Comprehensive Energy Audit
For

Noorvik Water Treatment Plant

Prepared For

City of Noorvik

November 17, 2015

Prepared By:

ANTHC-DEHE
4500 Diplomacy Dr.,
Anchorage, AK 99508

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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 Noorvik, Alaska. The authors of this report are Kevin Ulrich, Energy Manager-in-Training (EMIT); Chris Mercer, Certified Energy Manager (CEM); and Praveen K.C., Professional Engineer (PE)

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

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of Water Treatment Plant Operators Elino Bantatua and Eric Howarth, Noorvik City Clerk Lisa Cleveland, and Noorvik City Administrator Roberta Murphy.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Noorvik and the Alaska Rural Utility Collaborative (ARUC). The scope of the audit focused on Noorvik Water Treatment Plant. 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 and distribution processes, and plug loads.

In the near future, a representative of ANTHC will be contacting both the City of Noorvik and the water treatment plant operators 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 2016 calendar year.

The total predicted energy cost for the Noorvik Water Treatment Plant is $196,757 per year. Electricity represents the largest portion with an annual cost of $122,888. This includes $42,375 paid by the city and $80,513 paid by the Power Cost Equalization (PCE) program through the State of Alaska. Fuel oil represents the remaining portion with an annual cost of $73,868.

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 Noorvik, the cost of electricity without PCE is $0.58/KWH and the cost of electricity with PCE is $0.20/KWH.

There is a heat recovery project currently underway to transfer recovered heat from the generator cooling loop in the power plant to the water treatment plant. The power plant has individual cooling loops and the project would tie the three loops into a common cooling loop. The project was funded by a grant from the Renewable Energy Fund Round 6 administered by the Alaska Energy Authority and is expected to have a significant impact in the fuel usage for the Noorvik Water Treatment Plant.

The table below lists the total usage of electricity and #1 oil in the water treatment plant a before and after the proposed retrofits.

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	235,550 kWh	153,515 kWh
#1 Oil	16,415 gallons	3,512 gallons

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	594.9	37.95	$39.40
With Proposed Retrofits	197.7	12.61	$19.12
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 Noorvik 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]	CO_2 Savings
1	Other Electrical -: Backwash Pump	Reduce backwash time from 20 minutes per pressure tank to 10 minutes per pressure tank.	$2,827	$500	82.61	0.2	560.8
2	Other Electrical - Backwash Effluent Pump	Reduce backwash time from 20 minutes per pressure tank to 10 minutes per pressure tank.	$622	$250	36.36	0.4	123.8
3	Water Circulation Heating Load	Lower circulation temperature to 34F.	$28,065	$16,000	30.49	0.6	131,610.4
4	Other Electrical - Hydronic Circulation Pumps	Shut off one pump and operate one of the two pumps at a time.	$4,159	$2,000	24.00	0.5	15,569.3
5	Setback Thermostat: Water Treatment Plant	Install a programmable thermostat and set temperature back to 60 deg. F when unoccupied for the Water Treatment Plant space.	$853	$500	22.96	0.6	3,956.2
6	Other Electrical - Lift Station Electric Heat	Shut off electric heater in lift station and convert to using glycol-based unit heater.	$5,201	$3,000	20.37	0.6	19,966.0
7	Other Electrical - Raw Water Heat Tape	Shut off heat tape and use only for emergency that purposes.	$6,628	$5,000	19.37	0.8	25,441.9
8	Heating, Ventilation, and Domestic Hot Water	Clean and tune boilers to remove soot and improve efficiency. Add controls to the garage unit heater to reduce run time. Remove glycol from cold storage room baseboard heaters so that no unnecessary heating is applied to this space.	$7,516	$10,000	12.84	1.3	33,241.3
9	Water Circulation Heating Load	Lower circulation temperature to 34F.	$8,667	$16,000	7.35	1.8	40,678.1
10	Lighting - Garage	Replace new energy-efficient LED lighting and add new occupancy sensor.	$470	$980	5.65	2.1	1,445.7

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
11	Water Circulation Heating Load	Lower circulation temperature to 34F.	$5,436	$16,000	4.61	2.9	25,511.2
12	Lighting - Loft	Replace new energy-efficient LED lighting.	$60	$160	4.39	2.7	183.3
13	Other Electrical - Vacuum Pump 2	Replace vacuum pump with new modulating Mink pump.	$10,227	$35,000	4.23	3.4	38,842.8
14	Water Circulation Heating Load	Lower circulation temperature to 34F.	$4,491	$16,000	3.81	3.6	21,075.8
15	Lighting - Water Treatment Room, 4-Bulb Fixtures	Replace new energy-efficient LED lighting and add new occupancy sensor.	$3,577	$11,500	3.66	3.2	10,954.1
16	Lighting - Office	Replace new energy-efficient LED lighting and add new occupancy sensor.	$181	$660	3.23	3.6	553.9
17	Lighting - Vacuum System Room	Replace new energy-efficient LED lighting and add new occupancy sensor.	$848	$3,460	2.88	4.1	2,589.6
18	Other Electrical - Vacuum Pump 1	Replace vacuum pump with new modulating Mink pump.	$6,710	$35,000	2.76	5.2	25,344.1
19	Water Storage Tank Heating Load	Lower water storage tank temperature from 50F to 34F and add a tank mixer to prevent ice formation.	$3,033	$23,000	1.92	7.6	15,634.9
20	Lighting - Water Treatment Room, 2-Bulb Fixtures	Replace new energy-efficient LED lighting and add new occupancy sensor.	$510	$3,140	1.91	6.2	1,543.3
21	Lighting - Entryway	Replace new energy-efficient LED lighting and add new occupancy sensor.	$64	$580	1.29	9.1	192.8
22	Raw Water Intake Heating Load	Lower raw water heat add from 43F to 40F and reduce flow rate from 27 GPM to 15 GPM.	$659	$8,000	1.12	12.1	3,091.9
23	Setback Thermostat: Lift Station	Install a programmable thermostat and set temperature back to 40 deg. F when unoccupied for the Lift Station space.	$62	$1,000	0.83	16.2	285.5
24	Ventilation	Build enclosure around the chlorine injection system and reduce chlorine ventilation fan run time to emergency purposes.	$577	$15,000	0.77	26.0	354.4
25	Exterior Door: Entryway Door	Remove existing door and install a new door with an insulated core.	$34	$1,211	0.66	35.7	157.4

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
26	Exterior Door: Garage Door	Remove existing door and install a new door with an insulated core.	$49	$1,817	0.63	37.1	226.7
27	Exterior Door: Process Room Door	Remove existing door and install a new door with an insulated core.	$48	$1,817	0.62	38.1	220.8
28	Exterior Door: Cold Storage Room Door	Remove existing door and install a new door with an insulated core.	$47	$1,817	0.61	38.4	219.1
29	Window: Process Room Broken Window	Replace existing window with triple-pane window.	$14	$633	0.38	45.9	63.8
30	Window: Office	Replace existing window with triple-pane window.	$13	$633	0.34	50.4	58.3
31	Backwash Heating Load	Lower backwash temperature to 38F and reduce backwash time to half of the current schedule.	$54	$3,000	0.31	55.4	254.3
32	Lighting - Lift Station	Replace new energy-efficient LED lighting.	$4	$200	0.23	50.8	17.4
33	Lighting - Bathroom	Replace new energy-efficient LED lighting.	$1	$100	0.18	67.0	6.6
34	Lighting - Cold Storage Room	Replace new energy-efficient LED lighting and add new occupancy sensor.	$11	$820	0.16	75.7	47.9
35	Window: Process Room, Non-South Walls	Replace existing window with triple-pane window.	$20	$3,163	0.11	157.0	93.3
36	Window: Garage	Replace existing window with triple-pane window.	$7	$1,265	0.10	171.4	34.2
37	Window: Process Room - South Wall	Replace existing window with triple-pane window.	$7	$1,265	0.10	171.4	34.3
38	Setback Thermostat: Garage	Install a programmable thermostat and set temperature back to 50 deg. F when unoccupied for the Garage space.	$0	$500	0.00	999.9	0.0
	TOTAL, all measures		**$101,749**	**$240,972**	**6.31**	**2.4**	**420,184.9**

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 $101,249 per year, or 51.5% of the buildings' total energy costs. These measures are estimated to cost $240,972, for an overall simple payback period of 2.4 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**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$5,881	$448	$171	$7,617	$113,240	$3,456	$58,815	$6,588	**$196,757**
With Proposed Retrofits	$5,792	$389	$170	$2,552	$74,312	$2,622	$6,461	$2,670	**$95,508**
Savings	$90	$59	$1	$5,065	$38,928	$834	$52,354	$3,919	**$101,249**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Noorvik Water Treatment Plant. 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
- Water consumption, treatment (optional) & 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 Noorvik Water Treatment Plant 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.

