Comprehensive Energy Audit
For

Venetie Water Treatment Plant and Washeteria

Prepared For
The Venetie Village Council

July 19, 2018

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PREFACE

This energy audit was conducted using funds provided by the U.S. Department of Agriculture - Rural Development (USDA RD) through the Rural Alaska Village Grant (RAVG) Program. Coordination with the Native Village of Venetie and the Venetie Village Council has been undertaken to provide maximum accuracy in identifying facilities to audit, and to facilitate energy efficiency project development after the audit process is complete.

The Rural Energy Initiative at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for the Venetie Village Council, Alaska. The authors of this report are Cody Uhlig, Senior Project Manager, Professional Engineer (PE), and Certified Energy Manager (CEM); Kelli Whelan, Energy Auditor I; and Kevin Ulrich, Assistant Engineering Project Manager, Mechanical Engineer in Training (EIT), and 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 March of 2018 by the ANTHC Rural Energy Initiative. This report analyzes historical energy use, and identifies costs and savings of recommended energy conservation measures. Discussions of site-specific concerns, non-recommended measures, and an energy conservation action plan are also included in this report.

ACKNOWLEDGMENTS

The ANTHC Rural Energy Initiative gratefully acknowledges the assistance of Patrick (PJ) Hanson, First Chief of the Venetie Village Council; Donna Erick, former Venetie Village Council Administrator; John Frank, Water Treatment Plant Operator; and Sarah Frank, Washeteria caretaker.

LIMITATIONS OF THIS STUDY

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

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

1. EXECUTIVE SUMMARY

This report was prepared for the Venetie Village Council. The scope of the audit focused on Venetie Water Treatment Plant and Washeteria building. 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 electric loads.

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy costs for the Venetie Water Treatment Plant and Washeteria are $138,052 per year. Fuel oil is the largest expense, with the annual fuel usage estimated at $86,344 or 62.5% of the total energy cost for the facility. Electricity is the second highest expense, estimated at $51,708 per year (before applying the PCE electricity subsidy), or 37.4% of the total energy costs. The building is also heated by heat recovered from nearby power plant radiators, but Venetie Village Electric, the local utility, does not charge for this service. Through a site visit, it was determined the heat recovery system is unlikely to be operating as designed (see Section 3.1 for more information).

The State of Alaska Power Cost Equalization (PCE) program provides a subsidy to rural communities across the state to lower electricity costs and make energy affordable in rural Alaska. In Venetie, the cost of electricity without the PCE subsidy was approximately $0.90 per kilowatt-hour (kWh) and the cost with PCE was approximately $0.38 per kWh in 2018.

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

Table 1.1: Predicted Annual Use for the Venetie Water Treatment Plant and Washeteria

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	57,453 kWh	19,686 kWh
#1 Oil	9,594 gallons	1,089 gallons
Heat Recovery (waste heat)	0.00 million Btu	466.75 million Btu

Note: The heat recovery system was not working properly during the site visit in March 2018. See Section 3.1 – Heat Recovery Information for further explanation.

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

Table 1.2: Building Benchmarks for the Venetie Water Treatment Plant and Washeteria

Building Benchmarks			
Description	EUI (kBTU/sq. ft.)	EUI/HDD (Btu/sq. ft./HDD)	ECI ($/sq. ft.)
Existing Building	1,385.3	89.90	$130.76
With Proposed Retrofits	641.9	41.66	$26.07
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 Venetie Water Treatment Plant and Washeteria. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.3: Summary of Recommended Energy Efficiency Measures

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings[1]**	**Installed Cost**	**Savings to Investment Ratio, SIR[2]**	**Simple Payback (Years)[3]**	**CO_2 Savings**
1	Other Electrical: Upper Heat Trace	Turn off the upper heat trace between batch water treatment runs as long as the transmission line continues to drain completely. Use the heat trace only for freeze prevention.	$11,668	$8	12,282.08	0.0	31,114.3
2	Other Electrical: HP-2 Circulation Pump Setting	Verify that the circulation pump is on Speed I to match the design criteria. The energy savings reflects a speed setting change from Speed II to Speed I.	$138	$4	387.44	0.0	366.8
3	Other Electrical: HP-1 Dryer Plenum Circulation Pump - Dryers	Install a variable speed, electrically commutated (ECM) pump that can adapt to the dryer and cabinet heater heat demands. Set pump controls to maintain a constant temperature in Dryer Plenum loop. Insulate all plumbing. Directly related to recommendation #4.	$45,101	$3,060	135.66	0.1	107,388.6

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings[1]	Installed Cost	Savings to Investment Ratio, SIR[2]	Simple Payback (Years)[3]	CO_2 Savings
4	Heating, Ventilation, and Domestic Hot Water	Clean and tune boilers. Depending on the boilers' conditions, they may need a complete overhaul. Troubleshoot the heat recovery system and controls. Replace the brazed plate heat exchanger for the heat recovery system. Flushing done during the onsite trip indicated that the heat exchange rate does not improve. Replace the HP-1 Dryer Plenum circulation pump with a variable speed, ECM pump. Retrofit cost is split between the cabinet heater and the dryers retrofit based on runtime. Directly related to recommendation #3. Replace circulation pump HP-7 with a variable speed, ECM pump. Install low-flow showerheads and faucet aerators to reduce hot water consumption by 50%.	$41,475	$15,734	24.22	0.4	71,136.8
5	Programmable Thermostat: Public Washer and Dryer Access	Install a programmable thermostat to regulate the temperature in the washer and dryer area. Program a temperature setback to 60°F when the washeteria is closed.	$97	$341	3.33	3.5	786.8

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings[1]	Installed Cost	Savings to Investment Ratio, SIR[2]	Simple Payback (Years)[3]	CO_2 Savings
6	Lighting: Public Washer and Dryer Access	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting.	$489 + $28 Maint. Savings	$3,085	2.62	6.0	1,303.7
7	Other Electrical: Lower Heat Trace	Regrade the lower transmission line so the line drains completely between batch treatments. Seal the rewired connection to reduce the risk of electrical shock. Use the lower heat trace only for freeze prevention.	$11,199	$50,000	1.89	4.5	29,863.5
8	Lighting: Boiler Room	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting.	$65 + $8 Maint. Savings	$926	1.25	12.6	173.7
9	Lighting: Water Treatment Plant	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting.	$239 + $29 Maint. Savings	$3,394	1.24	12.7	637.4
10	Lighting: Bathroom #2	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting.	$8 + $1 Maint. Savings	$154	0.99	15.9	22.2
11	Lighting: Bathroom #1	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting.	$3 + $1 Maint. Savings	$132	0.50	31.7	7.4
12	Lighting: Bathroom #3	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting (assuming the toilet is fixed and usage returns to normal).	$3 + $1 Maint. Savings	$132	0.50	31.7	7.4
13	Programmable Thermostat: Dryer Plenum	Install a programmable thermostat to maintain a lower temperature in the Dryer Plenum when the building is unoccupied.	$13	$341	0.45	26.3	120.6
14	Lighting: Utility Room (watering point access)	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting.	$1 + $3 Maint. Savings	$265	0.21	74.0	2.1
15	Lighting: Dryer Plenum	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting.	$2 + $6 Maint. Savings	$530	0.21	74.1	4.1

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings[1]	Installed Cost	Savings to Investment Ratio, SIR[2]	Simple Payback (Years)[3]	CO_2 Savings
16	Lighting: Outdoor Lighting	Replace high-pressure sodium wall pack with an energy efficient LED equivalent.	$1 + $3 Maint. Savings	$504	0.14	116.5	2.8
17	Air Tightening	Rehang the washeteria door so that it is plumb with the doorframe. Replace the washeteria door handle. Add weather stripping around washeteria and water treatment plant doors and windows. Re-caulk windows as needed.	$8	$775	0.09	98.8	73.1
18	Building Shell: Water Treatment Plant/Washeteria Subfloor	Install R-5 rigid board insulation under the subfloor on the exterior of the building. Cost estimate includes materials, freight, and labor.	$9	$7,207	0.02	795.6	84.4
19	Windows: Boiler Room	Replace the existing windows with a triple pane, low-E, argon windows.	$2	$1,368	0.02	756.4	16.9
20	Windows: Public Washer and Dryer Access	Replace the existing windows with a triple pane, low-E, argon windows.	$5	$4,104	0.02	757.5	50.8
21	Window: Water Treatment Plant	Replace the existing window with a triple pane, low-E, argon window.	$1	$1,368	0.02	944.0	13.1
22	Programmable Thermostat: Bathroom #1	Install a programmable thermostat to regulate the temperature in the bathroom. Program a temperature setback to 60°F when the washeteria is closed.	$0	$341	0.01	804.6	3.9
23	Programmable Thermostat: Bathroom #2	Install a programmable thermostat to regulate the temperature in the bathroom. Program a temperature setback to 60°F when the washeteria is closed.	$0	$341	0.01	808.3	3.9

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings[1]	Installed Cost	Savings to Investment Ratio, SIR[2]	Simple Payback (Years)[3]	CO_2 Savings
24	Programmable Thermostat: Bathroom #3	Install a programmable thermostat to regulate the temperature in the bathroom. Program a temperature setback to 60°F when the washeteria is closed.	$0	$341	0.01	804.6	3.9
		TOTAL, all measures	**$110,528 + $81 Maint. Savings**	**$94,454**	**10.65**	**0.9**	**243,188.2**

Table Notes:

[1] Maintenance savings were calculated by determining the approximate number and cost of fluorescent bulbs that would need to be replaced over the lifetime of an equivalent LED bulb, and then adding that subtotal to the cost of labor for changing each bulb. The total was divided over the lifespan of the LED equivalent bulb. Note: the LED lifespan is capped at 30 years.

