Comprehensive Energy Audit For Holy Cross Water Treatment Plant and Lift Station

Prepared For
City of Holy Cross

August 5, 2014

Prepared By:

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PREFACE

The Energy Projects Group at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for The City of Holy Cross, Alaska. The authors of this report are Carl Remley, Certified Energy Auditor (CEA) and Certified Energy Manager (CEM) and Gavin Dixon. Kevin Ulrich and Remote Maintenance Worker (RMW) Bruce Werba participated in the on-site portion of this audit which was performed in April of 2014.

The purpose of this report is to provide a comprehensive documentation of the findings and analysis that resulted from an energy audit conducted in April of 2014 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.

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 associated RMW for each community has been undertaken to provide maximum accuracy in identifying audits and coordinating potential follow up retrofit activities.

In the near future, a representative of ANTHC will be contacting both the City of Holy Cross and the water treatment plant operator to follow up on the recommendations made in this audit report. A Rural Alaska Village Grant has funded ANTHC to provide the City with assistance in understanding the report and in implementing the recommendations. Funding for implementation of the recommended retrofits is being partially provided for by the above listed funding agencies, as well as the State of Alaska.

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of Mayor Rebecca Demientief, Bookkeeper Connie Walker, City Clerk Michelle Sims, and Water Treatment Plant Operators David Walker and Ernest “Leo” Peters.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Holy Cross and the Alaska Rural Utilities Collaborative (ARUC). The scope of the audit focused on the Holy Cross water treatment plant and associated lift station. 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 energy use, and plug loads.

The total predicted energy cost for the water treatment plant (WTP) and lift station (LS) is $56,685 per year. This total compares favorably with the $56,432 actual cost. Electricity represents the largest piece with an annual cost of $33,320. This includes $11,429 paid by the City of Holy Cross (end user) and $21,891 paid by the Power Cost Equalization (PCE) Program through the State of Alaska. This means that the City of Holy Cross (City) will realize approximately 34% of any electricity savings displayed in this report, the remainder will be saved by the State of Alaska PCE program. The WTP is predicted to spend $23,365 for heating oil annually. 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 in rural Alaska affordable. In Holy Cross, the cost of electricity without PCE is $0.50/KWH, and the cost of electricity with PCE is $0.17/KWH. For the purposes of this report, electricity costs and savings are calculated using the $0.50 per kilowatt hour rate.

Table 1.1 below summarizes the energy efficiency measures analyzed for the Water Treatment Plant. 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]
1	Other Electrical – North Circulation Pump Operation Schedule	Shut off the north water circulation pump in the summer.	$1,505 plus $50 Maintenance. Savings	$500	45.45	0.3

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2	Lighting – Convert Exterior WTP Incandescent Lighting to LED	Replace existing incandescent lighting with new energy efficient LED wall pack	$222	$250	10.41	1.1
3	Lighting – Convert Exterior WTP Metal Halide Lighting to LED	Replace existing metal halide lighting with new energy efficient LED wall pack	$160	$250	7.53	1.6
4	Water Treatment Plant Floor	Fill floor spacing with blown-in dense pack insulation.	$1,701	$5,549	6.68	3.3
5	Other Electrical – Add a valve in Lift Station Slough Line to Prevent Infiltration	Adding valve will prevent slough from flooding lift station when slough is higher than line.	$1,422	$2,400	6.59	1.7
6	Setback Thermostat: Water Treatment Plant	Install a programmable thermostat and program it to set the WTP temperature to 60.0 degrees when unoccupied such as at night and on weekends	$706	$2,600	3.46	3.7
7	Exterior Door: Water Treatment Plant	Remove existing metal door and install a new standard insulated door.	$90	$1,211	1.62	13.5
8	Exterior Wall: Water Treatment Plant	Install insulation and siding on the Water Treatment Plant wall.	$666	$10,020	1.44	15.0
9	Heating And DHW-Add Heat Recovery System for Water Plant & Lift Station	Implement a heat recovery system that recovers heat from the AVEC power plant and utilizes that recovered heat to meet most of the heating loads of both the WTP and Lift Station.	$14,499 plus $2,000 Maintenance Savings	$371,000	1.04	22.5
10	Lighting – Replace Interior Fluorescent Lighting in WTP with LED Replacement Lamps	Replace existing fluorescent lamps in four lamp fixtures with LED replacement lamps with no ballast.	$48 plus $15 Maintenance Savings	$500	1.07	7.9
11	Lighting – Replace Interior Fluorescent Lighting in WTP with LED Replacement Lamps	Replace existing fluorescent lamps in two lamp fixtures with LED replacement lamps with no ballast.	$176 plus $50 Maintenance Savings	$1,900	1.00	8.4
	TOTAL, all measures		**$21,195 plus $2,115 Maintenance Savings**	**$396,181**	**1.24**	**17.0**

