Comprehensive Energy Audit
For
Nunam Iqua Water Treatment Plant & Washeteria

Prepared For

City of Nunam Iqua

June 25, 2012

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PREFACE

The Energy Projects Group at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for the City of Nunam Iqua. The authors of this report are Carl Remley, Certified Energy Auditor (CEA) and Certified Energy Manager (CEM) and Gavin Dixon.

The purpose of this report is to provide a comprehensive document that summarizes the findings and analysis that resulted from an energy audit conducted over the past couple months by the Energy Projects Group of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy efficiency measures. Discussions of site specific concerns and an Energy Efficiency Action Plan are also included in this report.

ACKNOWLEDGMENTS

The Energy Projects Group gratefully acknowledges the assistance of Mathew Ignatius and Dan Johnson, Water Plant Operators, and Carin Finch, City Advisor.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Nunam Iqua. The scope of the audit focused on Water Treatment Plant & Washeteria. The scope of this report is a comprehensive energy study, which included an analysis of building shell, interior and exterior lighting systems, HVAC systems, process loads, washeteria loads and plug loads.

Based on electricity and fuel oil prices in effect at the time of the audit, the annual predicted energy costs for the buildings analyzed are $22,495 for electricity, $16,892 for #1 oil, $11 for recovered heat, and $29,133 for propane. The total energy costs are $68,531 per year.

The recovered heat is provided by the City of Nunam Iqua at no cost to the Water Treatment Plant & Washeteria.

It should be noted that this facility received power cost equalization (PCE) from the State of Alaska last year. If this facility had not received PCE, total electricity cost would have been $79,603.

Table 1.1 below summarizes the energy efficiency measures recommended for the Water Treatment Plant & 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]
1	Utilador glycol Pumps	Shut off the utilador glycol pumps and heat the utilador with the circulated water	$3,509	$10	2172.04	0.0
2	Water circulation loop pumps	Use only the 1 horsepower circulation pumps instead of alternating between the 1 and 2 horsepower pumps.	$524	$10	324.10	0.0
3	Process heat add improvements	Significant fuel oil savings can be realized by repairing/replacing and re-commissioning the controls on the raw water heat add, the potable water storage tank heat add, and the force main glycol loop.	$5,817	$11,000	7.18	1.9
4	Lighting – Water Treatment Plant – high bay metal halide night light	Replace this nightlight with fluorescent (2 lamp) T8 4' F32T8 30 energy-saver lamps	$310	$300	6.39	1.0
5	Improvements to boilers, boiler controls, and heat recovery	Add a boiler control system and upgrade the boilers and heat recovery system.	$3,095	$13,000	4.04	4.2
6	Lighting - Controls retrofit: WTP mezzanine lighting	Add a new occupancy sensor to the mezzanine lighting.	$154	$250	3.81	1.6
7	Lighting - Washeteria rest room incandescent lamps	Replace the Incandescent lamps with 6 - 15 Watt fluorescent CFL lamps	$51	$100	3.13	2.0
8	Lighting – Exterior lighting	Replace the three 70 watt metal halide fixtures with 3 LED 17 watt fixtures.	$282	$750	2.33	2.7
9	Lighting - Power Retrofit: WTP Hi-Bay	Replace the WTP 250 watt fixtures with 8 Fluorescent (4 lamp) T8 4' F32T8 30 watt fixtures	$468	$2,800	1.04	6.0
	TOTAL, all measures		**$14,209**	**$28,220**	**5.82**	**2.0**

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 $14,209 per year, or 20.7% of the buildings' total energy costs. These measures are estimated to cost $28,220, for an overall simple payback period of 2.0 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	Space Cooling	Water Heating	Lighting	Refrigeration	Other Electrical	Process Heat Add	Clothes Drying	Ventilation Fans	Total Cost
Existing Building	$8,367	$0	$121	$3,168	$164	$14,078	$12,516	$30,118	$0	**$68,531**
With All Proposed Retrofits	$5,270	$0	$111	$1,915	$164	$10,045	$6,698	$30,118	$0	**$54,322**
SAVINGS	$3,096	$0	$10	$1,253	$0	$4,032	$5,817	$0	$0	**$14,209**

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 & Washeteria. The scope of this project included evaluating building shell, process loads, lighting and other electrical systems, HVAC 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 and 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 and process loads
- 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 Water Treatment Plant & 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.

