Comprehensive Energy Audit
For

Stebbins Washeteria

Prepared For
City of Stebbins

August 6, 2015

Prepared By:

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PREFACE

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

The Energy Projects Group at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for The City of Stebbins, Alaska. The authors of this report are Carl Remley, Certified Energy Auditor (CEA) and Certified Energy Manager (CEM) and Kevin Ulrich. Energy Manager-in-Training (EMIT).

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in April of 2015 by the Energy Projects Group of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy conservation measures. Discussions of site-specific concerns, non-recommended measures, and an energy conservation action plan are also included in this report. Please note that this report is for the Stebbins Washeteria only. A separate report covers the Stebbins Old Water Plant.

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of Water Treatment Plant Operator Peter Martin and Stebbins City Administrator Nora Tom.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Stebbins. The scope of the audit focused on Stebbins Washeteria. 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, water treatment equipment, and plug loads.

In the near future, a representative of ANTHC will be contacting both the City of Stebbins and the water treatment plant operator to follow up on the recommendations made in this audit report. Funding has been provided to ANTHC through a Rural Alaska Village Grant and the Denali Commission to provide the city with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations within the 2015 calendar year.

The total predicted energy cost for the Stebbins Washeteria Plant is $52,728 per year. Fuel oil represents the largest portion of the building energy consumption with an annual cost of $31,725. Electricity represents the remaining portion with an annual cost of $21,003. This includes $8,078 paid by the City and $12,925 paid by the Power Cost Equalization (PCE) program through the State of Alaska. These predictions are based on the electricity and fuel prices at the time of the audit.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower the electricity costs and make energy affordable in rural Alaska. In Stebbins, the cost of electricity without PCE is $0.52/KWH and the cost of electricity with PCE is $0.20/KWH.

The Stebbins Washeteria received funding from the Renewable Energy Fund managed by the Alaska Energy Authority to implement a heat recovery system from the new power plant to the new water plant, washeteria, old water plant, clinic, and school buildings. The projected savings for this project for the Stebbins Washeteria are reflected in this report.

The table below lists the total usage of electricity, #1 oil, and recovered heat in the washeteria before and after the proposed retrofits.

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	39,149 KWH	30,560 KWH
#1 Oil	7,536 gallons	995 gallons
Heat Recovery	0.00 million Btu	573.09 million Btu

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

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	629.6	44.12	$29.42
With Proposed Retrofits	451.3	31.62	$14.99
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 1.1 below summarizes the energy efficiency measures analyzed for the Stebbins Washeteria. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.1
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
1	Lighting - Power Retrofit: Exterior Lighting	Replace with new energy-efficient lighting	$208 + $120 Maint.	$1,200	3.80	3.7	586.6
2	Mens room, Womens Room and Main Washeteria	Replace existing window with U-0.22 vinyl window.	$168	$942	3.10	5.6	839.0
3	Lighting - Power Retrofit: Behind Washer Area & Attic	Replace with new energy-efficient lighting	$41 + $36 Maint.	$360	3.07	4.7	127.9
4	Lighting - Power Retrofit: Main Washeteria Area & Arctic Entry	Replace with new energy-efficient lighting	$113 + $99 Maint.	$990	3.07	4.7	351.2
5	Lighting - Power Retrofit: Bathrooms	Replace with new energy-efficient lighting	$61 + $54 Maint.	$540	3.07	4.7	191.5
6	Ventilation	Repair AHU-1 and rewire restroom exhaust fan such that both operate only during occupied hours.	$2,237	$10,000	3.04	4.5	11,244.1
7	Heating, Ventilation, and Domestic Hot Water	Add a heat recovery system that recovers heat from the AVEC power plant and transfers the heat to the washeteria. Clean and tune boilers. Repair or replace boiler components, controls, and valves. Recalibrate and recommission boilers.	$22,910 + $1,000 Maint.	$200,000	2.77	8.4	106,563.5
8	Lighting - Power Retrofit: Bathroom 2 Lamp	Replace with new energy-efficient lighting	$33 + $36 Maint.	$360	2.81	5.2	111.8
9	Lighting - Power Retrofit: Mechanical Room	Replace with new energy-efficient lighting	$4 + $36 Maint.	$360	1.64	9.0	12.9
10	Refrigeration - Power Retrofit: Whirlpool Fridge	Replace with small soda refridgerator.	$96	$500	1.62	5.2	326.2

Table 1.1 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
	TOTAL, all measures		$25,871 + $1,381 Maint.	$215,252	2.79	7.9	120,354.7

Table Notes:

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

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

With all of these energy efficiency measures in place, the annual utility cost can be reduced by $25,871 per year, or 49.1% of the buildings' total energy costs. These measures are estimated to cost $215,252, for an overall simple payback period of 7.9 years.

