Energy Efficiency Evaluation Report
City of Whitefish Emergency Services Center
275 Flathead Ave
Whitefish, MT 59337

Prepared and provided by
Montana Resource Efficiency Program (MREP)

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Acronyms

AC	Air-conditioning
AHU	Air-Handling Unit
Btu	British thermal unit – a measure of heat
CBECS	Commercial Buildings Energy Consumption Survey
CF	Cubic Feet – volume of natural gas
CFM	Cubic Feet per Minute – a typical airflow unit of measure
DAT	Discharge Air Temperature
DDC	Direct Digital Controls – digital building automation system
DX	A type of air-conditioning
ECM	Energy Conservation Measure
EUI	Energy Use Index – benchmarking a building's energy consumption
FEC	Flathead Electric Coop
HP	Horsepower
HPS	High Pressure Sodium
HRV	Heat Recovery Ventilator
HVAC	Heating, Ventilation and Air-Conditioning
Kwh	Kilowatt-hour – a measure of electrical use
LED	Super energy efficient lighting which uses Light Emitting Diodes to generate light
MBH	Million Btu hour
MREP	Montana Resource Efficiency Program
MT DEQ	Montana Department of Environmental Quality
NCAT	National Center for Appropriate Technology
NWE	NorthWestern Energy
O&M	Operations and Maintenance
OAT	Outdoor Air Temperature
PH	Phase, of electricity
RcX	Retro-commissioning
SF	Square feet
Solar PV	Solar Photovoltaic
T5	A type of 4 foot fluorescent lamp, typically 32 watts per lamp
T5HO	A type of 4 foot fluorescent lamp, typically 32 watts per lamp
TAB	Test and Balance
Therm	100,000 Btu, a measure of heat
US EPA	United States Environmental Protection Agency
VAV	Variable Air Volume
W	Watts

Executive Summary

The following report summarizes the results of the energy and water use audit of the Whitefish Emergency Services Center in Whitefish, MT. A team of people from the City of Whitefish and the Montana Resource Efficiency Program (MREP) conducted the assessment. This report encompasses an evaluation of the energy consuming components and systems on the building, including HVAC, lighting, and domestic hot water.

The Montana Resource Efficiency Program is a partnership between the National Center of Appropriate Technology (NCAT) and the MT DEQ that conducts energy audits for Montana businesses. This project is funded through a US EPA Pollution Prevention grant with a goal of increasing energy efficiency and decreasing carbon dioxide emissions.

MREP analyzed the implementation costs and expected savings from each identified opportunity for energy conservation, water conservation, renewable energy, or operational improvements. Our audit shows that the Whitefish Emergency Services Center could greatly benefit from installing some identified measures listed below. Based on payback time, equipment, expected life, contribution to improving overall building performance, and potential funding, MREP recommends improvements be prioritized in roughly the following order:

- Replace light bulbs with LEDs
- Modify heating boiler activation and hot water reset schedule
- Perform regular maintenance of system via DDC controls service
- Conduct building retro-commissioning
- Modify courtroom HVAC system

Operational or maintenance projects including:

- Add HRVs to Apparatus Bay and Police Garage
- Add exhaust fan to elevator mechanical room
- Repair inoperable VAV20
- Shut off ceiling fans in Apparatus Bay in the summer
- Annual maintenance on HVAC and clean coils on refrigeration equipment

1. Building Overview

The Whitefish Emergency Services Center was originally constructed in 2009. The three-story building measures approximately 35,000 square feet (sf) of occupied space, with 15,000 sf on the first floor, 17,500 sf on the second floor, and 2,500 sf on the third floor. Portions of first floor are below grade as the building is on a slope, and the main entrance is on that first-floor level. The building is the primary fire and police station for the City of Whitefish. The building includes offices, dorm rooms, a kitchen and a lounge, a fire department apparatus bay, a police vehicle garage including a sally port, a squad room, evidence storage, holding cells, and a courtroom.

HVAC equipment includes a central Air Handling Unit (AHU) that incorporates a Variable Air Volume (VAV) system and DX cooling, a central boiler/hydronic system, in-slab hydronic heating, unit heaters, individual DX air conditioners, and multiple exhaust fans. The AHU serves most of the space while the unit heaters and in-slab hydronic system heat the apparatus bay along with the police vehicle garage. DX air conditioning units serve individual server rooms and exhaust fans serve individual spaces such as bathrooms, the police garage, evidence room, and kitchen. The Apparatus Bay has no mechanical ventilation while the police garage has a manually controlled exhaust fan.

Domestic hot water is provided by one tank-style natural gas hot water heater and this is also served by a solar hot water system that was installed after construction on the building was finished. Electricity is provided by Flathead Electric Coop (FEC) and natural gas is provided by Northwestern Energy (NWE). Water is provided by the City of Whitefish. Overall, the building is in good condition.

1.1. Energy Usage

Utility data, available from FEC and NWE, consists of three and a half years of electrical data and two years of natural gas data. The facility consumed an average of 368,890 kWh of electricity annually in 2013 through 2016. The peak demand during this time was 108.8 kW, with an annual total average of 747.9 kW/yr. The average annual electricity cost was $20,343.90, which resulted in a blended rate of $0.055/kWh. Electricity consumption did go down starting in the fall of 2016 due to modifications made to the central AHU, which is discussed in detail later in this report.

From August 2015 through July 2016, the facility consumed 20,154 therms of natural gas at a cost of $13,783.81, resulting in a rate of $0.684/therm. From August 2016 through July 2017, the facility consumed 17,812 therms of natural gas at a cost of $12,649.79, resulting in a rate of $0.710/therm.

1.2. Energy Use and Cost Data

Table 1 summarizes utility data including total consumption and cost of service. Figures 1 through 5 are graphic displays of the monthly utility consumption and cost for electricity and natural gas. Tables 2 and 3 summarize estimates for end use consumption.

Table 1. Annual Average Energy Consumption and Costs

Utility	Annual Consumption	Utility Rates	Annual Cost	Utility
Electricity (kWh)	368,890	$0.055/kWh	$20,343.90	Flathead Electric Coop
Natural gas (therms**)**	18,983	$0.696 / therms	$13,216	Northwestern Energy
Water -building (gallons)	160,550	$0.0286/gal	$4593.25	City of Whitefish
Water – irrigation (gallons)	1,099,515	$0.0026/gal	$2864.86	City of Whitefish

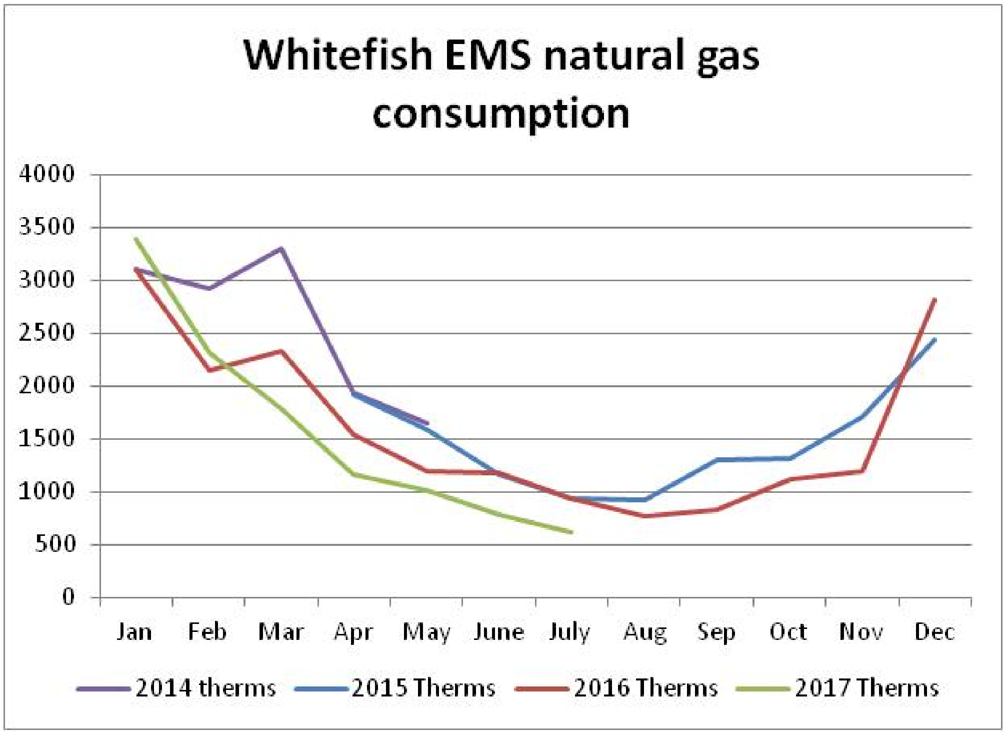


Figure 1. Monthly Natural Gas Consumption

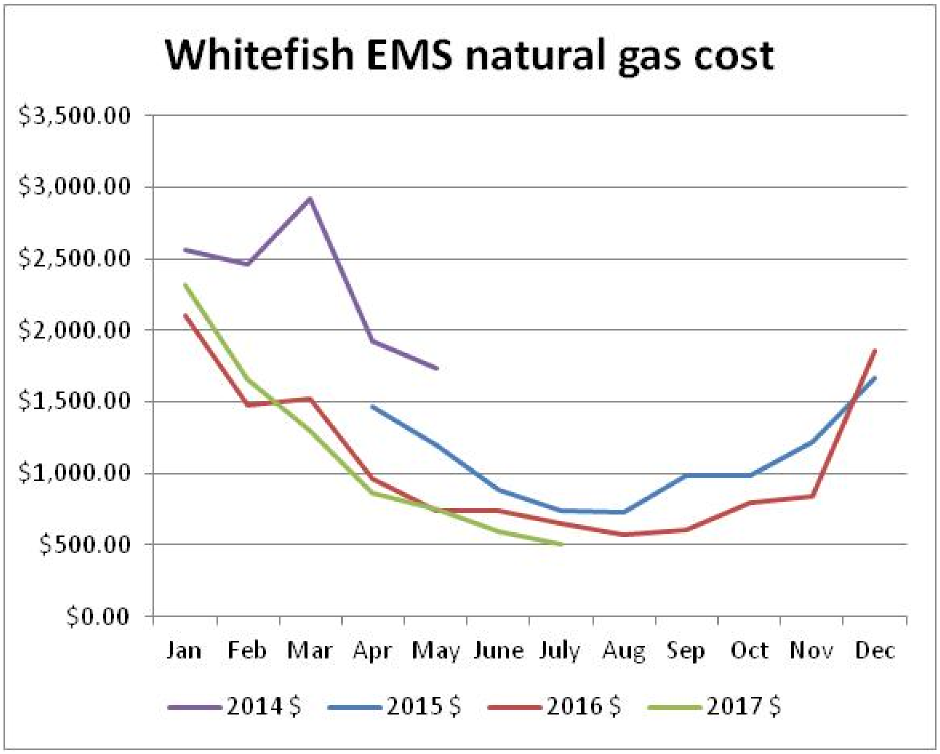


Figure 2. Monthly Natural Gas Cost

This natural gas energy use profile is typical for a building that uses natural gas for heating and domestic hot water. The summer gas usage is higher than expected because of year-round heating needs in the courtroom and associated spaces. Summer heating gas consumption was estimated by calculating the heat loss from piping throughout the building plus a small increase for the actual heat produced and boiler cycling losses. The domestic hot water consumption was calculated based on the summer monthly gas consumption minus the calculated heating usage and applied to all 12 months. The balance of the total natural gas consumption is assumed to be used for heating.