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

1) Garage: 475 square feet
2) Water Treatment Plant: 4,375 square feet
3) Lift Station: 144 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. Noorvik Water Treatment Plant

3.1. Building Description

The 4,994 square foot Noorvik Water Treatment Plant was constructed in 1970, with a normal occupancy of 4 people. The number of hours of operation for this building average 8 hours per day, considering five days of the week.

The Noorvik Water Treatment Plant serves as the water distribution center for the residents of the community and also houses the sewer system components.

The Noorvik Water Treatment Plant has four distribution loops with that are used to provide water service to the community. All four loops use 3" piping within a heated utilidor to distribute the water. Common utilidors are shared by all water loops, sewer loops, and glycol heat trace loops that run throughout the community. The South Loop serves the southern part of town and has a length of approximately 3300 ft. The Hotham Peak Loop serves the southern and eastern parts of town and has a length of approximately 6500 ft. The School Loop serves the school and surrounding residences and has a length of approximately 4100 ft. The North Loop serves the northern part of town and has a length of approximately 8400 ft.

Water is pumped into the water treatment plant from a raw water intake in the nearby Kobuk River approximately 750 ft. from the building. The water is pumped through pressure filter tanks and is injected with a variety of chemicals before being pumped in to the large settlement tank inside the water treatment plant building. The water is then transferred to the water storage tank where it stays before being distributed through the water circulation loops.

Description of Building Shell

The exterior walls are constructed with stressed skin panels that are 12 inches thick with 10.5 inches of polyurethane foam insulation. The insulation is slightly damaged and there are 4,401 square feet of wall space in the building.

The building has a cathedral ceiling with standard framing and six inches of polyurethane foam insulation. The framing has a standard spacing of 24 inches. The insulation has some damage and there is approximately 4,854 square feet of roof space in the building.

The building is built on pilings with I-joist framing. The bottom layer is ten inches thick with 9.5 inches of blue foam insulation. The insulation is slightly damaged and there is approximately 4,850 square feet of floor space in the building.

There are 11 windows in the building and each window has approximately five square feet of area for a total window space of 55 square feet. The windows are double-paned with wood framing. There are broken windows in the office and near the raw water intake that have shattered glass and the office window has been covered with plywood. Additionally, a window in the vacuum room is permanently propped open with no ability to close the mechanism.

There are four total entrances into the building including three sets of double doors and one single door. The main entryway has a single door with a wooden core and metal sheathing. The other entrances are located in the garage, the cold storage room, and near the oil-fired boilers and all the doors are also made from a wooden core with metal sheathing. Between the four entrances there are seven total doors and approximately 154 square feet of door space.

Description of Heating Plants

The Heating Plants used in the building are:

Boiler 1

Nameplate Information:	Burnham V906A
Fuel Type:	#1 Oil
Input Rating:	400,000 BTU/hr
Steady State Efficiency:	60 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	Aug - Jun
Notes:	Rated for 703,000 BTU/H

Nozzle size is for 4 GPH at 100PSI, Boiler is currently operated at 60PSI fuel pressure, so assumed fuel supply value is 3 GPH.

Boiler 2

Nameplate Information:	Burnham V906A
Fuel Type:	#1 Oil
Input Rating:	400,000 BTU/hr
Steady State Efficiency:	60 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	Aug - Jun
Notes:	Rated for 703,000 BTU/H

Nozzle size is for 4 GPH at 100PSI, Boiler is currently operated at 60PSI fuel pressure, so assumed fuel supply value is 3 GPH.

The boilers were inspected for soot residue and general cleanliness. The inside of Boiler 1 is shown in the picture below. The inner chamber has a consistent soot coating that reduces the operating efficiency and creates more losses.

Space Heating Distribution Systems

There are six total unit heaters associated with the water treatment plant with four of them in the main treatment process room, one in the garage, and one in the lift station building. Out of the four in the main process room, only three of them are functional. The unit heaters are a Grinell Thermolier model with 1/8 HP motors that combined to produce approximately 72,000 BTU/hr. The garage unit heater has a ¼ HP motor and produces approximately 40,000 BTU/hr, but the leakage in the garage causes this unit to operate constantly during the heating months. The lift station unit heater is a small Modine model with a 0.15 HP motor but it is rarely used because of an electric heater in the lift station that is run constantly.

In addition to the unit heaters, there are baseboard heaters present in the main process room and the cold storage room that distribute heat from flowing glycol into the open space.

Domestic Hot Water System

There is an Amtrol hot water heater with a 75 gallon capacity that is used to provide hot water for the bathroom sink, utility sink, and the shower. The shower is rarely used and the sinks are used occasionally throughout the day. The average estimated hot water usage for the building is approximately 5 gallons per day.

Description of Building Ventilation System

The boilers and vacuum pumps are ventilated through stacks that penetrate the roof of the building. There is a ventilation fan near the chemical injection point that is used to move air cycle outside air to the area with the chlorine tank to prevent air contamination. Chlorine requires continuous ventilation if it is in an occupied area.

Lighting

The main water treatment plant process room has 28 fixtures with four T8 4-ft. fluorescent light bulbs in each fixture. The lights are on for 8 hours per day and they consume approximately 9,215 KWH annually.

The main water treatment plant process room has 8 fixtures with two T8 4-ft. fluorescent light bulbs in each fixture. The lights are on for 8 hours per day and they consume approximately 1,345 KWH annually.

The vacuum sewer room has 6 fixtures with four T12 4-ft. fluorescent light bulbs in each fixture. The lights are on for 8 hours per day and 75% of the time and they consume approximately 1,889 KWH annually.

The garage has 6 fixtures with two T12 4-ft. fluorescent light bulbs in each fixture. The lights are on for 8 hours per day and 80% of the time and they consume approximately 1,012 KWH annually.

The office has 2 fixtures with two T12 4-ft. fluorescent light bulbs in each fixture. The lights are on for 8 hours per day and they consume approximately 422 KWH annually.

The entryway has one fixture with two T12 4-ft. fluorescent light bulbs in the fixture. The lights are on for 8 hours per day and they consume approximately 168 KWH annually.

The loft has 2 fixtures with two T8 4-ft. fluorescent light bulbs in each fixture. The lights are on for 8 hours per day and they consume approximately 336 KWH annually.

The cold storage room has 2 fixtures with four T8 4-ft. fluorescent light bulbs in each fixture. The lights are on for about 30 minutes per day and they consume approximately 41 KWH annually.

The bathroom has one fixture with two T12 2-ft. fluorescent light bulbs in the fixture. The lights are on about 30 minutes per day and they consume approximately 11 KWH annually.

The lift station has 6 fixtures with an A-Lamp 75 Watt incandescent light bulb in each fixture. The lights are only used when the operators are in the lift station for about 30 minutes per week and they consume approximately 12 KWH annually.

Plug Loads

The water treatment plant has a variety of power tools, a telephone, and some 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 two vacuum pumps in the building that are used to collect all the sewage from the vacuum sewer system. One pump is a Toshiba model that is rated for 10 HP and was measured by an energy meter to operate at approximately 6300 Watts of power. The pump runs 78% of the time all year long and consumes approximately 43,076 KWH annually. The second vacuum pump is a Baldor model that is rated for 10 HP and was measured by an energy meter to operate at approximately 6900 Watts of power. The pump runs 88% of the time all year long and consumes approximately 53,227 KWH annually.

There are vacuum discharge pumps that are used to discharge the collected sewage to the sewage lagoon. The pumps are rated for 6,500 Watts and one of the pumps runs approximately 5% of the time all year long. They consume approximately 2,849 KWH annually.