Table Notes:

[1] Savings to Investment Ratio (SIR) is a life-cycle cost measure calculated by dividing the total savings over the life of a project (expressed in today's dollars) by its investment costs. The SIR is an indication of the profitability of a measure; the higher the SIR, the more profitable the

project. An SIR greater than 1.0 indicates a cost-effective project (i.e. more savings than cost). Remember that this profitability is based on the position of that Energy Efficiency Measure (EEM) in the overall list and assumes that the measures above it are implemented first.

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

With all of these energy efficiency measures in place, the annual utility cost can be reduced by $21,195 per year, or 37.4% of the buildings' total energy costs. These measures are estimated to cost $396,181, for an overall simple payback period of 17.0 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**	**Lighting**	**Other Electrical**	**Water Circulation Heat**	**Tank Heat**	**Service Fees**	**Total Cost**
Existing Building	$5,497	$0	$0	$1,320	$26,982	$13,011	$9,815	$60	**$56,685**
With Proposed Retrofits	$3,001	$0	$0	$693	$24,117	$4,343	$3,276	$60	**$35,490**
Savings	$2,495	$0	$0	$627	$2,865	$8,668	$6,539	$0	**$21,195**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Water Treatment Plant and Lift Station. The scope of this project included evaluating building shell, lighting and other electrical systems, and heating and ventilating equipment, water process loads, 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, ventilation, and air conditioning equipment (HVAC)
- Lighting systems and controls
- Building-specific equipment
- Water consumption, treatment & disposal

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

Details collected from the Holy Cross Water Treatment Plant (WTP) and Lift Station (LS) 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.

Water Treatment Plant is classified as being made up of the following activity areas:

1) Water Treatment Plant: 928 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 ventilating, lighting, plug load, water treatment process 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. Water Treatment Plant

3.1. Building Description

The 928 square foot Holy Cross WTP was constructed in 1982 and had significant upgrades in both 1986 and 1995. The normal occupancy is one person, the operator. The building is occupied approximately four hours per day, seven days per week.

The Holy Cross WTP houses a circulating water system with three loops that provide water to the residents of the community. One loop services the north end of town and is approximately 4,000 feet long. A second loop serves the south side of town and is approximately 1,850 feet long. A third loop serves the west side of town and runs to the water storage tank. This loop is approximately 4,500 feet long.

The raw water is pumped from a well directly beneath the WTP. The raw water is treated with chlorine but does not require significant filtration. The chlorine is injected prior to making a run up a hill to a 125,000 gallon water storage tank.

The sewer system has a force main that goes through one lift station before being forced to the sewage lagoon approximately 1000 feet from the WTP. The 144 square foot lift station is of panel construction.

Description of Building Shell

The exterior walls are four inch frame construction with and interior vapor barrier and 3.5 inches of fiberglass insulation.

The roof of the building is constructed with 2x4 framed trusses with a vapor barrier and 5.5 inches of board stock insulation in the ceiling. The roof has standard 24” spacing with an area of 928 square feet.

The floor and foundation of the building is constructed with a 4” concrete slab with no insulation. There is 928 square feet of floor space.

There are four windows in the building totaling 18 square feet. Each window is double-paned with wood framing. The windows are in good condition.

There are two entrances to the WTP. The primary entrance is a metal door with no insulation or windows. The door is not hanging completely vertical in the hinges. The other door is a standard wood door with insulation the leads from the office to outside.

The 144 square foot lift station has four inch panel walls and a six inch panel roof. The urethane foam insulation is 3.5 inches thick in the walls and 5.5 inches think in the roof. The concrete floor is not insulated.

Description of Heating Plants

The Heating Plants used in the building are:

WTP System 2000

Nameplate Information:	Energy Kinetics
Fuel Type:	#1 Oil
Input Rating:	348,000 BTU/hr
Steady State Efficiency:	88 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	Oct - Jul
Notes:	Installed by Ameresco two years ago.