Table 2. Annual End Use Natural Gas Consumption

End Use	Annual Consumption (therms)	Annual Cost of Service	% of Natural Gas
Space Heating	11,889	$8,278	63%
Domestic Hot Water	7,094	$4,939	37%

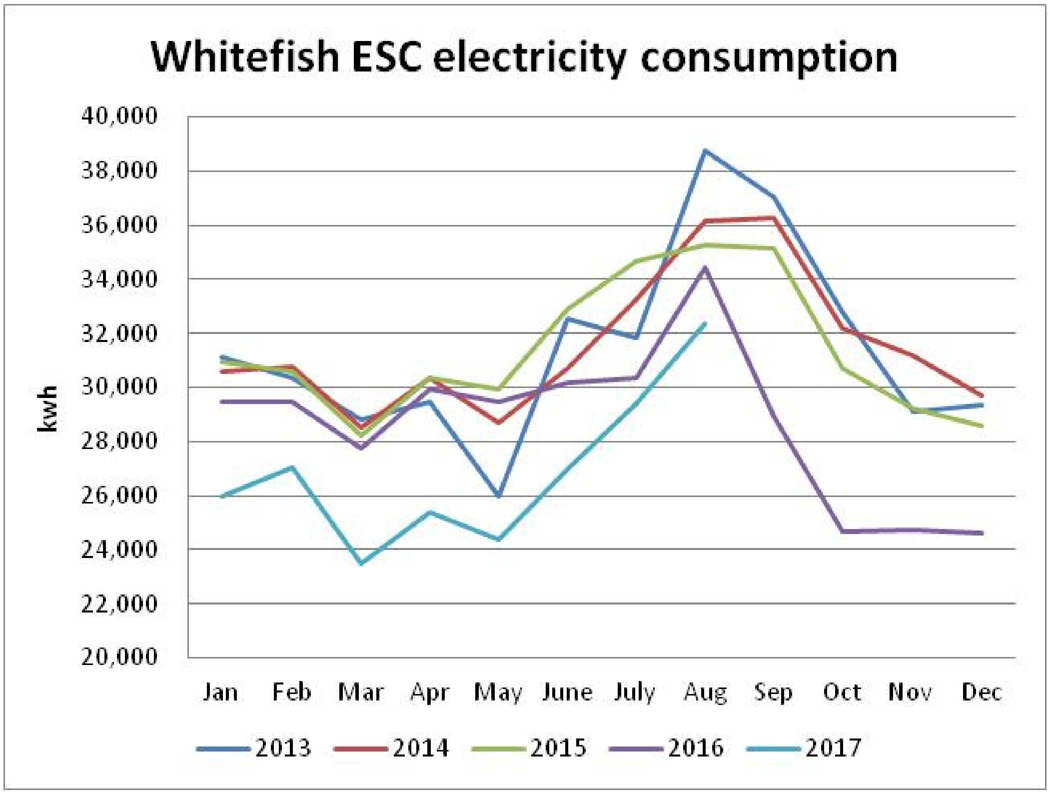


Figure 3. Monthly Electricity Consumption

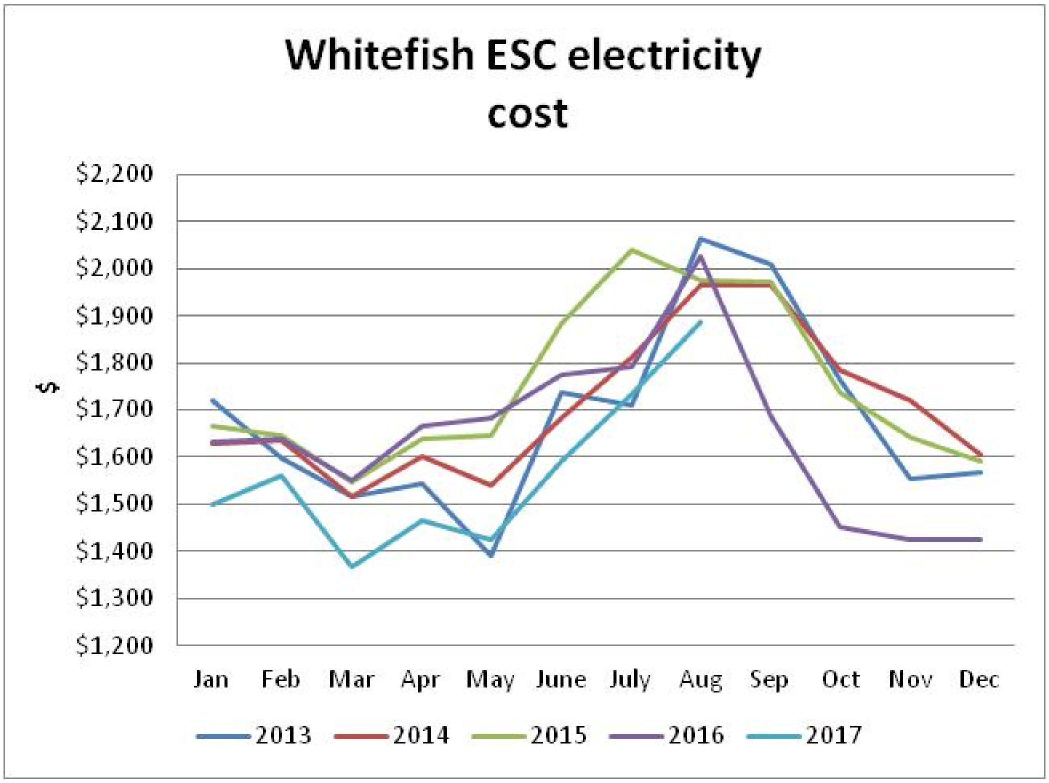


Figure 4. Monthly Electricity Cost

This electrical energy use profile is representative of an air-conditioned building in this climate since the consumption rises in the summer and drops in the winter. Analyzing the electricity use by the different equipment within the facility assists the analyst and building owner in assessing and quantifying different energy conservation recommendations. Lighting electricity consumption is based on a lighting audit. Typically, cooling consumption is the difference between the daily summer and winter consumption, and miscellaneous/plug loads are the balance. However, in this case, this method did not provide accurate results, estimating only 5% of the annual energy consumption being cooling and 74% being miscellaneous/plug loads. As a result, this audit only breaks out the energy consumption of the lighting.

Table 3. Annual End Use Electricity Consumption

End Use	Annual Consumption (kwh)	Annual Cost	% of Electricity
Lighting	78,423	$4,230	21%
Cooling / misc / plug loads	337,200	$16,114	79%

As shown in Figure 5, the monthly demand profile does show one anomaly which occurred in July 2015. Monthly demand charges should be monitored closely as they can significantly raise the electrical charges. High demand readings can be caused by changes in operation or meter read errors. Other than this one reading, the monthly demand is representative of an air-conditioned building.

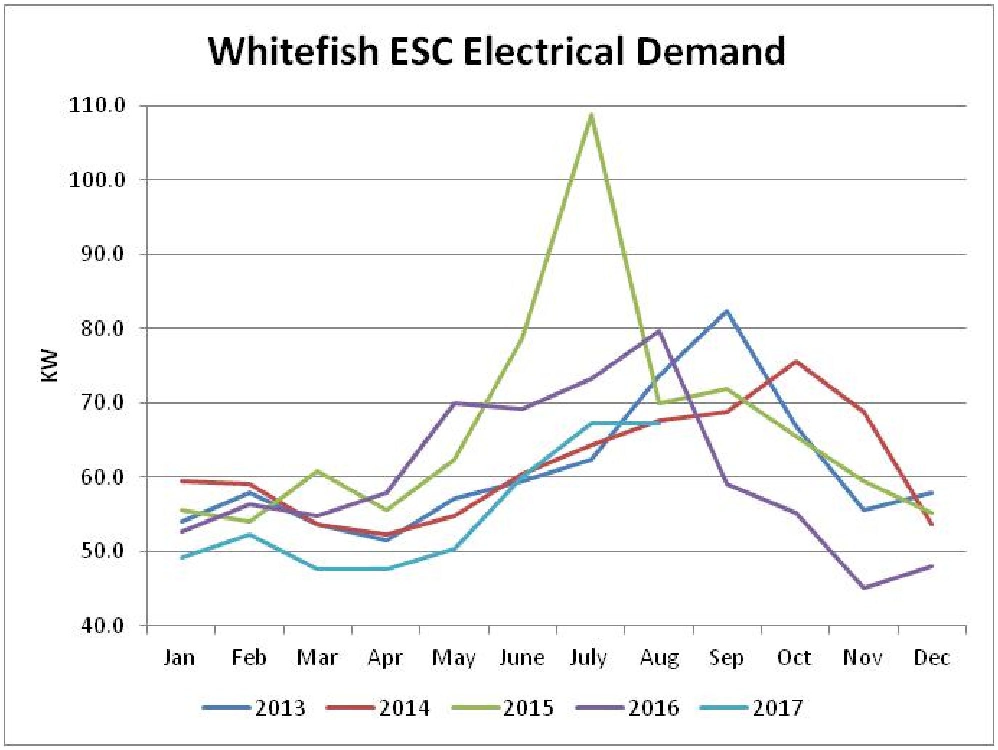


Figure 5. Monthly Electricity Demand

One item of note is the reduction of electrical consumption, which is seen starting in the fall of 2016. ATS, the controls contractor, reported that until this date the AHU/VAV air stations had no filtration and were all reading low. This caused the AHU/VAV system speed to increase in an attempt to deliver additional air. The additional air was not correctly measured, because the sensors were plugged, so the system was running at full speed nearly all the time. This caused unnecessary and excessive electricity consumption. At that time, ATS installed filters on the air stations and the AHU/VAV system slowed down. This was confirmed by NCAT during their site visit and DDC trend review. This has resulted in an approximate 16% annual savings in electrical consumption. Prior to 2016, the annual electrical consumption was approximately 375,000 kwh. After the filters were installed, the annual consumption has dropped to 318,000 kwh. Data is presented in Table 4 and is graphically shown in Figure 3. This represents an annual savings of approximately 57,000 kwh and $3000 which shows that doing regular maintenance on the system can have significant energy savings and reduce operating costs.

