Comprehensive Energy Audit
For
Chistochina Water Building

Prepared For
Cheesh'Na Tribe

March 19, 2019

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EXECUTIVE SUMMARY

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in October of 2018 by the ANTHC Rural Energy Initiative for the Cheesh'Na Tribal Council. An energy audit is a comprehensive energy study, which includes an analysis of building shell, interior and exterior lighting systems, heating and ventilation systems, and electric loads. Coordination with the Cheesh'Na Tribal Council has been undertaken to provide maximum accuracy in identifying facilities to audit, and to facilitate energy efficiency project development after the audit process is complete.

Using field data, a virtual representation of the Chistochina Water Building was created using the building modeling software AkWarm©. The model was validated by comparing the initial results with at least one year of historical energy use data. Next, energy efficiency measures (EEMs) such as LED lighting and boiler control improvements were added to the model. The AkWarm© software calculates the annual cost savings and payback period for the investment, and then ranks all EEMs based on their payback period.

There are limitations using this software, which may affect the accuracy of the EEMs cost savings. This report should serve as a guide when deciding which EEMS to pursue further. All EEMs and installation costs should be verified with a certified professional in that field before construction begins.

ACKNOWLEDGMENTS

The ANTHC Rural Energy Initiative gratefully acknowledges the assistance of James (Jim) Beeter, Maintenance Manager; and Pete Peschang, Cheesh'Na Tribal Council Administrator.

Funding for the project was provided by the U.S. Department of Energy – Office of Indian Energy.

FACILITY DESCRIPTION

The Chistochina Water Building was constructed in 2016 to provide water and public sanitation facilities to Chistochina. The building contains a process room (heating systems, pump controls, and freeze prevention/recovery systems), two public bathrooms with coin-operated showers, and an unused storage room. Typically, the facility is occupied by one person for a few hours per day, but the bathrooms are used more frequently in the summer.

Building Shell

Total square footage (ft.^{2})	626
Wall Height (ft.)	8

Structural Component	Construction Type	Insulation
Walls	2x6 stick frame, 16” on-center	R-19 fiberglass batt
Foundation	On-grade, gravel pad	4” XPS foam board around foundation wall
Ceiling with Attic	Standard truss, 24” on-center	R-50 fiberglass batt
Water Process Room Exterior Doors	Metal door with ¼ lite window	EPS core
Bathroom Exterior Doors	Metal door, no window	EPS core
Storage Room Exterior Door	Metal door, no window	EPS core

Figures 1.1 a) and b): Chistochina Water Building exterior.

Water and Sewer System

Water is pumped from two wells (53 feet and 59 feet deep) to the Process Room, about 150 feet away. Chistochina does not have any additional water treatment or storage at this time. The well pumps pressurize the water building indoor plumbing, the public watering point, and a branched water distribution line to three community buildings. Only two community buildings have active water connections.

The building's wastewater, primarily run off from the public watering point, is handled by an E/one lift station. The pressurized wastewater system empties into a septic tank and drain field approximately 1,300 feet from the water building. The Chistochina Recreation Center, Community Building, and Village Office also have E/one lift stations, but none were in use as of October 2018.

See Appendix A for a complete list of the facility's equipment and electrical loads.

Heating

Two Energy Kinetics System 2000 boilers provide space heating, glycol heat trace, and domestic hot water (DHW) through an indirect hot water generator. Zone valves control the heat distribution throughout the building. See Appendix A for additional information.

Figure 1.2: Chistochina Water Building boilers.

A Tekmar 262 boiler and DHW control was installed to regulate the boilers and indirect hot water generator, but was not functional as of October 2018. The boilers were regulated by Energy Kinetics System 2000 Energy Manager panels at the time; however, these panels only regulate individual boilers and provide no manual control over temperature set points. The indirect hot water heater was offline at the time of the site visit. Only Boiler #1 was operational due to a leak at Boiler #2. The Boiler #1 circulation pump, which should operate only when the boiler is firing, ran continuously. The primary heating loop circulation pump cycled based on calls for heat from the zone valve control panel. None of the building's thermostats are programmable.