Table 1.2 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 1.2

Annual Energy Cost Estimate								
Description	Space Heating	Water Heating	Ventilation Fans	Clothes Drying	Lighting	Refrigeration	Other Electrical	Total Cost
Existing Building	$10,893	$13,993	$3,320	$17,274	$3,855	$321	$3,012	**$52,728**
With Proposed Retrofits	$4,068	$4,814	$3,389	$8,010	$3,254	$216	$3,046	**$26,858**
Savings	$6,825	$9,178	-$69	$9,264	$602	$105	-$34	**$25,871**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Stebbins 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%/year in excess of general inflation.

2.2 Audit Description

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

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

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 Stebbins 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.

Stebbins Washeteria is classified as being made up of the following activity areas:

1) Washeteria: 1,792 square feet

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

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

2.3. Method of Analysis

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

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

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

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

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

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

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

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

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

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

2.4 Limitations of Study

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

3. Stebbins Washeteria

3.1. Building Description

The 1,792 square foot Stebbins Washeteria was constructed in 2002. It has a normal occupancy of 8 people and operates for an average of 10 hours per day.

The Stebbins Washeteria serves as the primary location for laundromat and shower services within the community. The building houses seven washers and four dryers that are available for public use. Water is supplied from the old water plant for use in the washeteria machines and showers. A new water treatment plant is under construction for the City of Stebbins and will be completed in summer 2015. The water will then be supplied by the new water plant. The Stebbins Washeteria also houses a watering point that is used by the community as a local water supply.

The washeteria is currently funded to receive excess heat from a heat recovery system that will circulate heat from the AVEC power plant to the new water plant, old water plant, washeteria, school, and clinic. The heat recovery savings are reflected in one of the energy efficiency measures in this report.

The old water plant is located next to the washeteria. Details on the old water plant are available in a separate energy audit report.

Description of Building Shell

The exterior walls are constructed stressed skin panel construction with 5.5 inches of polyurethane foam insulation. The insulation is in good condition and there is approximately 1,960 square feet of walls.

The roof of the building is constructed from lumber with standard 24 inch framing, a cathedral ceiling, and 5.5 inches of polyurethane foam insulation. The insulation is in good condition and there is approximately 1,889 square feet of roof space.

The building floor is constructed with approximately 5.5 inches of polyurethane foam insulation. The insulation has some damage and there is approximately 1,792 square feet of floor space.

There are six windows in the washeteria, three of which are broken with wood frames that are each approximately 8 feet in total area. The combined area of the windows is 24 square feet. These three windows are missing glass and have plywood covers.

There are two exterior doors in the facility that are both metal with a polyurethane core. The two doors combine to have a total area of 46 square feet.

Description of Heating Plants

The Heating Plants used in the building are:

Weil McLain Boiler #2

Nameplate Information:	Model 580
Fuel Type:	#1 Oil
Input Rating:	596,000 BTU/hr
Steady State Efficiency:	70 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Notes: In bad shape, over fired, and not running lean. Very sooted. Could use a lot of cleaning and tuning.

Weil McLain Boiler #1

Nameplate Information:	Weil McLain 580
Fuel Type:	#1 Oil
Input Rating:	596,000 BTU/hr
Steady State Efficiency:	70 %
Idle Loss:	2 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Notes: In bad shape, over fired, and not running lean. Very sooted. Could use a lot of cleaning and tuning.

Space Heating Distribution Systems

There are two pumps in the building that operate within the building hydronic heating system. One pump circulates heated glycol from the boilers into the primary heating loop of the building. The pump is rated at 1/3 HP and operates when the boilers are firing. A second pump circulates the heated glycol through the building heating loop. This pump is rated at ¾ HP.

