Comprehensive Energy Audit
For
Too'gha, Inc. Water and Sanitation System Facilities

Prepared For

Too'gha Inc.

January 16, 2018

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PREFACE

This energy audit was conducted using funds provided by the Denali Commission. Coordination with Too'gha, Inc. (who manages the water and sanitation facilities) and the City of Tanana 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 Too'gha, Inc. in Tanana, Alaska. The author of this report is Bailey Gamble, Mechanical Engineer I who conducted the audit with the support of Cody Uhlig, PE, Senior Project Manager and Certified Energy Manager (CEM).

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in December of 2017. This report analyzes historical energy use and identifies costs and savings of recommended energy conservation measures.

ACKNOWLEDGMENTS

The ANTHC Rural Energy Initiative gratefully acknowledges the assistance of Water Treatment Plant Operators Charlie Wright and David Sanders, Sr., Tanana City Manager Jeff Weltzin and Too'gha Financial Manager, Clarissa Gunter.

1. EXECUTIVE SUMMARY

This report was prepared for Too'gha Inc. The scope of the audit focused on five facilities associated with the Too'gha managed water and sanitation system; the combination Water Treatment Plant (WTP) and Laundromat building, the neighboring garage housing the biomass boilers, the pump house and the east and west lift stations. The scope of this report is a comprehensive energy study, which included an analysis of building shells, interior and exterior lighting systems, heating systems, and plug loads.

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy cost for the system facilities is $104,835 per year. Electricity represents the largest portion with an annual cost of approximately $63,683 at $0.66 per kWh. This includes about $30,932 paid by the village and about $32,751 paid by the Power Cost Equalization (PCE) program through the State of Alaska. Fuel represents the remaining portion, with an annual cost of approximately $30,042 for biomass (wood) at $350 per chord and $11,110 for fuel oil at $5.80 per gallon.

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 Tanana, the cost of electricity for small commercial facilities without PCE is $0.66/kWh. The last reported PCE rate is $0.34/kWh saving the village over $30,000 a year on electricity across all water and sanitation system facilities.

Table 1.1 lists the total usage of electricity, wood and fuel oil in the Too'gha facilities before and after the proposed retrofits.

Table 1.1: Predicted Annual Fuel Use for the Too'gha Water and Sanitation Facilities

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	96,327 kWh	69,774 kWh
Wood (Birch and Spruce)	85.83 cords	68.72 cords
#2 Oil	1,915 gallons	1,844 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 Too'gha Water and Sanitation Facilities

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	616.7	42.27	$22.75
With Proposed Retrofits	497.7	34.11	$17.56
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 Too'gha water and sanitation facilities. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return. Note that estimates are for work performed by a contractor. Using local labor to implement retrofits where possible would reduce installed costs. Each retrofit is described in detail starting at section 4.3 of this report.

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	Raw Water Transmission Line Circulating Heat Trace	Manually turn heat trace line off when raw water is being pumped. Note: These savings are partially offset due to water entering the building at a lower temperature, increasing raw water heat add load.	$3,515	$100	429.09	0.0	4,652.3
2	Laundry Room Thermostat and Space Heating Load	Install programmable thermostat and implement a heating setback to 60.0 deg F for the laundry room and bathroom space during unoccupied hours.	$875	$200	53.16	0.2	616.4
3	Pump House Space Heating Load	Weatherize and re-install fuel tank in order to bring Monitor Stove back online, reduce heating setpoint to 50 deg F.	$4,141	$1,400	34.74	0.3	10,773.4
4	Laundry Room Lighting, LED Bulbs	Install occupancy sensor to control laundry room lights.	$381	$120	26.67	0.3	1,031.4
5	East Lift Station Space Heating Load	Reduce heating setpoint 40 deg F, install exhaust fan in wet well room with automatic shutters that close when the fan is off.	$1,570	$900	20.49	0.6	4,058.0
6	Distribution Loop Heat Add Load	Upgrade heat add temperature controllers to Tekmar 775 or comparable units. Drop setpoint temperatures to 50 deg F for the east loop and 47 deg F for the east loop.	$2,612	$1,600	20.28	0.6	1,931.0
7	Laundromat Exterior Lighting (above entry)	Replace with new, energy efficient LED bulbs.	$688	$300	19.30	0.4	1,769.0
8	West Lift Station Space Heating Load	Reduce heating setpoint 40 deg F, install exhaust fan in wet well room with automatic shutters that close when the fan is off.	$1,353	$900	17.65	0.7	3,474.0

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
9	WTP Mechanical Room Space Heating Load	Implement a heating setback to 60.0 deg F for the mechanical room space during unoccupied hours.	$263	$200	15.97	0.8	188.3
10	Garage Exterior Lighting, HPS Bulb Fixtures	Replace with new fixtures with energy efficient LED bulbs and daylight sensors.	$174	$120	12.23	0.7	447.4
11	Garage Shell, Air Leakage	Perform air sealing, address fire damaged ceiling, reconnect air intake on middle boiler, build insulated boxes to surround the dampers on each of the intake flues (to prevent dampers from freezing).	$1,258	$1,500	9.98	1.2	473.9
12	Laundry Room Lighting, CFL Bulbs	Replace with new, energy efficient LED bulbs, control using occupancy sensor.	$401	$445	7.58	1.1	1,077.3
13	Garage Exterior Lighting, CFL Bulb	Replace with new, energy efficient LED bulb.	$15	$20	6.27	1.3	38.2
14	Laundromat Entryway Lights	Replace with new, energy efficient LED bulbs.	$28	$40	5.86	1.4	74.9
15	East Lift Station Wet Well Lighting	Replace with new, energy efficient LED bulbs.	$30	$60	5.85	2.0	76.7
16	West Lift Station Wet Well Lighting	Replace with new, energy efficient LED bulbs.	$30	$60	5.85	2.0	76.7
17	WTP Boiler Room Thermostat and Space Heating Load	Install programmable thermostat and implement a heating setback to 60.0 deg F for the boiler room space during unoccupied hours.	$69	$200	4.17	2.9	49.3
18	West Lift Station Exterior Lighting	Replace with new fixtures with energy efficient LED bulbs and daylight sensors.	$148	$300	4.17	2.0	381.2
19	Water Treatment Plant Heating Generation and Distribution	Replace dryer, building heat and water heat loop circ pumps with Magna3s (six total, sized for their specific loops), install two ceiling fans in the process room area to move warm air down. Replace eight shower heads with low flow shower heads to reduce water heating load.	$6,399	$28,000	3.25	4.4	14,147.7
20	Laundromat Bathroom Lights	Replace with new, energy efficient LED bulbs.	$91	$240	3.21	2.6	244.4
21	WTP/Laundromat Exterior Wall Mount Lighting	Replace with new fixtures with energy efficient LED bulbs and daylight sensors.	$682	$1,800	3.19	2.6	1,752.2
22	WTP/Laundromat Shell, Air Leakage	Perform air sealing to reduce air leakage by 5%.	$145	$500	2.49	3.4	66.9
23	Pump House Interior Lighting	Replace with new, energy efficient LED bulbs.	$14	$80	2.01	5.8	35.2

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
24	WTP Watering Point Lighting	Replace with new, energy efficient LED bulb, Install occupancy sensor to control.	$58	$290	1.68	5.0	154.9
25	Boiler Garage Interior Lighting	Replace with new, energy efficient LED bulbs.	$25	$160	1.33	6.4	64.7
26	Water Storage Tank Heat Add Load	Replace Grundfos UP 15-42 SF with Grundfos Alpha1 circulating pump, upgrade controls, install existing larger heat exchanger, reduce setpoint temperature to 50 deg F.	$405	$5,300	0.93	13.1	627.1
27	WTP/Laundromat Office Lighting	Replace with new, energy efficient LED bulb, Install occupancy sensor to control.	$16	$250	0.54	15.5	43.1
28	East Lift Station Control Panel Room Lighting	Replace with new, energy efficient LED bulbs.	$3	$120	0.31	38.1	8.1
29	West Lift Station control Panel Room Lighting	Replace with new, energy efficient LED bulbs.	$3	$120	0.31	38.0	8.1
30	WTP/Laundromat Attic Lighting	Replace with new, energy efficient LED bulbs.	$4	$500	0.09	137.6	9.7
31	East Lift Station Exterior Lighting	Replace with new fixtures with energy efficient LED bulbs and daylight sensors.	-$42	$300	-1.18	999.9	-108.0
32	Raw Water Heat Add Load	Upgrade the heat add temperature controller to a Tekmar 775, reduce setpoint to 46 deg F. Note: This retrofit shows a misleading increase in energy use that correlates with recommendation No. 1. This is explained in detail in section 4.	-$1,450	$800	-22.30	999.9	-1,533.6
	TOTAL, all measures		**$23,903**	**$46,925**	**6.20**	**2.0**	**46,710.1**

Table Notes:

[1] Savings to Investment Ratio (SIR) is a life-cycle cost measure calculated by dividing the total savings over the life of a project (expressed in today's dollars) by its investment costs. The SIR is an indication of the profitability of a measure; the higher the SIR, the more profitable the project. An SIR greater than 1.0 indicates a cost-effective project (i.e. more savings than cost). Remember that this profitability is based on the position of that Energy Efficiency Measure (EEM) in the overall list and assumes that the measures above it are implemented first.

[2] Simple Payback (SP) is a measure of the length of time required for the savings from an EEM to payback the investment cost, not counting interest on the investment and any future changes in energy prices. It is calculated by dividing the investment cost by the expected first-year savings of the EEM.

With all of these energy efficiency measures in place, the annual utility cost can be reduced by $23,903 per year, or 23.0% of the buildings' total energy costs. These measures are estimated to cost $46,925, 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.