Table 4. Annual End Electricity Consumption - before and after AHU VAV slowdown

Electrical consumption comparison			
Before and after AHU VAV slowdown (Sep 2016)			
	Average kwh - 2013 to Sep 2016	Average kwh- Sep 2016 to present	% change
Jan	30,520	26,000	-15%
Feb	30,290	27,040	-11%
Mar	28,320	23,480	-17%
Apr	30,020	25,400	-15%
May	28,520	24,400	-14%
June	31,570	26,960	-15%
July	32,520	29,400	-10%
Aug	36,150	32,360	-10%
Sep	36,133	28,920	-20%
Oct	31,867	24,640	-23%
Nov	29,813	24,720	-17%
Dec	29,200	24,600	-16%
Annually	374,923	317,920	**-15%**

1.3. Energy Usage Analysis

Electricity and natural gas consumption can be compared to similar buildings using Commercial Buildings Energy Consumption Survey (CBECS) data. This comparison gives us an idea if there are any significant issues with the energy consumption of a building and guides the investigation into where savings might be most readily achievable.

Utility consumption is best compared to an average of similar building, for use type, climate zone, and square footage. The most comparable building use in the CBECS system is a "Fire or Police station", but unfortunately the building type data does not consider climate zone. The average electricity consumption for this building type is 11.8 kwh/sf. This building uses 10.8 kwh/sf. The average natural gas consumption for this building type is 40.9 cf/sf, while this building uses 54.0 cf/sf. Based on this comparison, the electrical consumption of this building is quite good being lower than the average for the building type. The natural gas consumption is a little higher, which is likely attributed to the cold climate and higher than normal heating needs, as compared to buildings of these types across the entire USA. The overall Energy Use Index (EUI) for this building is 93, which is slightly higher than the national average of 88.3. Although this energy audit has identified energy conservation opportunities, this energy use analysis does not indicate that the building uses an excessive amount of energy.

2. Building Systems

2.1. Occupancy

The building is open 24 hours per day, seven days per week for on-duty police and fire and the office and public areas in both spaces are typically occupied during normal business hours (Monday through Friday, five days a week, nine hours a day). Occupancy at this site ranges from 3-50 people with the low-end occupancy during off hours staffed only by firefighters.

2.2. Lighting

Most of the building has T5 light fixtures, however they are mix of T5 and T5HO. There is also a small number of other fixtures including CFL's, T8, High Pressure Sodium (HPS), and LED exit lights.

The owner reported that lighting occupancy controls sometimes leave the lights on for an extended period after the rooms were vacated.

2.3. Heating, Ventilation, and Air Conditioning (HVAC)

Most of the space is heated and cooled with the central VAV Air Handling Unit (AHU) which is controlled via an ATS DDC system. The VAV boxes are served with hot water using Taco load match pumps and a single pipe hot water distribution piping system.

The apparatus bay is heated with two gas-fired unit heaters which hang from the ceiling, along with in-slab radiant hydronic heat, which is served from the central boiler system. Neither the apparatus bay nor the police garage have cooling. The apparatus bay has no mechanical ventilation but it does have eight ceiling fans which reportedly run constantly. The apparatus bay has a source capture vehicle exhaust system which connects directly to the tailpipes of the vehicles. This system starts automatically when the vehicle does and stops when the vehicle turns off or exits the space. It has an automatic detachment and retraction mechanism.

The police garage (vehicle storage, sally port, and vehicle processing) is heated with two gas-fired unit heaters which hang from the ceiling. There are exhaust fans (on a manual switch) which are provided with makeup air through an un-heated outside air louver in the wall of the garage. This louver automatically opens and closes with exhaust fan operation. In the winter the exhaust fans are likely rarely used because of the subsequent introduction of cold outside air directly into the occupied space.

Two computer IT server rooms are cooled with separate DX air conditioning units. Multiple exhaust fans serve individual spaces including bathrooms, a kitchen hood, an evidence room, a decon room, and the police garage areas. The unit heaters, DX AC units, and exhaust fans are controlled locally and they are not in the DDC system.

The Owner reported multiple operational issues in the building including the following:

- Some spaces are not adequately cooled (typically the fire house sleeping rooms).
- The courtroom and adjacent spaces are chronically overcooled in the summer which results in cold complaints and the boiler operating all summer long.
- There are complaints of odors coming from the elevator equipment room. Instead of a dedicated exhaust fan, this space has a transfer grille installed to return air to the central AHU. This causes any odors in the room to be transferred throughout the building.
- The plenum return system for the AHU is reported to cause difficulty in controlling individual space temperatures.
- Corner offices in the police department were cool in the winter, and balancing dampers were manually adjusted to remedy this. Because the VAV AHU controls actual airflow, adjusting these dampers likely did not achieve the goal but more likely created unintended consequences of poor temperature control and airflow in other zones.
- Sometimes the domestic cold water comes out of the taps warm.
- The prevailing winds did not allow the AHU's outside air and relief air dampers to operate correctly. This was remedied with a plywood barricade to protect the louvers from the direct force of winds and is an acceptable solution.

Additional operational issues were identified through the course of the audit including:

- Air flow stations on VAV boxes had been plugged, and these were repaired and upgraded with filters by ATS in the fall of 2016.
- Numerous VAV issues, discussed later in this report.
- The original high efficiency central boiler had been replaced with a lower efficiency unit.
- Inability of the AHU VAV system to maintain space setpoints. Some of this may be caused by unrealistic setpoints (75 degree in the summer for a basement space) but others are caused by system problems (heating valve failure/leak by) and temporary fixes implemented by the controls system.
- The outside air temperature (OAT) sensor is affected by the sun and during the early and late hours of the summer it can read much higher than the ambient air temperature. This affects the heating hot water reset schedule (unless that is changed) and limits the ability of the system to use economizer (outside air) cooling. When the system thinks it is hot out, but it is actually cool, mechanical cooling is used at great expense compared to increasing the amount of outside air in the system.
- Boiler enable and hydronic hot water temperature control were based on outside air temp which is not the most energy efficient control method.
- The boiler hot water reset schedule had a minimum temperature of 140˚F which is quite high for warm weather heating.
- The apparatus bay had no mechanical ventilation.
- The police garage ventilation is likely rarely used in the winter because the makeup air is unheated and introduced directly into the space through a wall louver. When it is very cold outside having cold fresh air blow in through this louver would be a deterrent to use.

Specific VAV system problems are as follows:

- VAV20- Dorm 223 - During the summer site visit this box was observed as attempting full heat but producing none, indicating a problem with the circulating pump or heating coil. During trend review of the system in early fall, this room was observed as too cold. The controls system noted that the hot water is valved off to prevent overheating. This may indicate that a temporary fix implemented at one time has later caused operational problems. It is advised to solve the problem (whether that is through repairing the circulating pump/coil, AHU DAT or VAV airflow) to better resolve the issue for all seasons.
- Zone setpoints - limits on zone setpoints should be implemented to ensure the AHU is not attempting to provide a space temperature that is unachievable during the season. For example, VAV27, the weight room, was set to 60 deg. With full cooling airflow, the space temperature was only down to 70 degrees with an OAT of 80 degrees. Not only does this setpoint need adjusting, but the zone may need additional cooling airflow or box sizing adjustment.
- VAV18 - During the summer site visit, this space could not stay cool enough. This may be related to AHU DAT limitations (mentioned previously), or balancing issues. It was noted that this VAV was not set up with the same airflows as during the TAB.
- VAV24 - This has a maximum DDC airflow of 150 while the TAB called for 200. This could be the cause of inadequate cooling issues which were observed in the early fall trend review.

Retro-commissioning

The problems this building face are multifaceted and troubleshooting them is recommended by conducting building retro-commissioning (RcX). RcX will include a full investigation of the system, which will identify equipment that is not operating correctly, systems that are not adjusted properly, and make recommendations for changes to the system to improve operation. This audit did some RcX to identify some of the above-mentioned problems. Since many of these problems are in spaces served by the central VAV AHU and boiler/hydronic system, piece-meal solutions which address one problem often unintentionally create another. Potential causes and possible recommended solutions of the identified AHU VAV / Boiler hydronic issues are discussed below.

- Inadequate cooling and overcooling - Some spaces cannot get cool enough (e.g. dorm rooms) while other spaces get too cold (court room and associated). These problems may be related because as the system is adjusted to attempt to not overcool one space, then subsequently other spaces may not be adequately cooled. The discharge air temperature (DAT) of the air from the AHU is adjusted by a call for cooling, and when different spaces need it warmer and cooler then usually neither space is completely comfortable. Adjustment of the AHU DAT setpoint reset schedule may reduce the problem, although there are likely other issues. The sizing of the VAV boxes and adjusted airflow may not be correct for the actual load in the space. Overall testing and adjusting of this can reduce the problem. Other causes of this could be a failure with the zone hot water pump or heating coil. Either hot water leaking by or hot water not adequately flowing can contribute to these problems.

- RcX may need to see the operation/status of the zone heating pumps on each VAV box so graphical changes to the DDC interface may be necessary. Additional graphics modifications may be needed depending on the specific scope of RcX selected by the City of Whitefish.

- Courtroom and associated spaces - Since these rooms are essentially in a basement, there is very little need for cooling in the summer. The AHU is going to provide cooling air in the summertime, which tends to overcool the space and then it calls for heat. This call for heat results in the boilers operating unnecessarily and holding the AHU "hostage" by not allowing it to produce cool enough air for other spaces (reference inadequate cooling above). These spaces should be evaluated for redesign and alternates to using the VAV AHU for the summer months. The solution for these spaces may be adding a separate ventilation system for summer use that does not introduce cooling when it is not needed. One possibility is adding a HRV or MAU and closing off the VAV dampers when cooling is not called. The goal would be to stop overcooling the space and allow the boiler system to be shut down for three months of the year. RcX could evaluate this possibility and better determine if it is feasible.
- VAV airflows - some of the airflows do not match the settings when the building was originally tested and balanced. This often is the result of an effort to solve specific problems, and can unintentionally create other problems. Overall testing of the system and balancing through the RcX process is recommended to best match the space needs with available system air, heating, and cooling.
- Heating season issues were not assessed and it is recommended that RcX be conducted during both the heating and cooling season.
- Boiler hot water temperature control should be evaluated during RcX to identify more energy efficient ways to set the heating hot water temperature during warm times of the year. The goal would be to reduce excess natural gas consumption and subsequent resulting cooling load. A rudimentary method of controlling the temperature is used, using the OAT to set a certain hot water temperature. This often results in excessively warm water being produced which is inefficient causing excess heat loss through the pipes and an increase in cooling needs during the warmer months of the year. A more efficient way to control the temperature may be to have the controls system look at each zone and set the temperature based on how much heat is being called. Care must be taken to not allow certain zones to hold this hostage, if problems with overcooling (mentioned previously) cannot be remedied.

RcX could investigate the problem of warm water out of the cold domestic water taps. This would likely inspect cold and hot potable water piping to determine if missing insulation is the cause of warm water coming out of the cold-water taps. If insulation is missing, and the pipes are nearly touching, the hot water line could easily heat up the cold water line resulting in this problem.