A value of $25 per hour was estimated for local labor. The length of time for changing each bulb was estimated at 15 minutes.

[2] 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.

[3] 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 $110,528 per year, or 80.1% of the buildings' total energy costs. These measures are estimated to cost $94,454, for an overall simple payback period of 0.9 years.

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

Table 1.4: Detailed Breakdown of Energy Costs in the Building

Annual Energy Cost Estimate							
Description	Space Heating	Water Heating	Ventilation Fans	Clothes Drying	Lighting	Other Electrical	Total Cost
Existing Building	$7,063	$15,157	$16	$83,699	$2,759	$29,358	**$138,052**
With Proposed Retrofits	$4,885	$4,309	$16	$9,874	$1,949	$6,491	**$27,524**
Savings	$2,178	$10,848	$0	$73,825	$810	$22,867	**$110,528**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

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

2.2 Audit Description

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

- Building envelope (roof, windows, etc.)
- Heating, ventilation, and air conditioning equipment (HVAC)
- Lighting systems and controls
- Building-specific equipment

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

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

Venetie Water Treatment Plant and Washeteria has the following heated areas:

1. Public Washer and Dryer Access: 472 square feet
2. Bathroom #1: 42 square feet
3. Bathroom #2: 42 square feet
4. Bathroom #3: 42 square feet
5. Dryer Plenum: 73 square feet
6. Water Treatment Plant: 385 square feet

The Venetie Water Treatment Plant and Washeteria also has the following unheated areas:

- An arctic entry, a storage room, a utility room (access to the watering point plumbing), and a boiler room.

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 and to calculate the energy used. The factors include:

- Occupancy hours
- Local climate conditions
- Prices paid for energy

2.3. Method of Analysis

Data collected was processed using AkWarm© Energy Use Software to estimate energy savings for each of the proposed energy efficiency measures (EEMs). The recommendations focus on the building envelope; heating and ventilation systems; lighting, electrical load, and other 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 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 U.S. 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 (construction) 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. VENETIE WATER TREATMENT PLANT AND WASHETERIA

3.1. Building Description

The 1,441 square foot Venetie Water Treatment Plant and Washeteria was constructed in the 1990s as the primary location for all water treatment and distribution services for Venetie. The building is staffed for about two hours per day. About five to 10 people utilize the washers, dryers, and bathrooms each day. The washeteria facilities are open to the public Monday through Sunday, 10:00 AM through 7:00 PM. See Figure 1 below for an aerial view of the water treatment system.

Figure 1: An aerial view of the Venetie water treatment system. The blue circle (lower left) represents the pump house and well. The black line is approximate location of the raw water transmission line and drain port. The water treatment plant and water storage tank are circled in black (upper center). Photo courtesy of Google Earth.

Groundwater is pumped and treated in batches from a single well approximately 1,100 feet from the water treatment plant and washeteria building. The pump head is protected by a well house and heated with electric heat trace. See Figures 2a. below for reference. The raw water transmission line between the pump house and the water treatment plant is split into two, an upper line and lower line, upstream and downstream of the sump in Figure 2b below. The lines are connected at a drain port (inside of the sump), which is designed to allow both lines to drain completely after each batch treatment (Figure 2b.).

Figures 2a. (left): Venetie pump house. Figure 2b. (right): Venetie sump. The lower line from the pump house (coming in from the left) connects to the upper line (going out to the right), which runs to the water treatment plant. The stub out in the center of the photo is the drain port.

Self-regulating, electric heat trace was installed along the transmission line for thawing. During the 2017-2018 winter, the lower line heat trace was cut after the heat trace was damaged and no longer functioning. The lower line has since been rewired and converted to a plug-in heat trace. It should be noted that the rewired connection is not waterproof, creating a potential shock hazard due to its close proximity to standing water.

Upon entering the water treatment plant, raw water is filtered through a bag filter train (Figure 3) and disinfected with chlorine before being stored in a 428,000-gallon water storage tank (Figure 4). The water storage tank must be refilled every three to four months; each batch treatment process lasts about two weeks.

Figure 3: The water treatment plant bag filtration system.

Figure 4: Water storage utilidor and tank.

Treated water is used in the washeteria and made available to the public via a watering point on the outside of the washeteria. Water is also supplied to the John Fredson School, which is pumped directly from the water storage tank. Venetie is an unserved community, so it does not have additional heating loads or distribution loops.

Description of Building Shell

The exterior walls have 2x4 wood-framed construction with 16” on-center studs. The stud cavities are assumed to be filled with R-19 fiberglass insulation. The exterior sidewalls are approximately 11 feet high from the bottom of the subfloor. The walls at the front and back of the building are approximately 11 feet tall at the sides, and 16 feet tall at the roof apex. The building is constructed above grade on pilings, which are about three feet tall.

The cathedral ceiling is 2x6 standard truss, wood framed construction. It is insulated with approximately 9.5 inches of R-30 fiberglass batt between the interior ceiling and the roof.

There are six double pane, wood-framed windows present in the facility: four in the public washer and dryer access area, one in the water treatment plant, and one in the boiler room. There is one single-door entrance to the washeteria, and a single-door entrance to the boiler room at the back of the building. The washeteria entrance door is windowless and made of insulated vinyl. The boiler room doors are insulated metal and do not have windows.

Description of Heating Plants

The heating plants used in the building are:

B-1 Boiler

Nameplate Information:	Weil-McLain 480 Commercial Boiler with a Becket Burner
Fuel Type:	#1 Oil
Input Rating:	469,200 BTU per hour
Steady State Efficiency:	81.8 % (estimated)
Idle Loss:	1.5 % (estimated)
Heat Distribution Type:	Water (originally 50/50 propylene glycol)
Boiler Operation:	All Year
Notes:	Boiler needs to be serviced (cleaned once a year).

B-2 Boiler

Nameplate Information:	Weil-McLain 480 Commercial Boiler with a Becket Burner
Fuel Type:	#1 Oil
Input Rating:	469,200 BTU per hour
Steady State Efficiency:	81.8 % (estimated)
Idle Loss:	1.5 % (estimated)
Heat Distribution Type:	Water (originally 50/50 propylene glycol)
Boiler Operation:	All Year
Notes:	Boiler needs to be serviced (cleaned once a year).

Figure 5: Weil-McLain 480 Commercial boilers.

Heat Recovery System

Nameplate Information:	Brazed plate heat exchanger
Heat Exchanger Capacity:	250,000 BTU per hour
Steady State Efficiency:	50 % (estimated)
Heat Distribution Type:	Glycol (power plant) to water (water treatment plant)
Boiler Operation:	All Year
Notes:	There was minimal heat transfer across the exchanger.

Figure 6: Heat recovery system (left) and heat exchanger (right) in the water treatment plant boiler room.

Space Heating Distribution Systems

Water is circulated through the boilers using two Grundfos UP 43-75 BF pumps (labeled HP-3A and HP-3B). These pumps are plumbed in parallel for redundancy. Heat is supplied to the washeteria through baseboard fin foil heaters in the bathrooms, and a unit heater in the washer and dryer area (Beacon Morris model no. HB-060). The baseboard heating along the wall outside of the bathrooms has been removed. The water treatment plant is heated by a unit heater (Beacon Morris model no. HB-060). Heat is supplied to the dryer plenum through a Trane Force-Flo cabinet heater.

Domestic Hot Water System

Hot water is generated using two Amtrol indirect hot water heaters (model no. WH-80-ZCDW). Water is circulated on demand by a Grundfos UPS 32-80 F circulation pump (set to Speed 3).

Heat Recovery System Information

Waste heat is captured from the nearby Venetie Village Electric power plant radiators, and then circulated to the water treatment plant/washeteria building and the Venetie Clinic using a Grundfos UPS 50-80/2F circulation pump (HP-5). Heat is transferred to the water treatment plant/washeteria heating system through a 250,000 BTU per hour rated brazed plate heat exchanger (GEA Heat Exchangers, Inc. model no. FP10X20L-70). The captured heat is then circulated in the water treatment plant and washeteria by a Grundfos UPS 40-80/4F pump (HP-7).