The negative values shown for savings in water heating and clothes drying reflect the more precise space heating controls. If space heating is better regulated, ambient air temperature will be lower and the hot water generator and dryer air heating coil will have to add more heat to their associated heating loads. These small losses are offset by larger savings in space heating.

Table 1.4: Detailed Breakdown of Energy Costs in the Building

Annual Energy Cost Estimate											
Description	Space Heating	Water Heating	Ventilation Fans	Clothes Drying	Lighting	Refrigeration	Other Electrical	Raw Water Heat Add	Water Circulation Heat	Tank Heat	Total Cost
Existing Building	$47,006	$1,154	$2,344	$6,844	$5,004	$198	$14,957	$15,450	$9,200	$2,676	**$104,835**
With Proposed Retrofits	$30,861	$1,172	$2,346	$6,987	$2,195	$199	$14,970	$13,565	$6,327	$2,311	**$80,932**
Savings	$16,145	-$17	-$2	-$142	$2,809	$0	-$13	$1,885	$2,873	$365	**$23,903**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Too'gha, Inc. water and sanitation facilities. 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 treatment and distribution equipment

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

Details collected from the Too'gha water and sanitation facilities 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 Too'gha water and sanitation system facilities are classified as being made up of the following activity areas:

1) WTP/Laundromat Building: 4,608 square feet
    a. Boiler Room: 450 square feet
    b. Mechanical Room: 1,710 square feet
    c. Laundry Room, Offices and Bathrooms: 2,448 square feet
2) Garage: 921 square feet
3) East Lift Station: 150 square feet
4) West Lift Station: 150 square feet
5) Pump House: 121 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, and 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. TOO'GHA WATER AND SANITATION SYSTEM FACIILTIES

3.1. Building Description

The Too'gha water and sanitation system is comprised of a main combination water treatment plant and laundromat building along with four auxiliary facilities including a garage that houses the biomass boilers, two lift stations and a pump house. The primary 4,608 square foot WTP/Laundromat building was constructed around 2002. Two operators manage the water and sanitation system seven days a week, passing in and out of the water treatment plant as they tend to the system components. The laundromat provides washer and dryer as well as hot shower service, however, the coin service hot showers were not operational at the time of the audit. The laundromat is open to the community from 10:00 am to 10:00 pm five days a week. It is closed on Tuesday and Thursday. A janitor arrives to clean the building each day that the laundromat is open from about 6:00 pm to 8:00 pm. Building occupancy fluctuates throughout the day from zero to six people.

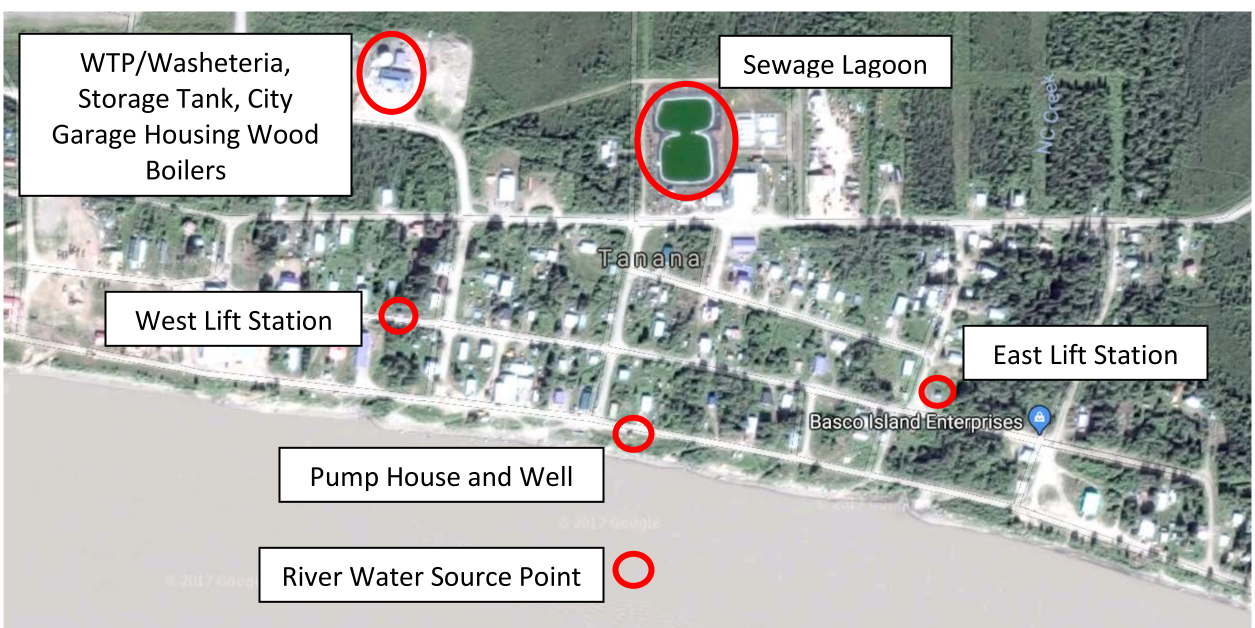


Figure 1: Aerial view of Tanana Water system Facilities

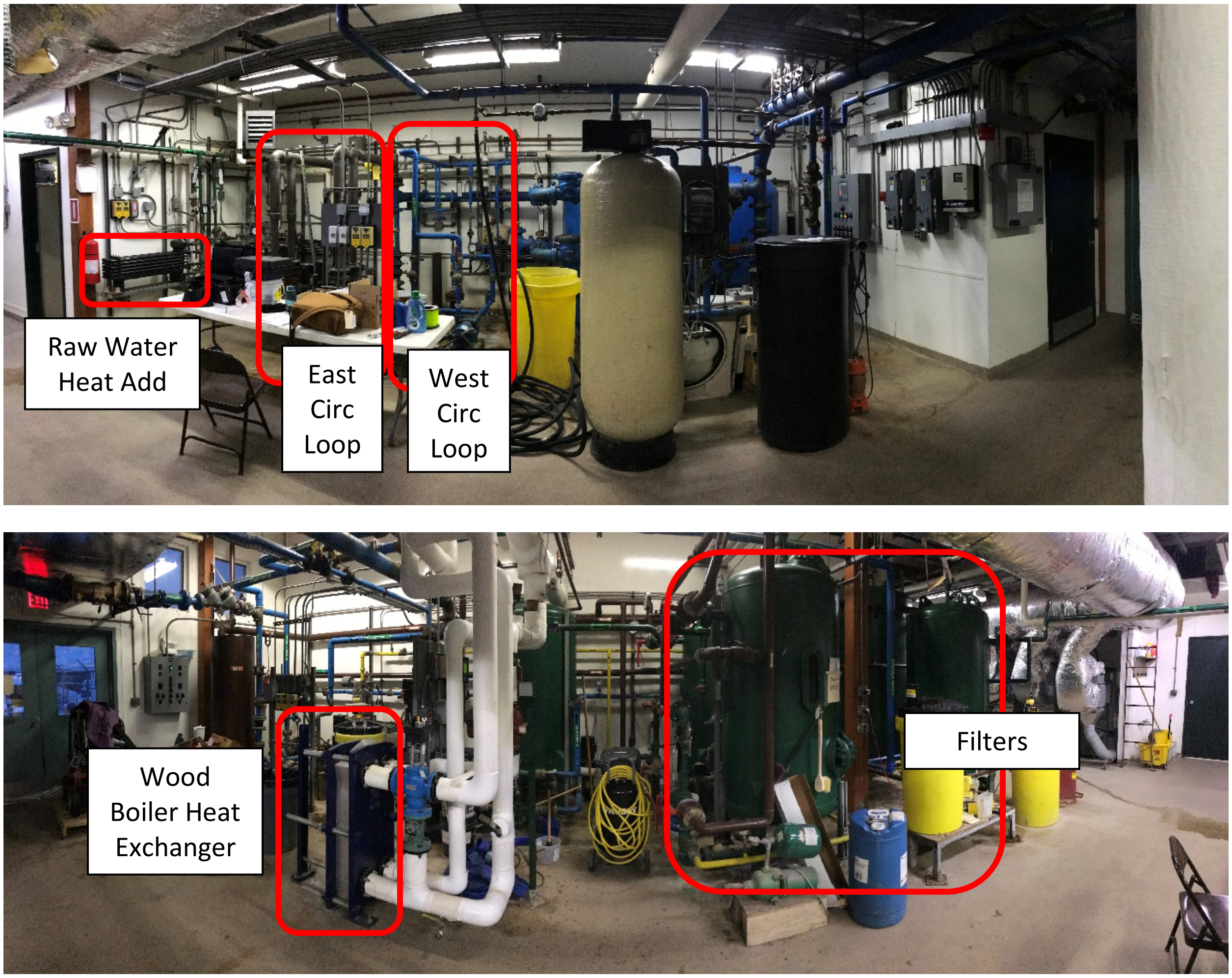


Figure 2: Process and Distribution Room in the Too'gha Water Treatment Plant

System Flow Narrative

From April to November, the community's raw water in drawn from a well located near the pump house on the bank of the Yukon River, about 1360 feet south east of the WTP. When the surface of the Yukon is frozen, operators use the river itself as the preferred water source by installing a temporary submersible pump directly into the river. A 300 foot heat tape runs from the pump house to the submersible pump to prevent freezing when this winter pumping system is in use. Water is usually pumped twice a month. It requires 4-5 days to fill the tank when pumping from the well versus 3 days when pumping from the river. Community members prefer the river water, which operators report to contain less sediment during the winter months, requiring a lower quantity of treatment chemicals than the well water.