WTP System 2000

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Input Rating:	348,000 BTU/hr
Steady State Efficiency:	88 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
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WTP Electric Heater

Fuel Type:	Electricity
Input Rating:	13,650 BTU/hr
Steady State Efficiency:	100 %
Idle Loss:	0 %
Heat Distribution Type:	Air

Lift Station Electric Heat

Nameplate Information:	1800 Watt Electric Heater
Fuel Type:	Electricity
Input Rating:	6,140 BTU/hr
Steady State Efficiency:	100 %
Idle Loss:	0 %
Heat Distribution Type:	Air

Notes: Heat required due to domestic water in lift station

Space Heating Distribution Systems

The WTP heat is distributed with two Modine unit heaters that each put out approximately 10,000 BTU/hr. The unit heaters have thermostats to control the fans that were set to 70 degrees. There are electric heaters present in the lift station and the WTP.

Lighting

There are 6 fixtures with four T-8 fluorescent light bulbs in each fixture and 4 fixtures with two T-8 fluorescent light bulbs present in the interior of the WTP. These are on for five hours per day in the week and two hours per day on the weekends for approximately 31 hours per week. There is a standard 60W incandescent light bulb as well as a 70W metal halide light bulb on the exterior of the building. These exterior lights are on for approximately 18 hours per day for six months and approximately 7 hours per day for six months. The lift station has a 70W metal halide light bulb and 2 FLUOR CFL 15W light bulbs on the building. These lights are on for approximate 30 minutes per day for six days each week.

Plug Loads

The WTP has a variety of power tools, a telephone, and some other miscellaneous loads that require a plug into an electrical outlet. Additionally, the building is outfitted with a variety of controls used to operate the major components of the WTP. The total usage of these loads is estimated to be approximately 200 watts.

Major Equipment

There are two well pumps powered from the WTP, only one of which is used at a time. When operating, they use approximately 3,888 watts. The average run time per day is 7 hours.

Each of the three loops has two pumps to circulate the water through the system. Only one of these two pumps is used at a time. The north loop pumps use 1,204 watts and are on all year long. The south loop pumps use 1,877 watts each, and the west loop pumps use 2,491 watts each. The south and west loops are generally shut off in the summer.

The water system is injected with chlorine from a 120 watt LMI pump that runs whenever the well pump runs.

The lift station has a pump that uses 2,200 watts. This pump normally runs 20% of the time every day of the year. However, overflow from the slough to the lift station results in excessive run time whenever the slough is high.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

The electric usage profile charts (below) represents the predicted electrical usage for both the WTP and LS. The model used to predict usage was calibrated to approximately match actual usage. The electric utility measures consumption in kilowatt-hours (KWH). One KWH of usage is equivalent to 1,000 watts running for one hour.

The fuel oil usage profile shows the fuel oil usage for the WTP. 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-Holy Cross - 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	$ 0.50/kWh
#1 Oil	$ 4.02/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, the unsubsidized cost of energy for the WTP and LS ARUC and RMW is $56,685 annually for electricity and fuel oil costs.