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

1) Water Treatment Plant: 2,862 square feet
2) Washeteria: 1,758 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; HVAC; 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. Water Treatment Plant & Washeteria

3.1. Building Description

The 4,620 square foot Water Treatment Plant & Washeteria was constructed in 2001. It has a normal occupancy of one person plus the customers in the Washeteria and one person in the Water Treatment Plant. The number of hours of operation for this building average 40 hours per week in the Water Treatment Plant and 24 hours per week in the Washeteria.

The Water Treatment Plant is used to process raw water into treated potable water, distribute that water throughout the village and then collect the waste water. The Washeteria is used as a place for residents to both wash clothes and take showers. Both the Water Treatment Plant and the Washeteria have rest room facilities.

Raw water is brought into the Water Treatment Plant, processed as required to make it potable, stored, and then circulated though out the village. The water is automatically heated to a controlled temperature at each step of the process. The circulation is done through an enclosed heated utilador that also contains the vacuum sewer lines. Once collected, the sewage is head in a storage tank and when accumulated pumps to a sewage lagoon through a heated discharge line.

The Washeteria is used by some village residents to wash and dry clothes and take showers. There are approximately seven washers and six dryers.

Description of Building Shell

The building shell is of panelized construction with an average of 5.5 inches of polyurethane foam insulation in the walls and six inches in the cathedral ceiling. There are a total of 24 square feet of double pane windows, all of them in the Washeteria.

Description of Heating Plants

The Heating Plants used in the building are:

Weil McClain

Fuel Type:	#1 Oil
Input Rating:	1,005,000 BTU/hr
Steady State Efficiency:	85 %
Idle Loss:	0.75 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Weil McLain

Fuel Type:	#1 Oil
Input Rating:	1,005,000 BTU/hr
Steady State Efficiency:	85 %
Idle Loss:	0.75 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Heat Recovery System

Fuel Type:	Heat Recovery System
Input Rating:	300,000 BTU/hr
Steady State Efficiency:	85 %
Idle Loss:	0.75 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

The majority of the heat (approximately 70 percent) is supplied by the heat recovery system. The remaining is supplied by the two boilers. The entire system is in fair condition but needs some maintenance and control upgrades.

Space Heating Distribution System

The building heat is distributed via a heating loop and associated circulation pump to a combination of baseboard and unit heaters. There is a separate loop that serves the propane storage room.

Domestic Hot Water System

The domestic hot water system is almost exclusively for the services provided by the Washeteria. This includes the washing machines, the showers and the rest rooms. There is a rest room in the Water Treatment Plant as well.

Waste Heat Recovery Information

The City of Nunam Iqua owns and operates an electric power plant to supply electricity for the village. Waste heat from this plant is recovered and utilized in combination with the Water Treatment Plant & Washeteria boilers to provide both space and process heat for the Water Treatment Plant & washeteria.

Description of Building Ventilation System

The only ventilation system is for the propane heated dryers.

Lighting

The existing lighting within the Water Treatment Plant & Washeteria is a combination of incandescent, fluorescent, and metal halide.

Plug Loads

The only significant plug loads are a few small pumps in the Water Treatment Plant, a freezer in the Washeteria, and the washers and dryers.

Major Equipment

The major equipment is mostly associated with the Water Treatment Plant and consists of the raw water pump, the process pumps, the water circulation pumps for the north and south loops, the system pressure pumps, the vacuum sewer pumps, the force main pump, and several heat add pumps associated with the heating system.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

The electric usage profile charts (below) represent the predicted electrical usage for the building. If actual electricity usage records were available, the model used to predict usage was calibrated to approximately match actual usage. The electric utility measures consumption in kilowatt-hours (kWh) and maximum demand in kilowatts (kW). One kWh usage is equivalent to 1,000 watts running for one hour.

The propane usage profile shows the propane usage for the building. Propane is sold by the gallon, and its energy value is approximately 91,800 BTUs per gallon.