There are four sets of circulations pumps with one set of two circulation pumps for each of the four distribution loops. The South Loop has two pumps that are rated for 1.5 HP and were measured by an energy meter to use approximately 710 Watts of power. One of the pumps runs constantly from September to May and they consume approximately 4,145 KWH annually. The North Loop has two pumps that are rated for 1.5 HP and were measured by an energy meter to use approximately 710 Watts of power. One of the pumps runs constantly from September to May and they consume approximately 4,145 KWH annually. The school loop has two pumps that are rated for 1.5 HP and were measured by an energy meter to use approximately 860 Watts of power. One of the pumps runs constantly from September to May and they consume approximately 5,021 KWH of power. The Hotham Peak Loop has two pumps that are rated for 3 HP and were measured by an energy meter to use approximately 1,850 Watts annually. One of the pumps runs constantly from September to May and they consume approximately 10,800 KWH annually.

Each of the four circulation loops has a glycol circulation pump that is used to distribute heated glycol through the utilidors that run the entire length of the distribution loops. The South Loop has a pump that is rated for 1.5 HP and was measured by an energy meter to consume approximately 750 Watts of power. The pump runs constantly from September to May and consumes approximately 4,379 KWH annually. The North Loop has a pump that is rated for 1.5 HP and was measured by an energy meter to consume approximately 750 Watts of power. The pump runs constantly from September to May and consumes approximately 4,379 KWH annually. The School Loop has a pump that is rated for 1.5 HP and was measured by an energy meter to consume approximately 750 Watts of power. The pump runs constantly from September to May and consumes approximately 4,379 KWH annually. The Hotham Peak Loop has a pump that is rated for 1.5 HP and was measured by an energy meter to consume approximately 530 Watts of power. The pump runs constantly from September to May and consumes approximately 3,094 KWH annually.

There is a heat tape line that is used to heat the raw water intake line from the intake structure to the building. The heat tape is in constant operation from September to May and the light indicator on the panel was broken during our visit. The heat tape consumes approximately 14,572 KWH annually.

There is a heat tape line that is used to heat the pipe between the water treatment plant building and the water storage tank. The heat tape is only used for emergency purposes and consumes approximately 164 KWH annually.

There are two pumps that are used to add heat to the water storage tank through a small glycol line. The pumps are rated at 87 Watts and one of the pumps runs constantly from September through April. The pumps consume approximately 477 KWH annually.

There are two pumps that are used to distribute heated glycol to the sewer force main heat trace lines to prevent the sewage from freezing. The pumps are rated for 1,125 Watts and one of the pumps runs constantly from September to May. The pumps consume approximately 6,568 KWH annually.

There are two pumps that are used to heat the tank box and utilidor between the water treatment plant building and the water storage tank. The pumps are rated at 85 Watts and both of them run constantly from September through April. The pumps consume approximately 931 KWH.

There are two pressure pumps that are used to keep the pressure in the water system at an acceptable level. The pumps are rated at 5 HP and one of the pumps runs 8% of the time all year long. The pumps consume approximately 1,985 KWH annually.

There is a glycol reservoir tank that is used to heat an expansion tank for the hydronic heating system. The pump is rated for 3 HP and is estimated to run approximately 30 minutes per week. The pump consumes approximately 59 KWH annually.

There are two pumps that fire with the boilers to cycle the glycol through the system. The pumps are rated for 300 Watts and run whenever the boilers are firing during the heating season from September to May. The pumps consume approximately 1,751 KWH annually.

There are two circulation pumps that are used to circulate the heated glycol throughout the hydronic heating system to all the individual heat-add loads. The pumps are rated at 1700 Watts of power each and both of them run constantly from September to May. The two pumps consume approximately 19,849 KWH annually.

There is a glycol makeup pump that is used to circulate the glycol as it is used in the heating system. The pump is rated for 250 Watts and runs constantly from September to May. The pump consumes approximately 1,460 KWH annually.

There are heat trace pumps that are used to circulate heated glycol through the raw water heat trace lines to prevent the raw water from freezing. The pumps are rated for 1,150 Watts and one of the pumps runs constantly from September to May.   The pumps consume approximately 6,714 KWH annually.

There is a circulation pump that is used to pull water from the raw water intake through the raw water heat exchanger. The pump is rated for 150 Watts and runs constantly from September to May. The pump consumes approximately 876 KWH annually.

There are two pumps that are used to inject polymer into the water treatment process. The pumps are rated for 50 Watts and one of the pumps runs constantly from September to May. The pumps consume approximately 584 KWH annually.

There is a process water reclaim pump that is used to pump water from the water intake to the sewer treatment process. The pump is rated for 250 Watts and runs constantly from September to May. The pump consumes approximately 1,460 KWH annually.

There are three pumps that are used to feed chemicals into the untreated water for the water treatment process. The pumps are rated at 22 Watts each and all of the pumps run constantly from September to May. The pumps consume approximately 385 KWH annually.

There is a backwash pump that is used in the backwash process to clean the filters. The pump is rated for 15 HP and operates for about one hour per week throughout the year. The pump consumes approximately 609 KWH annually.

There are two backwash effluent pumps that are used to pump the waste water from the backwash process into the large holding tank. The pumps are rated for 2200 Watts of power and one of them runs about one hour per week throughout the year. The pumps consume approximately 134 KWH annually.

There is a backwash air scour that is used to remove excess air from the backwash process. The pump is rated for 5 HP and operates for about one hour per week throughout the year. The pump consumes approximately 213 KWH annually.

The lift station has two pumps that are used to collect the sewage from the south part of town as well as the school and push the sewage to the sewage lagoon. The pumps are rated at 5 HP and one of the pumps runs about 13% of the time all year long. The pumps consume approximately 3,875 KWH annually.

The lift station has an electric heat tape that is used to thaw the sewer collection lines that run to the lift station. The heat tape was estimated to be approximately 5000 ft. long and runs only for emergency thaw purposes during the winter. The heat tape consumes approximately 4,379 KWH annually.

There is an electric heater in the lift station that is used to provide space heat in the building. The heater runs constantly from September to May and consumes approximately 11,676 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 Alaska Village Electric Cooperative (AVEC) provides electricity to the residents of Noorvik as well as all the commercial and public facilities.

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	$ 0.58/kWh
#1 Oil	$ 4.50/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, ARUC pays approximately $196,757 annually for electricity and other fuel costs for the Noorvik Water Treatment Plant.