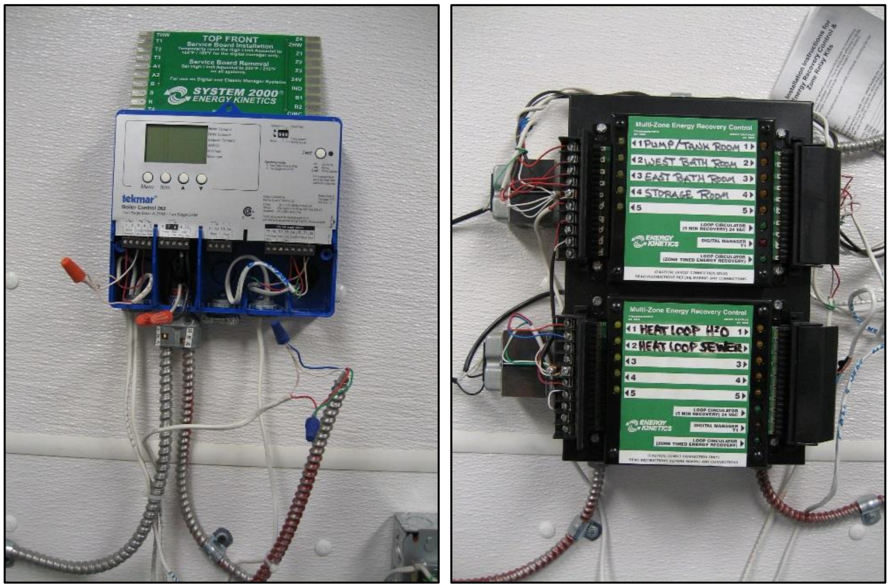
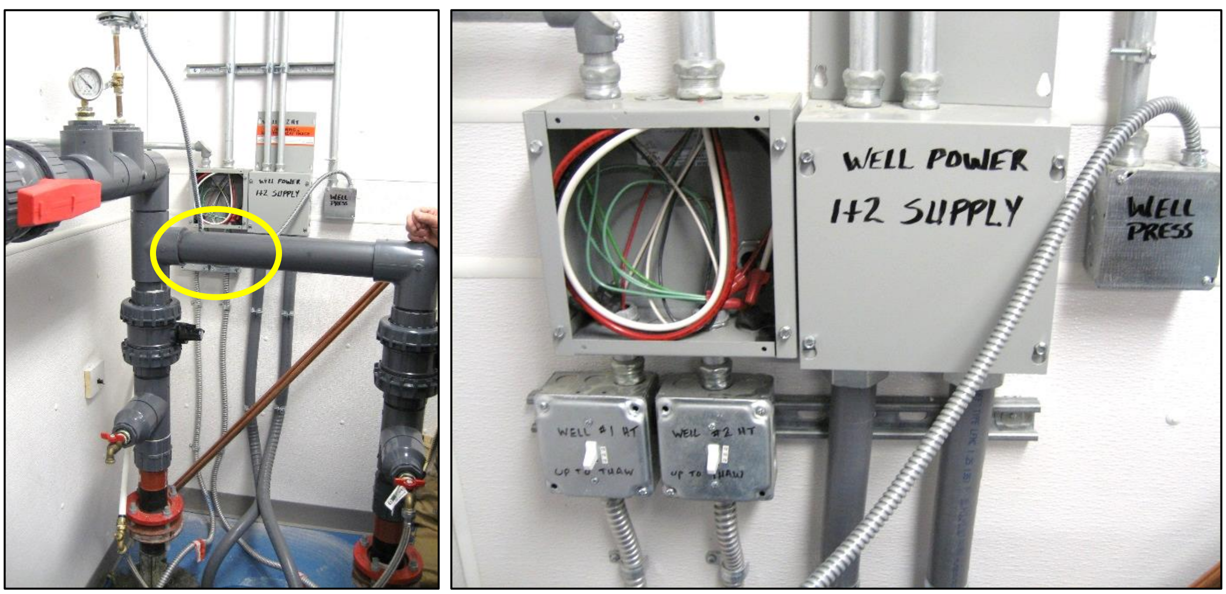


Figure 1.3 a): Tekmar 262 control (left) and Figure 1.3 b): the building zone valve panel (right).

Freeze Prevention and Recovery

Electric heat tape was installed along both raw water lines and down into each well for freeze recovery. The electric heat tape is rarely used. However, the heat tape controls are obscured by the raw water line inside the Process Room, leading to unintentional electrical consumption in 2017.



Figures 1.4 a) and b): Hidden electrical heat tape controls.

The water and E/one sewer lines have glycol heat trace lines installed along the mains. The glycol heat trace system is operated intermittently throughout the winter, depending on the water supply pressure, and in April when the frost line is pushed below the water and sewer mains.

Figure 1.5: Water Building water and sewer glycol heat trace controls and heat exchangers.

The public watering point drain has a glycol heat trace to prevent ice buildup. The heat trace zone valve is opened once the ice sensor installed in the pad becomes iced over.