There are issues with the existing heat recovery infrastructure. During the site visit, the boiler set points were higher than the heat recovery temperature gauges, indicating that the boiler system may have been heating the heat recovery loop that goes to the clinic. Second, pipe corrosion is a common problem in the water treatment plant. It is possible that the brazed plate heat exchanger is corroded or clogged, because flushing minimally improved the heat transfer across the exchanger. Third, circulation pump HP-5, which circulates the recovered heat through the water treatment plant and washeteria, was knocking during the site visit. Pump HP-5 needed maintenance or replacement. Lastly, the exterior transmission line between the power plant, water treatment plant/washeteria building, and the clinic is insulated by only 2" of flexible pre-insulated PEX piping (see Figure 7 below). This is less than is typical for these types of installations and can cause a higher rate of ambient heat loss.

Figure 7: Exterior heat recovery transmission line (black flexible pipe). The piping running parallel to the water storage tank utilitdor is a node to the clinic.

Description of Building Ventilation System

The washeteria bathrooms are ventilated by three small exhaust fans. There are also two large ceiling fans in the building: one in the public washer and dryer access area, and one on the water treatment plant side. The ceiling fans were not in use during the site visit.

Lighting

Lighting in the water treatment plant consumes approximately 3,057 kWh annually and constitutes approximately 5.3% of the building's current electrical consumption.

Table 3.1: Breakdown of Lighting by Location and Bulb Type

Location	Bulb Type	Fixtures	Bulbs per Fixture	Annual Usage (kWh)
Boiler Room	4 ft. Fluorescent T-8 (32 W)	3	4	247
Water Treatment Plant	4 ft. Fluorescent T-8 (32 W)	11	4	905
Dryer Plenum	4 ft. Fluorescent T-8 (32 W)	2	4	6
Public Washer and Dryer Access Area	4 ft. Fluorescent T-8 (32 W)	10	4	1,851
Utility Room (watering point plumbing access)	4 ft. Fluorescent T-8 (32 W)	1	4	3
Bathroom #1	4 ft. Fluorescent T-8 (32 W)	1	2	10.5
Bathroom #2	4 ft. Fluorescent T-8 (32 W)	1	2	31.5
Bathroom #3	4 ft. Fluorescent T-8 (32 W)	1	2	1.5
Outdoor Lighting	High Pressure Sodium Wall Pack (50 W)	1	1	1.5
Total Energy Consumption				**3,057**

Note: Bathroom #3 is rarely used due to a broken toilet. Under normal usage, the lighting in Bathroom #3 would use about 10.5 kWh per year.

Major Equipment

Table 3.2 contains the details on each of the major electricity consuming mechanical components found in the raw water transmission line, water treatment plant, and washeteria. Major equipment consumes approximately 46,758 kWh annually, constituting about 81.4% of the building's current electrical consumption.

Table 3.2: Major Equipment List

Major Equipment	Purpose	Rating (W)	Operating Schedule	Annual Energy Consumption (kWh)
Well Pump (3/4 HP)	Extract and pump raw water to the water treatment plant.	559	Active during the batch treatment process (approximately once every three months for two weeks continuously)	805
HP-1: Grundfos UPS 40-160 F Circulation Pump (3/4 HP)	Circulates heat to the Dryer Plenum cabinet heater and hydronic dryers.	800	Approximately 2.5 hours per day from Oct. 1 through April 30	624

HP-2: Grundfos UPS 32-80 F Circulation Pump (1/2 HP)	Circulates heat through the indirect hot water heaters.	250	On demand	2,190
HP-3A and HP-3B: Grundfos UPS 43-75 BF Circulation Pump (1/3 HP)	Circulates heat through the water treatment plant and washeteria hydronic heating system. Pumps are plumbed in parallel for redundancy.	184	Continuous from Oct. 1 through April 30	464
HP-4: Grundfos UPS 15-58 FC Circulation Pump	Circulates heat through the water storage tank heat exchanger.	85	Continuous from Oct. 1 through April 30	428.5
HP-5: Grundfos UPS 50-80/2F Circulation Pump (3/4 HP)	Circulates heat from the power plant radiators to the water treatment plant/washeteria and the clinic.	400	Continuous	3,504
HP-7: Grundfos UPS 40-80/4F Circulation Pump (1/2 HP)	Circulates water treatment plant/washeteria hydronic heating fluid through the waste heat recovery heat exchanger.	485	On demand (continuous during site visit)	4,249
CRP-301 and CRP-302: Grundfos UP 26-96 BF Circulation Pump	Circulates treated water from the water storage tank through a heat exchanger to heat the tank during the winter. Pumps are plumbed in parallel for redundancy.	205	Continuous from Oct. 1 through April 30	1,033
PP-401 and PP-402: Baldor Reliance Super E Pressure Pump (1.5 HP)	Pressurizes water from the water storage tank. Pumps are plumbed in parallel for redundancy. Only PP-402 was running during the site visit.	1,118	Measured runtime: 5.2%	496
CFP-2: FASCO no. 71638926 Chlorine Pump	Raw water disinfection.	163.3	Active during batch treatment process	235
Well Pump Heat Trace: LT8-JT	Maintains the pump head and upper portion of well shaft at an above-freezing temperature.	8 Watts/ft.	Continuous use from Oct. 1 through April 30	367
Raw Water Transmission Line Heat Trace: Nelson LLT2-JT (upper and lower lines)	Maintains the raw water transmission line at above freezing during the winter.	7 Watts/ft.	Continuous use from Oct. 1 through April 30	29,204
Watering Point Heat Trace: Raychem Guardian W51-12P	Freeze recovery for the watering point line.	72	Rarely used	2
Girbau, Inc. Continental Commercial Washers	Laundry. Two units total.	1,008	Approximately 1 hour per day	736

Whirlpool model no. CAE2743BQ0 Washers	Laundry. Two units total.	960	Continuous	701
Speed Queen model no. STT30SBCB2GW01 Commercial Dryers	Laundry. Two units total.	596.6 (per unit)	Assumed that three dryers are used approximately 2.5 hours per day	1,633
56" Three-blade Ceiling Fans	Air circulation. Two units total.	63 (per unit)	Approximately 9 hours per day from May 2 through August 31	69
Bathroom Exhaust Fans	Bathroom ventilation. Three units total.	23 (per unit)	Bathroom #1: approx. ½ hour per day Bathroom #2: approx. 1.5 hours per day. Bathroom #3: rarely	17.5
			Total Energy Consumption	**46,758**

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

The electric usage profile charts in Section 3.2.1.1 below represent the predicted electrical usage for the building. If actual electricity usage records were available, the model used to predict usage was calibrated to approximately match actual usage. The electric utility measures consumption in kilowatt-hours (kWh) and maximum demand in kilowatts (kW). One kWh usage is equivalent to 1,000 Watts running for one hour. One kW of electric demand is equivalent to 1,000 Watts running at a particular moment. The basic usage charges are shown as generation service and delivery charges along with several non-utility generation charges.

The fuel oil usage profile shows the fuel oil usage for the building. Fuel oil consumption is measured in gallons. One gallon of #1 Fuel Oil provides approximately 138,000 BTUs of energy.

Venetie Village Electric, a locally owned, private utility, supplies electricity to the Native Village of Venetie.

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

Table 3.3: Energy Cost Rates for Each Fuel Type

Average Energy Cost (as of March 2018)	
Description	**Average Energy Cost**
Electricity (before PCE)	$ 0.90/kWh
#1 Fuel Oil	$ 9.00/gallon
Waste Heat Recovery	$ 0.00/million BTU

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, the Venetie Village Council pays approximately $138,052 annually for electricity and other fuel costs for the Venetie Water Treatment Plant and Washeteria.

Figure 8 below reflects the estimated distribution of costs across the primary end uses of energy based on the AkWarm© computer simulation. Comparing the "Retrofit" bar in the figure to the "Existing" bar shows the potential savings from implementing all of the energy efficiency measures shown in this report.

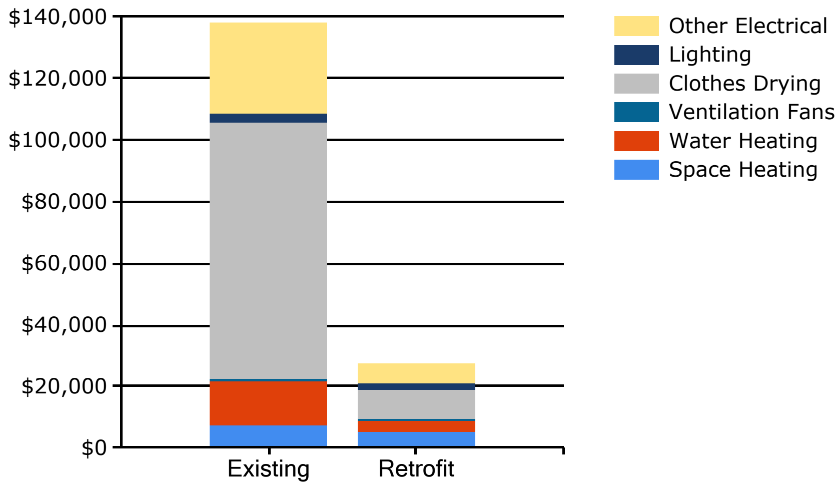


Figure 8: Annual energy costs by end use.