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

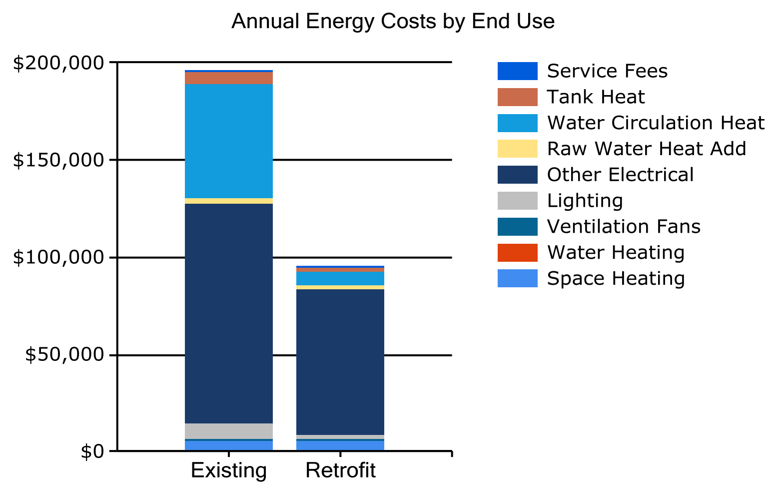


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

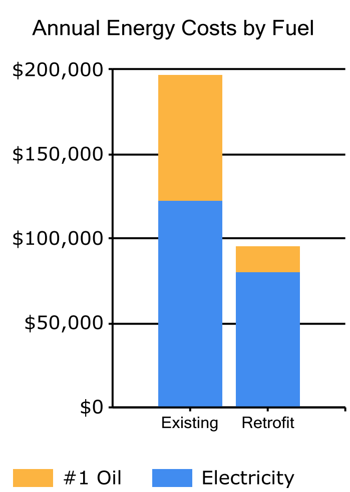
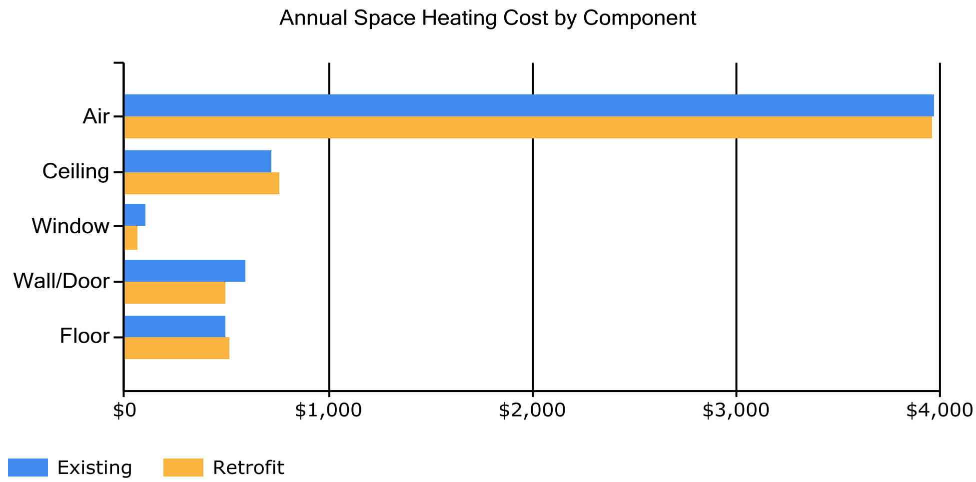


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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	85	82	63	44	46	44	46	46	45	46	44	84
DHW	1	1	1	2	1	0	0	0	0	1	1	1
Ventilation Fans	28	25	28	27	28	27	28	28	27	28	27	28
Lighting	1227	1118	1227	1187	1227	1187	1227	1227	1187	1227	1187	1227
Other Electrical	23382	21308	23382	22695	15832	8534	8819	8819	16051	23382	22628	23382
Raw Water Heat Add	12	10	12	11	1	1	1	1	7	12	11	12
Water Circulation Heat	248	235	237	170	75	24	8	11	34	125	189	254
Tank Heat	27	26	26	18	9	3	0	0	4	14	21	28

Fuel Oil #1 Consumption (Gallons)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	149	146	110	77	85	76	79	108	88	82	77	151
DHW	11	11	11	15	9	3	3	3	4	7	9	12
Raw Water Heat Add	95	87	95	93	10	9	9	13	60	98	93	95
Water Circulation Heat	1971	1904	1880	1345	620	197	68	117	279	989	1500	2016
Tank Heat	222	214	212	153	78	20	0	0	34	114	170	227

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
Noorvik 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	235,550 kWh	803,931	3.340	2,685,128
#1 Oil	16,415 gallons	2,166,806	1.010	2,188,474
Total		**2,970,737**		**4,873,602**
BUILDING AREA		4,994	Square Feet	
BUILDING SITE EUI		595	$kBTU/Ft^2/Yr$	
BUILDING SOURCE EUI		976	**$kBTU/Ft^2/Yr$**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

Table 3.5

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	594.9	37.95	$39.40
With Proposed Retrofits	197.7	12.61	$19.12
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 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 Noorvik Water Treatment Plant was modeled using AkWarm© energy use software to establish a baseline space heating energy usage. Climate data from Noorvik 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 Noorvik. 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 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. Calculations and cost estimates for analyzed measures are provided in Appendix C.

Table 4.1 Noorvik Water Treatment Plant, Noorvik, 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	Other Electrical -: Backwash Pump	Reduce backwash time from 20 minutes per pressure tank to 10 minutes per pressure tank.	$2,827	$500	82.61	0.2	560.8
2	Other Electrical - Backwash Effluent Pump	Reduce backwash time from 20 minutes per pressure tank to 10 minutes per pressure tank.	$622	$250	36.36	0.4	123.8
3	Water Circulation Heating Load	Lower circulation temperature to 34F.	$28,065	$16,000	30.49	0.6	131,610.4
4	Other Electrical - Hydronic Circulation Pumps	Shut off one pump and operate one of the two pumps at a time.	$4,159	$2,000	24.00	0.5	15,569.3
5	Setback Thermostat: Water Treatment Plant	Install a programmable thermostat and set temperature back to 60 deg. F when unoccupied for the Water Treatment Plant space.	$853	$500	22.96	0.6	3,956.2
6	Other Electrical - Lift Station Electric Heat	Shut off electric heater in lift station and convert to using glycol-based unit heater.	$5,201	$3,000	20.37	0.6	19,966.0
7	Other Electrical - Raw Water Heat Tape	Shut off heat tape and use only for emergency that purposes.	$6,628	$5,000	19.37	0.8	25,441.9
8	Heating, Ventilation, and Domestic Hot Water	Clean and tune boilers to remove soot and improve efficiency. Add controls to the garage unit heater to reduce run time. Remove glycol from cold storage room baseboard heaters so that no unnecessary heating is applied to this space.	$7,516	$10,000	12.84	1.3	33,241.3
9	Water Circulation Heating Load	Lower circulation temperature to 34F.	$8,667	$16,000	7.35	1.8	40,678.1
10	Lighting - Garage	Replace new energy-efficient LED lighting and add new occupancy sensor.	$470	$980	5.65	2.1	1,445.7
11	Water Circulation Heating Load	Lower circulation temperature to 34F.	$5,436	$16,000	4.61	2.9	25,511.2
12	Lighting - Loft	Replace new energy-efficient LED lighting.	$60	$160	4.39	2.7	183.3

Table 4.1 Noorvik Water Treatment Plant, Noorvik, 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**
13	Other Electrical - Vacuum Pump 2	Replace vacuum pump with new modulating Mink pump.	$10,227	$35,000	4.23	3.4	38,842.8
14	Water Circulation Heating Load	Lower circulation temperature to 34F.	$4,491	$16,000	3.81	3.6	21,075.8
15	Lighting - Water Treatment Room, 4-Bulb Fixtures	Replace new energy-efficient LED lighting and add new occupancy sensor.	$3,577	$11,500	3.66	3.2	10,954.1
16	Lighting - Office	Replace new energy-efficient LED lighting and add new occupancy sensor.	$181	$660	3.23	3.6	553.9
17	Lighting - Vacuum System Room	Replace new energy-efficient LED lighting and add new occupancy sensor.	$848	$3,460	2.88	4.1	2,589.6
18	Other Electrical - Vacuum Pump 1	Replace vacuum pump with new modulating Mink pump.	$6,710	$35,000	2.76	5.2	25,344.1
19	Water Storage Tank Heating Load	Lower water storage tank temperature from 50F to 34F and add a tank mixer to prevent ice formation.	$3,033	$23,000	1.92	7.6	15,634.9
20	Lighting - Water Treatment Room, 2-Bulb Fixtures	Replace new energy-efficient LED lighting and add new occupancy sensor.	$510	$3,140	1.91	6.2	1,543.3
21	Lighting - Entryway	Replace new energy-efficient LED lighting and add new occupancy sensor.	$64	$580	1.29	9.1	192.8
22	Raw Water Intake Heating Load	Lower raw water heat add from 43F to 40F and reduce flow rate from 27 GPM to 15 GPM.	$659	$8,000	1.12	12.1	3,091.9
23	Setback Thermostat: Lift Station	Install a programmable thermostat and set temperature back to 40 deg. F when unoccupied for the Lift Station space.	$62	$1,000	0.83	16.2	285.5
24	Ventilation	Build enclosure around the chlorine injection system and reduce chlorine ventilation fan run time to emergency purposes.	$577	$15,000	0.77	26.0	354.4

