Comprehensive Energy Audit
For

Yakutat Wastewater Treatment Plant

Prepared For

City and Borough of Yakutat

April 13, 2018

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Table of Contents

PREFACE

This energy audit was conducted using funds provided by the U.S. Department of Energy – Office of Indian Energy Technical Assistance Program. Coordination with the City and Borough of Yakutat has been undertaken to provide maximum accuracy in identifying facilities to audit and coordinating potential follow up retrofit activities.

The Rural Energy Initiative at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for the City and Borough of Yakutat, 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 (previously AmeriCorps VISTA); 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 May of 2017 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 Mayor Ralph Wolfe; City and Borough of Yakutat Manager Jon Erikson, EdD; and Utility Manager Ron Veebe.

1. EXECUTIVE SUMMARY

This report was prepared for the City and Borough of Yakutat. The scope of the audit focused on Yakutat Wastewater Treatment Plant and eight lift stations. The scope of this report is a comprehensive energy study, which included an analysis of building shell, interior and exterior lighting systems, heating and ventilation systems, and electric loads.

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy costs for all of the facilities are $30,405 per year. Electricity represents the largest form of energy use with an estimated cost of $23,247 per year. Fuel oil represents the remaining energy use with an estimated cost of $7,158 per year.

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 Yakutat, the cost of electricity without PCE was approximately $0.389/kWh and the cost with PCE was approximately $0.18/kWh in 2017.

Table 1.1 lists the total usage of electricity in the Yakutat Wastewater Treatment Plant and selected lift stations before and after the proposed retrofits.

Table 1.1: Predicted Annual Fuel Use for the Yakutat Wastewater Treatment Plant

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	59,760 kWh	51,193 kWh
#1 Oil	1,977 gallons	1,963 gallons

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

Table 1.2: Building Benchmarks for the Yakutat Wastewater Treatment Plant

Building Benchmarks			
Description	**EUI (kBTU/Sq. Ft.)**	**EUI/HDD (BTU/Sq. Ft./HDD)**	**ECI ($/Sq. Ft.)**
Existing Building	382.8	42.14	$25.03
With Proposed Retrofits	357.2	39.32	$22.24

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 Yakutat Wastewater Treatment Plant and eight lift stations. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.3: Summary of Recommended Energy Efficiency Measures

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
1	Lighting: YTT Lift Station Interior Lighting	Replace with new energy-efficient, direct-wire LED lighting.	\$3 + \$18 Maint. Savings	\$25	6.40	1.2	10.6
2	Wastewater Treatment Plant: Screening Room Garage Door	Add insulating blanket to garage door.	\$129	\$277	6.30	2.1	745.8
3	Lighting: Village Lift Station Lighting	Replace with new energy-efficient, direct-wire LED lighting.	\$1 + \$6 Maint. Savings	\$9	5.93	1.3	3.5
4	Lighting: Lagoon Lift Station Lighting	Replace with new energy-efficient, direct-wire LED lighting.	\$1 + \$6 Maint. Savings	\$12	4.69	1.8	2.5
5	Lighting: Tongass St. Lift Station Lighting	Replace with new energy-efficient, direct-wire LED lighting.	\$0 + \$2 Maint. Savings	\$12	3.38	4.8	2.0
6	Lagoon Lift Station	Replace insulation on ceiling, walls, floor, replace door, replace electric heater with thermostatically controlled unit.	\$783 + \$138 Maint. Savings	\$3,885	2.79	4.2	3,221.7
7	Wastewater Treatment Plant: Screening Room Controls	Add telemetry and timer controls to screen motors to match lift station pumping.	\$979	\$5,000	1.60	5.1	3,538.5
8	YTT Lift Station	Replace space heater with thermostatically controlled unit.	\$136 + \$258 Maint. Savings	\$3,000	1.56	7.6	558.4
9	Lighting: YTT Lift Station Exterior Lighting	Replace with new energy-efficient, direct-wire LED lighting.	\$3 + \$8 Maint. Savings	\$71	1.16	6.7	10.6

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
10	Jenson Lift Station	Replace insulation on ceiling, walls, floor, replace door, replace electric heater with thermostatically controlled unit.	$366 + $14 Maint. Savings	$4,488	0.99	11.8	1,503.5
11	Tongass St. Lift Station	Replace insulation on ceiling, walls, and floor. Replace door. Replace electric heater with thermostatically controlled unit.	$370 + $200 Maint. Savings	$7,962	0.85	14.0	1,520.6
12	Wastewater Treatment Plant: Screening Room Lighting	Replace with new energy-efficient, direct-wire LED lighting.	$36 + $16 Maint. Savings	$1,328	0.75	25.8	147.8
13	Wastewater Treatment Plant: Heating Systems	Wastewater plant boiler tune up. Install Magna pump for boiler circ. pump. Install Belimo or similar actuators on unit heater and air handler pre-heat glycol supply lines to reduce idle losses. Replace Fish Plant Lift Station heater with thermostat-controlled electric heater. Install programmable thermostat to regulate interior temperature in Lagoon Lift Station Replace Tongass St. Lift Station with thermostat-controlled electric heater. Replace Village Lift Station Electric Heat with thermostat-controlled electric heater. Install programmable thermostats in both YTT Lift Station pump and control rooms.	$229	$6,140	0.63	26.8	1,269.8

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
14	Wastewater Treatment Plant: Chemical Injection Room Lighting	Replace with new energy-efficient, direct-wire LED lighting.	$4 + $2 Maint. Savings	$177	0.61	30.6	13.4
15	Wastewater Treatment Plant: Screening Room Exterior Door	Replace existing door with a pre-hung, U-0.16 insulated metal door.	$10	$467	0.52	45.2	59.7
16	Fish Plant Lift Station	Insulation to ceiling, walls, replace door, floor, replace heater with thermostatically controlled unit.	$251 + $4 Maint. Savings	$6,254	0.48	24.6	1,030.9
17	Village Lift Station	Replace insulation on ceiling, walls, floor, replace door, replace electric heater with thermostatically controlled unit.	$73 + $54 Maint. Savings	$3,423	0.44	26.9	300.7
18	Wastewater Treatment Plant: Chemical Injection Room Exterior Door	Replace existing door with a pre-hung, U-0.16 insulated metal door.	$10	$1,410	0.17	137.9	58.8
19	Wastewater Treatment Plant: Air Sealing	Replace weather stripping around all exterior doors to reduce heat loss.	$0	$300	0.01	839.3	2.1

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
20	Wastewater Treatment Plant: Ventilation Systems	Repair or replace PACE air handler. Bring air handler pre-heat system back online. Repair or replace exhaust system in Chemical Add Room to reduce wall and door corrosion. Troubleshoot secondary exhaust fan in Screening Room. Manually regulate fans so that both units are used equally.	$2	$31,100	0.00	15,281.4	8.2
TOTAL (all EEMs)			**$3,384 + $726 Maint. Savings**	**$75,330**	**0.62**	**18.3**	**14,009.1**

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.

Once in place, the energy efficiency recommendations displayed in Table 1.3 would save $3,384 per year with a simple payback period of 18.3 years. The construction cost estimate for all energy efficiency recommendations is $75,330.

Some of the energy efficiency measures above will not be cost effective, but may improve plant operations. The cost-effective and not cost-effective measures are shown in Table 4.1. With just the cost effective measures in place, the annual utility cost can be reduced by $2,034 per year, or 6.7% of the buildings' total energy costs. These measures are estimated to cost $12,291, for an overall simple payback period of 5.0 years.

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

Table 1.4: Detailed Breakdown of Energy Costs in the Building

Annual Energy Cost Estimate							
Description	Space Heating	Water Heating	Ventilation Fans	Lighting	Refrigeration	Other Electrical	Total Cost
Existing Building	$11,012	$5	$2,547	$249	$86	$16,507	**$30,405**
With Proposed Retrofits	$8,949	$5	$2,545	$202	$86	$15,235	**$27,021**
Savings	$2,062	$0	$2	$48	$0	$1,272	**$3,384**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Yakutat Wastewater Treatment Plant and eight lift stations within the community. 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 Yakutat Wastewater Treatment Plant and eight lift stations 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 wastewater treatment building and the lift stations.