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: Nunam Iqua Electric - 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	$ 0.15/kWh
#1 Oil	$ 4.38/gallon
Recovered Heat	$ 0.01/million Btu
Propane	$ 8.00/gallon

The City of Nunam Iqua does not charge for the heat recovered from the power plant and used for heat at the Water Treatment Plant & Washeteria.

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Nunam Iqua pays approximately $68,531 annually for electricity and other fuel costs for the Water Treatment Plant &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

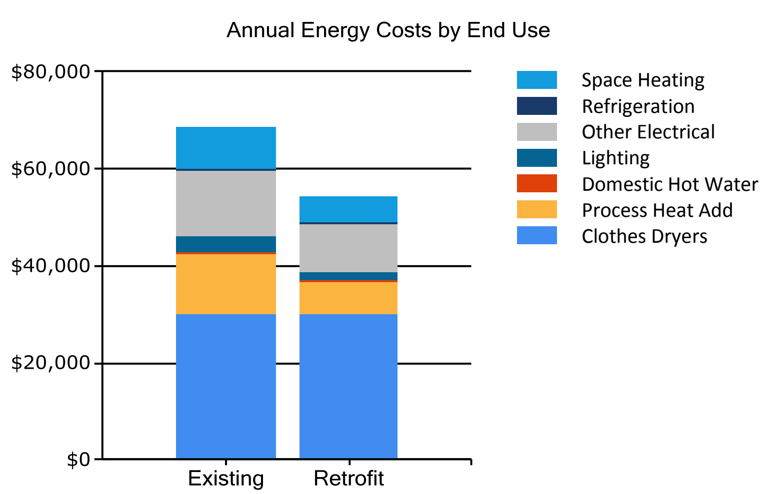


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The “Existing” bar shows the breakdown for the building as it is now; the “Retrofit” bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

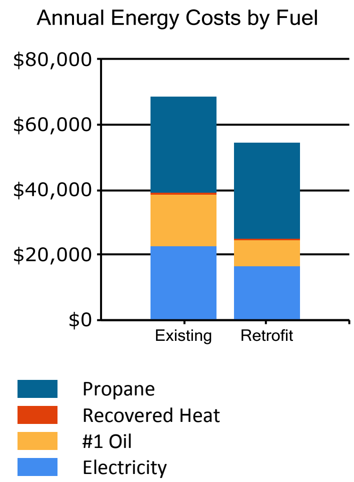
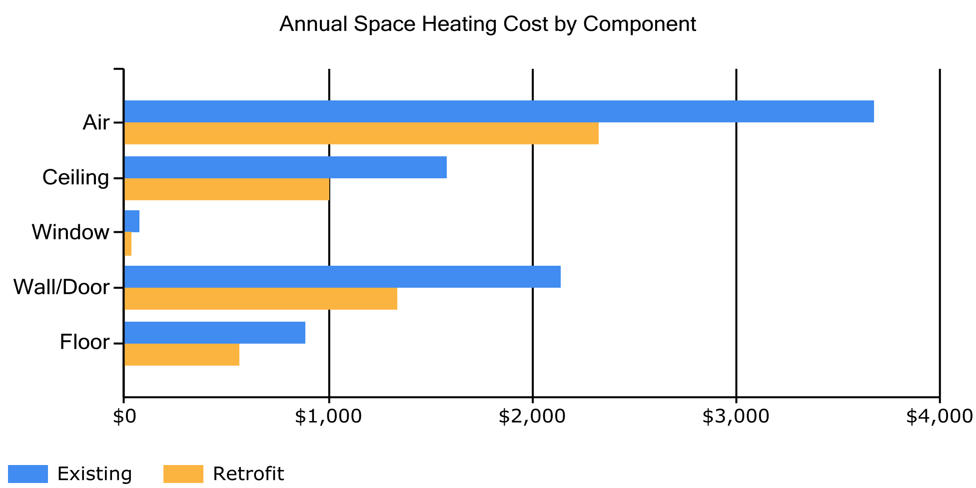