RcX is a service that can be customized to an owner's needs. The owner may choose the scale and scope of the work to be completed. A larger scale and scope will be necessary to dig deeply into problems and come up with engineered recommendations for system changes. Because the problems here are with zone temperature control, zone airflow, AHU speed/DAT, and boiler/hot water control, the RcX process will need to look at the AHU VAV and boiler systems entirely. Some ECM's are recommended here with the assumption that the RcX process will come to the same conclusion. It is recommended to have the RcX confirm these recommendations and finalize actual scope and estimated costs. RcX has limited ability to directly solve problems, and serves to diagnose problems and create a roadmap of exactly what is happening to recommend solutions. Problems cannot be fixed unless the causes are clearly identified, and this is what RcX does. The RcX process may include recommendations such as additional testing and balancing, controls system changes, or even recommendations for design changes. A summary scope of recommended RcX work is:

Recommended RcX Contractor scope:

- Develop Owner's Project Requirements
- Develop a commissioning plan. Include changes needed to DDC graphics and trending to conduct trend review.
- Document baseline operating conditions through DDC trending.
- Develop functional performance testing of systems and scenarios identified through trending. Conducting these tests during multiple seasons is recommended (three)
- Test system operation through functional performance testing, troubleshoot with controls contractor as applicable.
- Analyze design parameters for systems with problems identified in functional testing. This may include conducting load calcs, ventilation calcs, etc., to evaluate the sizing of installed systems.
- Identify operational and maintenance enhancements that results in improvements in energy efficiency and occupant comfort.
- Identify next steps for owner for implementing enhancements. These steps may include controls changes, mechanical system repairs and/or upgrades, and possibly testing and balancing.

Additional RcX scope and costs (these will be in addition to the RcX contractor fee)

- Controls contractor generating sequence of operation verbiage
- Controls contractor making necessary graphic modifications
- Control contractor participating in on-site functional testing (multi-season)

Additional Recommended RcX scope:

- Evaluate solutions to basement chronic heating, including HRV or MAU.
- Test lighting occupancy controls for time-off-delay and adjacent space activation.
- Update O&M documentation to include current control drawings, updated sequences of operation, and a narrative of current system operation and recommended monitoring issues.
- Investigate domestic water piping to identify source of heating of cold water.
- Investigate air transfer issues through doors as it relates to the plenum return system.

Other operational recommendations:

The building owner should install a dedicated exhaust fan for the elevator equipment room to prevent odors from being transmitted to other building spaces.

No changes to the plenum return system are recommended. While a plenum return shouldn't cause problematic airflow or temperature control between the spaces, they sometimes do. If air is being returned through doorways instead of the ceiling return grille, that air will affect the temperature of the space it moves into, making temperature control of that space more challenging. Where problems exist, it is recommended to keep doors shut as much as possible. Areas with chronic problems where doors can't be kept shut may be candidates for return ductwork modifications to increase the return through the ceiling space instead of passing through doorways. RcX could include investigating this in the scope but would take some redesign of the system.

Additionally, implementing rigid limitations on space setpoints will prevent unachievable setpoints from "holding the system hostage" and making it difficult or impossible for other zones to achieve their setpoint. Modify the controls system to implement these limits.

No changes are recommended for the wind barriers at the AHU air intake and relief. This reportedly is effective and as such is a creative successful solution.

Incorporate regular maintenance into the operation of the building. Having ATS do so last fall saves $3000 annually. As systems run, their operation does degrade. Having regular maintenance done is necessary to ensure those savings continue and to prevent additional increases in energy consumption and occupant complaints.

Consider adding mechanical ventilation to the apparatus bay and upgrading the system serving the police garage. HRV systems are an energy efficient way to add ventilation to a space. These systems recover heat from the exhaust air, into the air intake, so the air delivered to the space is always warmer than the outside air. This makes the use of the ventilation system not uncomfortable as the unheated louvers in the police garage are, and it should increase the use of the ventilation system and improve air quality. Adding a HRV to the apparatus bay would improve air quality and move towards providing that space with current code quantities of fresh air however it would increase the energy consumption of the building. Table 5 includes an inventory of mechanical equipment in the building and can be useful in future maintenance and upgrade plans.

Table 5. Mechanical Equipment

Mechanical Equipment	Make/Model Number
Central Air Handling Unit (AHU)	McQuay CAH040GDAC, 25 hp supply fan, 15 hp return fan, 17850 cfm, 2802 cfm OA, 480V 3 phase, hot water heating coil, DX cooling coil, economizer cooling
Central AHU DX Condensing Unit	Copeland Scroll ZR125KCE-TFD-455, 38 tons, 4 compressors
Boilers (2)	Aerco Benchmark 1.5 Low Nox, 1500 mbh input, 1290 mbh out, 86% eff, SN G12-2099 & G-12-2100.
Boiler circulation pumps (2)	TACO 1470, 0.5 hp high capacity in-line circulator
Hydronic Hot Water pumps (2)	TACO FI3007 1 hp frame mount pump
Unit Heaters	Reznor natural gas fired units, model UDAS size 100 in vehicle storage and qty two sized 250 in the apparatus bay
VAV hydronic zone pumps	TACO load match pumps, LO410, 0.025-0.028 hp
Exhaust Fans	Numerous types of Cook exhaust fans. Approximately 18 units that include roof downblast centrifugal, inline, cabinet ceiling, roof ventilator type fans
Server Room AC	Liebert PFH037A-PL7, 208 V, 1 ph
Upstairs server room AC	Liebert PFH037A-PL7, 208 V, 1 ph
Vehicle Exhaust (apparatus bay)	Plymovent Model OS 3, 4500 cfm, 10 vehicle unit, 20 hp
Exhaust Fans	Numerous Cook exhaust fans, fractional hp up to 1 hp

2.4. Domestic Water

Domestic water supply is provided from the City of Kalispell and the building consumption is metered separately for building water and irrigation water. The domestic hot water system includes one natural gas tank water heater and a connected solar hot water system. The natural gas unit is nominal 80% efficiency. Table 6 summarizes domestic hot water equipment in the building.

Table 6. Domestic Hot Water Equipment

Domestic Hot Water Equipment	Make/Model Number
Main Unit	Bradford White Model PDV100D2503N, SN FH12316223, 100 Gal, 250,000 Bth input, 80% efficient
Solar Hot Water Unit	No information available

2.5. Refrigeration

There is no refrigeration in the building other than residential style refrigerators.

2.6. Building Envelope

The building envelope is in excellent condition as it is less than 10 years old. The amount of insulation in the building is unknown. Given the recent construction it is believed to be adequate.

3. Conservation Measures

The information below explains all the opportunities identified and evaluated by the audit team. Overall, the team recommends City of Whitefish implement opportunities with short payback times and relatively low cost immediately, so that building performance can be improved quickly, without waiting for capital improvement projects to be funded. The team recommends pursuing longer payback and higher cost opportunities as soon as practical. The team also recommends implementing low-cost operational upgrades where they will have a positive effect on occupant comfort and facility use. The implementation costs are for budgetary and planning purposes, and do not represent design or detailed cost estimating.

3.1. Building Envelope Thermal and Air Barrier Opportunities

No opportunities to improve the building envelope were identified.

3.2. Lighting Conservation Opportunities

3.2.1. Replace Light Bulbs with LED

The lighting in the building is mostly T5 light fixtures, however they are mix of T5 and T5HO. There is also a small number of other fixtures including CFL's, T8’s, and LED exit lights. MREP recommends replacing all non-LED lamps with LED. Most T5 lamps will need to be replaced with retrofit kits, as opposed to simply relamping, because of ballast incompatibility with the multilevel switching. See Appendix A for examples of upgrade options and Appendix B for a detailed analysis. Flathead Electric Coop has excellent rebate opportunities for this upgrade and limits the total rebate amount to no more than 70% of the actual project cost. MREP calculates the maximum potential rebate at $18,180 and an allowable rebate of $17,137 (70% of estimated cost) and recommends you take into consideration the 70% cap when analyzing project costs. Please consult with FEC directly when proceeding with this upgrade, for qualifications, requirements, and exact amounts as much of their rebate program is custom and needs to be calculated prior to proceeding.

Table 7. Savings Associated with lighting upgrade

Savings (kwh/yr.)	Savings/yr.	Upfront Cost	Allowable Rebate	Net Cost	Simple Payback (yrs.)
44,969	$6,879	$36,360	$17,137	$19,223	2.8

3.2.2. Tune lighting controls - Retro-Commissioning

Retro-commissioning opportunities include testing and adjusting the auto-off duration of lighting controls. Additionally, test activation of occupancy controls in adjacent spaces to ensure adjacent traffic doesn't activate lighting in rooms. MREP recommends doing this in conjunction with HVAC retro-commissioning.

3.3. Plug Load Conservation Opportunities

Plug load usage was not evaluated by MREP.

3.4. HVAC Conservation Opportunities

3.4.1. Add second Outside Air Sensor

The City could add a second OAT sensor on an opposite side of the building, and implement a low select on the temperature used by the controls system. This will ensure that the selected sensor is in the shade and will eliminate the problem of summertime sun in the morning/evening falsely indicating that it is too warm outside for economizer cooling. This will allow the system to use economizer cooling instead of mechanical cooling for longer periods which should reduce the energy consumption of the mechanical cooling system**. This ECM is NOT recommended due to long payback, as shown in Table 8.**

Table 8. Savings Associated with adding a second OAT sensor

Savings (kwh/yr.)	Savings/yr.	Upfront Incremental Cost	Rebate	Net Cost	Simple Payback (yrs.)
942	$51	$3000	$0	$3000	59

3.4.2. Modify courtroom HVAC system

The courtroom and adjacent spaces chronic call for heat likely contributes significantly to the problem of other spaces on the AHU system being uncomfortable. This is because the AHU may be trying to cool other spaces and heat these. This is a common problem with basement spaces on a building-wide AHU system and can be solved by adding a separate system to serve the basement during the summer months. RcX is recommended to look closely at this to verify the recommendation and perhaps provide other possible solutions. This recommended change will require some engineering design.

The addition of a HRV or MAU (with heat) to serve these basement spaces in the summer months. This can be programmed to operate only during occupied hours which will minimize its energy consumption (fan power and any heating/cooling). It will provide the minimum necessary ventilation to the spaces and heating only. Any call for cooling will need to come from the central AHU VAV, and adequate control to integrate this system to the AHU will be necessary.

This energy savings will come not only in natural gas savings by being able to shut off the boilers in the summer, but also in electrical savings by reducing the cooling load in the building since the hot water is no longer circulating, along with eliminating the heat provided to these spaces. Additional savings, which are unquantified, include better operation of the cooling system which may allow the AHU supply fan to slow down as some zones don't struggle to cool.

This ECM is recommended even though the calculated payback is long. This is because of the additional unquantifiable savings and the increase in occupant comfort. This ECM will solve an ongoing problem of overcooling in the summer of the basement spaces. Savings associated with this measure are summarized in Table 9.