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

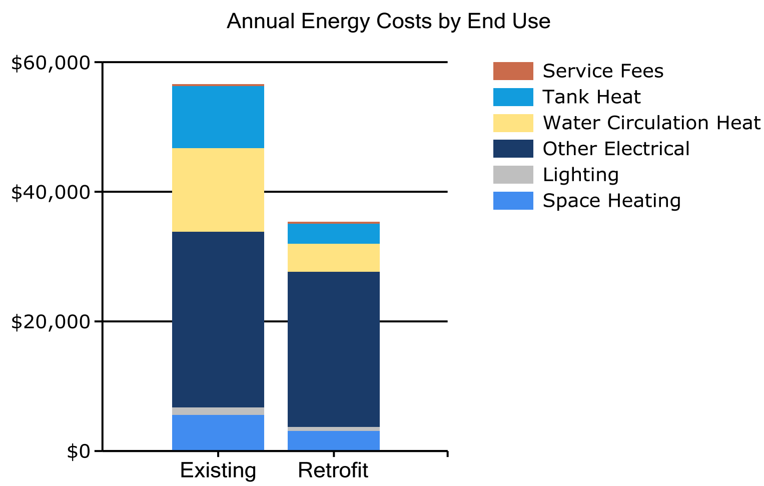


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

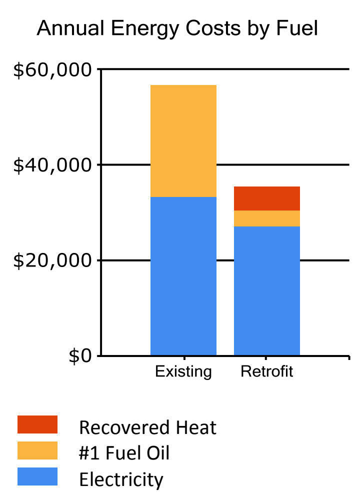
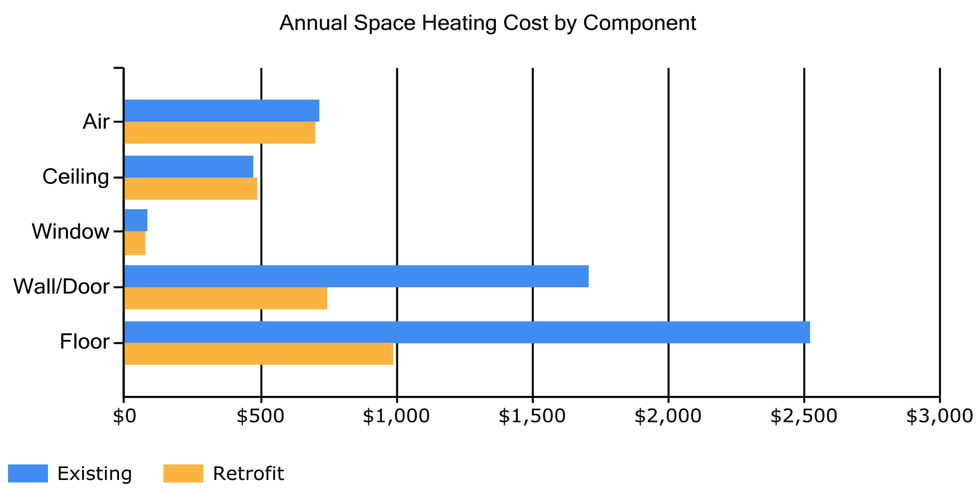


Figure 3.3 below addresses only space heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the existing 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	901	805	804	609	423	297	113	116	196	492	714	905
DHW	0	0	0	0	0	0	0	0	0	0	0	0
Ventilation_Fans	0	0	0	0	0	0	0	0	0	0	0	0
Lighting	258	235	258	179	185	179	185	185	179	258	250	258
Other_Electrical	5491	5004	5491	5314	5491	5314	2661	2242	2169	3500	5314	5491
Water_Circulation_Heat	220	201	224	224	242	236	11	0	0	185	220	220
Tank_Heat	166	152	169	169	182	178	8	0	0	139	166	166

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	92	81	75	43	9	0	14	20	34	45	62	93
DHW	0	0	0	0	0	0	0	0	0	0	0	0
Water_Circulation_Heat	356	324	356	346	359	348	43	0	0	155	345	356
Tank_Heat	268	245	269	261	271	263	32	0	0	117	260	268

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
Water Treatment Plant EUI Calculations

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	65,948 kWh	225,080	3.340	751,767
#1 Oil	5,812 gallons	767,206	1.010	774,878
Total		**992,286**		**1,526,645**
BUILDING AREA		704	Square Feet	
BUILDING SITE EUI		1,409	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		2,169	**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.				

3.3 AkWarm© Building Simulation

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

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 water treatment plant was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Holy Cross 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 Holy Cross. 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 ventilation load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building.