Yakutat Wastewater Treatment Plant is made up of the following activity areas:

1. Screening Room: 797 square feet
2. Chemical Injection Room: 148 square feet
3. Bathroom: 60 square feet
4. Office: 210 square feet

The following lift stations are also included in the model:

- Fish Plant Lift Station (Bayview Dr. Lift Station): 100 square feet
- High School Lift Station (Forest Hwy. Lift Station): 26 square feet
- Jenson Lift Station (Lift Station by JJJR): 86 square feet
- Lagoon Lift Station: 50 square feet
- Tongass St. Lift Station (ASHA Lift Station): 96 square feet
- Village Lift Station: 56 square feet
- YTT Lift Station (THRA Lift Station): 85 square feet

It should be noted that there is a system reconfiguration project underway that would combine the High School Lift Station and a lift station located within the elementary school nearby. The Elementary School Lift Station was not included in this report, because the electrical demand of the lift station would have been difficult to distinguish from the school's electrical loads. By eliminating the Elementary School Lift Station, the City and Borough of Yakutat should see a reduction in maintenance and electrical costs, as well as a health and safety benefit to the school's occupants. The reconfiguration project is in the design phase as of April 2018, and is being managed by the Department of Environmental Health and Engineering at ANTHC.

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

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

2.3. Method of Analysis

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

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

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

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

Savings includes the total discounted dollar savings considered over the life of the improvement. When these savings are added up, changes in future fuel prices as projected by the 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 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. YAKUTAT WASTEWATER TREATMENT PLANT

3.1. Building Description

The 1,215 square foot Yakutat Wastewater Treatment Plant was constructed in 2004 as the primary location for all wastewater collection, treatment, and disposal services for the community. The building is staffed for an average of one hour per day throughout the week. The wastewater system also includes 13 lift stations that collect the wastewater from the individual homes and buildings throughout the city and pump the wastewater to the treatment plant. This report covers eight of the 13 lift stations in Yakutat. The remaining lift stations could not be visited or little could be done to improve the lift station structure.

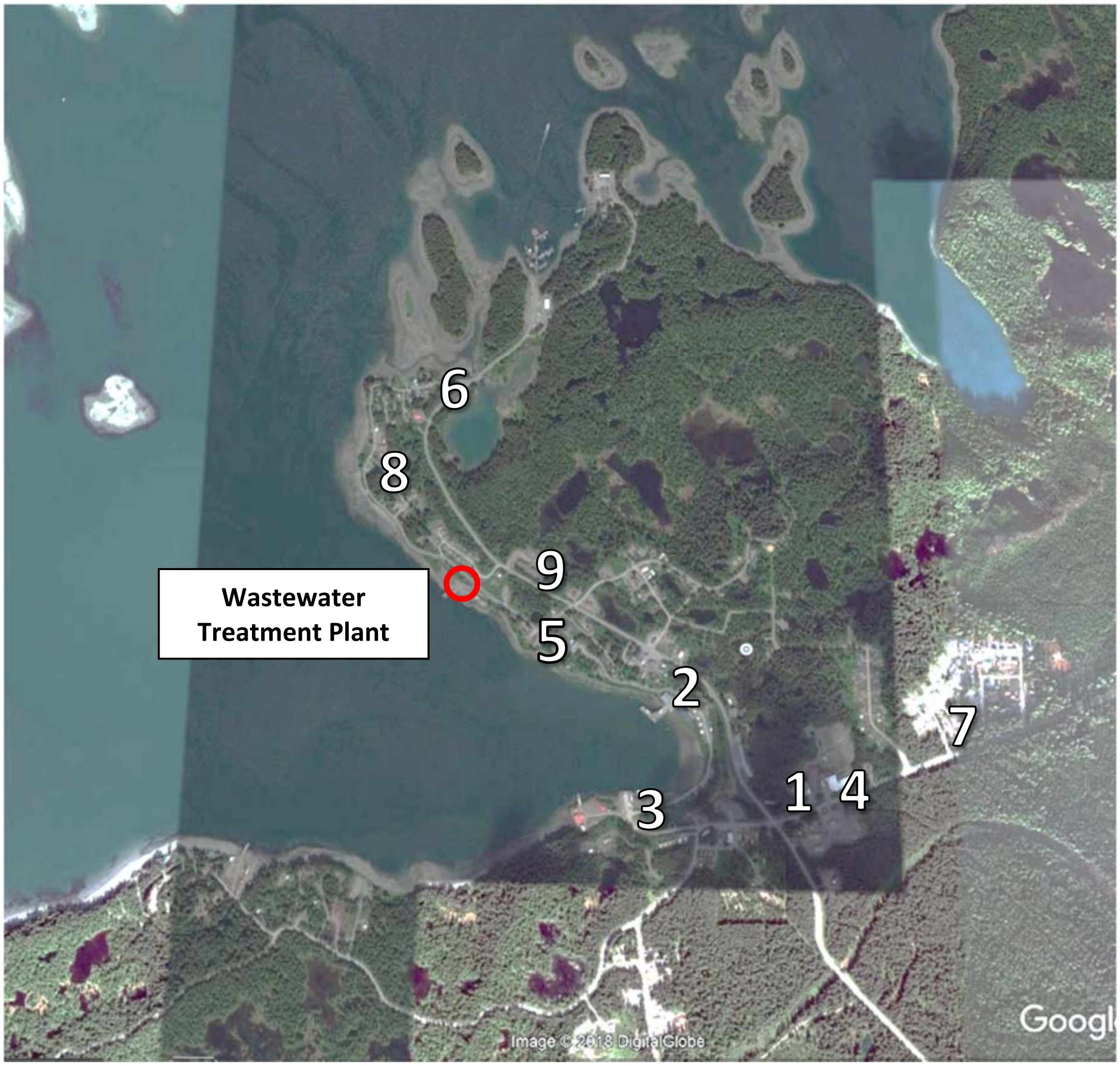


Figure 1: An aerial view of the Yakutat Wastewater System Facilities.

Figure 1 above shows an aerial view of Yakutat with the primary features of the wastewater treatment system and all of the lift stations covered in this report. The lift station labels are as follows:

1. Elementary School Lift Station (not included in the model)
2. Fish Plant Lift Station (Bayview Dr. Lift Station)
3. Fuel Field Lift Station (not included in the model)
4. High School Lift Station (Forest Hwy. Lift Station)
5. Jenson Lift Station (Lift Station by JJJR)
6. Lagoon Lift Station
7. Tongass St. Lift Station
8. Village Lift Station
9. YTT Lift Station (THRA Lift Station)

Wastewater is collected in the lift stations and pumped to the wastewater treatment plant. Once the wastewater enters the facility, it is processed through rotary screens before being treated with chlorine and sodium bisulfite. After the treatment, the treated wastewater is disposed of into Monti Bay.

Figures 2 – 9 show each of the lift stations reviewed over the course of the energy audit site visit.

Figure 2: Fish Plant Lift Station.

Figure 3: Fuel Field Lift Station.

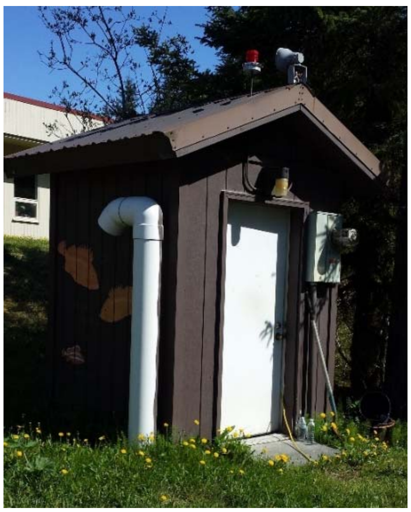


Figure 4: High School Lift Station.

Figure 5: Jenson Lift Station.

Figure 6: Lagoon Lift Station.

Figure 7: Tongass St. Lift Station.

Figure 8: Village Lift Station.

Figure 9: YTT (THRA) Lift Station.

Description of Building Shell

The wastewater treatment plant exterior walls have 2x8 metal framed construction with 24” on-center studs and approximately 1” of rigid foam insulation. The exterior walls are 15.5 feet high from the top of the foundation.

The wastewater treatment plant has a metal framed roof with an I-Beam structure and 4” of rigid foam insulation. The ceiling is 15.5 feet above the foundation at the walls and 16.8 feet above the foundation at the apex.

The wastewater treatment plant is constructed on grade with a concrete pad foundation. There is no insulation present in the foundation.

There are no windows in the wastewater treatment plant. There are four single-door entrances in the plant. Two of the doors are insulated metal with no windows and two of the entrances are insulated metal with quarter-lite windows. There is also a large garage door in the screening room that is approximately 10 feet tall and 12.5 feet wide.