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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
Lighting	1792	1633	1792	1735	1792	1735	1792	1792	1735	1792	1735	1792
Refrigeration	93	85	93	90	93	90	93	93	90	93	90	93
Other Electrical	11117	10131	11117	10758	6812	2686	2776	2776	2686	11117	10758	11117
Clothes Drying	557	508	557	539	557	539	557	557	539	557	539	557
Ventilation Fans	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Hot Water	67	61	67	65	67	65	67	67	65	67	65	67
Space Heating	2269	2066	2257	2174	2245	2173	2250	2245	2173	2246	2178	2269
Space Cooling	0	0	0	0	0	0	0	0	0	0	0	0

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Process Heat Add	242	221	242	235	242	235	242	242	235	242	235	242
Domestic Hot Water	0	0	0	0	0	0	0	0	0	0	0	0
Space Heating	85	77	85	82	85	82	85	85	82	85	82	85

Propane Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Clothes Drying	309	282	309	299	309	299	309	309	299	309	299	309

Recovered Heat Consumption (Million Btu)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Process Heat Add	102	93	102	99	102	0	0	0	0	102	99	102
Domestic Hot Water	21	19	21	21	21	21	21	21	21	21	21	21
Space Heating	6	5	2	0	0	0	2	0	0	0	1	6

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):

Building Site EUI = (Electricity in kBtu + Fuel Oil in kBtu + Propane in KBtu + Recovered Heat in KBtu) / Building Square Footage

Building Source EUI = (Electric Usage in kBtu X SS Ratio + Fuel Oil Usage in kBtu X SS Ratio + similar for other fuels) / Building Square Footage

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

Table 3.4
Water Treatment Plant & 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	149,965 kWh	511,830	3.340	1,709,514
#1 Oil	3,857 gallons	509,086	1.010	514,176
Recovered Heat	1,074.29 million Btu	1,074,288	1.280	1,375,089
Propane	3,642 gallons	334,298	1.010	337,641
Total		**2,429,501**		**3,936,419**
BUILDING AREA		4,620	Square Feet	
BUILDING SITE EUI		526	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		852	**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 HVAC system and central plant are modeled as well, accounting for the outside air ventilation required by the building and the heat recovery equipment in place.

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

For the purposes of this study, the Water Treatment Plant & Washeteria was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Nunum Iqua 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 Nunum Iqua. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the fuel and electric profiles generated will not likely compare perfectly with actual energy billing information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.
• The heating load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building.
• The model does not model HVAC 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
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]
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3	Process heat add improvements	Significant fuel oil savings can be realized by repairing/replacing and re-commissioning the controls on the raw water heat add, the potable water storage tank heat add, and the force main glycol loop.	$5,817	$11,000	7.18	1.9
4	Lighting – Water Treatment Plant – high bay metal halide night light	Replace this nightlight with fluorescent (2 lamp) T8 4' F32T8 30 energy-saver lamps	$310	$300	6.39	1.0
5	Improvements to boilers, boiler controls, and heat recovery	Add a boiler control system and upgrade the boilers and heat recovery system.	$3,095	$13,000	4.04	4.2

Table 4.1 PRIORITY LIST – ENERGY EFFICIENCY MEASURES						
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6	Lighting - Controls retrofit: WTP mezzanine lighting	Add a new occupancy sensor to the mezzanine lighting.	$154	$250	3.81	1.6
7	Lighting - Washeteria rest room incandescent lamps	Replace the Incandescent lamps with 6 - 15 Watt fluorescent CFL lamps	$51	$100	3.13	2.0
8	Lighting – Exterior lighting	Replace the three 70 watt metal halide fixtures with 3 LED 17 watt fixtures.	$282	$750	2.33	2.7
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	TOTAL, all measures		**$14,209**	**$28,220**	**5.82**	**2.0**

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 Mechanical Equipment Measures

4.3.1 Heating/Domestic Hot Water Measure

Rank	**Recommendation**				
5	Add a boiler control system and upgrade the boilers and heat recovery system.				
Installation Cost	$13,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$3,095
Breakeven Cost	$52,560	**Savings-to-Investment Ratio**	4.0	**Simple Payback yrs**	4

The following improvements can significantly reduce fuel oil and electricity consumption by the boilers and associated equipment; a Tekmar controller should be installed to control and sequence the boilers, the hot water circulator should be controlled by the Tekmar, the boilers should be shut off in the summer, the boiler temperatures should be controlled by the Tekmar and reset based on outside temperature, the appropriate control changes should be made to assure that heat can't back feed to the power plant, the system should be set up to maximize use of the heat recovery system, the heat recovery heat exchanger needs to be cleaned and have the gaskets replaced, and both boilers should be cleaned and tuned. This audit assumes that the WTP operators are directly involved in these improvements. The heat exchanger needs to be cleaned due to excessively high pressure drop across both sides. Cleaning it will both increase the amount of heat available and reduce the pumping load.