Water is delivered from the source to the WTP via an estimated 1750 feet of transmission line. A glycol heat trace circulates along the transmission line year round to prevent the line from freezing in the permafrost. After entering the WTP, heat is added to the raw water bringing it up to 48°F. The water is then chlorinated and passed through a catalytic media filter tank to oxidize and remove iron and manganese. Polymer coagulant is added to the water which then passes through a static mixer and into a reaction tank. Here particles have time to bond, forming larger particles that are more easily removed as the water then passes through two multi-media (anthracite, sand and garnet) filters. Next, the water passes through a granular activated carbon (GAC) tank where organic chemicals are removed. Finally, the water is chlorinated a second time then delivered to a 212,000 gallon water storage tank located behind the water treatment plant.

During the winter heating season, a heat add system located in the WTP boiler room maintains the temperature of the water in the tank at 48°F. In order to be distributed for community use, water flows from the tank back into the WTP where it is pressurized to 60 psi by two pressure pumps operating in lead, lag mode in combination with two 131 gallon hydropneumatic tanks. The pressurized water is then distributed throughout the community via two (east and west) distribution loops. Separate heat add systems maintain the 2 mile long east loop at a temperature of 52°F and the 1 mile long west loop at 47°F. The distribution loop pipes are buried in permafrost, so are circulated year round to prevent freezing.

Tanana is served by a gravity sewer system. Wastewater from east side homes flows into the east side lift station where two 2.5 hp grinder pumps then transmit it to the west lift station. Wastewater from west side homes and facilities flow directly to the west lift station. All wastewater is then pumped from the west lift station by two 7.5 hp grinder pumps to the lagoon located in the north central part of town.

Description of Building Shell

The exterior walls of the WTP/Laundromat building are constructed with single stud 2x6 lumber construction with a 16-inch offset. The average wall height is approximately 9 ft. The walls have approximately 5.5 inches polyurethane panel insulation slightly damaged due to age. There is approximately 2,064 square feet of exterior wall space in the building.

Although there is some attic storage space and plumping access, this space is open to the rest of the building interior. Considered from an insulation and heating standpoint, the building has a cathedral ceiling with 2x12 lumber construction. The roof has standard framing and a 24-inch offset. The peak ceiling height is approximately 16 ft. The ceiling has approximately 11.5 inches of insulated polyurethane panel insulation with slight damage due to age. There is approximately 4,751 square feet of roof space on the building.

Figure 3: Rags are used to mitigate air leakage under the process room doors.

The WTP is built on a concrete slab. There are 8 inches of panel insulation installed beneath floor. Panel insulation extends down from the walls to cover the edges of the slab as well. There is approximately 4,608 square feet of floor space in the building. There are a total of fifteen windows on the WTP/Laundromat building. On the front, south-facing side of the building there are six 3’7” x 3’7” and one 3’7” x 2’11” windows. The remainder of non-south facing windows include two more 3’7” x 3’7”, two 3’7” x 2’5” and four 3’0” x 2’5” windows. All windows are double-pane glass with vinyl frames.

There is a metal 3’ x 6’8” front entry door with an arctic entry and another metal 3’ x 6’8” door (no arctic entry) on the back side of the laundromat room in need of air sealing. There is a metal set of two 3’6” x 6’8” doors on the west side of the process room as well. Significant air leakage is visible along the bottom of the process room doors.

Description of Heating Plants

The demand for space heat in the WTP/Laundromat is seasonal, however, the washers and dryers demand heat year round. The raw water transmission line lies within a layer of permafrost, so the glycol heat trace that prevents this line from freezing also demands year round heat. Heat is supplied to the WTP and Laundromat by five different boilers. Three Garn 2000 Wood Fired Boilers located in a city garage behind the Laundromat serve as the primary heating source. Two large Burnham Oil-Fired boilers supplement the wood boilers when needed, although one of those was offline due to a burnt fuel line at the time of the audit visit.

The five boilers that serve the WTP and laundromat have the following specifications:

	Garn 2000 Wood Fired Boiler	Burnham Oil Fired Boiler
Number of Identical Boilers	3	2
Fuel Type	Wood (birch, spruce)	#2 Fuel Oil
Input Rating	311,000 BTU/hr	1,554,400 BTU/hr
Steady State Efficiency	76 %	80 %
Idle Loss	1.5 %	0.8 %
Heat Distribution Type	Water	Water
Boiler Operation	Year Round	Oct-May

Figure 4: Left: Garn wood boilers located in the city garage behind the Laundromat. Right: Burnham oil-fired boilers located in the WTP.

The east and west lift stations each have a wet-well room and a control panel room. The wet well rooms each contain two 3.6 kW electric cabinet heaters. The control rooms each contain one 1.5 kW electric unit heaters. These two buildings are heated to 54°F.

The pump house is currently heated by two 1.5 kW electric space heaters. There is an MP Monitor 2200 direct-vent, oil-fired heater present in the pump house, however, it is not in use as there is currently no fuel tank at this location.

Electric consumption associated with space heating totals 51,933 kWh annually constituting just over half of the total energy consumption of the water and sanitation system.

Space Heating Distribution Systems

Hydronic heating lines move heat throughout the WTP/Washeteria building and Garage to a variety of unit heaters and baseboard radiators that provide space heating. Space heating in the lift stations and pump house is provided by electric space heaters, primarily fan type with one radiator type present in the pump house.

Domestic Hot Water System

The washing machines, showers and sinks require hot water during the laundromat operational hours. Hot water use is estimated at around 120 gallons per day based on the following assumptions:

- 42 loads of laundry per week at 11-22 gallons of hot water per load depending on washer size.
- 20 hand washings per day at 0.3 gallons hot water per wash.
- 1 shower per day at 13 gallons hot water per shower (most coin operated showers were out of order at the time of visit).

The wood boilers supply heat to two 45 gallon hot water generators. One hot water generator serves the washers and is set to heat to 140°F and the other serves all other hot water needs and is set to heat to 110°F. Two older 85 gallon hot water generators formerly served by the oil fired boilers now provide additional hot water storage.

Figure 5: Left: The WTP/Laundromat Boiler Room. The white hot water generators on the left are served by the wood boilers. The older gray hot water generators behind them now serve as hot water storage tanks.

Heat Recovery Information

There is no system in place to deliver heat recovered from the diesel generators to meet water system heating demands. The east distribution loop passes near the power plant, so there is potential to develop recovered heat to be added at this point. This was not evaluated as part of this energy audit, but warrants further investigation.

Solar Array Information

There is a 5.5 kW solar array on the WTP/Laundromat building. There was little data available on the performance of this system. Modeling the system using PV Watts showed an estimated annual production of 5,510 kWh. Expansion of this system along with the incorporation of battery storage and more robust monitoring and data collection should be considered to offset electric costs.

Description of Building Ventilation System

Fresh air exchange is provided by a ventilation system operating on a set schedule from 8:00 am to 10:00 pm daily. There is a ventilation fan in the boiler room to prevent overheating that likely sees little use as the boilers rarely come on during the summer. There are exhaust fans located in the bathrooms as well. The dryers operate on an isolated ducted system that pulls and pre-heats outdoor air then exhausts damp air.

Lighting

Lighting in the Too'gha water and sanitation facilities consumes approximately 7863 kWh annually constituting only about 8% of the buildings' current electrical consumption. The majority of fluorescent bulbs inside of the WTP/Washeteria building have been replaced with LEDs to reduce energy consumption. The tables below show an inventory of all bulbs present in the facilities.

Table 3.1: Breakdown of Lighting by Bulb Type

Type of bulb	Total Number of Bulbs	kWh/year	Location(s)
17 W, 4' light emitting diode	43	2299	Mechanical room, boiler room, laundry room, storage room, bathrooms, office
12 W light emitting diode	2	56	Bathroom
13 W compact fluorescent spiral	34	1374	Laundry room, entry way, bathrooms, boiler garage interior
20 W compact fluorescent spiral	1	50	Garage exterior
32 W, 4' T8 fluorescent	16	52	WTP/Washeteria attic, lift station controls rooms

70 W high pressure sodium	4	1764	Washeteria entry way exterior, garage exterior
100 W high pressure sodium	6	1346	WTP/Washeteria exterior
250 W high pressure sodium	2	388	Lift station exteriors
25 W incandescent	4	28	Pump house interior
60 W incandescent	1	95	WTP watering point
100 W incandescent	6	114	Lift station wet wells
Total	119	7863	

Plug Loads

There are very few plug-in electric loads in the Too'gha facilities. There is a mini fridge, radio, phone and coffee pot in the attendant office area. The coffee pot is unplugged when not in use. The operator office contains common electronics such as a computer, printer and phone.

There is a single heat tape that runs from the pump house to the submersible pump during the winter months when the river is used as the water source. The heat tape is run only during the three day periods twice per month that water is being pumped and 1,167 kWh annually.

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 constitutes approximately 40% of the building's current electrical consumption.