Figure 10: Screening Room garage door.

Description of Heating Plants

The heating plants used in the building are:

Weil McLain Gold

Nameplate Information:	Weil McLain Gold Oil Boiler, Model No. A/B-WGO-7. Motor: Marathon Electric Model 4PH48s34S392B P, 1/2 HP. Pump: Grundfos UMC P/N: 96406955. Model: E. 0.375HP, 280W.
Fuel Type:	#1 Oil
Input Rating:	249,000 BTU/hr.
Steady State Efficiency:	85.1 %
Idle Loss:	1.5 %
Heat Distribution Type:	Water
Boiler Operation:	Oct - May
Notes:	Took off 2% efficiency for system wear and age.

Figure 11: Weil McLain boiler.

Toyotomi Water Heater

Nameplate Information:	Toyotomi Water Heater Model OM-148
Fuel Type:	#1 Oil
Input Rating:	148,000 BTU/hr.
Steady State Efficiency:	87 %
Heat Distribution Type:	Water
Boiler Operation:	Oct - May

Figure 12: Toyotomi OM-148 hot water heater.

The heating plants used in the lift stations are:

Fish Plant Lift Station Electric Heater (unheated)

Fuel Type:	Electricity
Input Rating:	1500 W
Steady State Efficiency:	100 %
Heat Distribution Type:	Air
Notes:	Lift station is currently unheated. The electric heater inside of the pump housing is broken.

High School Lift Station Electric Heater

Nameplate Information:	Electric Heater Model No. FPQ2-40S, HF3316TS.
Fuel Type:	Electricity
Input Rating:	3000 W
Steady State Efficiency:	100 %
Heat Distribution Type:	Air
Notes:	Set to "auto" at low/med temperature.

Figure 13: High School Lift Station electric heater.

Jenson Lift Station Electric Heater

Nameplate Information:	Building is currently unheated, but should be.
Fuel Type:	Electricity
Input Rating:	1500 W (assumed space heater load)
Steady State Efficiency:	100 %
Heat Distribution Type:	Air
Notes:	Assumed a 1.5 kW space heater for space, but this is likely undersized (especially without insulation).

Lagoon Lift Station Electric Unit Heater

Nameplate Information:	TPI Corporation Electric Air Heater. Model FPQ2-40S, HF3316TS-RP.
Fuel Type:	Electricity
Input Rating:	4000 W or 3000 W (depending on input voltage)
Steady State Efficiency:	100 %
Heat Distribution Type:	Air
Notes:	Set to high, fan on auto

Figure 14: Lagoon Lift Station electric heater.

Tongass St. Lift Station Electric Unit Heater

Fuel Type:	Electricity
Input Rating:	1000 W
Steady State Efficiency:	100 %
Heat Distribution Type:	Air
Notes:	Controls room is unheated. Unit heater may be in wet well.

Village Lift Station Space Heater

Nameplate Information:	"W" Model LH879G
Fuel Type:	Electricity
Input Rating:	1500 W
Steady State Efficiency:	100 %
Heat Distribution Type:	Air
Notes:	Electric space heater. Heater was unplugged during audit.

Figure 15: Village Lift Station space heater.

YTT Lift Station Pump Room Electric Heater

Nameplate Information:	Not labeled
Fuel Type:	Electricity
Input Rating:	3600 W
Steady State Efficiency:	100 %
Heat Distribution Type:	Air
Notes:	Electric baseboard heater approx. 4 ft. long. Thermostat does not work.

YTT Lift Station Control Room Electric Heater

Nameplate Information:	King Electric Manufacturing Company PAWS (PAW2022)
Fuel Type:	Electricity
Input Rating:	1000 W
Steady State Efficiency:	100 %
Heat Distribution Type:	Air
Notes:	Controlled manually by dial thermostat on wall. Wall mounted heater.

Figure 16: YTT Lift Station Control Room electric heater.

Space Heating Distribution Systems

Space heating in the wastewater treatment plant is distributed through three unit heaters, each of which is rated to produce approximately 40,000 BTUs per hour of heat. The unit heaters are heated by a fuel oil boiler located in the office. Glycol is pumped to the unit heaters by a Grundfos pump.

Figure 17: Wastewater Treatment Plant unit heaters.

Domestic Hot Water System

There is a Toyotomi OM-148 hot water heater that supplies hot water to a washing machine, shower, and sink in the plant. These are used occasionally by operations staff.

Description of Building Ventilation System

The Yakutat Wastewater Treatment Plant ventilation system consists of three exhaust fans and one supply air-handler unit. The air-handler unit in the office and one of the exhaust fans in the screening room appeared to be offline during the on-site visit. Detailed information on each exhaust fan and the air handler is listed in Table 3.1 below. The total annual consumption is approximately 6,541 kWh annually and constitutes approximately 10.9% of the current electrical consumption.

Table 3.1: Summary of Ventilation Fans

Label	Location	Rating (Watts)	CFM	Annual Energy Consumption (kWh)
PACE Air Handler (not in operation)	Office	761	2,470	0
Loren Cook Exhaust Fans (2)	Screening Room	746	2,581	6,539
Bathroom Exhaust Fan	Bathroom	23	70	2
			Total Energy Consumption	**6,541**

Figure 18: Exhaust Fan above grit screens (left). The PACE Air Handling unit and previous heat-add pipe (right).

Lighting

Lighting in the water treatment plant consumes approximately 642 kWh annually and constitutes approximately 1% of the system's current electrical consumption.

Table 3.2: Breakdown of Lighting by Location and Bulb Type

Location	Bulb Type	Fixtures	Bulbs per Fixture	Annual Usage (kWh)
Screening Room	Fluorescent T8 4ft. 32 Watt	15	2	315
Chemical Add Room	Fluorescent T8 4ft. 32 Watt	2	2	42
Bathroom	LED 4ft. Tube 17 Watt	1	2	3
Office	LED 4ft. Tube 17 Watt	4	3	251
Fish Plant Lift Station	LED A Lamp Equivalent 12 Watt	1	1	1
High School Lift Station	CFL Plug-in Quad Tube. 26 Watt	2	1	1
Jenson Lift Station	Incandescent A Lamp 100 Watt	2	1	5
Lagoon Lift Station	Incandescent A Lamp 75 Watt	1	1	2
Tongass St. Lift Station	Incandescent A Lamp 60 Watt	1	1	2
Village Lift Station	Incandescent A Lamp 100 Watt	1	1	3
YTT Lift Station Interior	Incandescent A Lamp 100 Watt	3	1	8
YTT Lift Station Exterior	HPS 150 Watt	2	1	9
			Total Energy Consumption	**642**

Major Equipment

Table 3.3 contains the details on each of the major electricity consuming mechanical components found in the wastewater treatment plant. Major equipment consumes approximately 8,952 kWh annually constituting about 15% of the wastewater system's current electrical consumption.

Table 3.3: Major Equipment List

Major Equipment	Purpose	Rating	Operating Schedule	Annual Energy Consumption (kWh)
Clothes Washer	Washes clothing and garments that have been used during plant operations.	2,400 Watts	~ 30 minutes per day	63
Rotary Screens (2)	Filter particulates and contaminates from wastewater prior to treatment.	0.5 HP each	Continuous	6,539
Sodium Bisulfite Injection Pump	Injects Sodium Bisulfite into the wastewater during the treatment process.	120 Watts	Continuous	1,052
Chlorine Injection Pump	Injects chlorine into the wastewater during the treatment process.	115 Watts	Continuous	1,008
Flow Meter	Monitors water flow through the treatment process.	8	Continuous	70
Mini-fridge	Contains food and beverages for operations staff	25	Continuous	220
			Total Energy Consumption	**8,952**