Figure 9 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

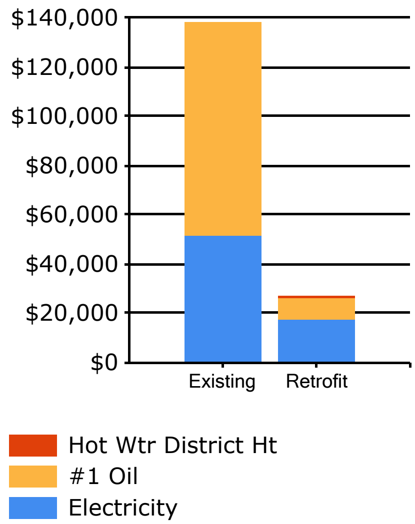


Figure 9: Annual energy costs by fuel type. Note: "Hot Wtr. District Ht." refers to the heat recovery system.

Figure 10 below addresses only space heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the walls and doors. For each component, the space heating costs are shown for the existing building (blue bar) and assuming that all retrofits are implemented (yellow bar).

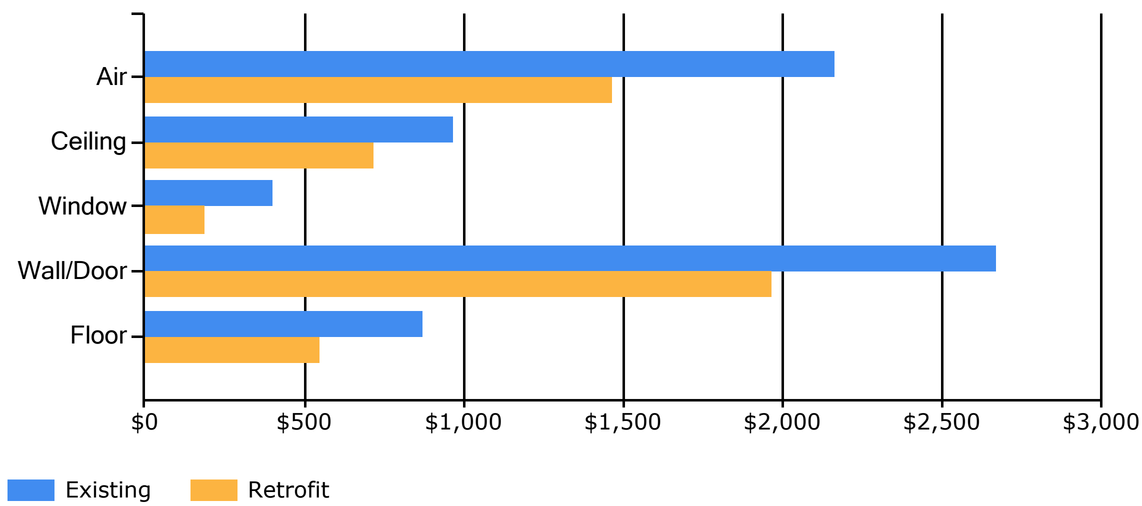


Figure 10: Annual space heating costs.

Tables 3.4.1 and 3.4.2 below show the model's estimate of the monthly use for the fuel and heat sources used in the building. The fuel use is broken down across the energy end uses. The heat recovery system was assumed to contribute no heat to the water treatment plant and washeteria building.

Table 3.4.1: Estimated Electrical Consumption by Category

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	683	615	667	637	658	637	658	658	637	658	656	681
Domestic Hot Water	459	418	459	444	202	196	202	202	196	459	444	459
Ventilation Fans	1	1	1	1	1	1	1	1	1	1	1	1
Clothes Drying	824	751	824	797	835	808	835	835	808	824	797	824
Lighting	260	237	260	252	260	252	260	260	252	260	252	260
Other Electrical	4,744	4,086	4,484	4,582	199	176	182	442	159	4,484	4,547	4,536

Table 3.4.2: Estimated #1 Fuel Oil Consumption by Category

Fuel Oil #2 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Hot Water	155	141	155	150	43	42	43	43	42	155	150	155
Clothes Drying	702	640	702	680	712	689	712	712	689	702	680	702

Note: There is no fuel consumption for "Space Heating", because the dryers, boilers, and other equipment in the building are supplying a sufficient amount of heat to displace the hydronic heating system. This calculation agrees with the observed operation of the building: the thermostat for the public laundromat access unit heater had to be turned up to 75° F before the heater turned on.

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., or in a specific region or state.

Source use differs from site usage when comparing a building's energy consumption with the national average. Site energy use is the energy consumed by the building at the building site only. Source energy use includes the site energy use as well as all of the losses to create and distribute the energy to the building. Source energy represents the total amount of raw fuel that is required to operate the building. It incorporates all transmission, delivery, and production losses, which allows for a complete assessment of energy efficiency in a building. The type of utility purchased has a substantial impact on the source energy use of a building. The U.S. Environmental Protection Agency 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 3.5 for details):

Building Site EUI = (Electric Usage in kBTU + Fuel Usage in kBTU) / Building Square Footage

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

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

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

Table 3.5: Building EUI Calculations for the Venetie Water Treatment Plant and Washeteria

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	57,453 kWh	196,087	3.340	654,930
#1 Oil	9,594 gallons	1,266,381	1.010	1,279,045
Heat Recovery	0.00 million BTU	0	1.280	0
Total		**1,462,468**		**1,933,974**
BUILDING AREA		1,056	Square Feet	
BUILDING SITE EUI		1,385	$kBTU/ft^2/yr.$	
BUILDING SOURCE EUI		**1,832**	**$kBTU/ft^2/yr.$**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

Table 3.6: Building Benchmarks for the Venetie Water Treatment Plant and Washeteria

Building Benchmarks			
Description	**EUI (kBTU/sq. ft.)**	**EUI/HDD (BTU/sq. ft./HDD)**	**ECI ($/sq. ft.)**
Existing Building	1,385.3	89.90	$130.76
With Proposed Retrofits	641.9	41.66	$26.07
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

3.3 AkWarm© Building Simulation

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

The model uses local weather data and is compared 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, increasing heat recovery, installing high efficiency boilers, adjusting outside air ventilation, and adding cogeneration systems.

For the purposes of this study, the Venetie Water Treatment Plant and Washeteria was modeled using AkWarm© energy use software to establish a baseline space heating energy usage. Climate data from Venetie was used for analysis. From this, the model was calibrated to predict the impact of theoretical energy savings measures. Once annual energy savings from a particular measure were predicted and the initial capital cost was estimated, payback scenarios were approximated.

Limitations of AkWarm© Models

1. The model is based on typical mean year weather data for Venetie. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the fuel and electric profiles generated will not likely compare perfectly with actual energy billing information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.

2. The heating load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in heating loads across different parts of the building.

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

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

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

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

Table 4.1: Summary List of Recommended Energy Efficiency Measures Ranked by Economic Priority

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings[1]**	**Installed Cost**	**Savings to Investment Ratio, SIR[2]**	**Simple Payback (Years)[3]**	**CO_2 Savings**
1	Other Electrical: Upper Heat Trace	Turn off the upper heat trace between batch water treatment runs as long as the transmission line continues to drain completely. Use the heat trace only for freeze prevention.	$11,668	$8	12,282.08	0.0	31,114.3
2	Other Electrical: HP-2 Circulation Pump Setting	Verify that the circulation pump is on Speed I to match the design criteria. The energy savings reflects a speed setting change from Speed II to Speed I.	$138	$4	387.44	0.0	366.8
3	Other Electrical: HP-1 Dryer Plenum Circulation Pump - Dryers	Install a variable speed, electrically commutated (ECM) pump that can adapt to the dryer and cabinet heater heat demands. Set pump controls to maintain a constant temperature in Dryer Plenum loop. Insulate all plumbing. Directly related to recommendation #4.	$45,101	$3,060	135.66	0.1	107,388.6

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings[1]	Installed Cost	Savings to Investment Ratio, SIR[2]	Simple Payback (Years)[3]	CO_2 Savings
4	Heating, Ventilation, and Domestic Hot Water	Clean and tune boilers. Depending on the boilers' conditions, they may need a complete overhaul. Troubleshoot the heat recovery system and controls. Replace the brazed plate heat exchanger for the heat recovery system. Flushing done during the onsite trip indicated that the heat exchange rate does not improve. Replace the HP-1 Dryer Plenum circulation pump with a variable speed, ECM pump. Retrofit cost is split between the cabinet heater and the dryers retrofit based on runtime. Directly related to recommendation #3. Replace circulation pump HP-7 with a variable speed, ECM pump. Install low-flow showerheads and faucet aerators to reduce hot water consumption by 50%.	$41,475	$15,734	24.22	0.4	71,136.8