Table 3.2: Major Equipment List

Major Pumps + Motors	Purpose	Motor Size	Operating Schedule	Annual Energy Consumption (kWh)
Well Pump	Pumping raw water from May-November	0.75 HP	Pump twice a month for 4-5 days at a time	924
Submersible Pump	Pumping raw water from December-April	1.5 HP	Pump twice a month for 3 days each time	870
West Loop Circulation Pump x 2	Circulating water in the west loop to prevent freezing	1 HP	Always on	4,927

East Loop Circulation Pump x 2	Circulating water in the east loop to prevent freezing	1.5 HP	Always on	5,286
Pressure Pumps x 2	Pressurizing water for distribution	3 HP	Operating in lead-lag, one running about 8% of the time	1,225
Building Heat Loop Circulating Pumps x 2	Deliver heated glycol to unit/baseboard heaters throughout building	0.75 HP	Winter heating season	2,463
Water Heat Loop Circulating Pumps x 2	Deliver heated glycol to all water heat-add systems	0.25 HP	Always on (to meet heat trace demand)	1,639
Dryer Heat Loop Circulating Pumps x 2	Deliver heated glycol to hydronic dryers, dryer intake air heating coil	2 HP	Laundromat Operating Hours	4,671
Raw Water Heat Trace Loop Circulating Pump x 2	Prevent freezing in raw water transmission line	0.5 HP	Always on	3,268
Dryer Fan and Drum Motors x 6	Move hot air through dryers and rotate drum	0.5 HP	About 20 loads per week, 20 hours per week total	289
35 lb Washing Machine Motors x 2	Rotate agitator, spin cycle components	2 HP	About 40 loads per week, 20 hours per week total	456
27 lb Washing Machine Motors x 4	Rotate agitator, spin cycle components	2 HP		684
18 lb Washing Machine Motors	Rotate agitator, spin cycle components	1.4 HP		326
Backwash Pump	Backwashing water filters	3 HP	About half an hour once per week	58
Air Scour Compressor Motor	Breaking up filter media to maximize effectiveness of backwash	2 HP	About half an hour once per week	37
Dryer Make-Up Air Fan Motor	Pull in air to be heated and passed through dryer	2 HP	On when dryers operate, about 20 hours per week	1,555
Dryer Exhaust Fan Motor	Push damp dryer air out	2 HP	On when dryers operate, about 20 hours per week	1,555
Building Ventilation Fan Motor	Provide fresh air exchanges for building during occupied hours	0.75 HP	From 8am-10pm daily	2,864

Boiler Room Ventilation Fan Motor	Keep boiler room from overheating	0.75 HP	Not in use	0
East Lift Station Grinder Pumps x 2	Pump sewage from east side of town over to west lift station	1.8 HP	Operating about 2% of the time	354
West Lift Station Grinder Pumps x 2	Pump sewage from community over to the lagoon.	7.5 HP	Operating about 6% of the time	5,886
			Total Energy Consumption	39,337

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.

Tanana Power Company, Inc. runs the local power plant. This utility provides electricity to the residents of Tanana as well as commercial and public facilities. The WTP/Laundromat also contains a 5.5 kW solar array that contributes an estimated 5,510 kWh, based upon PV Watts modeling.

The average cost for each type of fuel used in this building is shown below in Table 3.1. This figure includes all surcharges, subsidies, and utility customer charges:

Table 3.3: Energy Rates by Fuel Type in White Mountain

Table 3.3 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.6610/kWh
Birch Wood	$ 350/cords
#2 Oil	$ 5.80/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, Too'gha Inc. pays approximately $104,835 annually for electricity and other fuel costs for the water and sanitation system facilities.

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

Figure 3.1
Annual Energy Costs by End Use

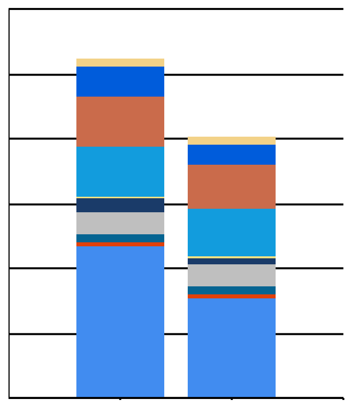


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The “Existing” bar shows the breakdown for the building as it is now; the “Retrofit” bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

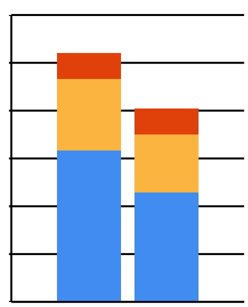
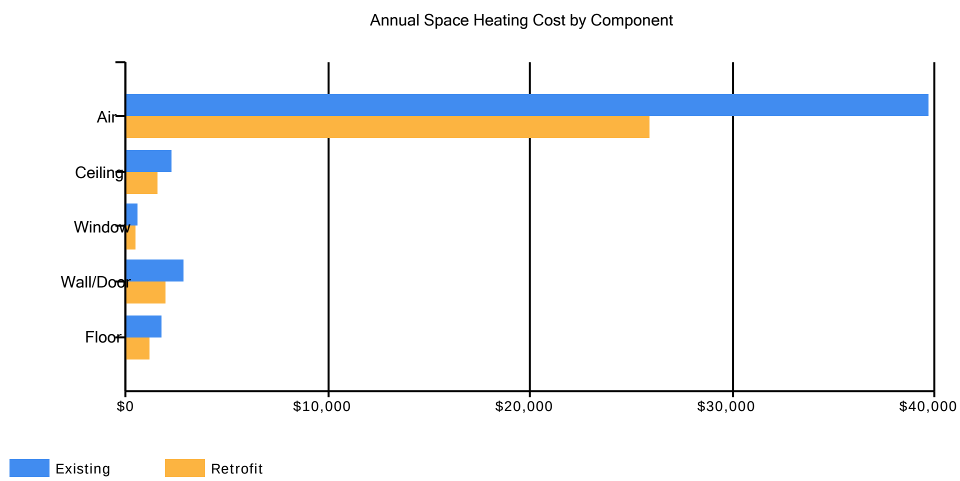


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing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

Figure 3.3
Annual Space Heating Cost by Component



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

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating & Auxiliary Facilities	7740	6567	6334	3316	2394	1935	1999	2003	2326	3336	6590	7393
DHW	54	49	54	52	54	52	54	54	52	54	52	54
Ventilation Fans	301	274	301	291	301	291	301	301	291	301	291	301
Clothes Drying	337	307	337	326	337	326	337	337	326	337	326	337
Lighting	724	660	635	612	525	504	521	628	612	721	701	724
Refrigeration	25	23	25	25	25	25	25	25	25	25	25	25
Other Electrical	2090	1904	2090	2017	1801	1743	1801	1801	1743	1801	1743	2085
Raw Water Heat Add	377	344	377	346	357	346	357	357	346	357	414	428
Water Circulation Heat	131	119	131	76	0	0	0	0	0	59	127	131
Tank Heat	106	93	95	47	0	0	0	0	0	38	96	104

Fuel Oil #2 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	95	73	67	65	4	0	0	1	8	67	66	83
DHW	0	0	0	0	0	0	0	0	0	0	0	0
Clothes Drying	9	9	10	11	6	6	6	6	6	12	9	9
Raw Water Heat Add	61	58	65	60	33	32	33	33	32	65	89	90
Water Circulation Heat	80	75	86	59	0	0	0	0	0	49	78	78
Tank Heat	26	22	21	8	0	0	0	0	0	8	21	24

Fuel Birch Wood Consumption (Cords)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Space Heating	6	4	4	2	0	0	0	0	0	2	4	5
DHW	0	0	0	0	0	0	0	0	0	0	0	0
Clothes Drying	1	1	1	1	1	1	1	1	1	1	1	1
Raw Water Heat Add	2	2	2	2	2	2	2	2	2	2	3	3
Water Circulation Heat	3	3	3	2	0	0	0	0	0	1	3	3
Tank Heat	1	1	1	0	0	0	0	0	0	0	1	1

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 3.4
Too'gha Water and Sanitation Facility 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	96,327 kWh	328,764	3.340	1,098,073
Birch Wood	85.83 cords	2,248,863	1.000	2,248,863
#2 Oil	1,915 gallons	264,337	1.010	266,981
Total		**2,841,965**		**3,613,916**
BUILDING AREA		4,608	Square Feet	
BUILDING SITE EUI		617	$kBTU/Ft^2/Yr$	
BUILDING SOURCE EUI		784	**$kBTU/Ft^2/Yr$**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

Table 3.5

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	**616.7**	**42.27**	**$22.75**
With Proposed Retrofits	**497.7**	**34.11**	**$17.56**
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 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 Too'gha water and sanitation facilities were modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Tanana 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. Equipment cost estimate calculations are provided in Appendix D.

Limitations of AkWarm© Models

• The model is based on typical mean year weather data for Tanana. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the fuel and electric profiles generated will not likely compare perfectly with actual energy billing information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.
• 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 cooling/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	Raw Water Transmission Line Circulating Heat Trace	Manually turn heat trace line off when raw water is being pumped. Note: These savings are partially offset due to water entering the building at a lower temperature, increasing raw water heat add load.	$3,515	$100	429.09	0.0	4,652.3
2	Laundry Room Thermostat and Space Heating Load	Install programmable thermostat and implement a heating setback to 60.0 deg F for the laundry room and bathroom space during unoccupied hours.	$875	$200	53.16	0.2	616.4
3	Pump House Space Heating Load	Weatherize and re-install fuel tank in order to bring Monitor Stove back online, reduce heating setpoint to 50 deg F.	$4,141	$1,400	34.74	0.3	10,773.4
4	Laundry Room Lighting, LED Bulbs	Install occupancy sensor to control laundry room lights.	$381	$120	26.67	0.3	1,031.4
5	East Lift Station Space Heating Load	Reduce heating setpoint 40 deg F, install exhaust fan in wet well room with automatic shutters that close when the fan is off.	$1,570	$900	20.49	0.6	4,058.0
6	Distribution Loop Heat Add Load	Upgrade heat add temperature controllers to Tekmar 775 or comparable units. Drop setpoint temperatures to 50 deg F for the east loop and 47 deg F for the east loop.	$2,612	$1,600	20.28	0.6	1,931.0
7	Laundromat Exterior Lighting (above entry)	Replace with new, energy efficient LED bulbs.	$688	$300	19.30	0.4	1,769.0
8	West Lift Station Space Heating Load	Reduce heating setpoint 40 deg F, install exhaust fan in wet well room with automatic shutters that close when the fan is off.	$1,353	$900	17.65	0.7	3,474.0
9	WTP Mechanical Room Space Heating Load	Implement a heating setback to 60.0 deg F for the mechanical room space during unoccupied hours.	$263	$200	15.97	0.8	188.3