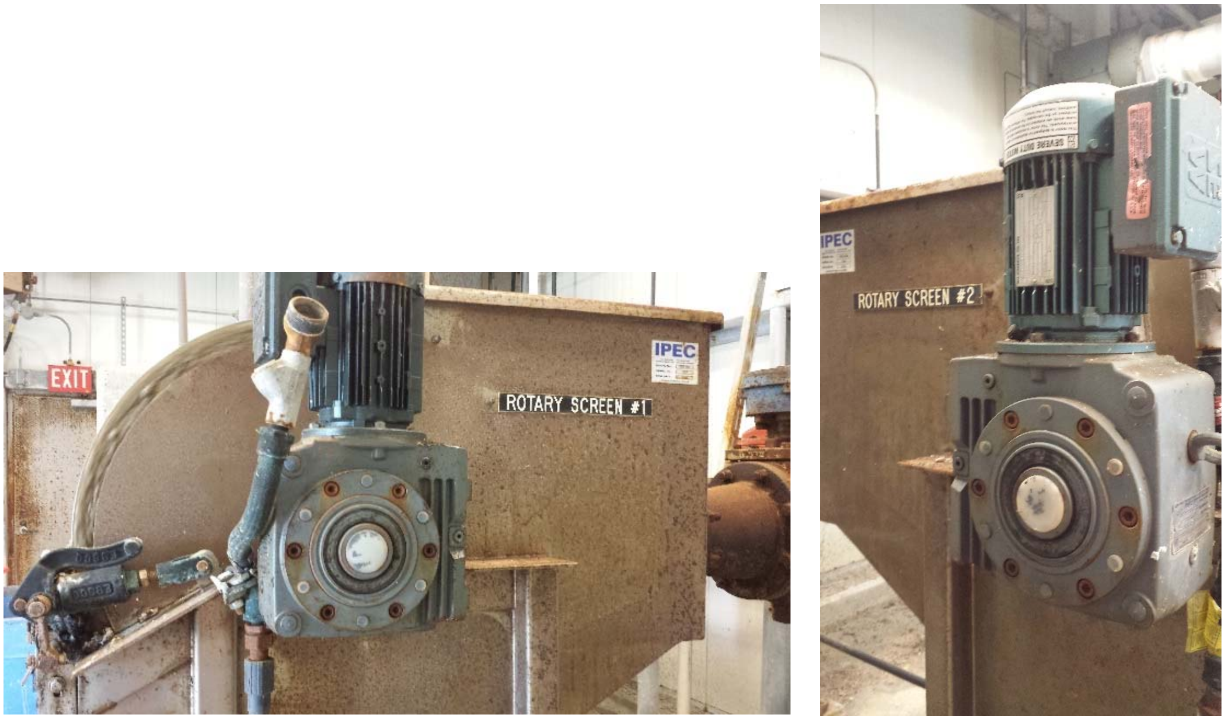


Figure 19: Rotary grit and solids screens in the wastewater treatment plant.

Figure 20: Chlorine disinfection pumps.

Figure 21: Mini-fridge.

Table 3.4 contains the details on each of the lift station pumps. Major equipment consumes approximately 33,641 kWh annually constituting about 56.3% of the building's current electrical consumption.

Table 3.4: Lift Station Pump List

Major Equipment	Rating	Operating Schedule	Annual Energy Consumption (kWh)
Fish Plant Lift Station Pump 1	2.5 HP	Not Used	0
Fish Plant Lift Station Pump 2	4 HP	~ 2 hours per day	2,490
High School Lift Station Pump 1	15 HP	~ 0.5 – 1 hour per day	3,491
High School Lift Station Pump 2	15 HP	~ 0.5 – 1 hour per day	3,809
Jenson Lift Station Pump 1	2.5 HP	Not Used	0
Jenson Lift Station Pump 2	4 HP	~ 6 hour per day	6,535
Lagoon Lift Station Pump 1	15 HP	~ 0.5 – 1 hour per day	2,768
Lagoon Lift Station Pump 2	15 HP	Not Used	0
Tongass St. Lift Station Pump 1	7.5 HP	~ 30 minutes per day	1,167
Tongass St. Lift Station Pump 2	7.5 HP	~ 30 minutes per day	876
Village Lift Station	15 HP	~2-3 hours per day	8,419
YTT Lift Station Pump 1	10 HP	Not Used	0
YTT Lift Station Pump 2	10 HP	~ 1.5 hours per day	4,086
		Total Energy Consumption	**33,641**

Figure 22: Fish Plant Lift Station pumps.

Figure 23: YTT Lift Station pump motor.

Figure 24: Village Lift Station pumps.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

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

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

The Alaska Village Electric Cooperative (AVEC) provides electricity to the residents of Yakutat as well as to all public and commercial facilities. During the site visit, the power plant was owned and operated by Yakutat Power, Inc. This development took place between the energy audit site visit and the development of this report.

The average cost for each type of fuel used in this building is shown below in Table 3.5. This figure includes all surcharges, subsidies, and utility customer charges:

Table 3.5: Energy Cost Rates for Each Fuel Type

Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.389/kWh
#1 Oil	$ 3.62/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City and Borough of Yakutat pays approximately $30,378 annually for electricity and other fuel costs for the Yakutat Wastewater Treatment Plant and eight of the community's lift stations.

Figure 25 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.

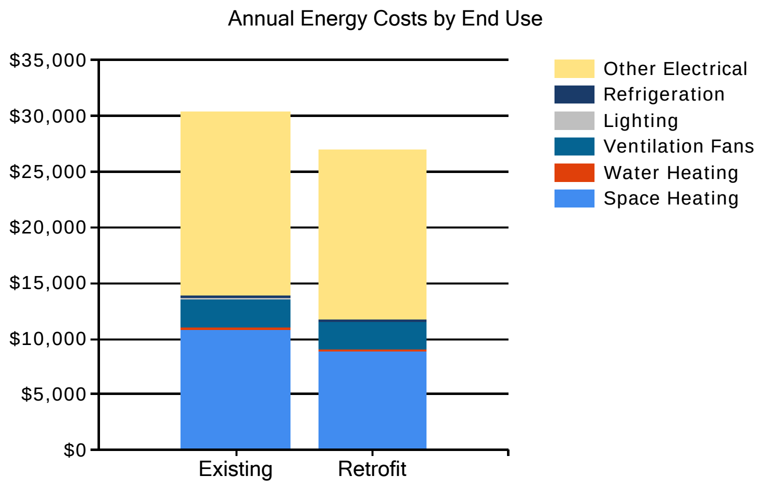


Figure 25: Annual energy costs by end use.

Figure 26 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.

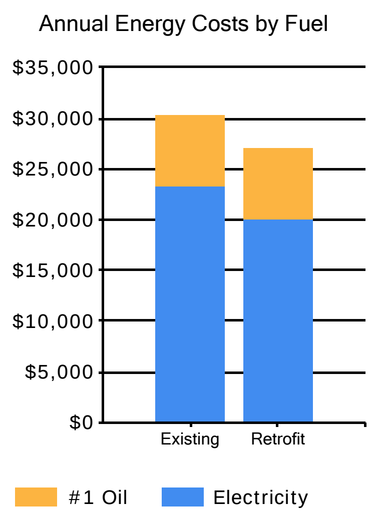


Figure 26: Annual energy costs by fuel type.

Figure 27 below addresses only space heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the walls and doors. For each component, the space heating cost for the existing building is shown (blue bar) and the space heating cost assuming all retrofits are implemented (yellow bar) are shown.

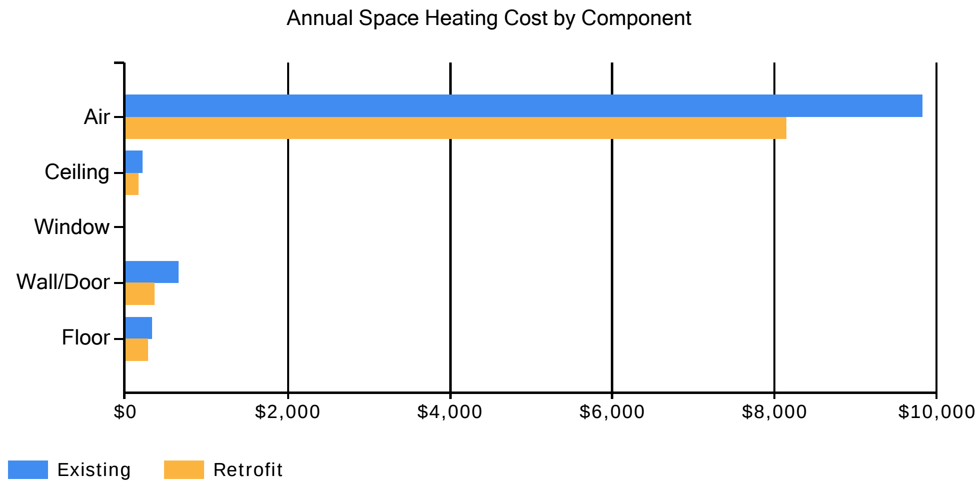


Figure 27: Annual space heating costs.

Tables 3.6 and 3.7 below show AkWarm's estimate of the monthly fuel use for each of the fuels used in the building. For each fuel, the fuel use is broken down across the energy end uses.