Figure 1.6: Honeywell Ice Sensor for the watering point drain heat trace.

MODEL RESULTS

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy costs for the Chistochina Water Building are $6,808. Table 2.1 contains a breakdown of energy usage and costs by commodity.

Table 2.1: Predicted Annual Use and Savings for the Chistochina Water Building

Fuel	Existing Building	With Proposed Retrofits	Predicted Annual Savings
Electricity	4,350 kWh	1,607 kWh	2,743 kWh
	$4,586	$1,694	$2,891
#1 Oil	677 gallons	572 gallons	105 gallons
	$1,787	$1,779	$327

Note: Estimated costs and savings based on $1.054 per kWh (includes high demand charges) and $3.11 for #1 fuel oil. An accidental heat trace use in 2017 has been included in the electrical consumption above. Typically, the building uses about 2,994 kWh per year.

Actual electrical and fuel consumption varied by year. In 2016-2017, the annual electrical consumption was approximately 2,841 kWh and about 700 gallons of fuel oil was consumed. In 2017-2018, approximately 4,363 kWh and 645 gallons of fuel oil were consumed. The AkWarm© model was an attempt to capture an average annual usage.

Table 2.2 below summarizes the energy efficiency measures (EEMs) recommended for the Chistochina Water Building, and ranks the EEMs by economic viability.

- Installed Cost: Includes materials, 15% surcharge on materials for freight fees, local and specialist labor time, specialist travel, and indirect labor charges when applicable.
- Savings to Investment Ratio (SIR): The annual savings divided by the installation cost. It is an indication of the profitability of an EEM: the higher the SIR, the more profitable the project. It should be noted that the SIR is dependent on the EEMs rank in the overall list and assumes that the measures above it are implemented first.
- Simple Payback (SP): The investment cost divided by the expected first-year savings. The SP estimates the length of time required to pay back the installed cost through the energy savings, not counting interest on the investment and any future changes in energy prices.
- Maintenance Savings (Maint. Savings): Any operations or maintenance costs that are unnecessary after the EEM is installed (i.e. changing fluorescent light bulbs). The maintenance savings includes materials, 15% freight, and labor, and is divided over the expected lifespan of the EEM.

Table 2.2: Summary of Recommended Energy Efficiency Measures

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)
1	Controls: Well Pump Electric Heat Tape	Install LED light indicators or other controls on the raw water line heat trace to limit electrical consumption.	$1,189	$725	23.91	0.6
2	Lighting: Process (Pump) Room	Remove ballasts and replace existing fluorescent bulbs with direct wire, energy efficient LEDs.	$52 + $244 Maint. Savings	$633	6.91	2.1

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)
3	Heating and Hot Water	Clean and tune boilers. Perform annual efficiency testing. Troubleshoot and reconnect Tekmar 262. Set lead lag boilers, and alternate boilers to decrease wear and tear. Boiler circulation pumps should run only when boilers are running. Primary loop circulators should respond based on calls for heat. Replace zone valve Z1 (pump room unit heater). Insulate all hydronic heating and DHW plumbing in the boiler/pump room. Label all piping. Provide wall chart for Tekmar controller.	$742	$5,400	2.15	7.3
4	Lighting: Bathroom Lighting	Remove ballasts and replace existing fluorescent bulbs with direct wire, energy efficient LEDs.	$29 + $6 Maint. Savings	$406	1.24	11.6
5	Programmable Thermostat: Bathroom #1	Install programmable thermostats in both bathrooms. Set back the space temperature to 60° F when the bathrooms are unoccupied. Related to EEM #8.	$16	$200	1.05	12.3
6	Setback Thermostat: Bathroom #2	Install programmable thermostats in both bathrooms. Set back the space temperature to 60° F when the bathrooms are unoccupied. Related to EEM #7.	$16	$200	1.04	12.3

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)
7	Lighting: Boiler Room	Remove ballasts and replace existing fluorescent bulbs with direct wire, energy efficient LEDs.	$19 + $5 Maint. Savings	$350	1.00	14.6
8	Lighting: Boiler Room	Replace the light switch in the boiler room with an occupancy sensor.	$12	$260	0.65	22.2
9	Lighting: Storage Room	Remove ballasts and replace existing fluorescent bulbs with direct wire, energy efficient LEDs.	$0 + $2 Maint. Savings	$71	0.32	47.1
4	Lighting: Exterior Lighting	Replace the high-pressure sodium wall packs with integrated LED wall packs.	$171	$980	2.55	5.7
		TOTAL for all measures	**$2,075 + $256 Maint. Savings**	**$8,245**	**3.79**	**4.0**

Replacing the exterior lighting with LED wall-packs will not be a financially viable recommendation if the exterior lights are continued to be used minimally. If lighting usage is expected to increase, this EEM will have an economic payback. The wall-pack retrofit should have an integrated dusk-to-dawn sensor and the controls be left on the timer setting to minimize electrical consumption.