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

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

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

Table 4.1 Water Treatment Plant, Holy Cross, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES						
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**
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9	Heating And DHW-Add Heat Recovery System for Water Plant & Lift Station	Implement a heat recovery system that recovers heat from the AVEC power plant and utilizes that recovered heat to meet most of the heating loads of both the WTP and Lift Station.	$14,499 plus $2,000 Maintenance Savings	$371,000	1.04	22.5
10	Lighting – Replace Interior Fluorescent Lighting in WTP with LED Replacement Lamps	Replace existing fluorescent lamps in four lamp fixtures with LED replacement lamps with no ballast.	$48 plus $15 Maintenance Savings	$500	1.07	7.9
11	Lighting – Replace Interior Fluorescent Lighting in WTP with LED Replacement Lamps	Replace existing fluorescent lamps in two lamp fixtures with LED replacement lamps with no ballast.	$176 plus $50 Maintenance Savings	$1,900	1.00	8.4
	TOTAL, all measures		**$21,195 plus $2,115 Maintenance Savings**	**$396,181**	**1.24**	**17.0**

4.2 Interactive Effects of Projects

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

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

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

4.3 Building Shell Measures

4.3.1 Insulation Measures

Rank	**Location**	**Existing Type/R-Value**	**Recommendation Type/R-Value**
4	WTP Floor	Framing Type: 2 x Lumber Insulating Sheathing: None Top Insulation Layer: None Bottom Insulation Layer: None Modeled R-Value: 5.8	Fill cavity within the floor joists with blown, dense pack insulation by making a small hole in the concrete floor.

Installation Cost	$5,549	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$1,701
Breakeven Cost	$37,061	**Savings-to-Investment Ratio**	6.7	**Simple Payback yrs**	3

Auditors Notes: The floor has no insulation and there is no room to maneuver beneath the building. Create small hole in the concrete floor and install R-19 blown-in, dense pack insulation into the floor.

Rank	**Location**	**Existing Type/R-Value**	**Recommendation Type/R-Value**
8	Above-Grade Wall: WTP	Wall Type: Single Stud Siding Configuration: Just Siding Insul. Sheathing: None Structural Wall: 2 x 4, 16 inches on center R-11 Batt:FG or RW, 3.5 inches Window and door headers: Not Insulated Insulation Quality: Damaged Modeled R-Value: 10.1	Install rigid foam board insulation with additional siding.

Installation Cost	$10,020	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$666
Breakeven Cost	$14,433	**Savings-to-Investment Ratio**	1.4	**Simple Payback yrs**	15

Auditors Notes: The current walls are 2x4 frame construction with 3.5” insulation. We recommend increasing the insulation by adding R-25 rigid foam board insulation to the exterior of the WTP and T1-11 siding.

4.3.2 Door Measures

Rank	Location	Size/Type, Condition	Recommendation
7	Exterior Door: WTP	Door Type: Entrance, Metal, EPS core, metal edge, no glass Modeled R-Value: 2.7	Remove existing door and install a new better insulated door.

Installation Cost	$1,211	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$90
Breakeven Cost	$1,958	**Savings-to-Investment Ratio**	1.6	**Simple Payback yrs**	13

Auditors Notes: The current door is un-insulated metal. We recommend replacing the door with a standard pre-hung U-16 insulated door to reduce heat transfer through the door .

4.4 Mechanical Equipment Measures

4.4.1 Heating/Cooling/Domestic Hot Water Measure

Rank	Recommendation
9	Add a Recovered Heat System from the AVEC Power Plant to the water treatment plant and lift station.

Installation Cost	$371,000	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$14,499
				Maintenance Savings (/yr)	$2,000
Breakeven Cost	$384,615	**Savings-to-Investment Ratio**	1.0	**Simple Payback yrs**	22

Auditors Notes: The AVEC plant is approximately 750ft. from the WTP and 200 feet from the lift station. The plant uses a Detroit Diesel Series 60 generator that could be outfitted with marine jacket manifold to increase available recovered heat to supply the WTP and lift station. Inclusion of the lift station would increase the route distance to approximately 950feet. Implementing this recommendation will significantly reduce the oil consumption at the WTP and the electric heat usage at the lift station.

4.4.2 Night Setback Thermostat Measures

Rank	Building Space	Recommendation
6	Water Treatment Plant	Set the thermostat in the WTP building to 60.0 deg. F when unoccupied.

Installation Cost	$2,600	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$706
Breakeven Cost	$9,005	**Savings-to-Investment Ratio**	3.5	**Simple Payback yrs**	4

Auditors Notes: The heaters are set to 70 deg. F for all parts of the day. Reducing the heat load by lowering the temperature during unoccupied times can lower the heat demand and the energy costs. Install a programmable thermostat and program to heat the facility to 60 deg. F during unoccupied periods, such as evenings and weekends.