Domestic Hot Water System

There is a hot water heater in the building that provides hot water to the showers and to the washers. The hot water heater is unable to maintain the desired temperature of 120 deg. F due to an improperly calibrated mixing valve. There are two pumps associated with the domestic hot water circulation. One pump circulates the hot water to and from the heater and is rated at 0.150 HP. A second pump circulates the hot water through the building and is rated at one horsepower. This circulates the water throughout the building and operates based on dryer usage.

Heat Recovery Information

The Stebbins Washeteria received funding for a heat recovery project from the new power plant. The project will serve the old water treatment plant, new water treatment plant, washeteria, clinic, and school.

Description of Building Ventilation System

The washeteria building currently has an air handling unit that is constantly in operation because the controls for the unit are in manual override. The unit pulls 800 CFM while using 548 Watts of electricity for 24 hours per day. An exhaust fan that blows interior air to the outside is also in constant operation.

Lighting

The main washeteria room has 11 fixtures with three T8 fluorescent light bulbs in each fixture.

The mechanical room has four fixtures with three T8 fluorescent light bulbs in each fixture.

The back room leading to the mechanical room has four fixtures with three T8 fluorescent light bulbs in each fixture.

The bathrooms have six total fixtures with three T8 fluorescent light bulbs in each fixture. The bathrooms also have six total fixtures with two T8 fluorescent light bulbs in each fixture.

The exterior of the building has four light fixtures with a single 50 Watt incandescent light bulb in each fixture.

Plug Loads

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

Major Equipment

There are four large Continental Girbau washing machines that are used by the public for laudromat purposes. The machines combine to use approximately 2,966 KWH annually.

There are three small Continental Girbau washine machines that are used by the public for laundromat services. The machines combine to use approximately 1,841 KWH annually.

The controls for the watering point use approximately 368 KWH annually.

There is a heat tape that is used for freeze protection of the watering point that uses approximately 456 KWH annually.

There is a refrigerator in the washeteria office room that uses approximately 600 KWH annually.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

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

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

The following is a list of the utility companies providing energy to the building and the class of service provided:

Electricity: AVEC-Stebbins - Commercial - Sm

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

Table 3.1 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.52/KWH
#1 Oil	$ 4.21/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Stebbins pays approximately $52,728 annually for electricity and other fuel costs for the Stebbins Washeteria.

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

Figure 3.1
Annual Energy Costs by End Use

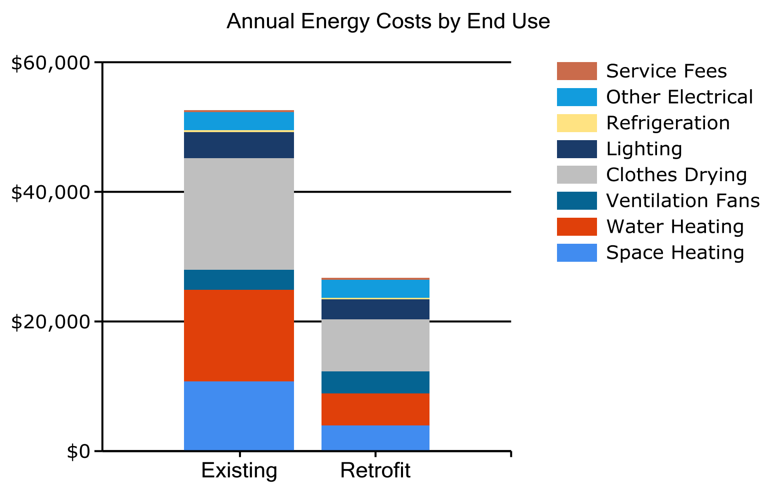


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The “Existing” bar shows the breakdown for the building as it is now; the “Retrofit” bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