Figure 2.1 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.

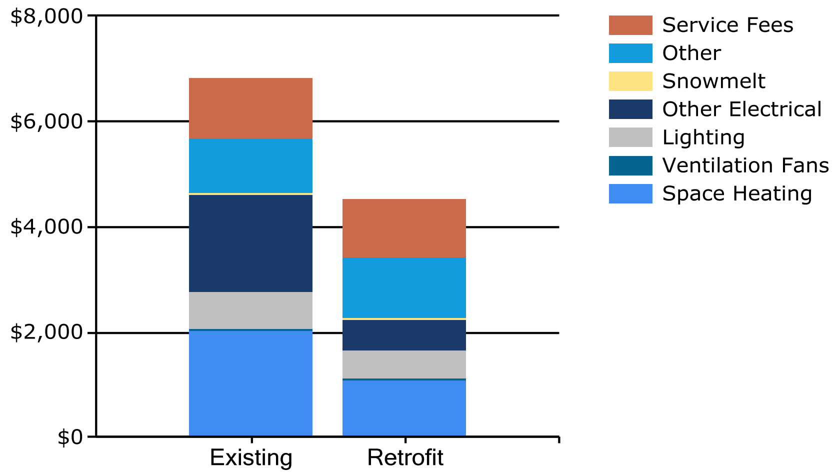


Figure 2.1: Annual energy costs by use before and after EEMs.

Interactive Effects of Projects

The annual energy savings for the EEMs in Table 2.2 are calculated assuming all recommended EEMs coming before that measure 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, electrical loads, facility equipment, and occupants generate heat within the building. Lighting-efficiency improvements, like converting incandescent and fluorescent bulbs to LEDs, are anticipated to slightly increase heating requirements. This increase in heating cost was factored into the lighting EEMs annual savings.

DETAILED ENERGY EFFICIENCY MEASURE DESCRIPTIONS

Heating and Domestic Hot Water

Rank	Recommendation
3	Clean and tune boilers. Perform annual efficiency testing. Troubleshoot and reconnect Tekmar 262. Set lead lag boilers, and alternate boilers to decrease wear and tear. Boiler circulation pumps should run only when boilers are running. Primary loop circulators should respond based on calls for heat. Troubleshoot zone valve Z1 (Process Room unit heater). May need to be replaced. Insulate all hydronic heating and DHW plumbing in the boiler/pump room. Label all components. Provide wall chart and troubleshooting guide for Tekmar 262 controller.

Installation Cost	$5,400	**Estimated Life of Measure (yrs.)**	20	**Energy Savings ($/yr.)**	$742
Breakeven Cost	$11,618	**Simple Payback (yrs.)**	7	**Energy Savings (MMBTU/yr.)**	16.3 MMBTU
		Savings-to-Investment Ratio	2.2		

Auditors Notes:

Performing annual maintenance on boilers is critical for maintaining combustion and heat transfer efficiency. Typically performed in the fall, boiler maintenance includes:

- Brushing between the cast iron sections to remove soot build up. This increases the heat transfer rate from the hot gas to the glycol or water.
- Cleaning out the remaining soot from the combustion chamber
- Replacing the boiler nozzle. Nozzles affect the spray pattern and atomization of the fuel. If the nozzle is partially clogged, fuel will either not reach the electrodes or will not be a fine enough spray for efficient combustion.
- Cleaning the electrodes and inspecting for damage. Replace components if necessary.
- When replacing the nozzle, adjust the electrodes to ensure complete combustion.
- Replacing the fuel filter.

The fuel pump pressure should be tested at this time and a smoke dot test performed.

The Tekmar 262 boiler and DHW control panel will give staff members more control over the boiler temperature set points, alternate and set lead/lag boilers, DHW generation, and boiler circulation pump operations. The Tekmar 262 was not in operation at the time of the site visit and may have been installed incorrectly. The controller issues need to be addressed and additional supporting documentation like wall charts and manuals to assist staff members in the future.

The zone valve controlling the heat flow to the Process Room unit heater responded slowly to adjustments in temperature, leading to unnecessary heat distribution. This may be a valve or zone valve control panel issue.

