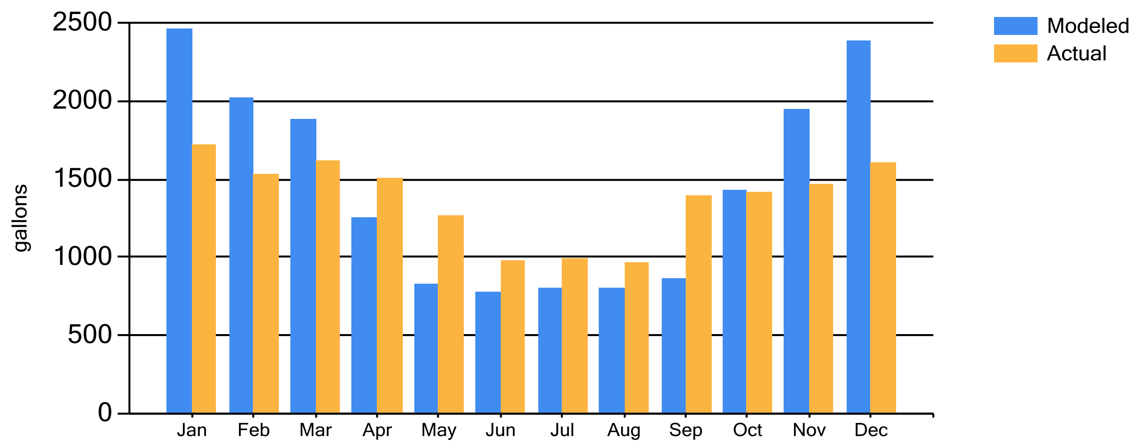
Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use



Appendix C - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	22.3	22.2	22.2	22.2	19.0	15.9	15.9	15.9	22.2	22.2	22.2	22.3
As Proposed	17.8	17.7	17.7	17.7	14.3	11.0	11.0	11.0	17.7	17.7	17.7	17.7

AkWarmCalc Ver 2.5.3.0, Energy Lib 3/7/2016