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
10	Garage Exterior Lighting, HPS Bulb Fixtures	Replace with new fixtures with energy efficient LED bulbs and daylight sensors.	$174	$120	12.23	0.7	447.4
11	Garage Shell, Air Leakage	Perform air sealing, address fire damaged ceiling, reconnect air intake on middle boiler, build insulated boxes to surround the dampers on each of the intake flues (to prevent dampers from freezing).	$1,258	$1,500	9.98	1.2	473.9
12	Laundry Room Lighting, CFL Bulbs	Replace with new, energy efficient LED bulbs, control using occupancy sensor.	$401	$445	7.58	1.1	1,077.3
13	Garage Exterior Lighting, CFL Bulb	Replace with new, energy efficient LED bulb.	$15	$20	6.27	1.3	38.2
14	Laundromat Entryway Lights	Replace with new, energy efficient LED bulbs.	$28	$40	5.86	1.4	74.9
15	East Lift Station Wet Well Lighting	Replace with new, energy efficient LED bulbs.	$30	$60	5.85	2.0	76.7
16	West Lift Station Wet Well Lighting	Replace with new, energy efficient LED bulbs.	$30	$60	5.85	2.0	76.7
17	WTP Boiler Room Thermostat and Space Heating Load	Install programmable thermostat and implement a heating setback to 60.0 deg F for the boiler room space during unoccupied hours.	$69	$200	4.17	2.9	49.3
18	West Lift Station Exterior Lighting	Replace with new fixtures with energy efficient LED bulbs and daylight sensors.	$148	$300	4.17	2.0	381.2
19	Water Treatment Plant Heating Generation and Distribution	Replace dryer, building heat and water heat loop circ pumps with Magna3s (six total, sized for their specific loops), install two ceiling fans in the process room area to move warm air down. Replace eight shower heads with low flow shower heads to reduce water heating load.	$6,399	$28,000	3.25	4.4	14,147.7
20	Laundromat Bathroom Lights	Replace with new, energy efficient LED bulbs.	$91	$240	3.21	2.6	244.4
21	WTP/Laundromat Exterior Wall Mount Lighting	Replace with new fixtures with energy efficient LED bulbs and daylight sensors.	$682	$1,800	3.19	2.6	1,752.2
22	WTP/Laundromat Shell, Air Leakage	Perform air sealing to reduce air leakage by 5%.	$145	$500	2.49	3.4	66.9
23	Pump House Interior Lighting	Replace with new, energy efficient LED bulbs.	$14	$80	2.01	5.8	35.2
24	WTP Watering Point Lighting	Replace with new, energy efficient LED bulb, Install occupancy sensor to control.	$58	$290	1.68	5.0	154.9

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
25	Boiler Garage Interior Lighting	Replace with new, energy efficient LED bulbs.	$25	$160	1.33	6.4	64.7
26	Water Storage Tank Heat Add Load	Replace Grundfos UP 15-42 SF with Grundfos Alpha1 circulating pump, upgrade controls, install existing larger heat exchanger, reduce setpoint temperature to 50 deg F.	$405	$5,300	0.93	13.1	627.1
27	WTP/Laundromat Office Lighting	Replace with new, energy efficient LED bulb, Install occupancy sensor to control.	$16	$250	0.54	15.5	43.1
28	East Lift Station Control Panel Room Lighting	Replace with new, energy efficient LED bulbs.	$3	$120	0.31	38.1	8.1
29	West Lift Station control Panel Room Lighting	Replace with new, energy efficient LED bulbs.	$3	$120	0.31	38.0	8.1
30	WTP/Laundromat Attic Lighting	Replace with new, energy efficient LED bulbs.	$4	$500	0.09	137.6	9.7
31	East Lift Station Exterior Lighting	Replace with new fixtures with energy efficient LED bulbs and daylight sensors.	-$42	$300	-1.18	999.9	-108.0
32	Raw Water Heat Add Load	Upgrade the heat add temperature controller to a Tekmar 775, reduce setpoint to 46 deg F. Note: This retrofit shows a misleading increase in energy use that correlates with recommendation No. 1. This is explained in detail in section 4.	-$1,450	$800	-22.30	999.9	-1,533.6
	TOTAL, all measures		**$23,903**	**$46,925**	**6.20**	**2.0**	**46,710.1**

4.2 Interactive Effects of Projects

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

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

Interior lighting, plug loads, facility equipment, and occupants generate heat within the building. 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

4.3.4 Air Sealing Measures

Rank	Location		Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
22			Air Tightness estimated as: 11474 cfm at 50 Pascals		Perform air sealing to reduce air leakage by 5%.	
Installation Cost	$500		**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$145
Breakeven Cost	$1,246		**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	9.6 MMBTU
			Savings-to-Investment Ratio	2.5		

Auditors Notes: Air exchange was calculated using the following equation: Total CFM = square footage, 4608 sq ft x 2.49. The number 2.49 is based upon the guide in the help section and takes into consideration the air exchange correlated with absent air stripping on some doors, boiler makeup air, many recessed light fixtures and an open attic, and building ventilation system.

This recommendation involves the replacement of threshold gaskets and air sealing of the back and side doors of the WTP/laundromat building.

4.4 Mechanical Equipment Measures

4.4.1 Heating/Cooling/Domestic Hot Water Measure

Rank	Recommendation					
19	Replace dryer, building heat and water heat loop circ pumps with Magna3s (six total, sized for their specific loops), install two ceiling fans in the process room area to move warm air down. Replace eight shower heads with low flow shower heads.					
Installation Cost	$28,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$6,399	
Breakeven Cost	$91,106	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	48.5 MMBTU	
		Savings-to-Investment Ratio	3.3			

Auditors Notes: This recommendation includes replacing all six circulating pumps on the three main hydronic loop lines (building space heat, water process and distribution line heat and dryer heat) with new, more efficient modulating Grundfos Magna3 circulating pumps. This will reduce energy consumption by reducing the run time and load associated with each pump. Newer Grundfos Alpha and Magna3 modulating circulating pumps consume significantly less energy than their Grundfos predecessors. Note that all pumps associated with the heating system, even if they are not mentioned in these recommendations, should be replaced with these newer models as they near the end of their functional lives.

Ceiling fans are recommended for the process room to move hot air that rises back down to the occupied space to improve space heating efficiency.

Low flow shower heads are recommended to reduce the consumption of hot water.

4.4.3 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
2	Washeteria and Bathrooms			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Washeteria and Bathrooms space.	
Installation Cost	$200	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$875
Breakeven Cost	$10,631	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	55.1 MMBTU
		Savings-to-Investment Ratio	53.2		

Auditors Notes: Heating temperature setbacks are recommended for all of the WTP/Laundromat spaces. Heating the building to 60 deg F during the night when the building is unoccupied will reduce diesel fuel consumption.

Rank	Building Space			Recommendation	
9	Water Treatment Plant Mechanical Space			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Water Treatment Plant Mechanical space.	
Installation Cost	$200	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$263
Breakeven Cost	$3,194	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	16.5 MMBTU
		Savings-to-Investment Ratio	16.0		
Auditors Notes: Heating temperature setbacks are recommended for all of the WTP/Laundromat spaces. Heating the building to 60 deg F during the night when the building is unoccupied will reduce diesel fuel consumption.					

Rank	Building Space			Recommendation	
17	Water Treatment Plant and Washeteria Boiler Room			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Water Treatment Plant and Washeteria Boiler Room space.	
Installation Cost	$200	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$69
Breakeven Cost	$835	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	4.3 MMBTU
		Savings-to-Investment Ratio	4.2		
Auditors Notes: Heating temperature setbacks are recommended for all of the WTP/Laundromat spaces. Heating the building to 60 deg F during the night when the building is unoccupied will reduce diesel fuel consumption.					

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.

A large portion of the bulbs in the WTP/Laundromat building have already been replaced with LEDs. Conversion of all bulbs in the five water and sanitation system facility to LED is recommended, with a handful of exterior fixtures as top priority.

4.5.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	Location		Existing Condition		Recommendation	
7	Laundromat Exterior Lighting (above entry)		3 HPS 70 Watt StdElectronic with Manual Switching		Replace with new, energy efficient LED bulbs.	
Installation Cost		$300	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$688
Breakeven Cost		$5,790	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	3.6 MMBTU
			Savings-to-Investment Ratio	19.3		
Auditors Notes: Replace the three large high pressure sodium bulbs in the ceiling mount fixtures above the Laundromat front door with three of their LED equivalent bulbs, such 18W screw in LEDs.						

Rank	Location		Existing Condition		Recommendation	
10	Garage Exterior Lighting, HPS Bulb Fixtures		HPS 70 Watt StdElectronic with Manual Switching		Replace with new fixtures with energy efficient LED bulbs and daylight sensors.	
Installation Cost		$120	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$174
Breakeven Cost		$1,467	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.9 MMBTU
			Savings-to-Investment Ratio	12.2		
Auditors Notes: Replace the high pressure sodium bulb exterior light fixture on the garage with a new LED fixture with a built in daylight sensor so that this light turns on only when it's dark outside. An 18W LED should be sufficient for this application.						

Rank	Location		Existing Condition		Recommendation	
12	Laundry Room Lighting, CFL Bulbs		16 FLUOR CFL, Spiral 13 W with Manual Switching		Replace with new, energy efficient LED bulbs, control using occupancy sensor.	
Installation Cost		$445	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$401
Breakeven Cost		$3,375	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.6 MMBTU
			Savings-to-Investment Ratio	7.6		
Auditors Notes: The main laundry room contains a mixture of LED and compact fluorescent bulbs. Replace the fluorescent bulbs with their LED equivalents and install and occupancy sensor to control. The occupancy sensor cost is divided between the two laundry room light sets modeled. Screw in 4W LED bulbs would be sufficient for this application.						