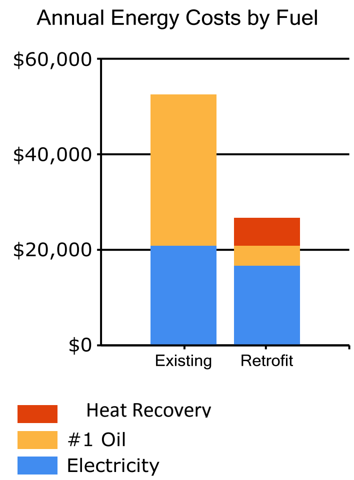
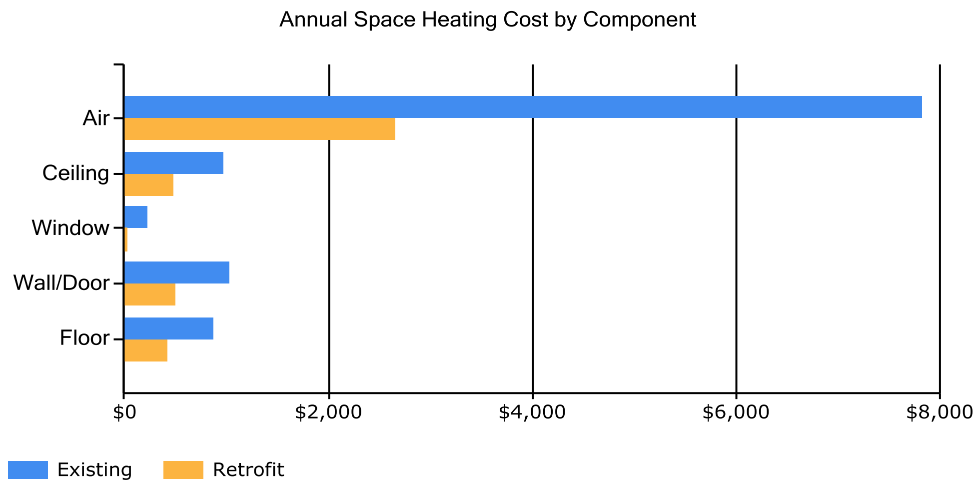


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing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

Figure 3.3
Annual Space Heating Cost by Component



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

Electrical Consumption (KWH)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Space_Heating	433	395	432	415	423	407	421	421	407	426	416	433
DHW	626	570	626	606	627	607	627	627	607	626	606	626
Ventilation_Fans	527	480	527	510	527	510	527	527	510	527	510	527
Clothes_Drying	603	549	603	583	602	583	602	602	583	602	583	603
Lighting	674	614	674	652	597	508	525	525	508	606	652	674
Refrigeration	51	46	51	49	51	49	51	51	49	51	49	51
Other_Electrical	505	461	505	489	471	425	439	439	425	476	489	505

Fuel Oil #1 Consumption (Gallons)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Space_Heating	283	270	274	194	87	48	50	50	49	142	210	291
DHW	193	175	193	191	208	207	214	214	206	203	190	192
Clothes_Drying	299	276	298	273	259	237	235	236	242	268	275	301

3.2.2 Energy Use Index (EUI)

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

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

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

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

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

Table 3.4
Stebbins Washeteria EUI Calculations

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	39,149 KWH	133,616	3.340	446,276
#1 Oil	7,536 gallons	994,714	1.010	1,004,661
Total		**1,128,330**		**1,450,937**
BUILDING AREA		1,792	Square Feet	
BUILDING SITE EUI		630	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		810	**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 3.5

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	**629.6**	**44.12**	**$29.42**
With Proposed Retrofits	**451.3**	**31.62**	**$14.99**
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

3.3 AkWarm© Building Simulation

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

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

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

Limitations of AkWarm© Models

• The model is based on typical mean year weather data for Stebbins. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the gas and electric profiles generated will not likely compare perfectly with actual energy billing information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.
• The heating and cooling load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building.
• The model does not model heating and ventilation systems that simultaneously provide both heating and cooling to the same building space (typically done as a means of providing temperature control in the space).

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 Stebbins Washeteria, Stebbins, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
1	Lighting - Power Retrofit: Exterior Lighting	Replace with new energy-efficient lighting	$208 + $120 Maint.	$1,200	3.80	3.7	586.6
2	Mens room, Womens Room and Main Washeteria	Replace existing window with U-0.22 vinyl window.	$168	$942	3.10	5.6	839.0
3	Lighting - Power Retrofit: Behind Washer Area & Attic	Replace with new energy-efficient lighting	$41 + $36 Maint.	$360	3.07	4.7	127.9
4	Lighting - Power Retrofit: Main Washeteria Area & Arctic Entry	Replace with new energy-efficient lighting	$113 + $99 Maint.	$990	3.07	4.7	351.2
5	Lighting - Power Retrofit: Bathrooms	Replace with new energy-efficient lighting	$61 + $54 Maint.	$540	3.07	4.7	191.5