None of the interior plumbing is insulated or labeled. Insulation will decrease uncontrolled heat loss to the Process Room. Recommended: fiberglass batt or high temperature- rated rubber pipe insulation. Labeling may assist staff members and supporting agencies (RMW, ANTHC, VSW) troubleshoot the heating and glycol heat trace processes in the future.

Programmable Thermostats and Temperature Set Backs

Rank	Building Space			Recommendation	
5	Bathroom 1			Install programmable thermostats in both bathrooms. Set back the space temperature to 60° F when the bathrooms are unoccupied.	
Installation Cost	$200	**Estimated Life of Measure (yrs.)**	15	**Energy Savings ($/yr.)**	$16
Breakeven Cost	$210	**Simple Payback (yrs.)**	12	**Energy Savings (MMBTU/yr.)**	0.5 MMBTU
		Savings-to-Investment Ratio	1.1		

Auditors Notes:

No need to heat a space unless someone is using it. In general, we recommend programming the thermostats to set back the room temperature to 60° F at night, but increasing the temperature to 65° F may be necessary during cold periods in the winter to prevent freeze ups. If the space is not being used (i.e. the bathrooms outside of summer), set the thermostat to the “Run” function to maintain a constant temperature.

Rank	Building Space			Recommendation	
6	Bathroom 2			Install programmable thermostats in both bathrooms. Set back the space temperature to 60° F when the bathrooms are unoccupied.	
Installation Cost	$200	**Estimated Life of Measure (yrs.)**	15	**Energy Savings ($/yr.)**	$16
Breakeven Cost	$209	**Simple Payback (yrs.)**	12	**Energy Savings (MMBTU/yr.)**	0.5 MMBTU
		Savings-to-Investment Ratio	1.0		

Auditors Notes:

No need to heat a space unless someone is using it. In general, we recommend programming the thermostats to set back the room temperature to 60° F at night, but increasing the temperature to 65° F may be necessary during cold periods in the winter to prevent freeze ups. If the space is not being used (i.e. the bathrooms outside of summer), set the thermostat to the “Run” function to maintain a constant temperature.

Lighting Improvements

Rank	Location	Existing Condition		Recommendation	
2	Process (Pump) Room	Four 4-bulb 4' T8 fluorescent (32W per bulb) ceiling mounted fixtures with manual light switch		Remove ballasts and replace existing fluorescent bulbs with direct wire, energy efficient LEDs.	
Installation Cost	$633	**Estimated Life of Measure (yrs.)**	20	**Energy Savings ($/yr.)**	$52
Breakeven Cost	$4,374	**Simple Payback (yrs.)**	2	**Energy Savings (MMBTU/yr.)**	0.0 MMBTU
		Savings-to-Investment Ratio	6.9	**Maintenance Savings ($/yr.)**	$244

Auditors Notes:

Each LED direct wire bulb has the lifespan of two T-8 fluorescent tubes. Maintenance cost includes the materials ($3.00 per bulb), freight, and labor (10 minutes local labor @ $25/hr.). Maintenance cost is divided over the lifetime of the retrofit.

Bypass ballasts. Total fluorescent retrofit cost: Materials ($10.49 per bulb + 1 tombstone per bulb) + 15% freight + 8 hours local labor (@$25/hour) + 2 hours electrician labor (@ $100/hour) + 30% contractor fee.

Rank	Location		Existing Condition		Recommendation	
4	Bathroom Lighting		Four 4-bulb 4' T8 fluorescent (32W per bulb) ceiling mounted fixtures with occupancy sensors		Remove ballasts and replace existing fluorescent bulbs with direct wire, energy efficient LEDs.	
Installation Cost		$406	**Estimated Life of Measure (yrs.)**	20	**Energy Savings ($/yr.)**	$29
Breakeven Cost		$505	**Simple Payback (yrs.)**	12	**Energy Savings (MMBTU/yr.)**	0.0 MMBTU
			Savings-to-Investment Ratio	1.2	**Maintenance Savings ($/yr.)**	$6

Auditors Notes:

Each LED direct wire bulb has the lifespan of two T-8 fluorescent tubes. Maintenance cost includes the materials ($3.00 per bulb), freight, and labor (10 minutes local labor @ $25/hr.). Maintenance cost is divided over the lifetime of the retrofit.

Bypass ballasts. Total fluorescent retrofit cost: Materials ($10.49 per bulb + 1 tombstone per bulb) + 15% freight + 8 hours local labor (@$25/hour) + 2 hours electrician labor (@ $100/hour) + 30% contractor fee.