Table 3.6: Estimated Electrical Consumption by Category

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	2,214	1,788	1,577	603	28	1	0	0	8	237	1,479	1,980
Ventilation Fans	556	506	556	538	556	538	556	556	538	556	538	556
Lighting	54	50	54	53	54	53	54	54	53	54	53	54
Refrigeration	19	17	19	18	19	18	19	19	18	19	18	19
Other Electrical	4,757	4,335	4,757	4,285	2,900	2,806	2,900	2,900	2,806	2,677	3,597	3,717

Table 3.7: Estimated Fuel Oil Consumption by Category

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	368	306	290	171	64	3	0	0	22	126	278	341

3.2.2 Energy Use Index (EUI)

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

Source use differs from site usage when comparing a building's energy consumption with the national average. Site energy use is the energy consumed by the building at the building site only. Source energy use includes the site energy use as well as all of the losses to create and distribute the energy to the building. Source energy represents the total amount of raw fuel that is required to operate the building. It incorporates all transmission, delivery, and production losses, which allows for a complete assessment of energy efficiency in a building. The type of utility purchased has a substantial impact on the source energy use of a building. The U.S. Environment Protection Agency (U.S. 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 3.8 for details):

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

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

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

Table 3.8: Building EUI Calculations for the Yakutat Wastewater Treatment Plant

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	59,760 kWh	203,962	3.340	681,234
#1 Oil	1,977 gallons	261,028	1.010	263,638
Total		**464,990**		**944,872**
BUILDING AREA		1,215	Square Feet	
BUILDING SITE EUI		383	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		778	**kBTU/Ft²/Yr**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

Table 3.9: Building Benchmarks for the Yakutat Wastewater Treatment Plant

Building Benchmarks			
Description	**EUI (kBTU/Sq. Ft.)**	**EUI/HDD (BTU/Sq. Ft./HDD)**	**ECI ($/Sq. Ft.)**
Existing Building	382.8	42.14	$25.03
With Proposed Retrofits	357.2	39.32	$22.24
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 systems and central plant are modeled as well, accounting for the outside air ventilation required by the building.

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 Yakutat Wastewater Treatment Plant and selected lift stations were modeled using AkWarm© energy use software to establish a baseline space heating energy usage. Climate data from Yakutat 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 Yakutat. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the gas and electric profiles generated will not likely compare perfectly with actual energy billing information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.

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.

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

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

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

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

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR[1]**	**Simple Payback (Years)[2]**	**CO_2 Savings**
1	Lighting: YTT Lift Station Interior Lighting	Replace with new energy-efficient, direct-wire LED lighting.	$3 + $18 Maint. Savings	$25	6.40	1.2	10.6
2	Wastewater Treatment Plant: Screening Room Garage Door	Add insulating blanket to garage door.	$129	$277	6.30	2.1	745.8
3	Lighting: Village Lift Station Lighting	Replace with new energy-efficient, direct-wire LED lighting.	$1 + $6 Maint. Savings	$9	5.93	1.3	3.5

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
4	Lighting: Lagoon Lift Station Lighting	Replace with new energy-efficient, direct-wire LED lighting.	$1 + $6 Maint. Savings	$12	4.69	1.8	2.5
5	Lighting: Tongass St. Lift Station Lighting	Replace with new energy-efficient, direct-wire LED lighting.	$0 + $2 Maint. Savings	$12	3.38	4.8	2.0
6	Lagoon Lift Station	Replace insulation on ceiling, walls, floor, replace door, replace electric heater with thermostatically controlled unit.	$783 + $138 Maint. Savings	$3,885	2.79	4.2	3,221.7
7	Wastewater Treatment Plant: Screening Room Controls	Add telemetry and timer controls to screen motors to match lift station pumping.	$979	$5,000	1.60	5.1	3,538.5
8	YTT Lift Station	Replace space heater with thermostatically controlled unit.	$136 + $258 Maint. Savings	$3,000	1.56	7.6	558.4
9	Lighting: YTT Lift Station Exterior Lighting	Replace with new energy-efficient, direct-wire LED lighting.	$3 + $8 Maint. Savings	$71	1.16	6.7	10.6
TOTAL (cost-effective measures)			**$2,034 + $436 Maint. Savings**	**$12,291**	**2.09**	**5.0**	**8,093.5**
10	Jenson Lift Station	Replace insulation on ceiling, walls, floor, replace door, replace electric heater with thermostatically controlled unit.	$366 + $14 Maint. Savings	$4,488	0.99	11.8	1,503.5
11	Tongass St. Lift Station	Replace insulation on ceiling, walls, and floor. Replace door. Replace electric heater with thermostatically controlled unit.	$370 + $200 Maint. Savings	$7,962	0.85	14.0	1,520.6
12	Wastewater Treatment Plant: Screening Room Lighting	Replace with new energy-efficient, direct-wire LED lighting.	$36 + $16 Maint. Savings	$1,328	0.75	25.8	147.8

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
13	Wastewater Treatment Plant: Heating Systems	Wastewater plant oiler tune up. Install Magna pump for boiler circ. pump. Install Belimo or similar actuators on unit heater and air handler pre-heat glycol supply lines to reduce idle losses. Replace Fish Plant Lift Station heater with thermostat-controlled electric heater. Install programmable thermostat to regulate interior temperature in Lagoon Lift Station Replace Tongass St. Lift Station with thermostat-controlled electric heater. Replace Village Lift Station Electric Heat with thermostat-controlled electric heater. Install programmable thermostats in both YTT Lift Station pump and control rooms.	$229	$6,140	0.63	26.8	1,269.8
14	Wastewater Treatment Plant: Chemical Injection Room Lighting	Replace with new energy-efficient, direct-wire LED lighting.	$4 + $2 Maint. Savings	$177	0.61	30.6	13.4
15	Wastewater Treatment Plant: Screening Room Exterior Door	Replace existing door with a pre-hung, U-0.16 insulated metal door.	$10	$467	0.52	45.2	59.7
16	Fish Plant Lift Station	Insulation to ceiling, walls, replace door, floor, replace heater with thermostatically controlled unit.	$251 + $4 Maint. Savings	$6,254	0.48	24.6	1,030.9

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**
17	Village Lift Station	Replace insulation on ceiling, walls, floor, replace door, replace electric heater with thermostatically controlled unit.	$73 + $54 Maint. Savings	$3,423	0.44	26.9	300.7
18	Wastewater Treatment Plant: Chemical Injection Room Exterior Door	Replace existing door with a pre-hung, U-0.16 insulated metal door.	$10	$1,410	0.17	137.9	58.8
19	Wastewater Treatment Plant: Air Sealing	Replace weather stripping around all exterior doors to reduce heat loss.	$0	$300	0.01	839.3	2.1
20	Wastewater Treatment Plant: Ventilation Systems	Repair or replace PACE air handler. Bring air handler pre-heat system back online. Repair or replace exhaust system in Chemical Add Room to reduce wall and door corrosion. Troubleshoot secondary exhaust fan in Screening Room. Manually regulate fans so that both units are used equally.	$2	$31,100	0.00	15,281.4	8.2
TOTAL (all EEMs)			**$3,384 + $726 Maint. Savings**	**$75,330**	**0.62**	**18.3**	**14,009.1**

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. Lighting-efficiency improvements are anticipated to slightly increase heating requirements. Heating penalties were included in the lighting project analysis.

4.3 Building Shell Measures

4.3.1 Door Measures

Rank	Location	Size/Type, Condition	Recommendation
2	Wastewater Treatment Plant: Screening Room Garage Door	Door Type: Hangar, 72'x12', 4 in., uninsulated Insulating Blanket: None Modeled R-Value: 0.9	Add insulating blanket to garage door.

Installation Cost	$277	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$129
Breakeven Cost	$1,744	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	4.6 MMBTU
		Savings-to-Investment Ratio	6.3		

Auditors Notes: Adding insulation to the door will reduce heat loss and air penetration in the building.

Rank	Location	Size/Type, Condition	Recommendation
15	Wastewater Treatment Plant: Screening Room Door	Door Type: Entrance, Metal, EPS core, metal edge, quarter lite Modeled R-Value: 2	Remove existing door and install a pre-hung U-0.16 insulated door.