Table 4.1 Stebbins Washeteria, Stebbins, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
6	Ventilation	Repair AHU-1 and rewire restroom exhaust fan such that both operate only during occupied hours.	$2,237	$10,000	3.04	4.5	11,244.1
7	Heating, Ventilation, and Domestic Hot Water	Add a heat recovery system that recovers heat from the AVEC power plant and transfers the heat to the washeteria. Clean and tune boilers. Repair or replace boiler components, controls, and valves. Recalibrate and recommission boilers.	$22,910 + $1,000 Maint.	$200,000	2.77	8.4	106,563.5
8	Lighting - Power Retrofit: Bathroom 2 Lamp	Replace with new energy-efficient lighting	$33 + $36 Maint.	$360	2.81	5.2	111.8
9	Lighting - Power Retrofit: Mechanical Room	Replace with new energy-efficient lighting	$4 + $36 Maint.	$360	1.64	9.0	12.9
10	Refrigeration - Power Retrofit: Whirlpool Fridge	Replace with small soda refrigerator.	$96	$500	1.62	5.2	326.2
	TOTAL, all measures		**$25,871 + $1,381 Maint.**	**$215,252**	**2.79**	**7.9**	**120,354.7**

4.2 Interactive Effects of Projects

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

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

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

4.3 Building Shell Measures

4.3.1 Window Measures

Rank	Location	Size/Type, Condition	Recommendation
2	Mens room, Womens Room and Main Washeteria	Glass: No glazing - broken, missing Frame: Insulated Fiberglass/Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.86 Solar Heat Gain Coefficient including Window Coverings: 0.11	Replace existing window with U-0.22 vinyl window.

Installation Cost	$942	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$168
Breakeven Cost	$2,916	**Savings-to-Investment Ratio**	3.1	**Simple Payback yrs**	6

Auditors Notes: Three of the six windows are broken and should be replaced.

4.4 Mechanical Equipment Measures

4.4.1 Heating /Domestic Hot Water Measure

Rank	Recommendation
7	Add a heat recovery system that recovers heat from the AVEC power plant and transfers the heat to the washeteria. Clean and tune boilers. Repair or replace boiler components, controls, and valves. Recalibrate and recommission boilers.

Installation Cost	$200,000	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$22,910
				Maintenance Savings (/yr)	$1,000
Breakeven Cost	$553,981	**Savings-to-Investment Ratio**	2.8	**Simple Payback yrs**	8

Auditors Notes: Add a heat recovery system that recovers heat from the AVEC power plant and transfers that heat to the washeteria. Clean and tune both boilers, replace barometric damper on boiler #2, replace or repair primary pump on boiler one, modify controls to reset boiler temperature based on outside temperature when washeteria is closed, shut off circulation loop when not required, shut off hot water pumps when washeteria is closed, replace the men's room zone control valve for baseboard heater, and re-calibrate and recommission the hot water mixing valve on the hot water system.

4.4.2 Ventilation System Measures

Rank	Description	Recommendation
6		Repair AHU-1 and rewire restroom exhaust fan such that both operate only during occupied hours.

Installation Cost	$10,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$2,237
Breakeven Cost	$30,376	**Savings-to-Investment Ratio**	3.0	**Simple Payback yrs**	4

Auditors Notes: Repair time clock and AHU-1 so the air handler and exhaust fan only operate when washeteria is open. Rewire restroom exhaust fan so it only runs lights are on and is shut off when time clock shuts off AHU-1. Repair or replace fan motor, filter, fan belt, heat control valve, and outside air actuator on AHU-1.

4.5 Electrical & Appliance Measures

4.5.1 Lighting Measures

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

4.5.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	Location	Existing Condition		Recommendation	
1	Exterior Lighting	4 INCAN A Lamp, Halogen 50W with Manual Switching		Replace with new energy-efficient lighting	
Installation Cost	$1,200	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$208
				Maintenance Savings (/yr)	$120
Breakeven Cost	$4,559	**Savings-to-Investment Ratio**	3.8	**Simple Payback yrs**	4
Auditors Notes: Replace 4 incandescent exterior lights with LED 17 Watt bulbs with an outdoor wall pack.					