Rank	Location		Existing Condition		Recommendation	
13	Garage Exterior Lighting, CFL Bulb		FLUOR CFL, Spiral 20 W with Manual Switching		Replace with new, energy efficient LED bulb.	
Installation Cost		$20	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$15
Breakeven Cost		$125	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
			Savings-to-Investment Ratio	6.3		
Auditors Notes: There is a single compact fluorescent bulb above the door that faces the laundromat on the garage. Replace this bulb with an 8W or less LED bulb.						

Rank	Location	Existing Condition	Recommendation
14	Laundromat Entryway Lights	FLUOR (2) CFL, Spiral 13 W with Manual Switching	Replace with new, energy efficient LED bulbs.

Installation Cost	$40	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$28
Breakeven Cost	$235	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	5.9		

Auditors Notes: Replace the two compact fluorescent bulbs in the entry way to the laundromat with 4W LED bulbs.

Rank	Location	Existing Condition	Recommendation
15	East Lift Station Wet Well Lighting	3 INCAN A Lamp, Std 100W with Manual Switching	Replace with new, energy efficient LED bulbs.

Installation Cost	$60	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$30
Breakeven Cost	$351	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	0.2 MMBTU
		Savings-to-Investment Ratio	5.9		

Auditors Notes: Replace the three incandescent bulbs in the east lift station wet well with 18 W LED bulbs.

Rank	Location	Existing Condition	Recommendation
16	West Lift Station Wet Well Lighting	3 INCAN A Lamp, Std 100W with Manual Switching	Replace with new, energy efficient LED bulbs.

Installation Cost	$60	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$30
Breakeven Cost	$351	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	0.2 MMBTU
		Savings-to-Investment Ratio	5.8		

Auditors Notes: Replace the three incandescent bulbs in the east lift station wet well with 18 W LED bulbs.

Rank	Location	Existing Condition	Recommendation
18	West Lift Station Exterior Lighting	HPS 250 Watt StdElectronic with Manual Switching	Replace with new fixtures with energy efficient LED bulbs and daylight sensors.

Installation Cost	$300	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$148
Breakeven Cost	$1,250	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	0.8 MMBTU
		Savings-to-Investment Ratio	4.2		

Auditors Notes: Current exterior lighting is often manually turned off to save energy. Replace HPS fixture with new LED fixture with daylight sensor and keep the lift station lit during dark hours. A 20 W LED bulb would be sufficient for this application.

Rank	Location		Existing Condition		Recommendation	
20	Laundromat Bathroom Lights		12 FLUOR CFL, Spiral 13 W with Manual Switching		Replace with new, energy efficient LED bulbs.	
Installation Cost		$240	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$91
Breakeven Cost		$769	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	0.2 MMBTU
			Savings-to-Investment Ratio	3.2		
Auditors Notes: Replace the 12 compact fluorescent spiral bulbs in the mens' and womens' bathrooms with their LED equivalents. 4 W bulbs would be sufficient for this application.						

Rank	Location		Existing Condition		Recommendation	
21	WTP/Laundromat Exterior Wall Mount Lighting		3 HPS 100 Watt StdElectronic with Daylight Sensor		Replace with new fixtures with energy efficient LED bulbs and daylight sensors.	
Installation Cost		$1,800	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$682
Breakeven Cost		$5,745	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	3.5 MMBTU
			Savings-to-Investment Ratio	3.2		
Auditors Notes: There are currently six high pressure sodium exterior wall mount light fixtures on the WTP/Laundromat building. The quantity of fixtures could be reduced to three. They should be replaced by LED fixtures with built in daylight sensors so that they operate only during dark hours. 18 W LED bulbs would be sufficient for this application.						

Rank	Location		Existing Condition		Recommendation	
23	Pump House Interior Lighting		4 INCAN A Lamp, Std 25W with Manual Switching		Replace with new, energy efficient LED bulbs.	
Installation Cost		$80	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$14
Breakeven Cost		$161	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
			Savings-to-Investment Ratio	2.0		
Auditors Notes: The pump house contains four standard incandescent screw-in bulbs. These should be replaced with 4W LED bulbs.						

Rank	Location		Existing Condition		Recommendation	
24	WTP Watering Point Lighting		INCAN A Lamp, Std 60W with Manual Switching		Replace with new, energy efficient LED bulb, Install occupancy sensor to control.	
Installation Cost		$290	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$58
Breakeven Cost		$487	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
			Savings-to-Investment Ratio	1.7		
Auditors Notes: The single incandescent screw-in bulb in the watering point room should be replaced with a 12W LED bulb controlled by an occupancy sensor.						

Rank	Location		Existing Condition		Recommendation	
25	Boiler Garage Interior Lighting		4 FLUOR (2) CFL, Spiral 13 W with Manual Switching		Replace with new, energy efficient LED bulbs.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$25	
Breakeven Cost	$212	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	0.1 MMBTU	
		Savings-to-Investment Ratio	1.3			
Auditors Notes: Replace the eight total compact fluorescent spiral bulbs in the garage with 4-8W LED bulbs.						

Rank	Location		Existing Condition		Recommendation	
28	East Lift Station Control Panel Room Lighting		FLUOR (3) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with new, energy efficient LED bulbs.	
Installation Cost	$120	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$3	
Breakeven Cost	$37	**Simple Payback (yrs)**	38	**Energy Savings (MMBTU/yr)**	0.0 MMBTU	
		Savings-to-Investment Ratio	0.3			
Auditors Notes: Replace the three 4’ T8 fluorescent bulbs with 4’ LED equivalents. 18W bulbs would be sufficient for this application.						

Rank	Location		Existing Condition		Recommendation	
29	West Lift Station control Panel Room Lighting		FLUOR (3) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with new, energy efficient LED bulbs.	
Installation Cost	$120	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$3	
Breakeven Cost	$37	**Simple Payback (yrs)**	38	**Energy Savings (MMBTU/yr)**	0.0 MMBTU	
		Savings-to-Investment Ratio	0.3			
Auditors Notes: Replace the three 4’ T8 fluorescent bulbs with 4’ LED equivalents. 18W bulbs would be sufficient for this application.						

Rank	Location		Existing Condition		Recommendation	
30	WTP/Laundromat Attic Lighting		10 FLUOR T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with new, energy efficient LED bulbs.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$4	
Breakeven Cost	$43	**Simple Payback (yrs)**	138	**Energy Savings (MMBTU/yr)**	0.0 MMBTU	
		Savings-to-Investment Ratio	0.1			
Auditors Notes: There are ten light fixtures in the attic that each contain one 4’ T8 fluorescent bulb. Replace these fluorescent bulbs with 4’ LED equivalents. 18W LED bulbs would be sufficient for this application.						

Rank	Location		Existing Condition		Recommendation	
31	East Lift Station Exterior Lighting		HPS 250 Watt StdElectronic with Manual Switching		Replace with new fixture with energy efficient LED bulbs and daylight sensor.	
Installation Cost		$300	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	-$42
Breakeven Cost		-$354	**Simple Payback (yrs)**	1000	**Energy Savings (MMBTU/yr)**	-0.2 MMBTU
			Savings-to-Investment Ratio	-1.2		
Auditors Notes: Exterior lighting on the lifts stations is often left off to conserve energy. Replace the high pressure sodium fixture with an LED fixture with daylight sensor and keep the lift station lit during dark hours.						

4.5.1b Lighting Measures – Lighting Controls

Rank	Location		Existing Condition		Recommendation	
4	Laundry Room Lighting, LED Bulbs		14 LED 17W Module StdElectronic with Manual Switching		Replace manual light switch with an occupancy sensor.	
Installation Cost		$120	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$381
Breakeven Cost		$3,201	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	0.4 MMBTU
			Savings-to-Investment Ratio	26.7		
Auditors Notes: Fluorescent tube lighting in the laundry room has already been replaced with energy efficient LED bulbs. Additional cost savings can be achieved by further improving the controls on this lighting. Install an occupancy sensor to control laundry room lights and reduce time on.						

Rank	Location		Existing Condition		Recommendation	
27	WTP/Laundromat Office Lighting		2 LED 17W Module StdElectronic with Manual Switching		Replace manual light switch with an occupancy sensor.	
Installation Cost		$250	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$16
Breakeven Cost		$136	**Simple Payback (yrs)**	16	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.5		
Auditors Notes: Fluorescent tube lighting in the laundry room has already been replaced with energy efficient LED bulbs. Additional cost savings can be achieved by further improving the controls on this lighting. Install an occupancy sensor to control laundry room lights and reduce time on.						

4.5.6 Other Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
1			Raw Water Heat Trace Heat Load		Manually turn heat trace line off when raw water is being pumped.	
Installation Cost	$100		**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$3,515
Breakeven Cost	$42,909		**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	172.7 MMBTU
			Savings-to-Investment Ratio	429.1		

Auditors Notes: The raw water heat trace runs along the transmission line from the WTP to the pump house. When water is not being pumped, this line does not drain back, so the heat trace is needed to prevent the standing water from freezing. When water is being pumped and moving through the transmission line, the risk of freezing is diminished, so it may not be necessary to circulate the heat trace during this time. The recommendation would require the operator to manually turn off the heat trace circulating pumps once water pumping begins and turn it back on when water pumping is finished. This could reduce the heat load and electric load associated with the heat trace. This recommendation should be considered an option that operators can experiment with – perhaps it would work year round, maybe in summer only, but would initially require close monitoring by the operator to ensure no signs of freeze up. Implementation of this measure would reduce the temperature of raw water coming in to the plant, so would increase the heat load on the raw water heat add, however, the two heat adds considered in combination would still see a savings overall.