Table 9. Savings Associated with adding separate ventilation with heat to the basement spaces

Savings (kwh/yr)	Savings (therm/yr)	Savings/yr	Upfront Cost	Rebate	Net Cost	Simple Payback (yrs)
2,698	821	$647	$12,700	$0	$12,700	19.6

3.4.3. Conduct Building Retro-Commissioning

This building is a good candidate to improve energy consumption and occupant comfort with retro-commissioning. It is recommended that the RcX scope include conducting a thorough review of the building operation including adequate detail and analysis to address the identified issues (operational and energy conservation) in this report. It should include identifying equipment that is not operating correctly, systems that are not adjusted properly, and make recommendations for changes to the system to improve operation. The RcX process will need to look at the AHU VAV and boiler systems entirely. Some ECM's are recommended here with the assumption that the RcX process will come to the same conclusion. It is recommended to have the RcX confirm these recommendations and refine actual scope and costs. RcX has limited ability to directly solve problems, and serves to be a roadmap of exactly what is happening and recommend solutions. Problems cannot be fixed unless the causes are clearly identified, and this is what RcX does. The RcX process may include recommendations such as additional testing and balancing, controls system changes, or even recommendations for design changes.

The cost of this RcX scope is estimated to be between $5,000 and $7,000. Recommendations that are not included here will be an additional cost to implement.

3.4.4. Modify heating boiler activation and hot water reset schedule.

The City should modify the boiler hot water temperature control so that the controls system looks at each zone and then sets the heating hot water temperature to keep each zone satisfied, and no higher. This same sequencing change should tell the boiler to turn on only when it is actually needed to maintain setpoint, and not simply based on an OAT. Care must be taken to not allow certain zones to hold this hostage (and always drive the temperature up), if problems with overcooling (basement courtroom spaces) cannot be remedied. This sequencing would look at the zone pump control and modulate the hot water temperature control as low as possible while keeping all zones satisfied (~pumps <90%). This control should keep the hot water system as cool as possible during the times of year that little heat is required. The savings here are calculated based on the existing condition of the boiler operating all summer long. Some cooling savings will also be realized in the summer when this additional heat must be removed by the mechanical cooling system however these are not easily quantified. This control scheme is so effective it is now included in energy codes. Table 10 summarizes the savings associated with this measure.

Table 10. Savings Associated with boiler activation and hot water temperature reset modification

Savings (therm/yr)	Savings/yr	Upfront Cost	Rebate	Net Cost	Simple Payback (yrs)
443	$308	$1200	$0	$1200	3.9

3.4.5. Upgrade heating boilers to high efficiency units.

MREP evaluated the replacement of the existing boilers with 96% efficient boilers to reduce natural gas consumption in the future when the boilers are replaced for maintenance purposes. This is not a wholesale replacement analysis since it does not include labor; it includes only the incremental cost from the current efficiency of 86% to 96% efficiency units. The payback is desirable when considering the cost of only one boiler, however with two it becomes too long for recommendation. If any other ECM's are implemented which reduce gas consumption the payback will get even longer, and this is a factor in recommending against this ECM. **This upgrade is NOT recommended, based on the long payback, as shown in Table 11.**

Table 11. Savings Associated with replacing heating boilers

Savings (therm/yr.)	Savings/yr.	Upfront Cost	Rebate	Net Cost	Simple Payback (yrs.)
1,238	$862	$15,232	$0	$15,232	17.7

3.4.6. Upgrade unit heaters to high efficiency units.

MREP evaluated the replacement of the existing unit heaters (apparatus bay and police garage) with high efficiency units. This analysis did not include detailed calculations of potential savings because there is no data for the gas consumed by these units as compared to the overall building gas consumption. Based on other energy audits recently conducted in the state where unit heaters were evaluated, this upgrade is not recommended. Costs and savings analysis for a brewery heated with unit heaters had a payback of 46 years. **This upgrade is NOT recommended.** It is recommended to consider installing higher efficiency units when they need to be replaced.

3.4.7. Perform regular maintenance of system via DDC controls service.

Modern DDC systems are complex systems that include sensors, actuators, valves, dampers, and tuning. Over time the performance of these systems will degrade, as demonstrated by the recent issue with the VAV air stations needing filtration. Conducting periodic maintenance on the system is imperative to maintaining optimal energy efficiency and operation. Without it, systems often end up running at full loads and the spaces are not comfortable. The energy savings of this work cannot be quantified but a good example is the recent energy savings of installing filters on the VAV air stations. Those savings numbers are presented in Table 12.

Table 12. Example of savings Associated with controls system maintenance

Savings (kwh/yr.)	Savings/yr.	Upfront Cost	Rebate	Net Cost	Simple Payback (yrs.)
57,000	$3,075	Varies	NA	NA	NA

3.5. Domestic Hot Water Conservation Opportunities

Opportunities to reduce energy usage by the domestic hot water would not be cost effective. While the natural gas hot water heater is only 80% efficient, the existence of the solar hot water system means that the use of the natural gas unit is much lower than would be expected. This means the payback on upgrading to a high efficiency unit would be long.

3.6. Renewable Energy Opportunities

3.6.1. Solar PV

MREP evaluated solar PV and found that it had a too long of a payback to recommend for immediate implementation. The low cost of electricity available through Flathead Electric Coop adversely affects payback of renewable energy projects.

Specific site conditions and system selection could result in an installation having a lower (or higher) payback. The owners should weigh their priorities regarding participating in alternative energy systems and the payback period. Actual system costs will vary, depending on distance of PV cells to the electrical service (this may be on the longer side), engineering structural analysis, type of inverter, and the type of system installed (ballasted vs. attached to the roof). A solar installer should be consulted for more detailed costs. Some code jurisdictions require solar installations to have an analysis completed by a structural engineer, which is separate from the installer. This preliminary analysis is based on a 10-kilowatt array, noting that actual sizing should be more closely developed working with a solar installer. **This upgrade is NOT recommended, based on the payback shown in Table 13.**

Table 13. Solar PV Savings

Savings (kwh/yr.)	Savings/yr.	Upfront Cost	Incentives	Net Cost	Simple Payback (yrs.)
12,218	$660	$27,000	$0	$27,000	39

3.7. Operational and Maintenance Improvement Opportunities

3.7.1. Add HRVs to Apparatus Bay and Police Garage

Adding HRVs to each the apparatus bay and police garage would improve ventilation. The sizing of the HRVs would need to be determined by an engineer. For the purposes of this analysis, a 4000-cfm and 2000-cfm unit has been estimated to serve each space, respectively. A 4000-cfm unit would be approximately $14,000 and a 2000-cfm unit would cost approximately $10,000.

3.7.2. Add exhaust fan to elevator mechanical room

And an exhaust fan to the elevator mechanical room to elimination the transmission of odors to the building central AHU system. A 100-cfm unit was in the original building design. Installation of this would cost approximately $1500.

3.7.3. Repair inoperable VAV20

A contractor could inspect and correct the lack of heating in this unit. The cost for this repair has not been estimated.

3.7.4. Shut off ceiling fans in Apparatus Bay in summer

Shutting off the ceiling fans in the apparatus bay during hot summer months would improve comfort by not blowing the stratified hot air down to the occupied space. It would also save a small amount of electricity (approximately $129). During other months running these fans improves energy efficiency of heating systems by bringing that warm air down, but in the summer months the high ceilings can be an effective heat sink for the space during the day.

3.7.5 Annual maintenance on HVAC and clean coils on refrigeration equipment

Annual maintenance of HVAC and refrigeration systems typically includes cleaning coils and is recommended annually. This also ensures that the systems are running optimally and reduces the likelihood of downtime. Implementation of this measure costs approximately $200 per small system, and $500 for a large, for a total of $900.

4. Summary of All Recommendations

Tables 13 through 17 summarize the recommended improvements by category. The tables provide lists of solutions for improved energy and water conservation, with associated estimated savings, implementation cost, and payback. Note that the cost estimates are for budgetary purposes and do not reflect engineering or actual contractor estimates.

Table 15. Lighting Conservation Opportunities

Item	Energy Conservation Measure	Electricity Savings (kWh/yr)	Annual Savings ($)	Net Costs ($)	Simple Payback (yrs.)	Utility Rebate
3.2.1	Replace light bulbs with LEDs	44,969	$6,879	$19,223	2.8	$17,137

Table 16. Heating, Ventilation, Air Conditioning, and Refrigeration Conservation Opportunities

Item	Energy Conservation Measure	Natural Gas Savings (therms/yr)	Electricity Savings (kwh)	Annual Cost Savings ($/yr)	Net Cost ($)	Simple Payback (yrs)	Utility Rebate
3.4.2	Modify courtroom HVAC system	821	2,698	$647	$12,700	19.6	$0
3.4.3	Conduct Building Retro-Commissioning	NA	NA	NA	$5000-$7000	NA	$0
3.4.4	Modify heating boiler activation and hot water reset schedule	443	NA	$308	$1200	3.9	$0
3.4.7	Perform regular maintenance of system via DDC controls service	NA	57,000	$3,075	Varies	NA	$0

Table 17. Operational Improvement Opportunities

Item	Energy Conservation Measure	Implementation Cost ($)
3.7.1	Add HRVs to Apparatus Bay and Police Garage	$10,000-$14,000
3.7.2	Add exhaust fan to elevator mechanical room	$1,500
3.7.3	Repair inoperable VAV20	Not estimated
3.7.4	Shut off ceiling fans in Apparatus Bay in summer	$0
3.7.5	Annual maintenance on HVAC and clean coils on refrigeration equipment	$900

5. Summary of ECM's Evaluated and Not Recommended

Tables 18 through 20 summarize these non-recommended improvements, by category. The tables provide a list of measures that were evaluated and found not to be cost effective for improved energy and water conservation, with associated estimated savings, implementation cost, and payback. Note that the cost estimates are for budgetary purposes and do not reflect engineering or actual contractor estimates.

Table 18. Heating, Ventilation, Air Conditioning, and Refrigeration Conservation Opportunities - not recommended

Item	Energy Conservation Measure	Natural Gas Savings (therms/ yr)	Electricity Savings (kWh/yr)	Annual Cost Savings ($/yr.)	Net Cost ($)	Simple Payback (yrs.)	Utility Rebate
3.4.1	Add second Outside Air Sensor	NA	942	$51	$300	59	$0
3.4.5	Upgrade heating boilers to high efficiency units	1,238	NA	$862	$15,232	17.7	$0
3.4.6	Upgrade unit heaters to high efficiency units.	NA	NA	NA	NA	~46	NA

Table 19. Domestic Hot Water Heating Conservation Opportunities - not recommended

Item	Energy Conservation Measure	Natural Gas Savings (therms)	Annual Cost Savings ($/yr.)	Net Cost ($)	Simple Payback (yrs.)	Utility Rebate
3.5	Replace Domestic Hot Water Heaters with High Efficiency Units	NA	NA	NA	NA	NA

Table 20. Renewable Energy Opportunities -not recommended

Item	Energy Conservation Measure	Annual Savings	Annual Cost Savings ($)	Net Cost ($)	Simple Payback (yrs.)	Fed Tax Incentive & REAP
3.6.1	Solar PV, 10KW array	12,218 kwh	$660	$27,000	39	$0

6. Utility Rebates/Funding Opportunities for Energy Efficiency Improvements

A total of up to $17,137 in rebates is available for the work recommended in this report. See each ECM for more information. Because rebate programs regularly change, always verify current rebate program status prior to commencing work.