Rank	Location		Existing Condition		Recommendation	
7	Boiler Room		Two 3-bulb 4' T8 fluorescent (32W per bulb) ceiling mounted fixtures with manual light switch		Remove ballasts and replace existing fluorescent bulbs with direct wire, energy efficient LEDs.	
Installation Cost		$350	**Estimated Life of Measure (yrs.)**	20	**Energy Savings ($/yr.)**	$19
Breakeven Cost		$349	**Simple Payback (yrs.)**	15	**Energy Savings (MMBTU/yr.)**	0.0 MMBTU
			Savings-to-Investment Ratio	1.0	**Maintenance Savings ($/yr.)**	$5

Auditors Notes:

Each LED direct wire bulb has the lifespan of two T-8 fluorescent tubes. Maintenance cost includes the materials ($3.00 per bulb), freight, and labor (10 minutes local labor @ $25/hr.). Maintenance cost is divided over the lifetime of the retrofit.

Bypass ballasts. Total fluorescent retrofit cost: Materials ($10.49 per bulb + 1 tombstone per bulb) + 15% freight + 8 hours local labor (@$25/hour) + 2 hours electrician labor (@ $100/hour) + 30% contractor fee.

Rank	Location		Existing Condition		Recommendation	
9	Future Storage Room		One 2-bulb 4' T8 fluorescent (32W per bulb) ceiling mounted fixtures with manual light switch		Remove ballasts and replace existing fluorescent bulbs with direct wire, energy efficient LEDs.	
Installation Cost		$71	**Estimated Life of Measure (yrs.)**	20	**Energy Savings ($/yr.)**	$0
Breakeven Cost		$22	**Simple Payback (yrs.)**	47	**Energy Savings (MMBTU/yr.)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.3	**Maintenance Savings ($/yr.)**	$2

Auditors Notes:

Each LED direct wire bulb has the lifespan of two T-8 fluorescent tubes. Maintenance cost includes the materials ($3.00 per bulb), freight, and labor (10 minutes local labor @ $25/hr.). Maintenance cost is divided over the lifetime of the retrofit.

Bypass ballasts. Total fluorescent retrofit cost: Materials ($10.49 per bulb + 1 tombstone per bulb) + 15% freight + 8 hours local labor (@$25/hour) + 2 hours electrician labor (@ $100/hour) + 30% contractor fee.

Rank	Location		Existing Condition		Recommendation	
8	Boiler Room		Two 3-bulb 4' T8 fluorescent (32W per bulb) ceiling mounted fixtures with manual light switch		Install an occupancy sensor to reduce electrical consumption.	
Installation Cost		$260	**Estimated Life of Measure (yrs.)**	20	**Energy Savings ($/yr.)**	$12
Breakeven Cost		$169	**Simple Payback (yrs.)**	22	**Energy Savings (MMBTU/yr.)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.7		

Auditors Notes: Each LED direct wire bulb has the lifespan of two T-8 fluorescent tubes. Maintenance cost includes the materials ($3.00 per bulb), freight, and labor (10 minutes local labor @ $25/hr.). Maintenance cost is divided over the lifetime of the retrofit.

Bypass ballasts. Total fluorescent retrofit cost: Materials ($10.49 per bulb + 1 tombstone per bulb) + 15% freight + 8 hours local labor (@$25/hour) + 2 hours electrician labor (@ $100/hour) + 30% contractor fee.

Other Electrical Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
1	Well Pump #1 Heat Tape		165 Electric Heat Tape with Manual Switching		Improve Manual Switching	
Installation Cost		$725	**Estimated Life of Measure (yrs.)**	20	**Energy Savings ($/yr.)**	$1,189
Breakeven Cost		$17,337	**Simple Payback (yrs.)**	1	**Energy Savings (MMBTU/yr.)**	5.8 MMBTU
			Savings-to-Investment Ratio	23.9		

Auditors Notes:

Install LED indicators or another indicator/timing device so that heat tape use is more obvious or turns off after a set period of time.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Chistochina Water Building	**Auditor Company:** Alaska Native Tribal Health Consortium
Address: P.O. Box 241	**Auditor Name:** Kelli Whelan
City: Chistochina	**Auditor Address:** 4500 Diplomacy Drive Anchorage, AK 99508
Client Name: Pete Peschang, James (Jim) Beeter	
Client Address: P.O. Box 241 Chistochina, AK 99586	**Auditor Phone:** (907) 729-3723
	Auditor FAX:
Client Phone: (907) 822-3503	**Auditor Comment:**
Client FAX: (907) 822-5179	
Design Data	
Building Area: 626 square feet	**Design Space Heating Load:** Design Loss at Space: 21,413 BTU/hour with Distribution Losses: 22,540 BTU/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 34,360 BTU/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 1 person	**Design Indoor Temperature:** 60.2°F (building average)
Actual City: Chistochina	**Design Outdoor Temperature:** -38.2°F
Weather/Fuel City: Chistochina	**Heating Degree Days:** 13,238°F-days
Utility Information	
Electric Utility: Alaska Power and Telephone	**Fuel Oil Provider:** Crowley
Average Annual Cost/kWh: $1.054/kWh	**Average Annual Cost/gal.:** $3.11/gallon

Appendix B – Major Equipment List

Boilers

Boiler #1 (off)	
Nameplate Information	Energy Kinetics System 2000 EK-1
Burner	Beckett AFG Series Oil Burner
Ignition Control	Genysis 7505
Nozzle Information	0.75x70°, Type B
Fuel Type	#1 fuel oil (diesel)
Input Rating	0.85 gal/hr. (117,300 BTU/hr.)
Combustion Efficiency	86.1 % (last tested on 2/29/16)
Idle Loss	1.5% (estimated)
Heat Distribution Type	50/50 glycol
Boiler Circulation Pump	TACO 007-B75-10J Cartridge Circulator

Boiler #2 (on)	
Nameplate Information	Energy Kinetics System 2000 EK-1
Burner	Beckett AFG Series Oil Burner
Ignition Control	Genysis 7505
Nozzle Information	0.75x70°, Type B
Fuel Type	#1 fuel oil (diesel)
Input Rating	0.85 gal/hr. (117,300 BTU/hr.)
Combustion Efficiency	86.6 % (last tested on 2/29/16)
Idle Loss	1.5% (estimated)
Heat Distribution Type	50/50 glycol
Boiler Circulation Pump	TACO 007-B75-10J Cartridge Circulator

Space Heating Systems

Process (Pump) Room Unit Heater	
Nameplate Information	Beacon Morris model HB-060
Heat Output	43,600 BTU/hr.
Additional Electrical Demand	1/20 HP motor (115V, 1.4A)

Additionally, three ceiling-mounted radiant panel heaters in bathrooms and future storage space. Flow rate through the panels: 1.0 gallons per minute.

Domestic Hot Water System

Indirect Hot Water Generator	
Nameplate Information	HTP model SSU-30
Capacity	30 gallon
Insulation	R-10 (estimated)
DHW Circulator	Grundfos model UPS15-58FC

Ventilation System

Boiler Room	
Nameplate Information	Cook model GN-164
Flow	150 CFM
Electrical Consumption	115 Watts
Controls	% Relative humidity (set point: 35%)

Bathroom Exhaust Fans (one per bathroom)	
Nameplate Information	Panasonic Whisperfit model FV-08VF2
Flow	50 CFM
Electrical Consumption	25 Watts
Controls	Occupancy sensor (tied to lighting)

Lighting

Location	Bulb Type	Fixtures	Bulbs per Fixture	Annual Usage (kWh)
Boiler Room	4ft. Fluorescent T-8 Tubes 32W	2	3	67
Pump (Process) Room	4ft. Fluorescent T-8 Tubes 32W	4	4	176
Future Storage Room	4ft. Fluorescent T-8 Tubes 32W	1	2	0
Bathroom Lighting	4ft. Fluorescent T-8 Tubes 32W	4	2	152
Exterior Lighting	High Pressure Sodium Wall Pack 70W	6	1	Minimal (modeled as 0 kWh)
			Total Energy Consumption	**395**

Major Equipment

Major Equipment	Purpose	Rating	Operating Schedule	Annual Energy Consumption (kWh)
Well Pump #1 Grundfos 40S30-9	Pumps water to the Water Building for distribution.	3 HP	Off	0
Well Pump #2 Grundfos 40S30-9	Pumps water to the Water Building for distribution.	3 HP	Runtime: 3.6% (metered 10/2018)	588
Self-limiting Electric Heat Tape	Raw water line freeze recovery.	7 W/ft.	Rarely used.	1,885
Primary Heat Loop Circulation Pump Grundfos UP26-99F	Circulates heat to heating zones as needed.	245 W	Runtime: 1.3% (metered 10/2018)	28
E/one Grinder Pump	Pumps wastewater to the septic tanks and drain field for disposal.	1 HP	Rarely used.	4.9
			Total Energy Consumption	**2,506**