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings[1]	Installed Cost	Savings to Investment Ratio, SIR[2]	Simple Payback (Years)[3]	CO_2 Savings
5	Programmable Thermostat: Public Washer and Dryer Access	Install a programmable thermostat to regulate the temperature in the washer and dryer area. Program a temperature setback to 60°F when the washeteria is closed.	$97	$341	3.33	3.5	786.8
6	Lighting: Public Washer and Dryer Access	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting.	$489 + $28 Maint. Savings	$3,085	2.62	6.0	1,303.7
7	Other Electrical: Lower Heat Trace	Regrade the lower transmission line so the line drains completely between batch treatments. Seal the rewired connection to reduce the risk of electrical shock. Use the lower heat trace only for freeze prevention.	$11,199	$50,000	1.89	4.5	29,863.5
8	Lighting: Boiler Room	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting.	$65 + $8 Maint. Savings	$926	1.25	12.6	173.7
9	Lighting: Water Treatment Plant	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting.	$239 + $29 Maint. Savings	$3,394	1.24	12.7	637.4
10	Lighting: Bathroom #2	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting.	$8 + $1 Maint. Savings	$154	0.99	15.9	22.2
11	Lighting: Bathroom #1	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting.	$3 + $1 Maint. Savings	$132	0.50	31.7	7.4
12	Lighting: Bathroom #3	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting (assuming the toilet is fixed and usage returns to normal).	$3 + $1 Maint. Savings	$132	0.50	31.7	7.4

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings[1]	Installed Cost	Savings to Investment Ratio, SIR[2]	Simple Payback (Years)[3]	CO_2 Savings
13	Programmable Thermostat: Dryer Plenum	Install a programmable thermostat to maintain a lower temperature in the Dryer Plenum when the building is unoccupied.	$13	$341	0.45	26.3	120.6
14	Lighting: Utility Room (watering point access)	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting.	$1 + $3 Maint. Savings	$265	0.21	74.0	2.1
15	Lighting: Dryer Plenum	Replace fluorescent tube lighting with direct wire, energy efficient LED lighting.	$2 + $6 Maint. Savings	$530	0.21	74.1	4.1
16	Lighting: Outdoor Lighting	Replace high-pressure sodium wall pack with an energy efficient LED equivalent.	$1 + $3 Maint. Savings	$504	0.14	116.5	2.8
17	Air Tightening	Rehang the washeteria door so that it is plumb with the doorframe. Replace the washeteria door handle. Add weather stripping around washeteria and water treatment plant doors and windows. Re-caulk windows as needed.	$8	$775	0.09	98.8	73.1
18	Building Shell: Water Treatment Plant/Washeteria Subfloor	Install R-5 rigid board insulation under the subfloor on the exterior of the building. Cost estimate includes materials, freight, and labor.	$9	$7,207	0.02	795.6	84.4
19	Windows: Boiler Room	Replace the existing windows with a triple pane, low-E, argon windows.	$2	$1,368	0.02	756.4	16.9
20	Windows: Public Washer and Dryer Access	Replace the existing windows with a triple pane, low-E, argon windows.	$5	$4,104	0.02	757.5	50.8

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings[1]**	**Installed Cost**	**Savings to Investment Ratio, SIR[2]**	**Simple Payback (Years)[3]**	**CO_2 Savings**
21	Window: Water Treatment Plant	Replace the existing window with a triple pane, low-E, argon window.	$1	$1,368	0.02	944.0	13.1
22	Programmable Thermostat: Bathroom #1	Install a programmable thermostat to regulate the temperature in the bathroom. Program a temperature setback to 60°F when the washeteria is closed.	$0	$341	0.01	804.6	3.9
23	Programmable Thermostat: Bathroom #2	Install a programmable thermostat to regulate the temperature in the bathroom. Program a temperature setback to 60°F when the washeteria is closed.	$0	$341	0.01	808.3	3.9
24	Programmable Thermostat: Bathroom #3	Install a programmable thermostat to regulate the temperature in the bathroom. Program a temperature setback to 60°F when the washeteria is closed.	$0	$341	0.01	804.6	3.9
		TOTAL, all measures	**$110,528 + $81 Maint. Savings**	**$94,454**	**10.65**	**0.9**	**243,188.2**

Table Notes:

[1] Maintenance savings were calculated by determining the approximate number and cost of fluorescent bulbs that would need to be replaced over the lifetime of an equivalent LED bulb, and then adding that subtotal to the cost of labor for changing each bulb. The total was divided over the lifespan of the LED equivalent bulb. Note: the LED lifespan is capped at 30 years.

A value of $25 per hour was estimated for local labor. The length of time for changing each bulb was estimated at 15 minutes.

[2] 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.

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

4.2 Interactive Effects of Projects

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

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

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

4.3 Building Shell Measures

4.3.1 Insulation Measures

Rank	Location		Existing Type/R-Value		Recommendation Type/R-Value	
18	Building Shell: Water Treatment Plant/Washeteria Subfloor		Framing Type: 2 x Lumber Insulating Sheathing: None Top Insulation Layer: R-30 Batt: FG or RW, 9.5 inches Bottom Insulation Layer: None Insulation Quality: Damaged Modeled R-Value: 29.1		Install R-5 rigid board insulation under the subfloor on the exterior of the building. Use spray foam insulation to seal any cracks or gaps. Replace the existing exterior board with all-weather plywood.	
Installation Cost		$7,207	**Estimated Life of Measure (yrs.)**	30	**Energy Savings ($/yr.)**	$9
Breakeven Cost		$174	**Simple Payback (yrs.)**	796	**Energy Savings (MMBTU/yr.)**	1.1 MMBTU
			Savings-to-Investment Ratio	0.0		
Auditors Notes: Cost: Materials ($3,813) + 15% freight + 96 hours local labor (@ $25/hour) = $7,207						

4.3.2 Window Measures

Rank	Location		Size/Type, Condition		Recommendation	
19	Window: Boiler Room		Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46		Replace the existing window with a triple pane, low-E, argon window.	
Installation Cost		$1,368	**Estimated Life of Measure (yrs.)**	20	**Energy Savings ($/yr.)**	$2
Breakeven Cost		$26	**Simple Payback (yrs.)**	762	**Energy Savings (MMBTU/yr.)**	0.2 MMBTU
			Savings-to-Investment Ratio	0.0		
Auditors Notes: Cost: Materials (approximately $900 per window, depending on size) + 15% freight + 4 hours local labor (@ $25/ hour) = $1,368						

Rank	Location	Size/Type, Condition	Recommendation
20	Window: Public Washer and Dryer Access	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46	Replace existing windows with triple pane, low-E, argon windows (four total).

Installation Cost	$4,104	**Estimated Life of Measure (yrs.)**	20	**Energy Savings ($/yr.)**	$5
Breakeven Cost	$79	**Simple Payback (yrs.)**	757	**Energy Savings (MMBTU/yr.)**	0.6 MMBTU
		Savings-to-Investment Ratio	0.0		

Auditors Notes: Cost: Materials (approximately $900 per window, depending on size) + 15% freight + 4 hours local labor (@ $25/ hour) = $4,104

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

Installation Cost	$1,368	**Estimated Life of Measure (yrs.)**	20	**Energy Savings ($/yr.)**	$1
Breakeven Cost	$21	**Simple Payback (yrs.)**	994	**Energy Savings (MMBTU/yr.)**	0.2 MMBTU
		Savings-to-Investment Ratio	0.0		

Auditors Notes: Cost: Materials (approximately $900 per window, depending on size) + 15% freight + 4 hours local labor (@ $25/ hour) = $1,368

4.3.3 Air Sealing Measures

Rank	**Location**		**Existing Air Leakage Level (cfm@50/75 Pa)**		**Recommended Air Leakage Reduction (cfm@50/75 Pa)**	
17	Water Treatment Plant/Washeteria Building		Air Tightness estimated as: 1687 cfm at 50 Pascal		Perform air sealing to reduce air leakage by 5%. Rehang the washeteria door so that it is plumb with the doorframe. Replace the washeteria door handle. Add weather stripping around washeteria and water treatment plant doors and windows. Re-caulk windows as needed.	
Installation Cost		$775	**Estimated Life of Measure (yrs.)**	10	**Energy Savings ($/yr.)**	$8
Breakeven Cost		$66	**Simple Payback (yrs.)**	99	**Energy Savings (MMBTU/yr.)**	0.9 MMBTU
			Savings-to-Investment Ratio	0.1		
Auditors Notes: Estimated labor: 8 hours local labor (@ $25/hr.) = $200						