Installation Cost	$467	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$10
Breakeven Cost	$244	**Simple Payback (yrs)**	45	**Energy Savings (MMBTU/yr)**	0.4 MMBTU
		Savings-to-Investment Ratio	0.5		

Auditors Notes:

Rank	Location	Size/Type, Condition	Recommendation
18	Wastewater Treatment Plant: Chemical Injection Room Exterior Door	Door Type: Entrance, Metal, EPS core, metal edge, quarter lite Modeled R-Value: 2	Remove existing door and install a pre-hung U-0.16 insulated door.

Installation Cost	$1,401	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$10
Breakeven Cost	$240	**Simple Payback (yrs)**	138	**Energy Savings (MMBTU/yr)**	0.4 MMBTU
		Savings-to-Investment Ratio	0.2		

Auditors Notes:

4.3.2 Air Sealing Measures

Rank	Location		Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
19	Wastewater Treatment Plant		Air Tightness estimated as: 1673 cfm at 50 Pascals		Perform air sealing to reduce air leakage by 5%.	
Installation Cost	$300	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$0	
Breakeven Cost	$3	**Simple Payback (yrs)**	869	**Energy Savings (MMBTU/yr)**	0.0 MMBTU	
		Savings-to-Investment Ratio	0.0			
Auditors Notes: Replace existing weather stripping around exterior doors.						

4.4 Mechanical Equipment Measures

4.4.1 Heating/ Domestic Hot Water Measure

Rank	Recommendation
13	Wastewater plant oiler tune up. Install Magna pump for boiler circulation pump. Install Belimo or similar actuators for unit heater and air handler pre-heat idle loss regulation. Replace Fish Plant Lift Station heater with thermostat-controlled electric heater. Install programmable thermostat to regulate interior temperature in Lagoon Lift Station. Replace Tongass St. Lift Station with thermostat-controlled electric heater. Replace Village Lift Station electric heater with thermostat-controlled electric heater. Install programmable thermostats in both YTT Lift Station pump and control rooms.

Installation Cost	$6,140	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$226
Breakeven Cost	$3,880	**Simple Payback (yrs)**	27	**Energy Savings (MMBTU/yr)**	7.3 MMBTU
		Savings-to-Investment Ratio	0.6		

Auditors Notes:

Boiler tune up. Cost includes= 4 hours maintenance specialist labor ($100/hr.) and 4 hours local labor ($25/hr) + materials ($400) + 15% freight + 1/3 round trip airfare, 2 days per diem ($60 per day), and lodging (1 night = $150) + 27% indirect rate = $1,570

Install Magna pump for boiler circ. pump. Cost includes= 4 hours maintenance specialist labor ($100/hr) and 4 hours local labor ($25/hr) + materials ($300) + 15% freight + 1/3 round trip airfare, 2 days per diem, and lodging (1 night = $150) + 27% indirect rate = $1,420

Install Belimo or similar actuators on unit heater lines to reduce heat loss through unit heaters and air handler when UH fans/AHU are off. Cost includes= $450 materials + 15% freight + 3 hours maintenance specialist labor (@ $100/hour) + 1/3 round trip airfare, 2 days per diem, and lodging (1 night = $150) + 27% indirect rate = $1,570

Replace Fish Plant Lift Station heater with thermostat-controlled electric heater. Included in retrofit cost: cost of unit + 1.5 hour electrician labor (@ $100/hr) + 15% freight. $378

Install programmable thermostat to regulate interior temperature in Lagoon Lift Station: Retrofit cost= unit cost + labor (1 hr local labor at $25/hr)+ 15% freight. $378

Replace Tongass St. Lift Station with thermostat-controlled electric heater. Included in retrofit cost: cost of unit + 1.5 hour electrician labor (@ $100/hr) + 15% freight. $378

Replace Village Lift Station Electric Heat with thermostat-controlled electric heater. Included in retrofit cost: cost of unit + 1.5 hour electrician labor (@ $100/hr) + 15% freight. $61

Install programmable thermostats in both YTT Lift Station pump and control rooms. Retrofit cost includes: unit cost + 15% freight + 3 hours local labor (@ $25/hr). $378

4.4.2 Ventilation System Measures

Rank	Description	Recommendation
20	Wastewater Treatment Plant: Ventilation Systems	Repair or replace PACE air handler. Bring air handler pre-heat system back online. Repair or replace exhaust system in Chemical Add Room to reduce wall and door corrosion. Troubleshoot secondary exhaust fan in Screening Room. Manually regulate fans so that both units are used equally.

Installation Cost	$31,100	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$2
Breakeven Cost	$29	**Simple Payback (yrs)**	15281	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.0		

Auditors Notes:

Bring PACE Air Handler back online with pre-heat. Cost estimate: $2000 materials + $1220 airfare + $4200 labor (42 hours for 2 HVAC specialists @ $100/hr) + 15% freight + 30% contractor indirect = $10,100. Contractor is Brod and Mclung PACE out of Portland, Oregon: http://www.pacifier.com/~ahs/index.html.

Install or fix exhaust system in Chemical add room. Cost estimate: $5000 materials + $1,182 airfare (1 roundtrip for initial consultation; 2 tickets for installation from Anchorage) + $4200 labor (42 hours for 2 HVAC specialists @ $100/hr) + 15% freight + 30% contractor indirect = $14,500. Contact information for Loren Cook rep in Anchorage: http://www.lorencook.com/rep.asp?optone=USA&opttwo=Alaska&optthree=Yakutat .

Troubleshoot second exhaust fan in screening room. Manually regulate fans so wear and tear is evenly divided between units. Cost estimate: $2500 materials + $1,220 airfare and per diem (1 roundtrip for initial consultation; 1 roundtrip for repairs) + $900 labor (4 hours consultation and 5 hours repair for 1 HVAC specialist @ $100/hr) + 15% freight + 30% contractor indirect = $6,494

4.5 Electrical & Appliance Measures

4.5.1 Lighting Measures

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

4.5.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	Location	Existing Condition	Recommendation
1	YTT Lift Station Interior Lighting	3 INCAN A Lamp, Std 100W	Replace with new energy-efficient LED lighting.

Installation Cost	$25	**Estimated Life of Measure (yrs)**	9	**Energy Savings ($/yr)**	$3
Breakeven Cost	$160	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	6.4	**Maintenance Savings ($/yr)**	$18

Auditors Notes: There are three total incandescent A lamp bulbs to be replaced. Actual energy usage is 14W. Original bulb: lifetime 0.9 years. Lifespan of 0.9 years or 10,000 hours. Used 10 minutes local labor (@ $25/hr). 15% freight included in both retrofit and maintenance savings.

Rank	Location	Existing Condition		Recommendation	
3	Village Lift Station Lighting	INCAN A Lamp, Std 100W		Replace with new energy-efficient LED lighting.	
Installation Cost	$9	**Estimated Life of Measure (yrs)**	9	**Energy Savings ($/yr)**	$1
Breakeven Cost	$53	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	5.9	**Maintenance Savings ($/yr)**	$6
Auditors Notes: There is one incandescent A lamp bulb to be replaced. Actual energy usage is 14W. Original bulb: lifetime 0.9 years. Lifespan of 0.9 years or 10,000 hours. Used 10 minutes local labor (@ $25/hr). 15%freight included in both retrofit and maintenance costs.					

Rank	Location	Existing Condition		Recommendation	
4	Lagoon Lift Station Lighting	INCAN A Lamp, Std 75W		Replace with new energy-efficient LED lighting.	
Installation Cost	$12	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$1
Breakeven Cost	$56	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	4.7	**Maintenance Savings ($/yr)**	$6
Auditors Notes: There is one incandescent A lamp bulb to be replaced. Original bulb has an approx. 0.9 year lifespan; $1.914/bulb. New bulb has an approx. 9.5-year lifespan; $6.49/bulb. Used 10 minutes of local help (@ $25/hr) for labor cost. 15% freight included in both retrofit and maintenance savings costs.					

Rank	Location	Existing Condition		Recommendation	
5	Tongass St. Lift Station Lighting	INCAN A Lamp, Std 60W		Replace with new energy-efficient LED lighting.	
Installation Cost	$12	**Estimated Life of Measure (yrs)**	23	**Energy Savings ($/yr)**	$0
Breakeven Cost	$41	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	3.4	**Maintenance Savings ($/yr)**	$2
Auditors Notes: There is one incandescent A lamp bulb to be replaced. Actual energy usage is 9W. Original bulb: lifetime 3.2 years. LED lifespan of 25,000 hours (@ 3hrs/day). Used 10 minutes local labor (@ $25/hr). 15% freight included in both retrofit and maintenance savings.					