4.5 Electrical & Appliance Measures

4.5.1 Lighting Measures

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

4.5.1 Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	Location	Existing Condition		Recommendation	
2	WTP Exterior Incandescent	INCAN (2) A Lamp, 60 watt with Manual Switching		Replace lighting with new energy-efficient LED bulbs.	
Installation Cost	$250	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$222
Breakeven Cost	$2,602	**Savings-to-Investment Ratio**	10.4	**Simple Payback yrs**	1
Auditors Notes: Replace exterior incandescent light bulbs with LED 17W Module exterior wall packs with photocell control. This will allow the exterior lighting to turn on when it is dark, and shut off automatically when there it daylight.					

Rank	Location	Existing Condition		Recommendation	
3	WTP Exterior Metal Halide	MH 70 Watt Magnetic with Manual Switching		Replace lighting with new energy-efficient LED bulbs.	
Installation Cost	$250	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$160
Breakeven Cost	$1,882	**Savings-to-Investment Ratio**	7.5	**Simple Payback yrs**	2
Auditors Notes: Replace exterior MH 70 Watt Magnetic light bulbs with LED 17W Module exterior wall packs with photocell control. This will allow the exterior lighting to turn on when it is dark, and shut off automatically when there it daylight.					

Rank	Location	Existing Condition		Recommendation	
10	WTP Lighting - 2 Lamp	4 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace lighting with new energy-efficient LED bulbs	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$48
				Maintenance Savings (/yr)	$15
Breakeven Cost	$533	**Savings-to-Investment Ratio**	1.1	**Simple Payback yrs**	8
Auditors Notes: Replace 2-bulb light fixtures with LED replacement light bulbs. This can be done by removing the ballast and direct wiring the light bulbs.					

Rank	Location	Existing Condition		Recommendation	
11	WTP Lighting - 4 Lamp	6 FLUOR (5) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace lighting with new energy-efficient LED bulbs	
Installation Cost	$1,900	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$176
				Maintenance Savings (/yr)	$50
Breakeven Cost	$1,905	**Savings-to-Investment Ratio**	1.0	**Simple Payback yrs**	8
Auditors Notes: Replace 5-bulb light fixtures with LED replacement light bulbs. This can be done by removing the ballast and direct wiring the light bulbs.					

4.5.2 Other Electrical Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
1	North Loop Circulation Pump		Water Circulation Pump with Manual Switching		Shut off water circulation pumps in the summer time.	
Installation Cost		$500	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$1,505
					Maintenance Savings (/yr)	$50
Breakeven Cost		$22,727	**Savings-to-Investment Ratio**	45.5	**Simple Payback yrs**	0
Auditors Notes: Per Leo, North Loop which is the longest loop was on all year in 2013 and this is reflected in electricity usage. Should shut off in summer from July 4th through October 20th just as the other circulation pumps are.						

Rank	Location		Description of Existing		Efficiency Recommendation	
5	Lift Station Pump		Lift Station Pump with Manual Switching		Replace valves that closes off the back up discharge line.	
Installation Cost		$2,400	**Estimated Life of Measure (yrs)**	14	**Energy Savings (/yr)**	$1,422
Breakeven Cost		$15,810	**Savings-to-Investment Ratio**	6.6	**Simple Payback yrs**	2
Auditors Notes: Replace the valve that closes off the back-up discharge line to the slough with a positive valve that can be opened and closed from the floor of the lift station. This will prevent the inflow from the slough during high water conditions that are causing excessive pump run times.						

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 ARUC, the City of Holy Cross, the RMW, and the Water Plant Operator to follow up on the recommendations made in this audit report. A Rural Alaska Village Grant has funded ANTHC to provide the City with assistance in understanding the report and implementing the recommendations.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