7. Montana Incentives for Renewable Energy and Efficiency Improvements

Grant funding, rebates, and tax incentives change regularly. Verify the status of each program, limitations and requirements prior to proceeding with a project. The US Department of Energy lists potential funding sources at http://energy.gov/savings and the NC Clean Energy Technology Center maintains a listing of potential funding sources for energy efficiency and renewable projects at http://www.dsireusa.org/.

8. Conclusion

Thank you for the opportunity to identify and facilitate the energy conservation projects at the City of Whitefish Emergency Services Center. We are happy to assist you with your project and to facilitate any utility rebates you would like to pursue. This project is made possible through the Montana Resource Efficiency Program (MREP) and NCAT. If you have any questions or concerns or have other energy conservation projects, please contact Laura Howe at (406) 241-2863 or laurah@ncat.org.

Appendix A. Examples of lighting products eligible for FEC rebates


T8 15W 4FT. DIR TITANIUM LED SERIES
GREENCREATIVE
DLC QPL LISTED
PRO
DIRect
15W REPLACES
32W Fluo.
60% Energy Savings
Compatible with Instant Start & Programmed Start ballasts
Easy to install - Plug & Play Direct
Exceptional efficacy 137 LPW
Suitable for use in totally enclosed fixtures
End-to-end lighting with no dark spots
Dimmable
50,000 H
ELECTRONIC BALLAST COMPATIBLE
PLUG & PLAY DIRect
5 YR WARRANTY
80 CRI (Ra)
ENCLOSED*
c UL us LISTED
FC
lighting facts
LM 79
LM 80
TM 21
IES
TUBE FEATURES
Extra Wide Beam Design - Frosted Glass Body
This lamp uses an innovative glass design that diffuses heat and light more evenly. As a result of its compact light engine, this lamp produces a light emitting area of 310°. This wider beam angle improves a fixture's total light distribution and creates a more complete lighting effect.
GREEN CREATIVE Wide Beam Light Distribution
310°
Lamp Front View
Lamp Back View
End-to-End Lighting - Micro-Designed Driver
GREEN CREATIVE
25mm 29mm
41 mm
Other LED Tubes
The lamp's micro-designed driver is located within the tube end cap which allows for better thermal performance and no dark spots. The result is powerful and seamless light from end to end.
www.greencreative.com / info@greencreative.com - Tel / Fax: (866) 774-5433 - / GREENCREATIVELED / GClightingLED / GREEN CREATIVE

A19 Omni-Directional LED Light Bulbs

40W & 60W Incandescent Replacement

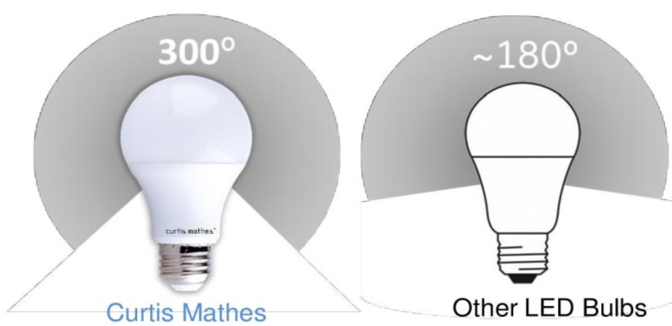
Product Features

- 9W LED A19 bulb equals 60W incandescent bulb, deliver 800lm brightness
- 6W LED A19 bulb equals to 40W incandescent bulb delivering 470lm
- Omni-direction diffusing light beam at average 300°
- Instant on-No warm-up period
- No UV/IR light in the beam
- Available in 2700K and 4000K Color Temperature
- Excellent Color Rendering at >80
- 25,000 hours rated life, it will last 22.8 years based on 3 hours per day usage
- Limited 10 year replacement warranty
- Dimmable & compatible with major dimmer brands

Environmental Commitment

- RoHS compliant – Contains no harmful lead or mercury
- Disposable with no environmental risk
- UV and IR free
- UL damp rated

Omnidirectional Light Distribution Comparison



Curtis Mathes A19 LED Omnidirectional A-Line lamps replicate true A19 incandescent with a 300-degree beam angle that produces even light in all directions.

Energy Star Rated Omni-Directional Dimmable LED Light Bulbs

Specification

Model	CMA19L-1110	CMA19L-1313
Bulb Type	A19	A19
Rated Wattage	6W	9W
Luminous Flux	470lm	800lm
Color Temperature	2700K or 4000K	2700K or 4000K
Beam Angle	300°	300°
CRI	>80	>80
Power Factor	>0.8	>0.8
Input Voltage	100-120V 60Hz	100-120V 60Hz
Dimming Range	10%-100%	10%-100%
Base	E26	E26

Packaging Information

Individual Box Dimension	62 x 62 x 117mm
Individual Box Gross weight	0.29 lbs
Master Carton Q'ty	50 pcs
Master carton Box dimension	334 x 332 x 254mm
Master carton box Gross weight	14.88 lbs
Quantity per GMA pallet	3600 pcs

Ordering Information

Models	Color Temperature
CMA19L-1313-8XX	XX = 27 for 2700K
CMA19L-1110-8XX	XX = 40 for 4000K

Examples: CMA10L-1313-827 for 9W 2700K CCT A19 bulb.

Caution

1. Suitable for use in operating environments between -20°C and +45°C (-4°F and + 113°F)
2. Not for use with emergency light fixtures or exit lights
3. Use in open fixture or fixtures with small air gaps 3 hours a day.

Curtis Mathes. Life | Always On.™

RKT-Recess Troffer Retrofit Kits

MaxLite
A NEW WAVE OF LIGHT

MaxLite's RKT Recess Troffer Retrofit Kits offer an economical alternative to upgrade to long lasting LED lighting, while not invading ceiling space or replacing existing fixture bodies. The RKT Series fits most commercially made fluorescent troffer bodies with multiple voltage, wattage and output versions.

PROJECT NAME
CATALOG NUMBER
NOTES
FIXTURE TYPE

FEATURES:

- One piece panels for easy handling and pre-aligned LED arrays
- Pre-punched holes for easy fastener insertion
- Screw fasteners allow for possible upgrades, and easy repair if needed
- Uses thermal dot technology for easy warranty control
- Multiple voltages, wattages and CCTs available
- 0-10 volt dimming available
- LM-80 qualified LEDs
- 100-277V input
- CRI: >82

CONSTRUCTION:

- Galvanized and painted 22 ga. body for maximum life and reflectance
- Insulated LED board mounting clips
- Insulated mounting grommets
- Integrated tunnel cover houses driver
- VHB adhesive holds LED strips in contact with body for thermal efficiency
- 'S' hook for temporary hanging in installation

Scan the QR code with a smartphone to view the installation video or visit the following link: http://bit.ly/ledRKT

Ordering Information:

Watts	Order Number	Model Number	Description	Lumens	CCT
45	71925	RKT2014U4535DV	2'X2' DIMMABLE TROFFER RETROFIT KIT	3590	3500
45	71926	RKT2014U4541DV	2'X2' DIMMABLE TROFFER RETROFIT KIT	3420	4100
45	71927	RKT2014U4550DV	2'X2' DIMMABLE TROFFER RETROFIT KIT	3770	5000
55	71917	RKT4514U5535DV	2'X4' DIMMABLE TROFFER RETROFIT KIT	4570	3500
55	71918	RKT4514U5541DV	2'X4' DIMMABLE TROFFER RETROFIT KIT	4498	4100
55	71919	RKT4514U5550DV	2'X4' DIMMABLE TROFFER RETROFIT KIT	4900	5000

MAX12187

MaxLite®: 1-800-555-5629 | Fax: 973-244-7333 | Web: www.maxlite.com | E-mail: info@maxlite.com

Revised: 04-28-16

Appendix B. Lighting Spreadsheet

National Center for Appropriate Technology
NCAT 3040 Continental Drive • P.O. Box 3838 • Butte, MT 59702