Rank	Location	Existing Condition		Recommendation	
9	YTT Lift Station Exterior Lighting	2 HPS 150 Watt Std Electronic		Replace with new energy-efficient, direct-wire LED lighting.	
Installation Cost	$71	**Estimated Life of Measure (yrs)**	9	**Energy Savings ($/yr)**	$3
Breakeven Cost	$82	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.2	**Maintenance Savings ($/yr)**	$8
Auditors Notes: There are two exterior wall packs to be replaced. Used 15 minutes local labor (@ $25/hr) for bulb replacement. 15% freight is factored into both the retrofit and maintenance savings costs. Original bulb: 24,000 hrs. lifespan. LED: 50,000 hr lifespan. Estimated lifespan of LED= 9 years.					

Rank	Location	Existing Condition		Recommendation	
12	Wastewater Treatment Plant: Screening Room	15 FLUOR (2) T8 4' F32T8 32W Standard Instant Electronic		Replace with new energy-efficient, direct-wire LED lighting.	
Installation Cost	$1,328	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$36
Breakeven Cost	$996	**Simple Payback (yrs)**	26	**Energy Savings (MMBTU/yr)**	0.3 MMBTU
		Savings-to-Investment Ratio	0.7	**Maintenance Savings ($/yr)**	$16
Auditors Notes: There are 15 fixtures with two fluorescent T8 4ft. lamps in each fixture for a total of 30 lamps to be replaced. Original bulbs: 27.4 years (@ 3hr/day), $3.073/bulb, 15 minutes to change each at $25/hr. LED replacements (tombstone included): 50,000 hrs. lifespan, $16.7375 per bulb, 15% freight, 15 minutes to rewire each at $100/hour (electrician).					

Rank	Location	Existing Condition		Recommendation	
14	Wastewater Treatment Plant: Chemical Add Room	2 FLUOR (2) T8 4' F32T8 32W Standard Instant Electronic		Replace with new energy-efficient, direct-wire LED lighting.	
Installation Cost	$177	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$4
Breakeven Cost	$107	**Simple Payback (yrs)**	31	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.6	**Maintenance Savings ($/yr)**	$2
Auditors Notes: There are two fixtures with two fluorescent T8 4ft. lamps in each fixture for a total of four lamps to be replaced. Original bulbs: 27.4 years (@ 3hr/day), $3.073/bulb, 15 minutes to change each at $25/hr. LED replacements (tombstone included): 50,000 hrs. lifespan, $16.7375 per bulb, 15% freight, 15 minutes to rewire each at $100/hour (electrician).					

4.5.2 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
7	Screening Room	2 Rotary Screens with Manual Switching		Remove Manual Switching and Add new Other Controls	
Installation Cost	$5,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$979
Breakeven Cost	$7,993	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	0.8 MMBTU
		Savings-to-Investment Ratio	1.6		
Auditors Notes: Install telemetry and timer controls on rotary screens so that the screens only come on when the last lift station or stations come on. Timer controls will turn off motors when force main is clear. Controls retrofit cost is an estimate.					

4.5.3 Other Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
6	Lagoon Lift Station			Replace insulation on ceiling, walls, floor, replace door, replace electric heater with thermostatically controlled unit.	
Installation Cost	$3,885	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$783
Breakeven Cost	$10,848	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	6.9 MMBTU
		Savings-to-Investment Ratio	2.8	**Maintenance Savings ($/yr)**	$138
Auditors Notes: All of the insulation measures will reduce the overall heat demand of the lift station and make the space more efficient for heating purposes. The programmable thermostat will prevent the lift station from being heated more than necessary to prevent freezing problems (assumed 30% reduction in post-insulation heat load, shown in maintenance savings).					

Rank	Location	Description of Existing	Efficiency Recommendation
8	YTT Lift Station Heat		Replace space heater with thermostatically controlled unit

Installation Cost	$3,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$136
Breakeven Cost	$4,675	**Simple Payback (yrs)**	8	**Energy Savings (MMBTU/yr)**	1.2 MMBTU
		Savings-to-Investment Ratio	1.6	**Maintenance Savings ($/yr)**	$258

Auditors Notes: All of the insulation measures will reduce the overall heat demand of the lift station and make the space more efficient for heating purposes. The programmable thermostat will prevent the lift station from being heated more than necessary to prevent freezing problems (assumed 30% reduction in post-insulation heat load, shown in maintenance savings).

Rank	Location	Description of Existing	Efficiency Recommendation
10	Jenson Lift Station Heat		Replace insulation on ceiling, walls, floor, replace door, replace electric heater with thermostatically controlled unit

Installation Cost	$4,488	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$366
Breakeven Cost	$4,461	**Simple Payback (yrs)**	12	**Energy Savings (MMBTU/yr)**	3.2 MMBTU
		Savings-to-Investment Ratio	1.0	**Maintenance Savings ($/yr)**	$14

Auditors Notes: All of the insulation measures will reduce the overall heat demand of the lift station and make the space more efficient for heating purposes. The programmable thermostat will prevent the lift station from being heated more than necessary to prevent freezing problems (assumed 30% reduction in post-insulation heat load, shown in maintenance savings).

Rank	Location	Description of Existing	Efficiency Recommendation
11	Tongass St. Lift Station Heat		Replace insulation on ceiling, walls, floor, replace door, replace electric heater with thermostatically controlled unit

Installation Cost	$7,962	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$370
Breakeven Cost	$6,730	**Simple Payback (yrs)**	14	**Energy Savings (MMBTU/yr)**	3.2 MMBTU
		Savings-to-Investment Ratio	0.8	**Maintenance Savings ($/yr)**	$200

Auditors Notes: All of the insulation measures will reduce the overall heat demand of the lift station and make the space more efficient for heating purposes. The programmable thermostat will prevent the lift station from being heated more than necessary to prevent freezing problems (assumed 30% reduction in post-insulation heat load, shown in maintenance savings).

Rank	Location	Description of Existing	Efficiency Recommendation
156	Fish Plant Lift Station Heat		Insulation to ceiling, walls, replace door, floor, replace heater with thermostatically controlled unit

Installation Cost	$6,254	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$251
Breakeven Cost	$2,992	**Simple Payback (yrs)**	25	**Energy Savings (MMBTU/yr)**	2.2 MMBTU
		Savings-to-Investment Ratio	0.5	**Maintenance Savings ($/yr)**	$4

Auditors Notes: All of the insulation measures will reduce the overall heat demand of the lift station and make the space more efficient for heating purposes. The programmable thermostat will prevent the lift station from being heated more than necessary to prevent freezing problems (assumed 30% reduction in post-insulation heat load, shown in maintenance savings).

Rank	Location	Description of Existing	Efficiency Recommendation		
17	Village Lift Station Heat		Replace insulation on ceiling, walls, floor, replace door, replace electric heater with thermostatically controlled unit		
Installation Cost	$3,423	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$73
Breakeven Cost	$1,503	**Simple Payback (yrs)**	27	**Energy Savings (MMBTU/yr)**	0.6 MMBTU
		Savings-to-Investment Ratio	0.4	**Maintenance Savings ($/yr)**	$54
Auditors Notes: All of the insulation measures will reduce the overall heat demand of the lift station and make the space more efficient for heating purposes. The programmable thermostat will prevent the lift station from being heated more than necessary to prevent freezing problems (assumed 30% reduction in post-insulation heat load, shown in maintenance savings).					

5. ENERGY EFFICIENCY ACTION PLAN

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

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

In the near future, a representative of ANTHC will be contacting the City and Borough of Yakutat to follow up on the recommendations made in this report. ANTHC will provide assistance in understanding the report and implementing the recommendations as desired by the City and Borough.