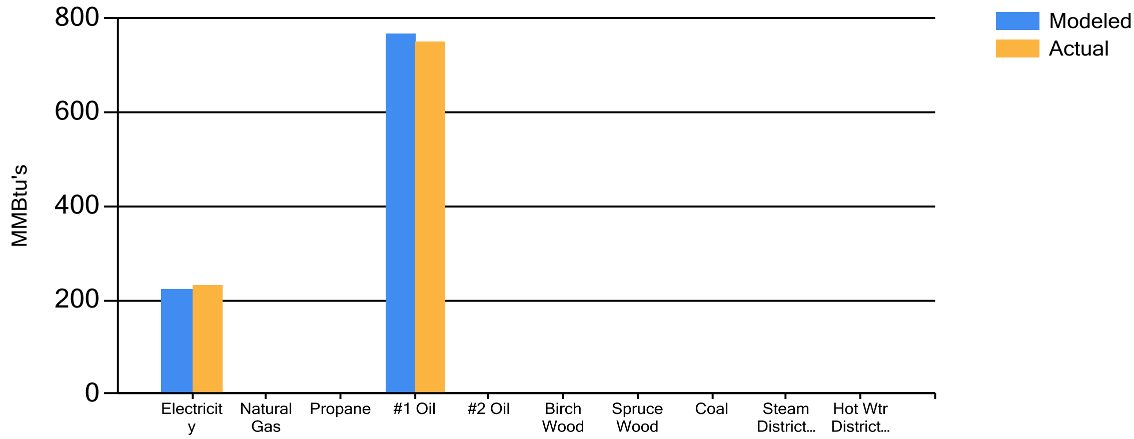
ENERGY AUDIT REPORT – PROJECT SUMMARY – Created 8/7/2014 4:45 PM	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Water Treatment Plant	**Auditor Company:** ANTHC-DEHE
Address: PO Box 227	**Auditor Name:** Carl Remley and Kevin Ulrich
City: Holy Cross	**Auditor Address:** 3900 Ambassador Drive, Suite 301 Anchorage, AK 99508
Client Name: David Walker & Ernest "Leo" Peters Jr & Bruce Werba (RMW)	
Client Address: PO Box 227 Holy Cross, AK 99602	**Auditor Phone:** (907) 729-3543
	Auditor FAX:
Client Phone: (907) 476-7163	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 704 square feet	**Design Space Heating Load:** Design Loss at Space: 13,991 Btu/hour with Distribution Losses: 15,545 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 23,697 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 0 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Holy Cross	**Design Outdoor Temperature:** -38.2 deg F
Weather/Fuel City: Holy Cross	**Heating Degree Days:** 13,462 deg F-days
Utility Information	
Electric Utility: AVEC-Holy Cross - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.505/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate										
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Other Electrical**	**Water Circulation Heat**	**Tank Heat**	**Service Fees**	**Total Cost**
Existing Building	$5,497	$0	$0	$0	$1,320	$26,982	$13,011	$9,815	$60	**$56,685**
With Proposed Retrofits	$2,999	$0	$0	$0	$691	$25,627	$4,342	$3,276	$60	**$36,995**
Savings	$2,498	$0	$0	$0	$629	$1,355	$8,669	$6,539	$0	**$19,690**

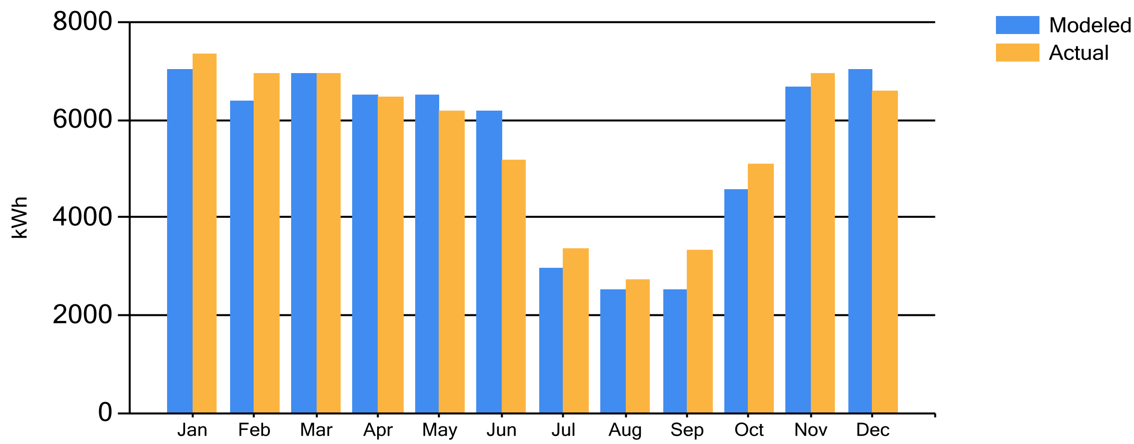
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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