11/1/2017

Whitefish EMS - lighting rebate analysis		Existing Condition						Recommended Modifications							Savings			Rebates and Costs					
Location	Fixture Tag, from plans	Qty	Existing Fixtures	Watts per Fixture	Annual Hours	kW	Annual kWh	Replacement Fixtures	Qty	Watts per Fixture	Occ. Sensors	Annual Hours	kW	Annual kWh	kW	kWh	$	Cost	Maximum Rebate per	Total Maxi-mum Rebate	Total Retrofit Cost	Allowable rebate (70% of cost)	Net Retrofit Cost
First Floor																							
Entry,	B	3	T5 lamps (2)	56.0	8760	0.168	1,472	LED Tube retrofit kit, 15W per lamp -2 lamp	3	30.0		8,760	0.09	788	0.078	683	$64.72	$175	$80	$ 240	$ 525	$ 240.00	**$ 285.00**
	BE	4	T5 lamps (2)	56.0	8760	0.224	1,962	LED Tube retrofit kit, 15W per lamp -2 lamp	4	30.0		8,760	0.12	1,051	0.104	911	$86.29	$175	$80	$ 320	$ 700	$ 320.00	**$ 380.00**
	D2	4	CFL downlight, 26W	26.0	8760	0.104	911	LED screw in	4	7.0		8,760	0.028	245	0.076	666	$63.06	$4	$5	$ 20	$ 16	$ 11.20	**$ 4.80**
	X1	1	LED	1.2	8760	0.001	11																
	X2	1	LED	1.2	8760	0.001	11																
Closet	J	1	T5 lamps (2)	56.0	260	0.056	15	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		260	0.03	8	0.026	7	$3.49	$20	$20	$ 20	$ 20	$ 14.00	**$ 6.00**
Dispatch	B	4	T5 lamps (2)	56.0	1170	0.224	262	LED Tube retrofit kit, 15W per lamp -2 lamp	4	30.0		585	0.12	70	0.104	192	$27.45	$175	$80	$ 320	$ 700	$ 320.00	**$ 380.00**
	S	2	Wall Sconce, 26W screw in	26.0	2496	0.052	130	LED screw in	2	7.0		2,496	0.014	35	0.038	95	$12.05	$4	$5	$ 10	$ 8	$ 5.60	**$ 2.40**
Dispatch Restroom	D2	1	CFL downlight, 26W	26.0	260	0.026	7	LED screw in	1	7.0		260	0.007	2	0.019	5	$2.55	$4	$5	$ 5	$ 4	$ 2.80	**$ 1.20**
	G2	1	T5 lamps (2) 14 W	28.0	260	0.028	7	LED Tube retrofit kit, 8W per lamp -2 lamp	1	16.0		260	0.016	4	0.012	3	$1.61	$175	$80	$ 80	$ 175	$ 80.00	**$ 95.00**
Server	F	1	T5 lamps (2)	56.0	104	0.056	6	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		104	0.03	3	0.026	3	$3.16	$20	$20	$ 20	$ 20	$ 14.00	**$ 6.00**
Hall to Chief office	B	3	T5 lamps (2)	56.0	6570	0.168	1,104	LED Tube retrofit kit, 15W per lamp -2 lamp	3	30.0		3,285	0.09	296	0.078	808	$74.93	$20	$20	$ 60	$ 60	$ 42.00	**$ 18.00**
	BE	1	T5 lamps (2)	56.0	8760	0.056	491	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		4,380	0.03	131	0.026	359	$32.33	$20	$20	$ 20	$ 20	$ 14.00	**$ 6.00**
Chief office 126	B	4	T5 lamps (2)	56.0	1040	0.224	233	LED Tube retrofit kit, 15W per lamp -2 lamp	4	30.0		1,040	0.12	125	0.104	108	$20.60	$175	$80	$ 320	$ 700	$ 320.00	**$ 380.00**
	S	2	Wall Sconce, 26W screw in	26.0	1040	0.052	54	LED screw in	2	7.0		1,040	0.014	15	0.038	40	$7.53	$4	$5	$ 10	$ 8	$ 5.60	**$ 2.40**
Asst Chief Office 125	B	4	T5 lamps (2)	56.0	1040	0.224	233	LED Tube retrofit kit, 15W per lamp -2 lamp	4	30.0		1,040	0.12	125	0.104	108	$20.60	$175	$80	$ 320	$ 700	$ 320.00	**$ 380.00**
	S	2	Wall Sconce, 26W screw in	26.0	1040	0.052	54	LED screw in	2	7.0		1,040	0.014	15	0.038	40	$7.53	$4	$5	$ 10	$ 8	$ 5.60	**$ 2.40**
Work Room	B	1	T5 lamps (2)	56.0	728	0.056	41	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		728	0.03	22	0.026	19	$4.49	$175	$80	$ 80	$ 175	$ 80.00	**$ 95.00**
	UC2	2	17W T8	17.0	728	0.034		LED Tube retrofit kit, 9W per lamp -1 lamp	2	9.0		728	0.018	13	0.016	(13)	$0.73	$10	$10	$ 20	$ 20	$ 14.00	**$ 6.00**

124 - conference	B	2	T5 lamps (2)	56.0	520	0.112	58	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		520	0.06	31	0.052	27	$8.09	$175	$80	$ 160	$ 350	$ 160.00	**$ 190.00**
	D2	1	CFL downlight, 26W	26.0	520	0.026	14	LED screw in	1	7.0		520	0.007	4	0.019	10	$2.95	$4	$5	$ 5	$ 4	$ 2.80	**$ 1.20**
Detectives	B	4	T5 lamps (2)	56.0	1170	0.224	262	LED Tube retrofit kit, 15W per lamp -2 lamp	4	30.0		1,170	0.12	140	0.104	122	$21.70	$175	$80	$ 320	$ 700	$ 320.00	**$ 380.00**
114 -Hallway to squad room	B	5	T5 lamps (2)	56.0	4368	0.280	1,223	LED Tube retrofit kit, 15W per lamp -2 lamp	5	30.0		4,368	0.15	655	0.130	568	$61.15	$20	$20	$ 100	$ 100	$ 70.00	**$ 30.00**
	BE	2	T5 lamps (2)	56.0	8760	0.112	981	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		8,760	0.06	526	0.052	456	$43.15	$20	$20	$ 40	$ 40	$ 28.00	**$ 12.00**
	X1	1	LED	1.2	8760	0.001	11																
Squad Room	B	1	T5 lamps (2)	56.0	6552	0.056	367	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		6,552	0.03	197	0.026	170	$16.88	$175	$80	$ 80	$ 175	$ 80.00	**$ 95.00**
	B-off day	3	T5 lamps (2)	56.0	4368	0.168	734	LED Tube retrofit kit, 15W per lamp -2 lamp	3	30.0		4,368	0.09	393	0.078	341	$36.69	$175	$80	$ 240	$ 525	$ 240.00	**$ 285.00**
Corridor 113	B	5	T5 lamps (2)	56.0	4380	0.280	1,226	LED Tube retrofit kit, 15W per lamp -2 lamp	5	30.0		4,380	0.15	657	0.130	569	$61.28	$20	$20	$ 100	$ 100	$ 70.00	**$ 30.00**
	BE	2	T5 lamps (2)	56.0	8760	0.112	981	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		8,760	0.06	526	0.052	456	$43.15	$20	$20	$ 40	$ 40	$ 28.00	**$ 12.00**
Evidence storage	F	2	T5 lamps (2)	56.0	260	0.112	29	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		260	0.06	16	0.052	14	$6.98	$20	$20	$ 40	$ 40	$ 28.00	**$ 12.00**
Evidence Lab	F	2	T5 lamps (2)	56.0	260	0.112	29	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		260	0.06	16	0.052	14	$6.98	$20	$20	$ 40	$ 40	$ 28.00	**$ 12.00**
Hall to garage	B	1	T5 lamps (2)	56.0	8760	0.056	491	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		8,760	0.03	263	0.026	228	$21.57	$20	$20	$ 20	$ 20	$ 14.00	**$ 6.00**
	B - off	1	T5 lamps (2)	56.0	0	0.056	-	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0			0.03	-	0.026	-	$2.94	$20	$20	$ 20	$ 20	$ 14.00	**$ 6.00**
	BE	1	T5 lamps (2)	56.0	8760	0.056	491	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		8,760	0.03	263	0.026	228	$21.57	$20	$20	$ 20	$ 20	$ 14.00	**$ 6.00**
	X1	1	LED	1.2	8760	0.001	11																
Vehicle processing	L	2	T5 HO lamps (2)	108.0	8760	0.216	1,892	LED Tube retrofit kit, 24W per lamp -2 lamp	2	48.0		8,760	0.096	841	0.120	1,051	$99.57	$20	$20	$ 40	$ 40	$ 28.00	**$ 12.00**
Sallyport	A	2	T5 HO lamps (4)	216.0	8760	0.432	3,784	LED Tube retrofit kit, 24W per lamp -4 lamp	2	96.0		8,760	0.192	1,682	0.240	2,102	$199.14	$40	$40	$ 80	$ 80	$ 56.00	**$ 24.00**
Garage	A	4	T5 HO lamps (4)	216.0	8760	0.864	7,569	LED Tube retrofit kit, 24W per lamp -4 lamp	4	96.0		8,760	0.384	3,364	0.480	4,205	$398.28	$40	$40	$ 160	$ 160	$ 112.00	**$ 48.00**
	X1	1	LED	1.2	8760	0.001	11																
Processing/booking	B	6	T5 lamps (2)	56.0	728	0.336	245	LED Tube retrofit kit, 15W per lamp -2 lamp	6	30.0		728	0.18	131	0.156	114	$26.91	$175	$80	$ 480	$ 1,050	$ 480.00	**$ 570.00**
	BE	1	T5 lamps (2)	56.0	8760	0.336	87	LED Tube retrofit kit, 15W per lamp -2 lamp	6	30.0		8,760	0.18	23	0.156	64	$22.85	$175	$80	$ 480	$ 1,050	$ 480.00	**$ 570.00**
	W	1	T5 HO lamps (1)	54.0	728	0.054	39	LED Tube retrofit kit, 24W per lamp -1 lamp	1	24.0		728	0.024	17	0.030	22	$5.18	$20	$15	$ 15	$ 20	$ 14.00	**$ 6.00**
Interrogation (both)	H	2	T5 lamps (2)	56.0	728	0.112	82	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		728	0.06	44	0.052	38	$8.97	$20	$20	$ 40	$ 40	$ 28.00	**$ 12.00**
Juvenile Cell	H	1	T5 lamps (2)	56.0	1095	0.056	61	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		1,095	0.03	33	0.026	28	$5.27	$20	$20	$ 20	$ 20	$ 14.00	**$ 6.00**
Isolation (padded)	H	1	T5 lamps (2)	56.0	1095	0.056	61	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		1,095	0.03	33	0.026	28	$5.27	$20	$20	$ 20	$ 20	$ 14.00	**$ 6.00**