4.4 Mechanical Equipment Measures

4.4.1 Heating/Domestic Hot Water Measure

Rank	Recommendation
4	Travel costs from Anchorage, lodging, and per diem for all retrofits is $1,712. This cost is divided between the Heating and Other Loads retrofits based on the labor estimated for each job. All indirect fees are included in the overall cost estimate. 1. Clean and tune boilers. Depending on the boilers' conditions, they may need a complete overhaul. Cost: Materials ($250) + 15% freight + 6 hours maintenance specialist (@ $100/hr.) +6 hours local labor (@ $25) = $1,038 2. Troubleshoot the heat recovery system and controls. Cost: 5 hours engineer (@ $125/hr.) = $625 (travel costs are included above) 3. Replace the brazed plate heat exchanger. The following cost estimate is for a 250,000 BTU/hr. brazed plate heat exchanger. Cost: Materials ($750) + 15% freight +4 hours maintenance specialist (@ $100/hr.) and 4 hours local labor (@ $25/hr.) = $1,363 4. Consider replacing HP-1 with a variable speed, electrically commutated pump. Cost: Materials (Pump: $2,050, additional wiring: $50) + 15% freight + 2 hours maintenance specialist (@ $100/hr.) and 2 hours local labor (@ $25/hr.) = $2,665 5. Consider replacing HP-7 with a variable speed, electrically commutated pump. Cost: Materials (Pump: $1,245, additional wiring: $50) + 15% freight + 2 hours maintenance specialist (@ $100/hr.) and 2 hours local labor (@ $25/hr.) = $1,740 6. Install low-flow showerheads and faucet aerators to reduce hot water consumption (estimated at ½ current hot water consumption). Cost: Materials ($50) + 15% freight + 1 hour local labor (@ $25/hr.) = $83

Installation Cost	$15,734	**Estimated Life of Measure (yrs.)**	10	**Energy Savings ($/yr.)**	$41,475
Breakeven Cost	$381,103	**Simple Payback (yrs.)**	0	**Energy Savings (MMBTU/yr.)**	71.5 MMBTU
		Savings-to-Investment Ratio	24.2		
Auditors Notes:					

4.4.2 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
5	Public Washer and Dryer Access			Install a programmable thermostat to regulate the temperature in the washer and dryer area. Program a temperature setback to 60°F when the washeteria is closed.	
Installation Cost	$341	**Estimated Life of Measure (yrs.)**	15	**Energy Savings ($/yr.)**	$97
Breakeven Cost	$1,136	**Simple Payback (yrs.)**	4	**Energy Savings (MMBTU/yr.)**	9.5 MMBTU
		Savings-to-Investment Ratio	3.3		
Auditors Notes: Cost: Materials ($70; includes additional wiring, conduit, and lockable case) + 15% freight + 1 hour electrician (@ $100/hour) + 15 minutes local labor (@ $25/hour) + contractor travel + 30% contractor fee = $341					

Rank	Building Space			Recommendation	
13	Dryer Plenum			Install a programmable thermostat to maintain a lower temperature in the Dryer Plenum when the building is unoccupied.	
Installation Cost	$341	**Estimated Life of Measure (yrs.)**	15	**Energy Savings ($/yr.)**	$13
Breakeven Cost	$152	**Simple Payback (yrs.)**	26	**Energy Savings (MMBTU/yr.)**	1.5 MMBTU
		Savings-to-Investment Ratio	0.4		
Auditors Notes: Cost: Materials ($70; includes additional wiring and conduit) + 15% freight + 1 hour electrician (@ $100/hour) + 15 minutes local labor (@ $25/hour) + contractor travel + 30% contractor fee = $341					

Rank	Building Space			Recommendation	
22	Bathroom #1			Install a programmable thermostat to regulate the temperature in the bathroom. Program a temperature setback to 60°F when the washeteria is closed.	
Installation Cost	$341	**Estimated Life of Measure (yrs.)**	15	**Energy Savings ($/yr.)**	$0
Breakeven Cost	$5	**Simple Payback (yrs.)**	808	**Energy Savings (MMBTU/yr.)**	0.1 MMBTU
		Savings-to-Investment Ratio	0.0		
Auditors Notes: Cost: Materials ($70; includes additional wiring, conduit, and lockable case) + 15% freight + 1 hour electrician (@ $100/hour) + 15 minutes local labor (@ $25/hour) + contractor travel + 30% contractor fee = $341					

Rank	Building Space			Recommendation	
23	Bathroom #2			Install a programmable thermostat to regulate the temperature in the bathroom. Program a temperature setback to 60°F when the washeteria is closed.	
Installation Cost	$341	**Estimated Life of Measure (yrs.)**	15	**Energy Savings ($/yr.)**	$0
Breakeven Cost	$5	**Simple Payback (yrs.)**	808	**Energy Savings (MMBTU/yr.)**	0.1 MMBTU
		Savings-to-Investment Ratio	0.0		
Auditors Notes: Cost: Materials ($70; includes additional wiring, conduit, and lockable case) + 15% freight + 1 hour electrician (@ $100/hour) + 15 minutes local labor (@ $25/hour) + contractor travel + 30% contractor fee = $341					

Rank	Building Space			Recommendation		
24	Bathroom #3			Install a programmable thermostat to regulate the temperature in the bathroom. Program a temperature setback to 60°F when the washeteria is closed.		
Installation Cost		$341	**Estimated Life of Measure (yrs.)**	15	**Energy Savings ($/yr.)**	$0
Breakeven Cost		$5	**Simple Payback (yrs.)**	805	**Energy Savings (MMBTU/yr.)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.0		
Auditors Notes: Cost: Materials ($70; includes additional wiring, conduit, and lockable case) + 15% freight + 1 hour electrician (@ $100/hour) + 15 minutes local labor (@ $25/hour) + contractor travel + 30% contractor fee = $341						

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. The heating load will see a small increase, as the more energy efficient bulbs give off less heat.

Rank	**Location**		**Existing Condition**		**Recommendation**	
6	Public Washer and Dryer Access		10 Fluorescent Fixtures (4 bulbs each) T-8 4' F32T8 32W Standard Instant Electronic Ballast		Replace the current bulbs with direct wire, energy efficient LED equivalents.	
Installation Cost		$3,085	**Estimated Life of Measure (yrs.)**	22	**Energy Savings ($/yr.)**	$489
Breakeven Cost		$8,089	**Simple Payback (yrs.)**	6	**Energy Savings (MMBTU/yr.)**	1.9 MMBTU
			Savings-to-Investment Ratio	2.6	**Maintenance Savings ($/yr.)**	$28
Auditors Notes: Each fluorescent bulb will be replaced twice per one LED bulb lifetime. Maintenance costs account for the labor and materials to change the fluorescent bulbs over the lifetime of the LED replacement. Retrofit: Materials ($16.74 per bulb, tombstone included) + 15% freight + 15 minutes electrician labor per bulb (@ $100/hour) + Travel + 30% contractor fee = $3,085. Travel and indirect costs are divided across the lighting recommendations for the building.						

Rank	**Location**		**Existing Condition**		**Recommendation**	
8	Boiler Room		3 Fluorescent Fixtures (4 bulbs each) T-8 4' F32T8 32W Standard Instant Electronic Ballast		Replace the current bulbs with direct wire, energy efficient LED equivalents.	
Installation Cost		$926	**Estimated Life of Measure (yrs.)**	22	**Energy Savings ($/yr.)**	$65
Breakeven Cost		$1,153	**Simple Payback (yrs.)**	13	**Energy Savings (MMBTU/yr.)**	0.2 MMBTU
			Savings-to-Investment Ratio	1.2	**Maintenance Savings ($/yr.)**	$8
Auditors Notes: Each fluorescent bulb will be replaced twice per one LED bulb lifetime. Maintenance costs account for the labor and materials to change the fluorescent bulbs over the lifetime of the LED replacement. Retrofit: Materials ($16.74 per bulb, tombstone included) + 15% freight + 15 minutes electrician labor per bulb (@ $100/hour) + Travel + 30% contractor fee = $926. Travel and indirect costs are divided across the lighting recommendations for the building.						

Rank	Location		Existing Condition		Recommendation	
9	Water Treatment Plant		11 Fluorescent Fixtures (4 bulbs each) T-8 4' F32T8 32W Standard Instant Electronic Ballast		Replace the current bulbs with direct wire, energy efficient LED equivalents.	
Installation Cost		$3,394	**Estimated Life of Measure (yrs.)**	22	**Energy Savings ($/yr.)**	$239
Breakeven Cost		$4,198	**Simple Payback (yrs.)**	13	**Energy Savings (MMBTU/yr.)**	0.9 MMBTU
			Savings-to-Investment Ratio	1.2	**Maintenance Savings ($/yr.)**	$29

Auditors Notes: Each fluorescent bulb will be replaced twice per one LED bulb lifetime. Maintenance costs account for the labor and materials to change the fluorescent bulbs over the lifetime of the LED replacement.

Retrofit: Materials (tombstone included) (2*$16.74) + 15% freight + 15 minutes electrician labor (@ $100/hour) + Travel + 30% contractor fee = $3,394. Travel and indirect costs are divided across the lighting recommendations for the building.