Table 4.1 Noorvik Water Treatment Plant, Noorvik, 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**
25	Exterior Door: Entryway Door	Remove existing door and install a new door with an insulated core.	$34	$1,211	0.66	35.7	157.4
26	Exterior Door: Garage Door	Remove existing door and install a new door with an insulated core.	$49	$1,817	0.63	37.1	226.7
27	Exterior Door: Process Room Door	Remove existing door and install a new door with an insulated core.	$48	$1,817	0.62	38.1	220.8
28	Exterior Door: Cold Storage Room Door	Remove existing door and install a new door with an insulated core.	$47	$1,817	0.61	38.4	219.1
29	Window: Process Room Broken Window	Replace existing window with triple-pane window.	$14	$633	0.38	45.9	63.8
30	Window: Office	Replace existing window with triple-pane window.	$13	$633	0.34	50.4	58.3
31	Backwash Heating Load	Lower backwash temperature to 38F and reduce backwash time to half of the current schedule.	$54	$3,000	0.31	55.4	254.3
32	Lighting - Lift Station	Replace new energy-efficient LED lighting.	$4	$200	0.23	50.8	17.4
33	Lighting - Bathroom	Replace new energy-efficient LED lighting.	$1	$100	0.18	67.0	6.6
34	Lighting - Cold Storage Room	Replace new energy-efficient LED lighting and add new occupancy sensor.	$11	$820	0.16	75.7	47.9
35	Window: Process Room, Non-South Walls	Replace existing window with triple-pane window.	$20	$3,163	0.11	157.0	93.3
36	Window: Garage	Replace existing window with triple-pane window.	$7	$1,265	0.10	171.4	34.2
37	Window: Process Room - South Wall	Replace existing window with triple-pane window.	$7	$1,265	0.10	171.4	34.3
38	Setback Thermostat: Garage	Install a programmable thermostat and set temperature back to 50 deg. F when unoccupied for the Garage space.	$0	$500	0.00	999.9	0.0
	TOTAL, all measures		**$101,749**	**$240,972**	**6.31**	**2.4**	**420,184.9**

4.2 Interactive Effects of Projects

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

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

Interior lighting, plug loads, facility equipment, and occupants generate heat within the building. Lighting-efficiency improvements are anticipated to slightly increase heating requirements. Heating penalties were included in the lighting project analysis.

4.3 Building Shell Measures

4.3.1 Window Measures

Rank	Location	Size/Type, Condition	Recommendation
29	Window: Process Room Broken Window	Glass: No glazing - broken, missing Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.94 Solar Heat Gain Coefficient including Window Coverings: 0.11	Replace existing window with triple-pane window.

Installation Cost	$633	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$14
Breakeven Cost	$238	**Savings-to-Investment Ratio**	0.4	**Simple Payback yrs**	46

Auditors Notes: This window has been shattered at some point and there is no cover to prevent heat loss through the broken glass. The window should be replaced because of the damages and the replacement window can be a triple-pane window for energy efficiency purposes.

Rank	Location	Size/Type, Condition	Recommendation
30	Window: Office	Glass: No glazing - broken, missing Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.94 Solar Heat Gain Coefficient including Window Coverings: 0.11	Replace existing window with triple-pane window.

Installation Cost	$633	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$13
Breakeven Cost	$217	**Savings-to-Investment Ratio**	0.3	**Simple Payback yrs**	50

Auditors Notes: This window has been shattered at some point and covered with plywood. The window should be replaced because of the damages and the replacement window can be a triple-pane window for energy efficiency purposes.

Rank	Location	Size/Type, Condition	Recommendation
35	Window: Process Room - Non-South Walls	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46	Replace existing window with triple-pane window.

Installation Cost	$3,163	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$20
Breakeven Cost	$348	**Savings-to-Investment Ratio**	0.1	**Simple Payback yrs**	157

Auditors Notes: Replace the windows in the water treatment plant building with triple-paned windows to prevent air leakage.

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

Installation Cost	$1,265	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$7
Breakeven Cost	$127	**Savings-to-Investment Ratio**	0.1	**Simple Payback yrs**	171

Auditors Notes: Replace the windows in the garage with triple-paned windows to prevent air leakage.

Rank	Location	Size/Type, Condition	Recommendation
37	Window: Process Room - South Wall	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46	Replace existing window with triple-pane window.

Installation Cost	$1,265	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$7
Breakeven Cost	$127	**Savings-to-Investment Ratio**	0.1	**Simple Payback yrs**	171

Auditors Notes: Replace the windows in the water treatment plant building with triple-paned windows to prevent air leakage.

4.3.2 Door Measures

Rank	Location	Size/Type, Condition	Recommendation
25	Exterior Door: Entryway Door	Door Type: Entrance, Wood, solid core flush, 1-3/8" Modeled R-Value: 2.6	Remove existing door and install a new door with an insulated core.

Installation Cost	$1,211	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$34
Breakeven Cost	$797	**Savings-to-Investment Ratio**	0.7	**Simple Payback yrs**	36

Auditors Notes: The existing door is not appropriate for use as an exterior door in an arctic setting. Air leakage is present and the door does not provide adequate insulation. Replace the existing door with a new metal door with an insulated core.

Rank	Location	Size/Type, Condition	Recommendation		
26	Exterior Door: Garage Door	Door Type: Entrance, Wood, solid core flush, 1-3/8" Modeled R-Value: 2.6	Remove existing door and install a new door with an insulated core.		
Installation Cost	$1,817	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$49
Breakeven Cost	$1,148	**Savings-to-Investment Ratio**	0.6	**Simple Payback yrs**	37
Auditors Notes: The existing doors are not appropriate for use as exterior doors in an arctic setting. Air leakage is present and the doors do not provide adequate insulation. Replace the existing doors with new metal doors with an insulated core.					

Rank	Location	Size/Type, Condition	Recommendation		
27	Exterior Door: Process Room Door	Door Type: Entrance, Wood, solid core flush, 1-3/8" Modeled R-Value: 2.6	Remove existing door and install a new door with an insulated core.		
Installation Cost	$1,817	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$48
Breakeven Cost	$1,119	**Savings-to-Investment Ratio**	0.6	**Simple Payback yrs**	38
Auditors Notes: The existing doors are not appropriate for use as exterior doors in an arctic setting. Air leakage is present and the doors do not provide adequate insulation. Replace the existing doors with new metal doors with an insulated core.					

Rank	Location	Size/Type, Condition	Recommendation		
28	Exterior Door: Cold Storage Room Door	Door Type: Entrance, Wood, solid core flush, 1-3/4" Modeled R-Value: 2.6	Remove existing door and install a new door with an insulated core.		
Installation Cost	$1,817	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$47
Breakeven Cost	$1,110	**Savings-to-Investment Ratio**	0.6	**Simple Payback yrs**	38
Auditors Notes: The existing doors are not appropriate for use as exterior doors in an arctic setting. Air leakage is present and the doors do not provide adequate insulation. Replace the existing doors with new metal doors with an insulated core.					

4.4 Mechanical Equipment Measures

4.4.1 Heating /Domestic Hot Water Measure

Rank	Recommendation				
8	Clean and tune boilers to remove soot and improve efficiency. Add controls to the garage unit heater to reduce run time. Remove glycol from cold storage room baseboard heaters so that no unnecessary heating is applied to this space.				
Installation Cost	$10,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$7,516
Breakeven Cost	$128,409	**Savings-to-Investment Ratio**	12.8	**Simple Payback yrs**	1
Auditors Notes: The boilers were tested with a stack efficiency tester and it was determined that the stack efficiency of the boiler was approximately 75%. Upon examination of the boiler interior, a coating of soot was found in the boiler that reduces the firing efficiency and creates residue in the stack. The boiler should be cleaned regularly so that the boiler can fire more efficiently and prolong the useful life. Additionally, the cold storage room was examined and it was determined that there is no need for heating in the room because of the current use and the contents that are stored in the room. The glycol in the baseboard of the room should be removed and the piping leading to the room should be closed so that there is no unnecessary heating taking place.					