APPENDICES

Appendix A – Scanned Energy Billing Data

1. Electricity Billing Data

Utility: AVEC (previously Yakutat Power, Inc.)
Reading: Monthly
Units: kWh

Month	Wastewater Treatment Plant	Fish Plant Lift Station	High School Lift Station	Jenson Lift Station	Lagoon Lift Station	Tongass St. Lift Station	Village Lift Station	YTT Lift Station
June 2016	1502	220	144	620	375	199	277	282
July 2016	1511	150	61	427	333	191	242	296
August 2016	1740	450	57	703	457	268	298	170
September 2016	1616	200	158	648	374	278	245	292
October 2016	1843	160	307	577	398	306	494	370
November 2016	1977	330	350	857	536	377	1263	448
December 2016	1889	180	611	857	0	0	1267	580
January 2017	2256	310	1104	568	581	296	1314	689
February 2017	1739	320	1326	555	518	332	1269	877
March 2017	2340	310	1492	624	641	318	1159	623
April 2017	1475	280	753	493	517	184	1009	482
May 2017	1957	170	495	622	438	148	85	476

Appendix B – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Yakutat Wastewater Treatment Plant (CBY Treatment Plant)	**Auditor Company:** Alaska Native Tribal Health Consortium
Address: CBY Small Dock	**Auditor Name:** Cody Uhlig and Kelli Whelan
City: Yakutat	**Auditor Address:** 4500 Diplomacy Drive Anchorage, AK 99508
Client Name: Jon Erickson, EdD	
Client Address: P.O. Box 160 Yakutat, AK 99689	**Auditor Phone:** (907) 729-3589
	Auditor FAX: (907) 729-4047
Client Phone: (907) 784-3323	**Auditor Comment:**
Client FAX: (907) 784-3281	
Design Data	
Building Area: 1,215 square feet	**Design Space Heating Load:** Design Loss at Space: 140,821 BTU/hour with Distribution Losses: 140,821 BTU/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 214,666 BTU/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 2 people	**Design Indoor Temperature:** 47.5 deg F (building average)
Actual City: Yakutat	**Design Outdoor Temperature:** 2.1 deg F
Weather/Fuel City: Yakutat	**Heating Degree Days:** 9,084 deg F-days
Utility Information	
Electric Utility: Alaska Village Electric Cooperative	**Average Annual Cost/kWh:** $0.389/kWh

Annual Energy Cost Estimate							
Description	**Space Heating**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Refrigeration**	**Other Electrical**	**Total Cost**
Existing Building	$11,012	$5	$2,547	$249	$86	$16,507	**$30,405**
With Proposed Retrofits	$8,949	$5	$2,545	$202	$86	$15,235	**$27,021**
Savings	$2,062	$0	$2	$48	$0	$1,272	**$3,384**

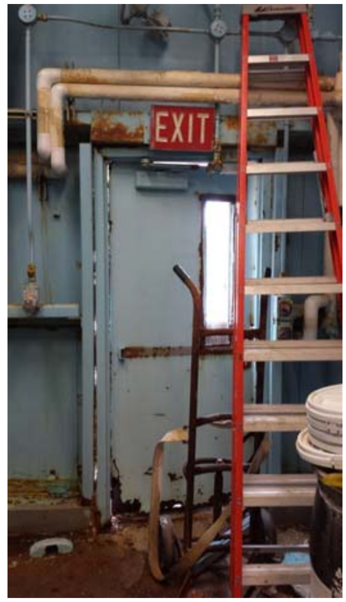
Building Benchmarks			
Description	**EUI (kBTU/Sq. Ft.)**	**EUI/HDD (Btu/Sq. Ft./HDD)**	**ECI ($/Sq. Ft.)**
Existing Building	382.8	42.14	$25.03
With Proposed Retrofits	357.2	39.32	$22.24

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 – Photographs from AkWarm Program

1. Yakutat Wastewater Treatment Plant

Office area.



Chemical Injection Room door.

Chlorine disinfectant pump.

Solids and grit screening room.

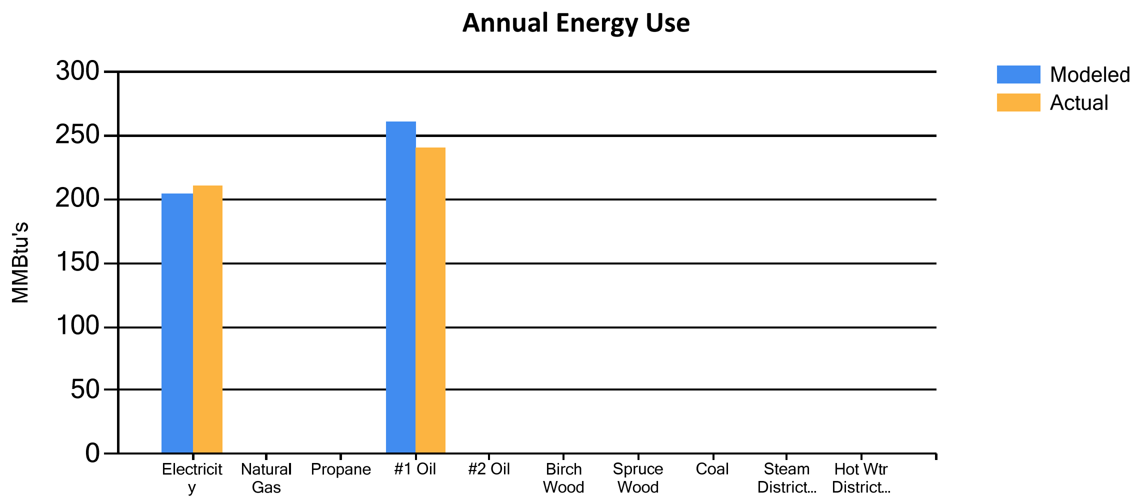
Wastewater Treatment Plant exterior.

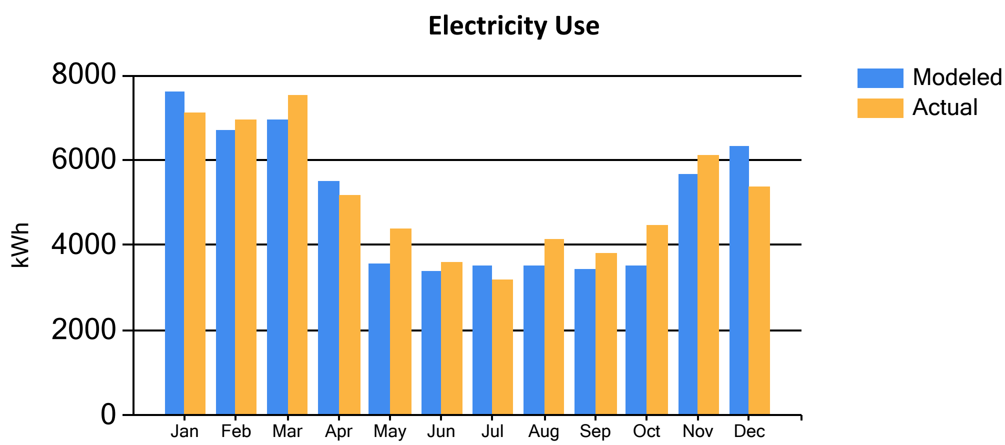
Plant entrance and air-handler intake.

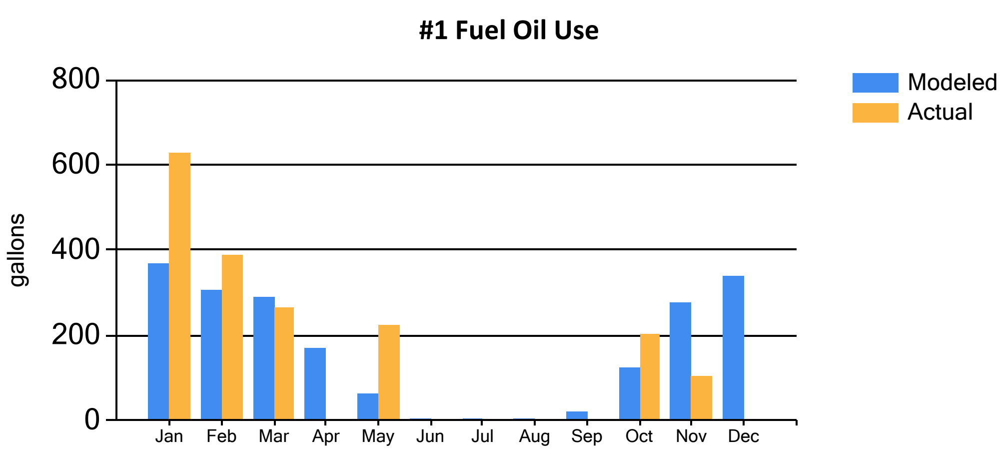
Side view and effluent contact tanks.

Appendix D – Actual Fuel Use versus Modeled Fuel Use

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







Appendix E - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	67.0	63.6	60.6	58.1	51.6	51.6	51.6	51.6	51.6	46.4	46.5	44.3
As Proposed	57.3	56.0	55.0	53.9	47.9	47.8	47.8	47.8	47.9	42.7	42.7	41.9

AkWarmCalc Ver 2.8.0.0, Energy Lib 3/3/2017