4.4 Electrical & Appliance Measures

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

4.4.1a Lighting Measures – Replace Existing Fixtures/Bulbs

<table>
<tr><th>Rank</th><th colspan="2">Location</th><th colspan="2">Existing Condition</th><th colspan="2">Recommendation</th></tr>
<tr><td>4</td><td colspan="2">WTP Hi-Bay Night light</td><td colspan="2">MH 250 Watt Magnetic with Manual Switching</td><td colspan="2">Replace with four foot fluorescent (2 lamp) T8 with F32 energy saver lamps.</td></tr>
<tr><td colspan="2">Installation Cost</td><td>$300</td><td>Estimated Life of Measure (yrs)</td><td>7</td><td>Energy Savings (/yr)</td><td>$310</td></tr>
<tr><td colspan="2">Breakeven Cost</td><td>$1,916</td><td>Savings-to-Investment Ratio</td><td>6.4</td><td>Simple Payback yrs</td><td>1</td></tr>
<tr><td colspan="7">Auditors Notes: The existing 250 watt metal halide fixture is used as a night light when the building is not occupied. This fixture should be replaced with a 2 lamp four foot fluorescent fixture which would provide adequate lighting when the WTP is not occupied.</td></tr>
</table>

<table>
<tr><th>Rank</th><th colspan="2">Location</th><th colspan="2">Existing Condition</th><th colspan="2">Recommendation</th></tr>
<tr><td>7</td><td colspan="2">Washeteria Rest Room Incandescent</td><td colspan="2">6 Incandescent A Lamps, Standard 60W with Manual Switching</td><td colspan="2">Replace with 6 Fluorescent CFL, A Lamp 15W</td></tr>
<tr><td colspan="2">Installation Cost</td><td>$100</td><td>Estimated Life of Measure (yrs)</td><td>7</td><td>Energy Savings (/yr)</td><td>$51</td></tr>
<tr><td colspan="2">Breakeven Cost</td><td>$313</td><td>Savings-to-Investment Ratio</td><td>3.1</td><td>Simple Payback yrs</td><td>2</td></tr>
<tr><td colspan="7">Auditors Notes: The incandescent lights in the washeteria rest rooms should be converted to Compact fluorescent lamps. The CFLs only use about 1/4 th of the power and last four times as long.</td></tr>
</table>

Rank	Location	Existing Condition	Recommendation
8	Exterior Lighting	3 MH 70 Watt Magnetic with Manual Switching	Replace with 3 LED 17W wallpack fixtures

Installation Cost	$750	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$282
Breakeven Cost	$1,745	**Savings-to-Investment Ratio**	2.3	**Simple Payback yrs**	3

Auditors Notes: The exterior lighting would use significantly less energy if it was converted from metal halide to LED.

Rank	Location	Existing Condition	Recommendation
9	WTP Hi-Bay	8 MH 250 Watt Magnetic with Manual Switching	Replace with 8 High Bay Fluorescent fixtures (4 lamp) with T8 4' F32 30 watt lamps

Installation Cost	$2,800	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$468
Breakeven Cost	$2,903	**Savings-to-Investment Ratio**	1.0	**Simple Payback yrs**	6

Auditors Notes: The high bay fluorescent fixtures will provide the same amount of light for less operating cost.