4.4.2 Ventilation System Measures

Rank	Description			Recommendation	
24	There is a chlorine ventilation fan that runs constantly in order to provide adequate air ventilation to the occupied space surrounding the chlorine injection point.			Build enclosure around the chlorine injection system and reduce chlorine ventilation fan run time to emergency purposes.	
Installation Cost	$15,000	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$77
				Maintenance Savings (/yr)	$500
Breakeven Cost	$11,595	**Savings-to-Investment Ratio**	0.8	**Simple Payback yrs**	26
Auditors Notes: If chlorine is openly stored in an occupied space, as it is in the Noorvik Water Treatment Plant at the chlorine injection point, constant ventilation is required to keep the indoor air quality at an acceptable standard. A separate room can be built around the chemical injection system so that the chemicals are not constantly exposed to the occupied space and the ventilation fan run time can be reduced dramatically.					

4.4.3 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
5	Water Treatment Plant			Install a programmable thermostat and set temperature back to 60 deg. F when unoccupied for the Water Treatment Plant space.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$853
Breakeven Cost	$11,481	**Savings-to-Investment Ratio**	23.0	**Simple Payback yrs**	1
Auditors Notes: Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Water Treatment Plant space. This will reduce the heating load and save on heating fuel usage. To do this, install a programmable thermostat and program the temperature setback for the unoccupied hours when the operators are not in the building.					

Rank	Building Space			Recommendation	
23	Lift Station			Install a programmable thermostat and set temperature back to 40 deg. F when unoccupied for the Lift Station space.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$62
Breakeven Cost	$830	**Savings-to-Investment Ratio**	0.8	**Simple Payback yrs**	16
Auditors Notes: Implement a Heating Temperature Unoccupied Setback to 40.0 deg F for the Lift Station space. This space is not occupied often and the temperature in the building only needs to be high enough to prevent the sewage from freezing and blocking pipes. To do this, install a programmable thermostat and program the temperature setback for the unoccupied hours when the operators are not in the building.					

Rank	Building Space			Recommendation	
38	Garage			Install a programmable thermostat and set temperature back to 50 deg. F when unoccupied for the Garage space.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$
Breakeven Cost	$	**Savings-to-Investment Ratio**	0.0	**Simple Payback yrs**	1000
Auditors Notes: Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Garage space. This will reduce the heating load and save on heating fuel usage. To do this, install a programmable thermostat and program the temperature setback for the unoccupied hours when the operators are not in the building.					

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	
10	Garage	6 FLUOR (2) T12 4' F40T12 40W Standard StdElectronic with Manual Switching		Replace new energy-efficient LED lighting and add new occupancy sensor.	
Installation Cost	$980	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$470
Breakeven Cost	$5,539	**Savings-to-Investment Ratio**	5.7	**Simple Payback yrs**	2
Auditors Notes: Replace existing fluorescent light fixtures with 17 Watt 4-ft. LED equivalents. This room has 6 fixtures with two bulbs per fixture for a total of 12 light bulbs to be replaced. An occupancy sensor can be installed to prevent the lights from coming on when they are not needed.					

Rank	Location	Existing Condition		Recommendation	
12	Loft	2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace new energy-efficient LED lighting.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$60
Breakeven Cost	$702	**Savings-to-Investment Ratio**	4.4	**Simple Payback yrs**	3
Auditors Notes: Replace existing fluorescent light fixtures with 17 Watt 4-ft. LED equivalents. This room has 2 fixtures with two bulbs per fixture for a total of 4 light bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
15	Water Treatment Room - 4 Bulb Fixtures	28 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace new energy-efficient LED lighting and add new occupancy sensor.	
Installation Cost	$11,500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$3,577
Breakeven Cost	$42,096	**Savings-to-Investment Ratio**	3.7	**Simple Payback yrs**	3
Auditors Notes: Replace existing fluorescent light fixtures with 17 Watt 4-ft. LED equivalents. This room has 28 fixtures with four bulbs per fixture for a total of 112 light bulbs to be replaced. Occupancy sensors can be installed to prevent the lights from coming on when they are not needed. The lights in the water treatment room will be divided into 4 zones with 4 total occupancy sensors.					

Rank	Location	Existing Condition		Recommendation	
16	Office	2 FLUOR (2) T12 4' F40T12 40W Standard StdElectronic with Manual Switching		Replace new energy-efficient LED lighting and add new occupancy sensor.	
Installation Cost	$660	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$181
Breakeven Cost	$2,131	**Savings-to-Investment Ratio**	3.2	**Simple Payback yrs**	4
Auditors Notes: Replace existing fluorescent light fixtures with 17 Watt 4-ft. LED equivalents. This room has 2 fixtures with two bulbs per fixture for a total of 4 light bulbs to be replaced. An occupancy sensor can be installed to prevent the lights from coming on when they are not needed.					

Rank	Location	Existing Condition		Recommendation	
17	Vacuum System Room	6 FLUOR (4) T12 4' F40T12 40W Standard StdElectronic with Manual Switching		Replace new energy-efficient LED lighting and add new occupancy sensor.	
Installation Cost	$3,460	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$848
Breakeven Cost	$9,973	**Savings-to-Investment Ratio**	2.9	**Simple Payback yrs**	4
Auditors Notes: Replace existing fluorescent light fixtures with 17 Watt 4-ft. LED equivalents. This room has 6 fixtures with four bulbs per fixture for a total of 24 light bulbs to be replaced. An occupancy sensor can be installed to prevent the lights from coming on when they are not needed.					

Rank	Location	Existing Condition		Recommendation	
20	Water Treatment Room - 2 Bulb Fixtures	8 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace new energy-efficient LED lighting and add new occupancy sensor.	
Installation Cost	$3,140	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$510
Breakeven Cost	$5,983	**Savings-to-Investment Ratio**	1.9	**Simple Payback yrs**	6
Auditors Notes: Replace existing fluorescent light fixtures with 17 Watt 4-ft. LED equivalents. This room has 8 fixtures with two bulbs per fixture for a total of 16 light bulbs to be replaced. Occupancy sensors can be installed to prevent the lights from coming on when they are not needed. The lights in the water treatment room will be divided into 4 zones with 4 total occupancy sensors.					

Rank	Location	Existing Condition		Recommendation	
21	Entryway	FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace new energy-efficient LED lighting and add new occupancy sensor.	
Installation Cost	$580	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$64
Breakeven Cost	$747	**Savings-to-Investment Ratio**	1.3	**Simple Payback yrs**	9
Auditors Notes: Replace existing fluorescent light fixtures with 17 Watt 4-ft. LED equivalents. This room has one fixture with two bulbs per fixture for a total of 2 light bulbs to be replaced. An occupancy sensor can be installed to prevent the lights from coming on when they are not needed.					

Rank	Location	Existing Condition		Recommendation	
32	Lift Station	6 INCAN A Lamp, Halogen 75W with Manual Switching		Replace new energy-efficient LED lighting.	
Installation Cost	$200	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$4
Breakeven Cost	$46	**Savings-to-Investment Ratio**	0.2	**Simple Payback yrs**	51
Auditors Notes: Replace existing fluorescent light fixtures with 10 Watt LED equivalents. This room has 6 fixtures with one bulb per fixture for a total of 6 light bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
33	Bathroom	FLUOR (2) T12 4' F40T12 34W Energy-Saver StdElectronic with Manual Switching		Replace new energy-efficient LED.	
Installation Cost	$100	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1
Breakeven Cost	$18	**Savings-to-Investment Ratio**	0.2	**Simple Payback yrs**	67
Auditors Notes: Replace existing fluorescent light fixtures with 17 Watt 4-ft. LED equivalents. This room has one fixture with two bulbs in the fixture for a total of 2 light bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
34	Cold Storage Room	2 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace new energy-efficient LED lighting and add new occupancy sensor.	
Installation Cost	$820	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$11
Breakeven Cost	$127	**Savings-to-Investment Ratio**	0.2	**Simple Payback yrs**	76
Auditors Notes: Replace existing fluorescent light fixtures with 17 Watt 4-ft. LED equivalents. This room has 2 fixtures with four bulbs per fixture for a total of 8 light bulbs to be replaced. An occupancy sensor can be installed to prevent the lights from coming on when they are not needed.					

4.5.2 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
1	Backwash Pump	Backwash Pump		Reduce backwash time from 20 minutes per pressure tank to 10 minutes per pressure tank.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$2,827
Breakeven Cost	$41,306	**Savings-to-Investment Ratio**	82.6	**Simple Payback yrs**	0
Auditors Notes: The backwash is run for 20 minutes each for two pressure tanks. The design time for a full backwash is 10 minutes. This run time should be reduced to decrease overall water consumption, reduce pump operation, and lower the demand for heat.					