Appendix C – Scanned Energy Billing Data

1. Electricity Billing Data

Utility: Alaska Power and Telephone (APT)
Reading: Monthly
Units: kWh

Month	Electrical Usage (kWh)	Cost
September 2017	145	$ 104.28
October 2017	150	$ 108.24
November 2017	167	$ 120.32
December 2017	162	$ 116.91
January 2018	196	$ 141.14
February 2018	307	$ 220.75
March 2018	316	$ 227.48
April 2018	507	$ 365.23
May 2018	793	$ 571.24
June 2018	893	$ 642.81
July 2018	513	$ 369.35
August 2018	214	$ 153.99

2. Billing Data for #1 Fuel Oil

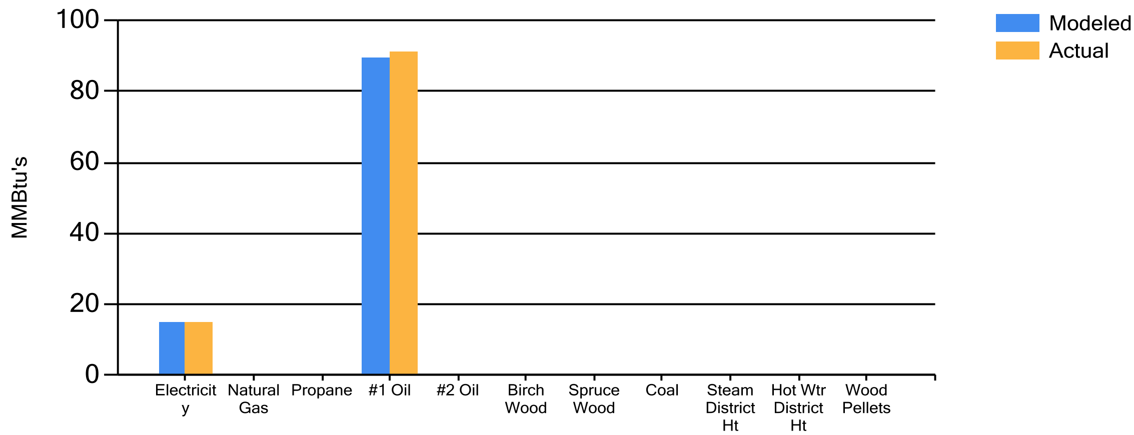
Utility: Crowley
Reading: Delivery
Units: Gallons

Month	#1 Fuel Oil (gallons)	Cost
April 2017	152	$472.42
August 2017	40	$ 124.49
October 2017	49	$ 152.96
November 2017	57	$ 178.00
December 2017	50	$ 156.75
January 2018	108	$ 336.93
February 2018	84	$ 260.42
March 2018	104	$ 324.13

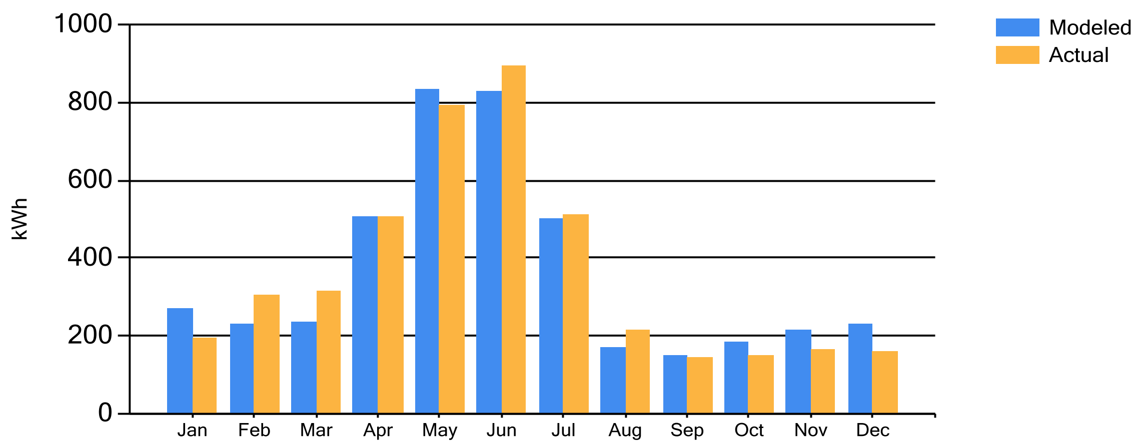
Appendix D – Actual Fuel Use versus Modeled Fuel Use

The orange bars show actual fuel and electrical use, and the blue bars are AkWarm ©'s prediction of each.

Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use