4.4.1b Lighting Measures – Lighting Controls

Rank	Location	Existing Condition	Recommendation
6	WTP Mezzanine Lighting	9 Fluorescent (2 lamp) T12 4' F40T12 40W Standard lamps	Add new Occupancy Sensor

Installation Cost	$250	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$154
Breakeven Cost	$951	**Savings-to-Investment Ratio**	3.8	**Simple Payback yrs**	2

Auditors Notes: The fluorescent lights on the mezzanine would use significantly less energy if occupancy sensors were installed to limit their use to when the area was occupied.

4.4.2 Other Electrical Measures

Rank	Location	Description of Existing	Efficiency Recommendation
1	Utilador Glycol Pumps	Utilador Glycol Pumps with Manual Switching	Stop using the utilador glycol pumps

Installation Cost	$10	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$3,509
Breakeven Cost	$21,720	**Savings-to-Investment Ratio**	2,172.0	**Simple Payback yrs**	0

Auditors Notes: The utiladors are heated by two methods presently. Heat is added to the water circulation loops and heat is added to the glycol circulation loop within each utilador. The heated water circulation loops can provide the heat necessary to prevent both the water and sewer lines from freezing. Recommend shutting off the Utilador circulation pumps.

Rank	Location	Description of Existing	Efficiency Recommendation
2	Water Circulation Loop pumps	Water Circulation Loop Pumps with Manual Switching	Use the 1 horsepower circulation pumps exclusively.

Installation Cost	$10	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$524
Breakeven Cost	$3,241	**Savings-to-Investment Ratio**	324.1	**Simple Payback yrs**	0

Auditors Notes: A study done by CE2 Engineers in December of 2010 found that one horsepower pumps could provide the circulation needed for both the north and south loops. At present, the one HP and two HP pumps are alternated weekly. A 25% reduction in consumption will be realized by not alternating them.

4.4.3 Process Heat Add Measures

Rank	Location		Description of Existing			Efficiency Recommendation	
3	Process Heat Add		The controls on the raw water heat add, the potable storage tank head add, and the force main glycol heat add are not functioning as designed.			Significant fuel oil savings can be realized by repairing/replacing and re-commissioning the controls on the raw water heat add, the potable water storage tank heat add, and the force main glycol loop.	
Installation Cost		$11,000	**Estimated Life of Measure (yrs)**	15		**Energy Savings (/yr)**	$5,817
Breakeven Cost		$78,935	**Savings-to-Investment Ratio**	7.2		**Simple Payback yrs**	2
Auditors Notes:							

5. ENERGY EFFICIENCY ACTION PLAN

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

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

APPENDICES

Appendix A – Listing of Energy Conservation and Renewable Energy Websites

Lighting
Illumination Engineering Society - http://www.iesna.org/

Energy Star Compact Fluorescent Lighting Program - www.energystar.gov/index.cfm?c=cfls.pr_cfls

DOE Solid State Lighting Program - http://www1.eere.energy.gov/buildings/ssl/

DOE office of Energy Efficiency and Renewable Energy - http://apps1.eere.energy.gov/consumer/your_workplace/

Energy Star – http://www.energystar.gov/index.cfm?c=lighting.pr_lighting

Hot Water Heaters

Heat Pump Water Heaters -
http://apps1.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=12840

Solar Water Heating

FEMP Federal Technology Alerts – http://www.eere.energy.gov/femp/pdfs/FTA_solwat_heat.pdf

Solar Radiation Data Manual – http://rredc.nrel.gov/solar/pubs/redbook

Plug Loads

DOE office of Energy Efficiency and Renewable Energy – http:apps1.eere.energy.gov/consumer/your_workplace/

Energy Star – http://www.energystar.gov/index.cfm?fuseaction=find_a_product

The Greenest Desktop Computers of 2008 - http://www.metaefficient.com/computers/the-greenest-pcs-of-2008.html

Wind

AWEA Web Site – http://www.awea.org

National Wind Coordinating Collaborative – http:www.nationalwind.org

Utility Wind Interest Group site: http://www.uwig.org

WPA Web Site – http://www.windpoweringamerica.gov

Homepower Web Site: http://homepower.com

Windustry Project: http://www.windustry.com

Solar

NREL – http://www.nrel.gov/rredc/

Firstlook – http://firstlook.3tiergroup.com

TMY or Weather Data – http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/

State and Utility Incentives and Utility Policies - http://www.dsireusa.org