Rank	Location	Existing Condition		Recommendation	
3	Behind Washer Area & Attic	4 FLUOR (3) T8 4' F32T8 25W Energy-Saver Instant StdElectronic with Manual Switching		Replace with new energy-efficient lighting	
Installation Cost	$360	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$41
				Maintenance Savings (/yr)	$36
Breakeven Cost	$1,105	**Savings-to-Investment Ratio**	3.1	**Simple Payback yrs**	5
Auditors Notes: Replace 4 fixtures containing 3 T8 fluorescent light bulbs each with 17 Watt LED light bulbs.					

Rank	Location	Existing Condition		Recommendation	
4	Main Washeteria Area & Arctic Entry	11 FLUOR (3) T8 4' F32T8 25W Energy-Saver Instant StdElectronic with Manual Switching		Replace with new energy-efficient lighting	
Installation Cost	$990	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$113
				Maintenance Savings (/yr)	$99
Breakeven Cost	$3,038	**Savings-to-Investment Ratio**	3.1	**Simple Payback yrs**	5
Auditors Notes: Replace 11 fixtures containing 3 T8 fluorescent light bulbs each with 17 Watt LED light bulbs.					

Rank	Location	Existing Condition		Recommendation	
5	Bathrooms	6 FLUOR (3) T8 4' F32T8 25W Energy-Saver Instant StdElectronic with Manual Switching		Replace with new energy-efficient lighting	
Installation Cost	$540	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$61
				Maintenance Savings (/yr)	$54
Breakeven Cost	$1,657	**Savings-to-Investment Ratio**	3.1	**Simple Payback yrs**	5
Auditors Notes: Replace 6 fixtures containing 3 T8 fluorescent light bulbs each with 17 Watt LED light bulbs.					

Rank	Location	Existing Condition		Recommendation	
8	Bathroom 2 Lamp	6 FLUOR (2) T8 4' F32T8 25W Energy-Saver Instant StdElectronic with Manual Switching		Replace with new energy-efficient lighting	
Installation Cost	$360	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$33
				Maintenance Savings (/yr)	$36
Breakeven Cost	$1,013	**Savings-to-Investment Ratio**	2.8	**Simple Payback yrs**	5
Auditors Notes: Replace 6 fixtures containing 2 T8 fluorescent light bulbs each with 17 Watt LED light bulbs.					

Rank	Location	Existing Condition		Recommendation	
9	Mechanical Room	4 FLUOR (3) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with new energy-efficient lighting	
Installation Cost	$360	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$4
				Maintenance Savings (/yr)	$36
Breakeven Cost	$591	**Savings-to-Investment Ratio**	1.6	**Simple Payback yrs**	9
Auditors Notes: Replace 4 fixtures containing 3 T8 fluorescent light bulbs each with 17 Watt LED light bulbs.					

4.5.2 Refrigeration Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
10	Whirlpool Fridge	Soda Fridge		Replace with small soda refrigerator.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$96
Breakeven Cost	$808	**Savings-to-Investment Ratio**	1.6	**Simple Payback yrs**	5
Auditors Notes: Replace 15 year old refrigerator with new energy star model.					

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 both the City of Stebbins and the water treatment plant operator to follow up on the recommendations made in this audit report. Funding has been provided to ANTHC through a Rural Alaska Village Grant and the Denali Commission to provide the city with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations within the 2015 calendar year.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Stebbins Washeteria	**Auditor Company:** ANTHC-DEHE
Address: P O Box 22	**Auditor Name:** Carl Remley and Kevin Ulrich
City: Stebbins **Client Name:** Nora Tom	**Auditor Address:** 3900 Ambassador Drive Anchorage, Alaska 99508
Client Address: P O Box 22 Stebbins, AK 99671	**Auditor Phone:** (907) 729-3543 **Auditor FAX:** ( ) -
Client Phone: (907) 934-3451 **Client FAX:**	**Auditor Comment:**
Design Data	
Building Area: 1,792 square feet	**Design Space Heating Load:** Design Loss at Space: 54,586 Btu/hour with Distribution Losses: 57,459 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 87,590 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 8 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Stebbins	**Design Outdoor Temperature:** -34 deg F
Weather/Fuel City: Stebbins	**Heating Degree Days:** 14,272 deg F-days
Utility Information	
Electric Utility: AVEC-Stebbins - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/KWH: $0.52/KWH	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate								
Description	**Space Heating**	**Water Heating**	**Ventilation Fans**	**Clothes Drying**	**Lighting**	**Refrigeration**	**Other Electrical**	**Total Cost**
Existing Building	$10,893	$13,993	$3,320	$17,274	$3,855	$321	$3,012	**$52,728**
With Proposed Retrofits	$4,068	$4,814	$3,389	$8,010	$3,254	$216	$3,046	**$26,858**
Savings	$6,825	$9,178	-$69	$9,264	$602	$105	-$34	**$25,871**