Rank	Location		Existing Condition		Recommendation	
10	Bathroom #2		Fluorescent Fixture (2 bulbs each) T-8 4' F32T8 32W Standard Instant Electronic Ballast		Replace the current bulbs with direct wire, energy efficient LED equivalents.	
Installation Cost		$154	**Estimated Life of Measure (yrs.)**	22	**Energy Savings ($/yr.)**	$8
Breakeven Cost		$152	**Simple Payback (yrs.)**	16	**Energy Savings (MMBTU/yr.)**	0.0 MMBTU
			Savings-to-Investment Ratio	1.0	**Maintenance Savings ($/yr.)**	$1

Auditors Notes: Each fluorescent bulb will be replaced twice per one LED bulb lifetime. Maintenance costs account for the labor and materials to change the fluorescent bulbs over the lifetime of the LED replacement.

Retrofit: Materials ($16.74, tombstone included) + 15% freight + 15 minutes electrician labor per bulb (@ $100/hour) + Travel + 30% contractor fee = $154. Travel and indirect costs are divided across the lighting recommendations for the building.

Rank	Location		Existing Condition		Recommendation	
11	Bathroom #1		Fluorescent Fixture (2 bulbs each) T-8 4' F32T8 32W Standard Instant Electronic Ballast		Replace the current bulbs with direct wire, energy efficient LED equivalents.	
Installation Cost		$132	**Estimated Life of Measure (yrs.)**	22	**Energy Savings ($/yr.)**	$3
Breakeven Cost		$66	**Simple Payback (yrs.)**	32	**Energy Savings (MMBTU/yr.)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.5	**Maintenance Savings ($/yr.)**	$1

Auditors Notes: Each fluorescent bulb will be replaced twice per one LED bulb lifetime. Maintenance costs account for the labor and materials to change the fluorescent bulbs over the lifetime of the LED replacement.

Retrofit: Materials ($16.74 per bulb, tombstone included) + 15% freight + 15 minutes electrician labor per bulb (@ $100/hour) + Travel + 30% contractor fee = $132. Travel and indirect costs are divided across the lighting recommendations for the building.

Rank	Location		Existing Condition		Recommendation	
12	Bathroom #3		Fluorescent Fixture (2 bulbs each) T-8 4' F32T8 32W Standard Instant Electronic Ballast		Replace the current bulbs with direct wire, energy efficient LED equivalents.	
Installation Cost		$132	**Estimated Life of Measure (yrs.)**	22	**Energy Savings ($/yr.)**	$3
Breakeven Cost		$66	**Simple Payback (yrs.)**	32	**Energy Savings (MMBTU/yr.)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.5	**Maintenance Savings ($/yr.)**	$1

Auditors Notes: Each fluorescent bulb will be replaced twice per one LED bulb lifetime. Maintenance costs account for the labor and materials to change the fluorescent bulbs over the lifetime of the LED replacement.

Retrofit: Materials ($16.74 per bulb, tombstone included) + 15% freight + 15 minutes electrician labor per bulb (@ $100/hour) + Travel + 30% contractor fee = $132. Travel and indirect costs are divided across the lighting recommendations for the building.

Rank	Location		Existing Condition		Recommendation	
14	Utility Room (watering point access)		Fluorescent Fixture (4 bulbs each) T-8 4' F32T8 32W Standard Instant Electronic Ballast		Replace the current bulbs with direct wire, energy efficient LED equivalents.	
Installation Cost		$265	**Estimated Life of Measure (yrs.)**	22	**Energy Savings ($/yr.)**	$1
Breakeven Cost		$57	**Simple Payback (yrs.)**	74	**Energy Savings (MMBTU/yr.)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.2	**Maintenance Savings ($/yr.)**	$3

Auditors Notes: Each fluorescent bulb will be replaced twice per one LED bulb lifetime. Maintenance costs account for the labor and materials to change the fluorescent bulbs over the lifetime of the LED replacement.

Retrofit: Materials ($16.74, tombstone included) + 15% freight + 15 minutes electrician labor per bulb (@ $100/hour) + Travel + 30% contractor fee = $265. Travel and indirect costs are divided across the lighting recommendations for the building.

Rank	Location		Existing Condition		Recommendation	
15	Dryer Plenum		2 Fluorescent Fixtures (4 bulbs each) T-8 4' F32T8 32W Standard Instant Electronic Ballasts		Replace the current bulbs with direct wire, energy efficient LED equivalents.	
Installation Cost		$530	**Estimated Life of Measure (yrs.)**	22	**Energy Savings ($/yr.)**	$2
Breakeven Cost		$113	**Simple Payback (yrs.)**	74	**Energy Savings (MMBTU/yr.)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.2	**Maintenance Savings ($/yr.)**	$6

Auditors Notes: Each fluorescent bulb will be replaced twice per one LED bulb lifetime. Maintenance costs account for the labor and materials to change the fluorescent bulbs over the lifetime of the LED replacement.

Retrofit: Materials ($16.74, tombstone included) + 15% freight + 15 minutes electrician labor per bulb (@ $100/hour) + Travel + 30% contractor fee = $530. Travel and indirect costs are divided across the lighting recommendations for the building.

Rank	Location		Existing Condition		Recommendation	
16	Outdoor Lighting		High Pressure Sodium 50 Watt Wall Pack		Replace bulb with an energy efficient LED equivalent.	
Installation Cost		$504	**Estimated Life of Measure (yrs.)**	22	**Energy Savings ($/yr.)**	$1
Breakeven Cost		$69	**Simple Payback (yrs.)**	116	**Energy Savings (MMBTU/yr.)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.1	**Maintenance Savings ($/yr.)**	$3
Auditors Notes: If the photo-sensor does not work, replace the fixture with a direct wire, LED-equivalent wall pack. Example: https://www.homedepot.com/p/Novolink-Bronze-1700-Lumen-Outdoor-Day-Light-Integrated-LED-Wall-Pack-Light-WL-20D/300735947 The HPS bulb will need to be replace four times over the lifetime of an LED-equivalent bulb. Local labor was used for the maintenance savings estimate (10 min at $25/hour). Retrofit cost: Materials ($250) + 15% freight + 1 hour electrician (@ $100/hour) + Contractor fee = $504						

4.6 Other Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
1	Upper Heat Trace		1170 Nelson LLT2-JT Electric Heat Trace		Turn the electric heat trace off between batch treatment runs as long as the line continues to drain completely.	
Installation Cost		$8	**Estimated Life of Measure (yrs.)**	10	**Energy Savings ($/yr.)**	$11,668
Breakeven Cost		$98,257	**Simple Payback (yrs.)**	0	**Energy Savings (MMBTU/yr.)**	44.2 MMBTU
			Savings-to-Investment Ratio	12,282.1		
Auditors Notes: Use heat trace only for freeze prevention.						

Rank	Location		Description of Existing		Efficiency Recommendation	
7	Lower Heat Trace		573 Nelson LLT2-JT Electric Heat Trace		Regrade lower transmission line so that it drains completely between batch treatments. Turn the electric heat trace off between batch treatment runs.	
Installation Cost		$50,000	**Estimated Life of Measure (yrs.)**	10	**Energy Savings ($/yr.)**	$11,199
Breakeven Cost		$94,306	**Simple Payback (yrs.)**	4	**Energy Savings (MMBTU/yr.)**	42.5 MMBTU
			Savings-to-Investment Ratio	1.9		
Auditors Notes: Use heat trace only for freeze prevention.						

Rank	Location		Description of Existing		Efficiency Recommendation	
2	HP-4 Water Storage Tank Circulation Pump		Circulates heat through the water storage tank heat add heat exchanger.		Verify that the pump speed setting is on Speed I. The energy savings below reflect changing the pump's speed from Speed II to Speed I.	
Installation Cost		$4	**Estimated Life of Measure (yrs.)**	15	**Energy Savings ($/yr.)**	$138
Breakeven Cost		$1,616	**Simple Payback (yrs.)**	0	**Energy Savings (MMBTU/yr.)**	0.5 MMBTU
			Savings-to-Investment Ratio	387.4		
Auditors Notes: Cost: 10 minutes local labor (@ $25/hr.) = $4.17						

Rank	Location		Description of Existing		Efficiency Recommendation	
3	HP-1 Dryer Plenum Circulation Pump		Circulates heat to the hydronic dryers and the CUH-1 cabinet heater.		Replace HP-1 with a MAGNA3 40-180 F pump. Set to maintain constant temperature in Dryer Plenum loop. Insulate all plumbing.	
Installation Cost		$3,060	**Estimated Life of Measure (yrs.)**	10	**Energy Savings ($/yr.)**	$45,101
Breakeven Cost		$415,123	**Simple Payback (yrs.)**	0	**Energy Savings (MMBTU/yr.)**	608.8 MMBTU
			Savings-to-Investment Ratio	135.7		
Auditors Notes: Retrofit installation cost is split between the cabinet heater and the dryers retrofit based on runtime. Cost includes materials, shipping, labor, travel expenses, and an indirect fee.						