Rank	Location		Description of Existing		Efficiency Recommendation	
3			Pump House Space Heating Load		Weatherize and re-install fuel tank in order to bring Monitor Stove back online, reduce heating setpoint to 50 deg F	
Installation Cost	$1,400		**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$4,141
Breakeven Cost	$48,641		**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	21.6 MMBTU
			Savings-to-Investment Ratio	34.7		

Auditors Notes: Fuel oil offers a more cost effective source of heat than electric based upon Tanana's energy costs. Re-install the fuel tank beside the pump house in order to bring the oil-fired heater back online, to eliminate the need to run electric heat in the pump house. Reduce the heating set point to 50 deg F.

Rank	Location		Description of Existing		Efficiency Recommendation	
5			East Lift Station Space Heating Load		Reduce heating setpoint 40 deg F, install exhaust fan with automatic shutters that close when the fan is off.	
Installation Cost	$900		**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$1,570
Breakeven Cost	$18,439		**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	8.1 MMBTU
			Savings-to-Investment Ratio	20.5		

Auditors Notes: The east and west lift station wet wells are currently being heated to 54 deg F. The heating setpoint can safely be reduced to 40 deg F in this type of space. There are vents present in each facility that remain open and allow heat to escape. These vents should be replaced with an exhaust fan with automatic shutters that close when the fan is off. This will allow for safe air exchange when the operators are working in the space, but reduce heat loss during the times that the wet well is unoccupied.

Rank	Location	Description of Existing		Efficiency Recommendation	
6		Distribution Line Heat Loads		Upgrade heat add temperature controllers to Tekmar 156 units. Drop setpoint temperatures to 50 deg F for the east loop and 47 deg F for the east loop	
Installation Cost	$1,600	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$2,612
Breakeven Cost	$32,440	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	181.4 MMBTU
		Savings-to-Investment Ratio	20.3		
Auditors Notes: The temperature controllers on the distribution line heat add systems are aged an exhibiting various ranges of functionality. These should be replaced with Tekmar 156 or similar units. Slight drops in the temperature settings for both loops to 50 deg F and 47 deg F for east and west respectively will save on fuel while still providing high enough temperatures to avoid condensation issues in home plumbing.					

Rank	Location	Description of Existing		Efficiency Recommendation	
8		West Lift Station Space Heating Load		Install ventilation fan with automatic shutters that close when the fan is off. Reduce heating setpoint to 40 deg F.	
Installation Cost	$900	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$1,353
Breakeven Cost	$15,888	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	7.0 MMBTU
		Savings-to-Investment Ratio	17.7		
Auditors Notes: Auditors Notes: The east and west lift station wet wells are currently being heated to 54 deg F. The heating setpoint can safely be reduced to 40 deg F in this type of space. There are vents present in each facility that remain open and allow heat to escape. These vents should be replaced with an exhaust fan with automatic shutters that close when the fan is off. This will allow for safe air exchange when the operators are working in the space, but reduce heat loss during the times that the wet well is unoccupied.					

Rank	Location	Description of Existing		Efficiency Recommendation	
11		Boiler Garage Space Heating Load		Perform air sealing, address fire damaged ceiling, reconnect air intake on middle boiler, build insulated boxes to surround the dampers on each of the intake flues (to prevent freezing)	
Installation Cost	$1,500	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$1,258
Breakeven Cost	$14,977	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	81.3 MMBTU
		Savings-to-Investment Ratio	10.0		
Auditors Notes: The boiler garage was previously damaged by fire leaving major gaps in insulation in the attic space. Too'gha already has plans in place to address this damage. Additional air sealing of doors and windows should be performed. At the time of the visit, the air intake flue on the middle boiler was disconnected due to issues with the damper freezing. This resulted in all combustion air being drawn into the boiler from the garage interior, increasing air flow into the building and space heating demand. In order to alleviate the freezing issue, insulated boxes should be built to surround the dampers. The middle intake should then be reconnected to draw outside air.					

<table>
<tr><th>Rank</th><th>Location</th><th colspan="2">Description of Existing</th><th colspan="3">Efficiency Recommendation</th></tr>
<tr><td>26</td><td colspan="2"></td><td colspan="2">Tank Heat Load</td><td colspan="2">Replace Grundfos UP 15-42 SF with Grundfos Alpha1 circulating pump, upgrade controls, install existing larger heat exchanger, reduce setpoint temperature to 50 deg F.</td></tr>
<tr><td colspan="2">Installation Cost</td><td>$5,300</td><td>Estimated Life of Measure (yrs)</td><td>15</td><td>Energy Savings ($/yr)</td><td>$405</td></tr>
<tr><td colspan="2">Breakeven Cost</td><td>$4,915</td><td>Simple Payback (yrs)</td><td>13</td><td>Energy Savings (MMBTU/yr)</td><td>16.7 MMBTU</td></tr>
<tr><td colspan="2"></td><td></td><td>Savings-to-Investment Ratio</td><td>0.9</td><td></td><td></td></tr>
<tr><td colspan="7">Auditors Notes: Too’gha already owns a higher capacity heat exchanger that is intended for installation on this heat add. Installing the new heat exchanger in addition to upgrades to the circulating pump and controls will allow for more precise temperature control. A greater portion of the heating demand can then be met at this point, alleviating the load at the currently maxed out distribution heat-add systems.</td></tr>
</table>

<table>
<tr><th>Rank</th><th>Location</th><th colspan="2">Description of Existing</th><th colspan="3">Efficiency Recommendation</th></tr>
<tr><td>32</td><td colspan="2"></td><td colspan="2">Raw Water Heat Add Load</td><td colspan="2">Upgrade the heat add temperature controller to a Tekmar 156, reduce setpoint to 46 deg F.</td></tr>
<tr><td colspan="2">Installation Cost</td><td>$800</td><td>Estimated Life of Measure (yrs)</td><td>15</td><td><b>Energy Savings ($/yr)</td><td>-$1,450</td></tr>
<tr><td colspan="2">Breakeven Cost</td><td>-$17,842</td><td>Simple Payback (yrs)</td><td>1000</td><td>Energy Savings (MMBTU/yr)</td><td>-84.6 MMBTU</td></tr>
<tr><td colspan="2"></td><td></td><td>Savings-to-Investment Ratio</td><td>-22.3</td><td></td><td></td></tr>
<tr><td colspan="7">Auditors Notes: This retrofit shows an increase in energy use when considered in conjunction with the recommendation to turn off the heat trace during times when water is being pumped, since water will come into the building at a lower temp. When considered together, the two retrofits show a $2000 savings as opposed to $580 in savings when the raw water heat add retrofit is considered alone.</td></tr>
</table>

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.

The total estimated cost of all recommended EEM's $46,923. The payback for all EEM combined is approximately 2.0 years. ANTHC is willing to assist the community with acquiring funds to complete the scope of work recommended in this energy audit.

There are several options for financing energy efficiency projects within the State of Alaska. These include the use of grants, loans, and other funding opportunities. Below is some information on potential funding opportunities.

Energy Efficiency Revolving Loan Program – This is a loan administered by the Alaska Housing Finance Corporation (AHFC) for use by any applicant who is also the owner of the building where the work will take place. It provides a loan for permanent energy-efficiency projects with a completion window of one year.

Sustainable Energy Transmission and Supply Program – This is a loan administered by the Alaska Energy Authority (AEA) for a government, business, or other organized body of people. It provides a loan for energy-efficiency or power transmission or distribution projects.

USDA-RD Communities Facilities Direct Loan & Grant Program - This is a loan or grant provided by the US Department of Agriculture – Rural Development (USDA-RD) for any essential community facility in a rural area. It provides a loan or grant to develop essential community facilities with upgrades or equipment for improvement.

APPENDICES

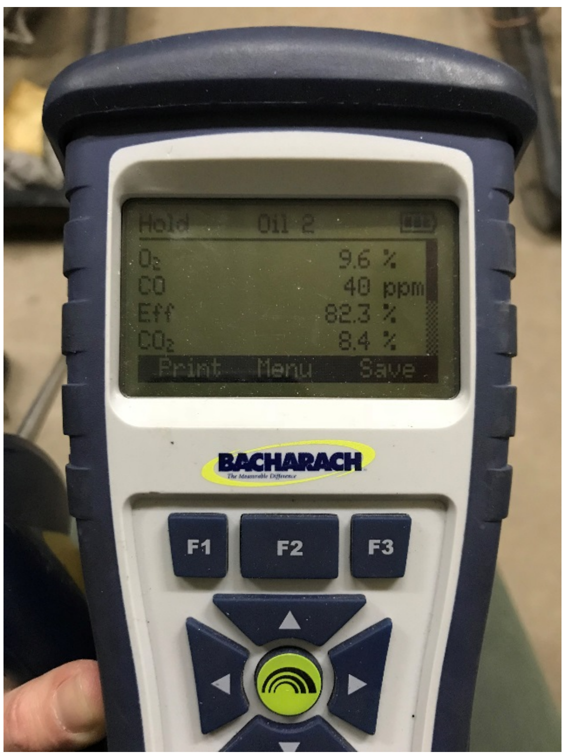
Appendix A – Scanned Energy Billing Data