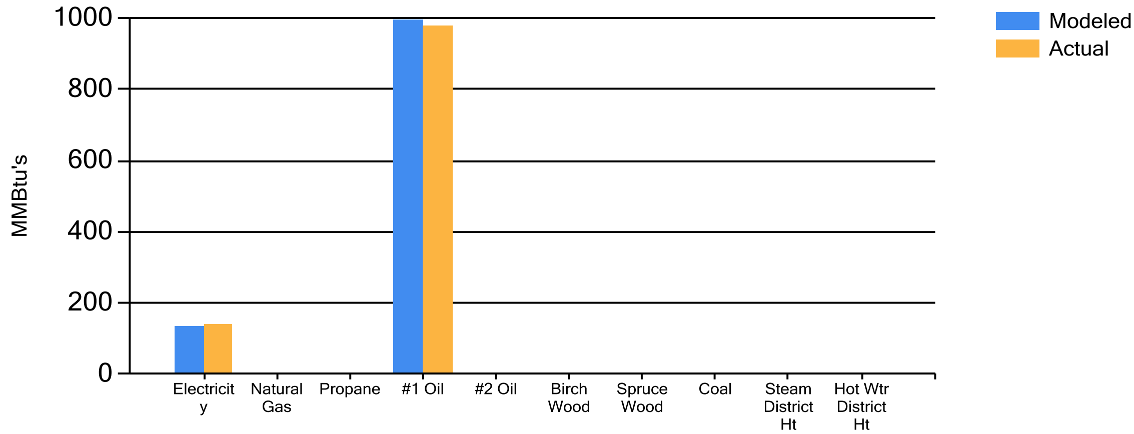
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	629.6	44.12	$29.42
With Proposed Retrofits	451.3	31.62	$14.99

EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area.
EUI/HDD: Energy Use Intensity per Heating Degree Day.
ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.

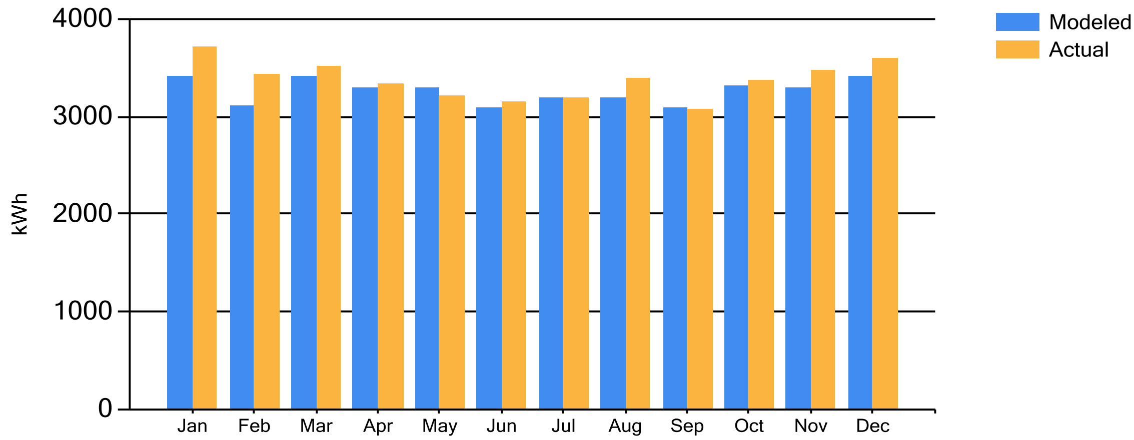
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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

Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use