Rank	Location	Description of Existing		Efficiency Recommendation	
2	Backwash Effluent Pump	Backwash Effluent Pump		Reduce backwash time from 20 minutes per pressure tank to 10 minutes per pressure tank.	
Installation Cost	$250	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$622
Breakeven Cost	$9,089	**Savings-to-Investment Ratio**	36.4	**Simple Payback yrs**	0
Auditors Notes: The backwash is run for 20 minutes each for two pressure tanks. The design time for a full backwash is 10 minutes. This run time should be reduced to decrease overall water consumption, reduce pump operation, and lower the demand for heat.					

Rank	Location	Description of Existing		Efficiency Recommendation	
4	Hydronic Circulation Pumps	Glycol Circulation Pumps		Shut off one pump and operate one of the two pumps at a time.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$4,159
Breakeven Cost	$48,004	**Savings-to-Investment Ratio**	24.0	**Simple Payback yrs**	0
Auditors Notes: There are two pumps in parallel that were both in operation. The system is designed such that only one pump needs to run. This recommendation is to turn off one pump.					

Rank	Location	Description of Existing		Efficiency Recommendation	
6	Lift Station Electric Heat	Electric Heater		Shut off electric heater in lift station and convert to using glycol-based unit heater.	
Installation Cost	$3,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$5,201
Breakeven Cost	$61,095	**Savings-to-Investment Ratio**	20.4	**Simple Payback yrs**	1
Auditors Notes: There is an electric heater present in the lift station that is in constant operation. The runtime can be reduced by lowering the thermostat to 40F and then switching to the glycol unit heater, which will either be powered by #1 fuel oil or the heat recovery project.					

Rank	Location	Description of Existing		Efficiency Recommendation	
7	Raw Water Heat Tape	Heat Tape		Shut off heat tape and use only for emergency that purposes.	
Installation Cost	$5,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$6,628
Breakeven Cost	$96,830	**Savings-to-Investment Ratio**	19.4	**Simple Payback yrs**	1
Auditors Notes: Shut off heat tape and use only for emergency purposes. Replace light bulb in panel so that the operator can visually see if the heat tape has been turned on.					

Rank	Location	Description of Existing		Efficiency Recommendation	
13	Vacuum Pump 2	Baldor Vacuum Pump		Replace vacuum pump with new modulating Mink pump.	
Installation Cost	$35,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$10,227
Breakeven Cost	$147,967	**Savings-to-Investment Ratio**	4.2	**Simple Payback yrs**	3
Auditors Notes: Replace with Mink Vacuum Pump					

Rank	Location	Description of Existing		Efficiency Recommendation	
18	Vacuum Pump 1	Toshiba Vacuum Pump		Replace vacuum pump with new modulating Mink pump.	
Installation Cost	$35,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$6,710
Breakeven Cost	$96,611	**Savings-to-Investment Ratio**	2.8	**Simple Payback yrs**	5
Auditors Notes: Replace vacuum pump with Mink pump to improve efficiency and reduce runtime.					

4.5.3 Other Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
3	North Loop	North Loop Circulation Heat Load		Lower circulation temperature to 34F.	
Installation Cost	$16,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$28,065
Breakeven Cost	$487,887	**Savings-to-Investment Ratio**	30.5	**Simple Payback yrs**	1
Auditors Notes: The circulation loop only needs to be heated enough to stay above freezing and with the utilidors having heat trace throughout all the distribution loops, the water does not need to be heated beyond 34 degrees to insure that. To modify the loops, the water treatment plant will need to install new modulating Belimo valves, new Honeywell 775 controls, install new glycol circulation pumps to accommodate a change flow rate, reprogram the heat-add controls, install a flow switch, reconfigure the glycol makeup system, and make sure that the new glycol pumps are positive displacement pumps to allow for quick freeze recovery with few damages.					

Rank	Location	Description of Existing	Efficiency Recommendation		
9	Hotham Peak Loop	Hotham Peak Loop Circulation Heat Load	Lower circulation temperature to 34F.		
Installation Cost	$16,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$8,667
Breakeven Cost	$117,603	**Savings-to-Investment Ratio**	7.4	**Simple Payback yrs**	2

Auditors Notes: The circulation loop only needs to be heated enough to stay above freezing and with the utilidors having heat trace throughout all the distribution loops, the water does not need to be heated beyond 34 degrees to insure that. To modify the loops, the water treatment plant will need to install new modulating Belimo valves, new Honeywell 775 controls, install new glycol circulation pumps to accommodate a change flow rate, reprogram the heat-add controls, install a flow switch, reconfigure the glycol makeup system, and make sure that the new glycol pumps are positive displacement pumps to allow for quick freeze recovery with few damages.

Rank	Location	Description of Existing	Efficiency Recommendation		
11	School Loop	School Loop Circulation Heat Load	Lower circulation temperature to 34F.		
Installation Cost	$16,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$5,436
Breakeven Cost	$73,755	**Savings-to-Investment Ratio**	4.6	**Simple Payback yrs**	3

Auditors Notes: The circulation loop only needs to be heated enough to stay above freezing and with the utilidors having heat trace throughout all the distribution loops, the water does not need to be heated beyond 34 degrees to insure that. To modify the loops, the water treatment plant will need to install new modulating Belimo valves, new Honeywell 775 controls, install new glycol circulation pumps to accommodate a change flow rate, reprogram the heat-add controls, install a flow switch, reconfigure the glycol makeup system, and make sure that the new glycol pumps are positive displacement pumps to allow for quick freeze recovery with few damages.

Rank	Location	Description of Existing	Efficiency Recommendation		
14	South Loop	South Loop Circulation Heat Load	Lower circulation temperature to 34F.		
Installation Cost	$16,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$4,491
Breakeven Cost	$60,931	**Savings-to-Investment Ratio**	3.8	**Simple Payback yrs**	4

Auditors Notes: The circulation loop only needs to be heated enough to stay above freezing and with the utilidors having heat trace throughout all the distribution loops, the water does not need to be heated beyond 34 degrees to insure that. To modify the loops, the water treatment plant will need to install new modulating Belimo valves, new Honeywell 775 controls, install new glycol circulation pumps to accommodate a change flow rate, reprogram the heat-add controls, install a flow switch, reconfigure the glycol makeup system, and make sure that the new glycol pumps are positive displacement pumps to allow for quick freeze recovery with few damages.

Rank	Location	Description of Existing	Efficiency Recommendation		
19	Water Storage Tank	Water Storage Tank Heat Load	Lower water storage tank temperature from 50F to 34F and add a tank mixer to prevent ice formation.		
Installation Cost	$23,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$3,033
Breakeven Cost	$44,145	**Savings-to-Investment Ratio**	1.9	**Simple Payback yrs**	8

Auditors Notes: The water storage tank only needs to be heated enough to stay above freezing and with the utilidors having heat trace throughout all the distribution loops, the water does not need to be heated beyond 34 degrees to insure that. To modify the line, the water treatment plant will need to install new modulating Belimo valves, new Honeywell 775 controls, install new glycol circulation pumps to accommodate a change flow rate, reprogram the heat-add controls, install a flow switch, reconfigure the glycol makeup system, and make sure that the new glycol pumps are positive displacement pumps to allow for quick freeze recovery with few damages. Additionally, a laminar flow tank mixer will need to be installed to prevent ice buildup in the water storage tank. The tank mixer is the key component that allows for water to be stored at 34 deg. F because it prevents the water from freezing by continuously circulating the water within the tank. The tank mixer has a side benefit of more thoroughly mixing the injected chemicals into the water and providing more contact time for the water treatment process.