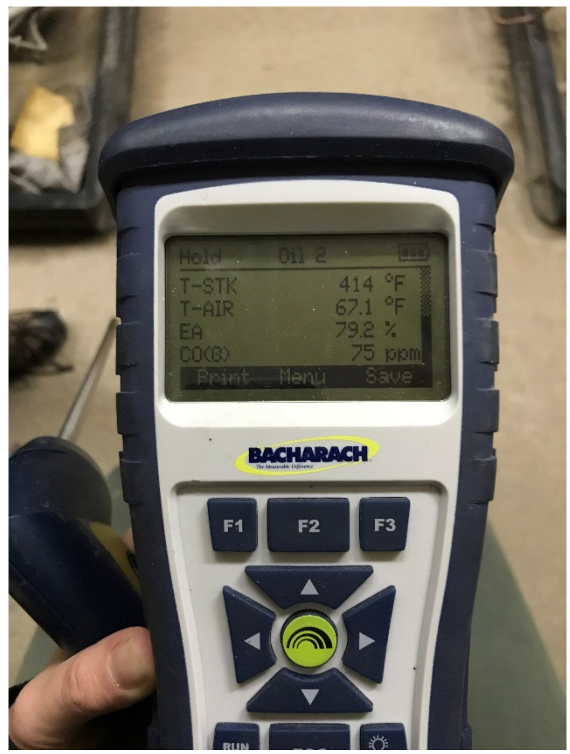
1. Electricity Data

Too'gha, Inc Electric Records		Electric Consumption in kWh											
Facility Name	Meter Number	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-16
WTP/Washetiera	01 010 242	8648	7120	7120	5760	4880			4800	5120	6320		8240
Boiler Garage	60 799 667	55	46	37	44	67			404	495	500		42
Pump House	57 736 109	1968	2131	2489	2068	677			426	479	1061		1646
East Lift Station	01 215 761	1215	981	1056	524	200			41	70	319		1219
West Lift Station	01 215 752	1390	1135	1201	727	1231			685	1170	1457		1373

Appendix B – Performance Results

1. Boiler Combustion Tests





Appendix C – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Tanana Water –and Sanitation Facilities	**Auditor Company:** Alaska Native Tribal Health Consortium
Address: Airport Rd.	**Auditor Name:** Bailey Gamble
City: Tanana	**Auditor Address:** 4500 Diplomacy Dr., Suite 454 Anchorage, AK 99508
Client Name: Charlie Wright	
Client Address: Airport Rd. Tanana, AK	**Auditor Phone:** (907) 729-4501
	Auditor FAX:
Client Phone: (907) 366-1087	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 4,608 square feet	**Design Space Heating Load:** Design Loss at Space: 191,794 Btu/hour with Distribution Losses: 213,105 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 324,855 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 4 people	**Design Indoor Temperature:** 68.7 deg F (building average)
Actual City: Tanana	**Design Outdoor Temperature:** -41.9 deg F
Weather/Fuel City: Tanana	**Heating Degree Days:** 14,590 deg F-days
Utility Information	
Electric Utility: Tanana Power Company, Inc.	**Average Annual Cost/kWh:** $0.661/kWh

Annual Energy Cost Estimate											
Description	**Space Heating**	**Water Heating**	**Ventilation Fans**	**Clothes Drying**	**Lighting**	**Refrigeration**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$47,006	$1,154	$2,344	$6,844	$5,004	$198	$14,957	$15,450	$9,200	$2,676	**$104,835**
With Proposed Retrofits	$30,861	$1,172	$2,346	$6,987	$2,195	$199	$14,970	$13,565	$6,327	$2,311	**$80,932**
Savings	$16,145	-$17	-$2	-$142	$2,809	$0	-$13	$1,885	$2,873	$365	**$23,903**

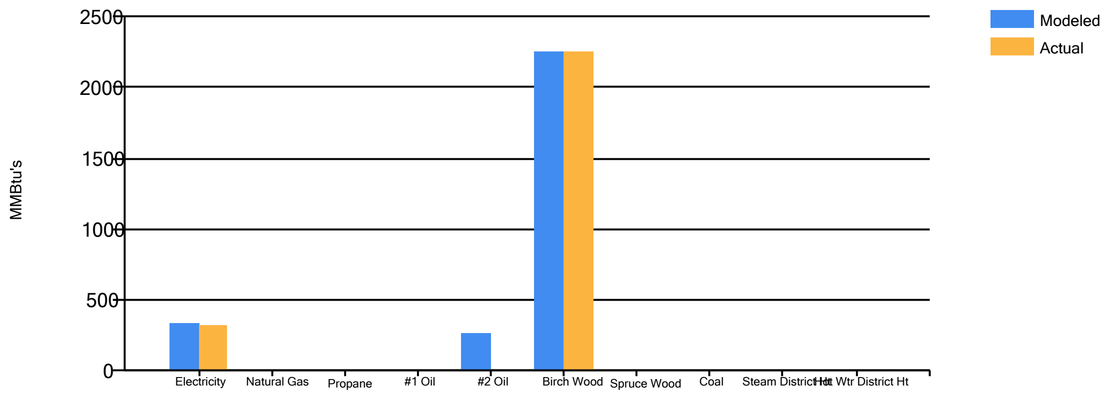
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	616.7	42.27	$22.75
With Proposed Retrofits	497.7	34.11	$17.56

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.

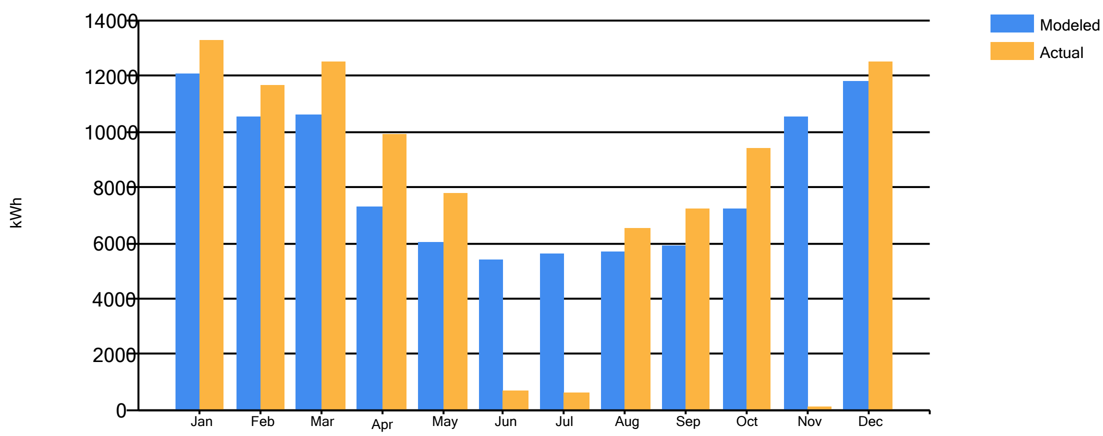
Appendix A – Actual Fuel Use versus Modeled Fuel Use

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

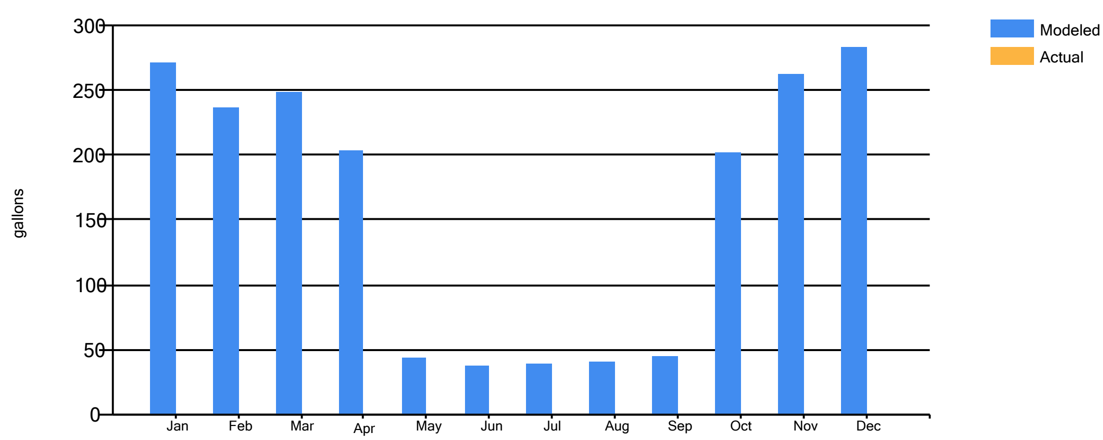
Annual Fuel Use



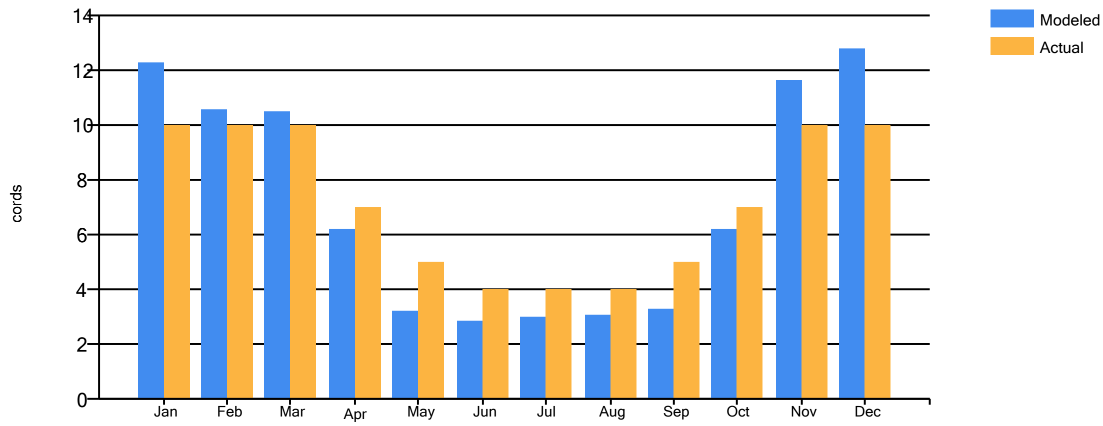
Electricity Fuel Use



#2 Fuel Oil Fuel Use



Birch Wood Fuel Use


Modeled
Actual
cords
14
12
10
8
6
4
2
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Appendix B - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	66.4	56.9	48.3	41.2	36.9	36.0	35.6	35.2	35.3	35.1	33.3	27.5
As Proposed	29.6	26.6	24.0	21.9	19.5	19.1	19.1	19.1	19.5	19.6	19.5	19.2

Estimated Demand Charges (at $0.00/kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
As Proposed	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

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