5. ENERGY EFFICIENCY ACTION PLAN

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

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

APPENDICES

Appendix A – Energy Billing Data

1. Electricity Billing Data

Utility: Venetie Village Electric
Reading: Monthly
Units: kWh

Month	Venetie Water Treatment Plant and Washeteria
January 2017	5,598
February 2017	8,019
March 2017	6,121
April 2017	0
May 2017	7,512
June 2017	3,633
July 2017	2,448
August 2017	2,100
September 2017	4,171
October 2017	5,357
November 2017	6,326
December 2017	6,326

Note: The electric reading for the months of November and December 2017 were billed jointly as 12,651 kWh. This reading was split evenly into two readings for modeling purposes.

2. #1 Fuel Oil Billing Data

Utility: Venetie Village Council
Reading: Total amount sold in 2017
Units: Gallons

Month	Venetie Water Treatment Plant and Washeteria
January 2017	500
June 2017	250
October 2017	500

Note: The Venetie Village Council reported the sale of 1,250 gallons to the washeteria in 2017. The total gallons sold was divided over three months based on typical building demand. This quantity seemed very low, because the heat recovery system was not contributing heat to the building at the time of the site visit. Water treatment plant/washeteria buildings of similar size and location typically use about 9,500 gallons of fuel oil per year.

Appendix B – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Venetie Water Treatment Plant and Washeteria	**Auditor Company:** Alaska Native Tribal Health Consortium
Address: Venetie	**Auditor Name:** Kevin Ulrich
City: Venetie	**Auditor Address:** 4500 Diplomacy Drive Anchorage, AK 99508
Client Name: Patrick (PJ) Hanson	
Client Address: P.O. Box 8119 Venetie, AK 9981	**Auditor Phone:** (907) 729-3237
	Auditor FAX: (907) 729-3509
Client Phone: (907) 849-8212	**Auditor Comment:** Assistant auditor: Kelli Whelan, MS Environmental Engineering: (907) 729-3723, kmwhelan@anthc.org
Client FAX:	
Design Data	
Building Area: 1,441 square feet	
Typical Occupancy: 6 people	**Design Indoor Temperature:** 67° F (building average)
Actual City: Venetie	**Design Outdoor Temperature:** -49.4° F
Weather/Fuel City: Venetie	**Heating Degree Days:** 15,409° F-days
Utility Information	
Electric Utility: Venetie Village Electric	**#1 Fuel Oil Provider:** Venetie Village Council
Average Annual Cost/kWh: $0.900/kWh	**Average Annual Cost/gallon:** $9.00/gal.

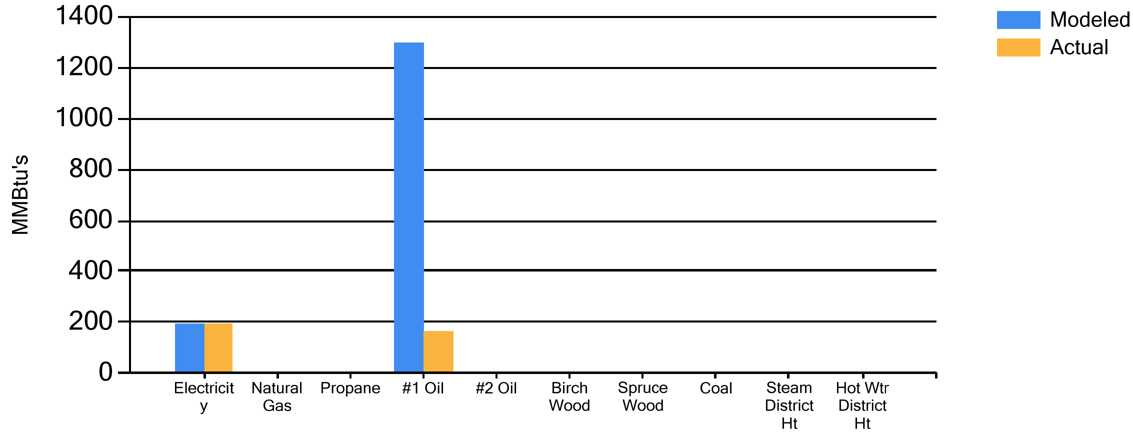
Annual Energy Cost Estimate							
Description	**Space Heating**	**Water Heating**	**Ventilation Fans**	**Clothes Drying**	**Lighting**	**Other Electrical**	**Total Cost**
Existing Building	$7,063	$15,157	$16	$83,699	$2,759	$29,358	**$138,052**
With Proposed Retrofits	$4,885	$4,309	$16	$9,874	$1,949	$6,491	**$27,524**
Savings	$2,178	$10,848	$0	$73,825	$810	$22,867	**$110,528**

Building Benchmarks			
Description	**EUI (kBTU/sq. ft.)**	**EUI/HDD (BTU/sq. ft./HDD)**	**ECI ($/sq. ft.)**
Existing Building	1,385.3	89.90	$130.76
With Proposed Retrofits	641.9	41.66	$26.07
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

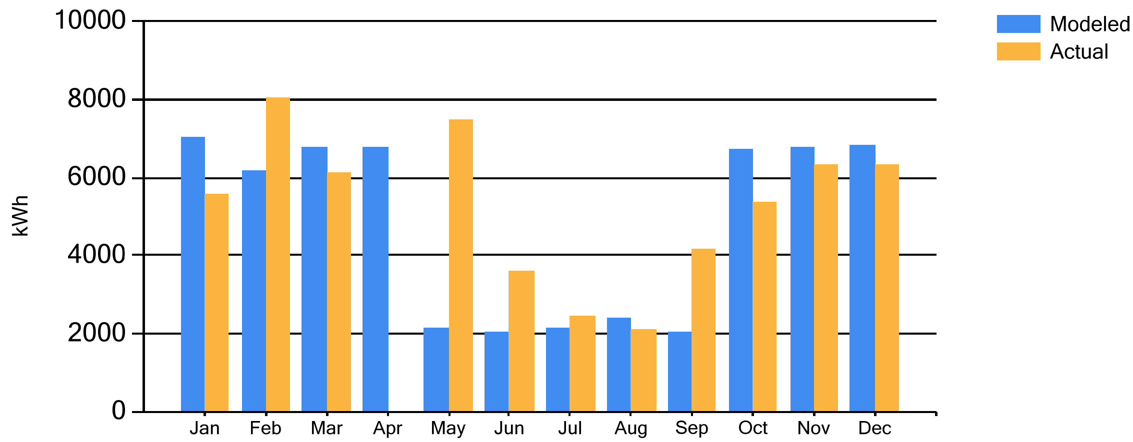
Appendix C – Actual Fuel Use versus Modeled Fuel Use

The orange bars show actual fuel use, and the blue bars are AkWarm's prediction of fuel use.

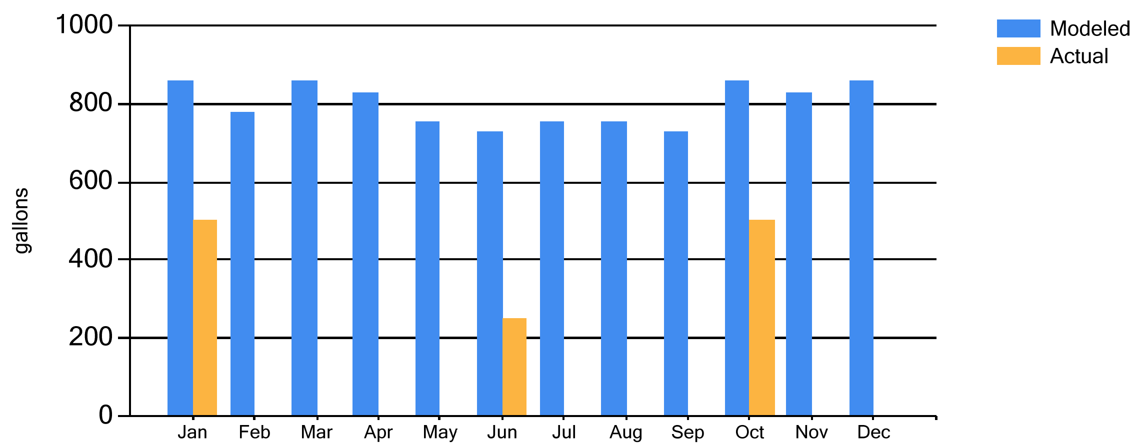
Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use



Note: The Venetie Village Council reported selling 1,250 gallons for fuel oil to the Venetie Washeteria and Water Treatment Plant. This amount is much lower than typical washeteria/water treatment plant consumption.

Appendix D - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	16.7	16.3	16.3	16.6	10.2	10.2	10.2	10.6	10.2	16.3	16.6	16.4
As Proposed	11.0	10.7	10.6	10.8	9.5	9.4	9.4	9.8	9.4	10.5	10.9	10.7

AkWarmCalc Ver 2.8.0.0, Energy Lib 3/26/2018