Rank	Location	Description of Existing		Efficiency Recommendation	
22	Raw Water Intake	Raw Water Heat Add Load		Lower raw water heat add from 43F to 40F and reduce flow rate from 27 GPM to 15 GPM.	
Installation Cost	$8,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$659
Breakeven Cost	$8,939	**Savings-to-Investment Ratio**	1.1	**Simple Payback yrs**	12

Auditors Notes: The raw water intake only needs to be heated enough to stay above freezing and with the utilidors having heat trace throughout all the distribution loops, the water does not need to be heated beyond 40 degrees to insure that. To modify the line, the water treatment plant will need to install new modulating Belimo valves, new Honeywell 775 controls, install new glycol circulation pumps to accommodate a change flow rate, reprogram the heat-add controls, install a flow switch, reconfigure the glycol makeup system, and make sure that the new glycol pumps are positive displacement pumps to allow for quick freeze recovery with few damages.

Rank	Location	Description of Existing		Efficiency Recommendation	
31	Backwash Tank	Backwash Load		Lower backwash temperature to 38F and reduce backwash time to half of the current schedule.	
Installation Cost	$3,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$54
Breakeven Cost	$944	**Savings-to-Investment Ratio**	0.3	**Simple Payback yrs**	55

Auditors Notes: The backwash is run for 20 minutes each for two pressure tanks. The design time for a full backwash is 10 minutes. This run time should be reduced to decrease overall water consumption, reduce pump operation, and lower the demand for heat. Additionally, the temperature can be lowered for the backwash process because the entire process takes place indoors and freeze protection is not needed. This allows the operating temperature to be reduced without serious consequence.

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 Noorvik 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 2016 calendar year.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Noorvik Water Treatment Plant	**Auditor Company:** ANTHC-DEHE
Address: PO Box 130, Noorvik AK 99763	**Auditor Name:** Chris Mercer, Praveen K.C., and Kevin Ulrich
City: Noorvik **Client Name:** Elino Bantatua, Eric Howarth	**Auditor Address:** 4500 Diplomacy Dr., Anchorage, AK 99508
Client Address:	**Auditor Phone:** (907) 729-3237 **Auditor FAX:**
Client Phone: (907) 636-2146 **Client FAX:**	**Auditor Comment:**
Design Data	
Building Area: 4,994 square feet	**Design Space Heating Load:** Design Loss at Space: 45,920 Btu/hour with Distribution Losses: 48,336 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 73,683 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 4 people	**Design Indoor Temperature:** 69.7 deg F (building average)
Actual City: Noorvik	**Design Outdoor Temperature:** -45 deg F
Weather/Fuel City: Noorvik	**Heating Degree Days:** 15,675 deg F-days
Utility Information	
Electric Utility: AVEC-Noorvik - Commercial - Lg	**Average Annual Cost/kWh:** $0.58/kWh

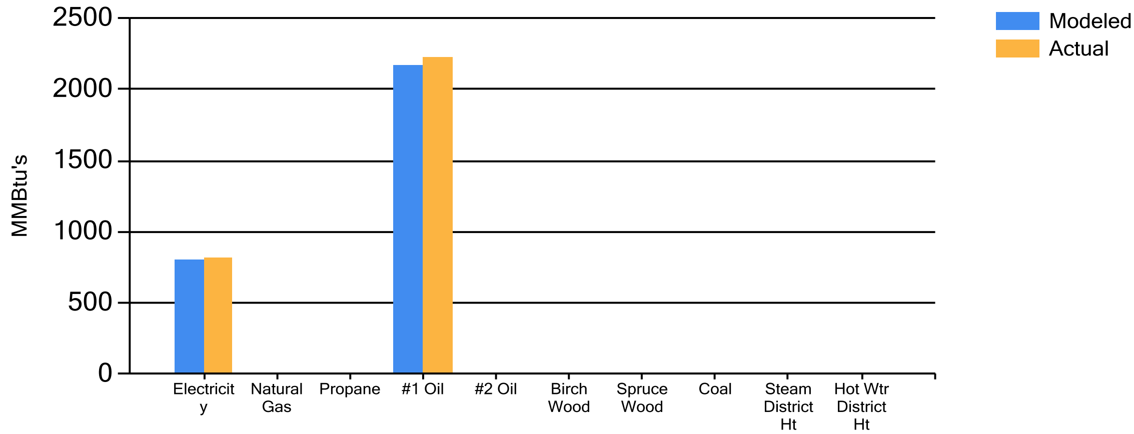
Annual Energy Cost Estimate									
Description	**Space Heating**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$5,881	$448	$171	$7,617	$113,240	$3,456	$58,815	$6,588	**$196,757**
With Proposed Retrofits	$5,792	$389	$170	$2,552	$74,312	$2,622	$6,461	$2,670	**$95,508**
Savings	$90	$59	$1	$5,065	$38,928	$834	$52,354	$3,919	**$101,249**

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	594.9	37.95	$39.40
With Proposed Retrofits	197.7	12.61	$19.12
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.			

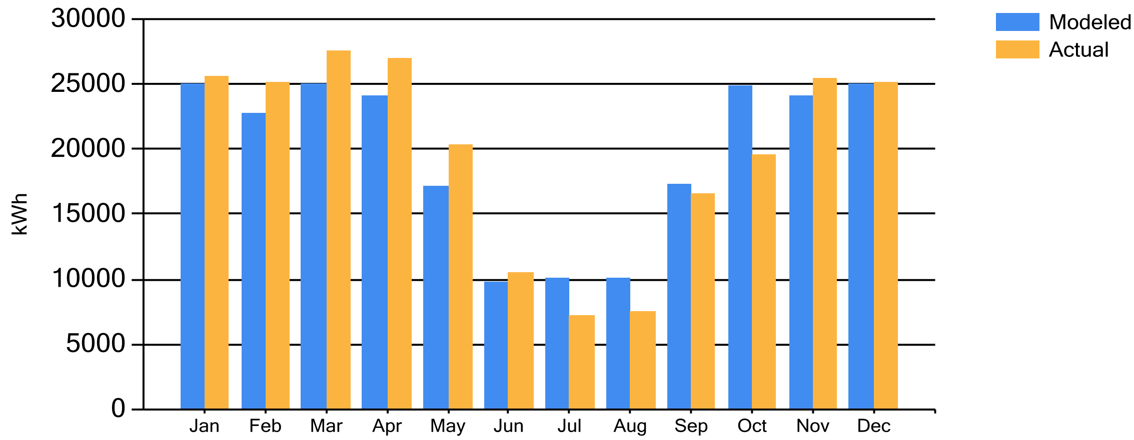
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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

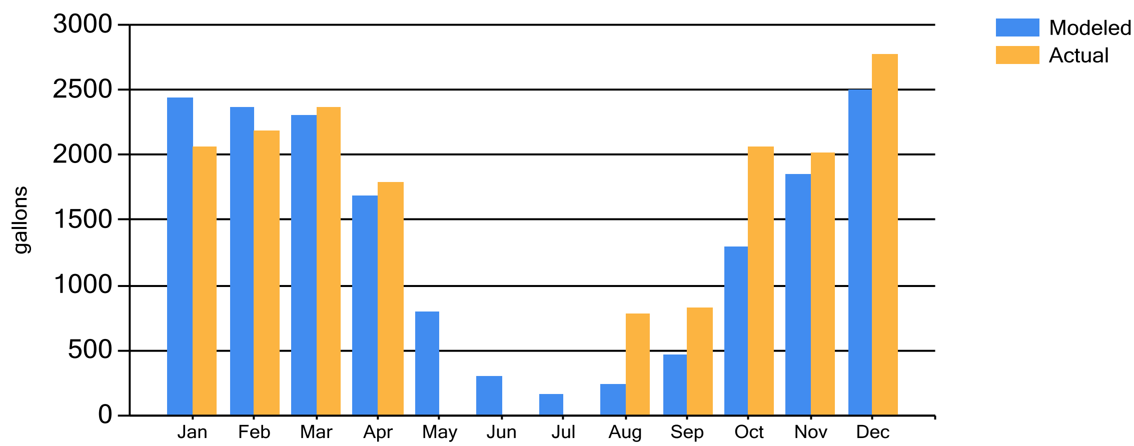
Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use



Appendix C - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	52.9	52.9	52.8	52.8	42.6	33.2	33.2	33.2	43.7	52.8	52.8	52.9
As Proposed	32.8	32.8	32.7	32.7	25.6	19.1	19.1	19.1	26.4	32.7	32.7	32.8

AkWarmCalc Ver 2.4.1.0, Energy Lib 3/30/2015