Holding, both	H	4	T5 lamps (2)	56.0	1095	0.224	245	LED Tube retrofit kit, 15W per lamp -2 lamp	4	30.0		1,095	0.12	131	0.104	114	$21.06	$20	$20	$ 80	$ 80	$ 56.00	$ 24.00
Armory	FE	1	T5 lamps (2)	56.0	8760	0.056	491	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		8,760	0.03	263	0.026	228	$21.57	$20	$20	$ 20	$ 20	$ 14.00	$ 6.00
109 Training storage/ task force	B	4	T5 lamps (2)	56.0	520	0.224	116	LED Tube retrofit kit, 15W per lamp -2 lamp	4	30.0		520	0.12	62	0.104	54	$16.17	$175	$80	$ 320	$ 700	$ 320.00	$ 380.00
small rooms	M	2	CFL downlight, 26W	26.0	520	0.052	27	LED screw in	2	7.0		520	0.014	7	0.038	20	$5.91	$4	$5	$ 10	$ 8	$ 5.60	$ 2.40
	F	1	T5 lamps (2)	56.0	520	0.056	29	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		520	0.03	16	0.026	14	$4.04	$20	$20	$ 20	$ 20	$ 14.00	$ 6.00
Lockers	B	5	T5 lamps (2)	56.0	1456	0.280	408	LED Tube retrofit kit, 15W per lamp -2 lamp	5	30.0		1,456	0.15	218	0.130	189	$30.17	$175	$80	$ 400	$ 875	$ 400.00	$ 475.00
Adjacent restrooms	G2	2	T5 lamps (2) 14 W	28.0	728	0.056	41	LED Tube retrofit kit, 8W per lamp -2 lamp	2	16.0		728	0.032	23	0.024	17	$4.14	$20	$20	$ 40	$ 40	$ 28.00	$ 12.00
	D3	2	CFL downlight, 26W	26.0	728	0.052	38	LED screw in	2	7.0		728	0.014	10	0.038	28	$6.56	$4	$5	$ 10	$ 8	$ 5.60	$ 2.40
records	B	3	T5 lamps (2)	56.0	1092	0.168	183	LED Tube retrofit kit, 15W per lamp -2 lamp	3	30.0		1,092	0.09	98	0.078	85	$15.78	$20	$20	$ 60	$ 60	$ 42.00	$ 18.00
140 break room	B	2	T5 lamps (2)	56.0	1456	0.112	163	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		1,456	0.06	87	0.052	76	$12.07	$175	$80	$ 160	$ 350	$ 160.00	$ 190.00
	UC2	1	17W T8	17.0	1456	0.017	25	LED Tube retrofit kit, 9W per lamp -1 lamp	1	9.0		1,456	0.009	13	0.008	12	$1.86	$20	$20	$ 20	$ 20	$ 14.00	$ 6.00
121 soft interview	B	2	T5 lamps (2)	56.0	728	0.112	82	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		728	0.06	44	0.052	38	$8.97	$175	$80	$ 160	$ 350	$ 160.00	$ 190.00
	S	1	Wall Sconce, 26W screw in	26.0	728	0.026	19	LED screw in	1	7.0		728	0.007	5	0.019	14	$3.28	$4	$5	$ 5	$ 4	$ 2.80	$ 1.20
138 elevator	F	1	T5 lamps (2)	56.0	260	0.056	15	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		260	0.03	8	0.026	7	$3.49	$20	$20	$ 20	$ 20	$ 14.00	$ 6.00
101 & 102 restrooms	G2	2	T5 lamps (2) 14 W	28.0	728	0.056	41	LED Tube retrofit kit, 8W per lamp -2 lamp	2	16.0		728	0.032	23	0.024	17	$4.14	$20	$20	$ 40	$ 40	$ 28.00	$ 12.00
Hall, Holding to court admin	B	8	T5 lamps (2)	56.0	4368	0.448	1,957	LED Tube retrofit kit, 15W per lamp -2 lamp	8	30.0		4,368	0.24	1,048	0.208	909	$97.84	$20	$20	$ 160	$ 160	$ 112.00	$ 48.00
	BE	6	T5 lamps (2)	56.0	8760	0.336	87	LED Tube retrofit kit, 15W per lamp -2 lamp	6	30.0		8,760	0.18	23	0.156	64	$22.85	$20	$20	$ 120	$ 120	$ 84.00	$ 36.00
	X1	4	single face LED exit light	1.2	8760	0.005	42																
	X2	1	double face LED exit light	1.2	8760	0.001	11																
Court admin and hall	B	6	T5 lamps (2)	2340	520	14.040	7,301	LED Tube retrofit kit, 15W per lamp -2 lamp	6	30.0		520	0.18	94	13.860	7,207	$2,155.20	$175	$80	$ 480	$ 1,050	$ 480.00	$ 570.00
	B-off day	1	T5 lamps (2)	2340.0	0	2.340	-	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0			0.03	-	2.310	-	$260.91	$175	$80	$ 80	$ 175	$ 80.00	$ 95.00
	BE	1	T5 lamps (2)	8760.0	8760	0.336	87	LED Tube retrofit kit, 15W per lamp -2 lamp	6	30.0		8,760	0.18	23	0.156	64	$22.85	$20	$20	$ 120	$ 120	$ 84.00	$ 36.00
	X1	2	single face LED exit light	1.2	8760	0.002	21																
Court admin office	B	2	T5 lamps (2)	56.0	260	0.112	29	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		260	0.06	16	0.052	14	$6.98	$20	$20	$ 40	$ 40	$ 28.00	$ 12.00
Court records	F	1	T5 lamps (2)	56.0	260	0.056	15	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		260	0.03	8	0.026	7	$3.49	$20	$20	$ 20	$ 20	$ 14.00	$ 6.00
Jury	B	4	T5 lamps (2)	196.0	196	0.784	154	LED Tube retrofit kit, 15W per lamp -2 lamp	4	30.0		196	0.12	24	0.664	130	$85.65	$175	$80	$ 320	$ 700	$ 320.00	$ 380.00

	UC2	1	17W T8	17.0	196	0.017		LED Tube retrofit kit, 9W per lamp -1 lamp	1	9.0		196	0.009	2	0.008	(2)	$0.76	$10	$10	$ 10	$ 10	$ 7.00	$ 3.00
Judge	B	4	T5 lamps (2)	56.0	390	0.224	87	LED Tube retrofit kit, 15W per lamp -2 lamp	4	30.0		390	0.12	47	0.104	41	$15.07	$20	$20	$ 80	$ 80	$ 56.00	$ 24.00
Courtroom and training	B	14	T5 lamps (2)	56.0	1300	0.784	1,019	LED Tube retrofit kit, 15W per lamp -2 lamp	14	30.0		1,300	0.42	546	0.364	473	$79.83	$175	$80	$ 1,120	$ 2,450	$ 1,120.00	$ 1,330.00
	J	28	T5 lamps (2)	56.0	1300	1.568	2,038	LED Tube retrofit kit, 15W per lamp -2 lamp	28	30.0		1,300	0.84	1,092	0.728	946	$159.67	$175	$80	$ 2,240	$ 4,900	$ 2,240.00	$ 2,660.00
Server Room	F	2	T5 lamps (2)	56.0	260	0.112	29	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		260	0.06	16	0.052	14	$6.98	$20	$20	$ 40	$ 40	$ 28.00	$ 12.00
Exterior	E3	4	HPS, 50 W	50.0	4380	0.200	876	LED retrofit, 20W	4	20.0		4,380	0.08	350	0.120	526	$56.56	$150	$0	$ -	$ 600	$ -	$ 600.00
	E2	7	CFL downlight, 42W	42.0	4380	0.294	1,288	LED screw in	7	15.0		4,380	0.105	460	0.189	828	$89.08	$4	$5	$ 35	$ 28	$ 19.60	$ 8.40
	E6	1	LED	10.0	4380	0.010	44																
Second Floor																							
Foyer	B	1	T5 lamps (2)	56.0	8750	0.056	490	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		8,750	0.03	263	0.026	228	$21.55	$175	$80	$ 80	$ 175	$ 80.00	$ 95.00
	B-empty	2	T5 lamps (2)	56.0	0	0.112	-	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0			0.06	-	0.052	-	$5.87	$175	$80	$ 160	$ 350	$ 160.00	$ 190.00
	BE	2	T5 lamps (2)	56.0	8760	0.112	981	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		8,760	0.06	526	0.052	456	$43.15	$175	$80	$ 160	$ 350	$ 160.00	$ 190.00
	K	2	T5 HO lamps (1)	54.0	8760	0.108	946	LED Tube retrofit kit, 24W per lamp -1 lamp	2	24.0		8,760	0.048	420	0.060	526	$49.78	$20	$20	$ 40	$ 40	$ 28.00	$ 12.00
	KE	2	T5 HO lamps (1)	54.0	8760	0.108	946	LED Tube retrofit kit, 24W per lamp -1 lamp	2	24.0		8,760	0.048	420	0.060	526	$49.78	$20	$20	$ 40	$ 40	$ 28.00	$ 12.00
	X2	1	double face LED exit light	1.2	8760	0.001	11																
235 Fire Corridor	B	2	T5 lamps (2)	56.0	6552	0.112	734	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		6,552	0.06	393	0.052	341	$33.75	$20	$20	$ 40	$ 40	$ 28.00	$ 12.00
	BE	1	T5 lamps (2)	56.0	8760	0.056	491	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		8,760	0.03	263	0.026	228	$21.57	$20	$20	$ 20	$ 20	$ 14.00	$ 6.00
	X2	1	double face LED exit light	1.2	8760	0.001	11																
Fire Admin	B	3	T5 lamps (2)	56.0	6552	0.168	1,101	LED Tube retrofit kit, 15W per lamp -2 lamp	3	30.0		6,552	0.09	590	0.078	511	$50.63	$175	$80	$ 240	$ 525	$ 240.00	$ 285.00
	BE	1	T5 lamps (2)	56.0	8760	0.056	491	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		8,760	0.03	263	0.026	228	$21.57	$175	$80	$ 80	$ 175	$ 80.00	$ 95.00
Fire Chief	B	2	T5 lamps (2)	56.0	1170	0.112	131	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		1,170	0.06	70	0.052	61	$10.85	$175	$20	$ 40	$ 350	$ 40.00	$ 310.00
	S	2	Wall Sconce, 26W screw in	26.0	1170	0.052	61	LED screw in	2	7.0		1,170	0.014	16	0.038	44	$7.93	$4	$5	$ 10	$ 8	$ 5.60	$ 2.40
206 Fire Marshall	B	2	T5 lamps (2)	56.0	1170	0.112	131	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		1,170	0.06	70	0.052	61	$10.85	$175	$80	$ 160	$ 350	$ 160.00	$ 190.00
	S	2	Wall Sconce, 26W screw in	26.0	1170	0.052	61	LED screw in	2	7.0		1,170	0.014	16	0.038	44	$7.93	$4	$5	$ 10	$ 8	$ 5.60	$ 2.40
201 Asst Chief	B	4	T5 lamps (2)	56.0	1170	0.224	262	LED Tube retrofit kit, 15W per lamp -2 lamp	4	30.0		1,170	0.12	140	0.104	122	$21.70	$175	$80	$ 320	$ 700	$ 320.00	$ 380.00
	S	3	Wall Sconce, 26W screw in	26.0	1170	0.078	91	LED screw in	3	7.0		1,170	0.021	25	0.057	67	$11.90	$4	$5	$ 15	$ 12	$ 8.40	$ 3.60

Conf Room	B	4	T5 lamps (2)	56.0	728	0.224	163	LED Tube retrofit kit, 15W per lamp -2 lamp	4	30.0		728	0.12	87	0.104	76	$17.94	$175	$80	$ 320	$ 700	$ 320.00	**$ 380.00**
	UC	1	17W T8	17.0	728	0.017		LED Tube retrofit kit, 9W per lamp -1 lamp	1	9.0		728	0.009	7	0.008	(7)	$0.37	$10	$10	$ 10	$ 10	$ 7.00	**$ 3.00**
Restroom	G2	1	T5 lamps (2) 14 W	28.0	520	0.028	15	LED Tube retrofit kit, 8W per lamp -2 lamp	1	16.0		520	0.016	8	0.012	6	$1.87	$20	$20	$ 20	$ 20	$ 14.00	**$ 6.00**
Hall to Kitchen/dorms	B	2	T5 lamps (2)	56.0	2016	0.112	226	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		2,016	0.06	121	0.052	105	$14.45	$20	$20	$ 40	$ 40	$ 28.00	**$ 12.00**
	B - off	7	T5 lamps (2)	56.0	0	0.392	-	LED Tube retrofit kit, 15W per lamp -2 lamp	7	30.0			0.21	-	0.182	-	$20.56	$20	$20	$ 140	$ 140	$ 98.00	**$ 42.00**
	BE	4	T5 lamps (2)	56.0	8760	0.224	1,962	LED Tube retrofit kit, 15W per lamp -2 lamp	4	30.0		8,760	0.12	1,051	0.104	911	$86.29	$20	$20	$ 80	$ 80	$ 56.00	**$ 24.00**
	X1	2	single face LED exit light	1.2	8760	0.002	21																
Dorm Rooms, all	B	9	T5 lamps (2)	56.0	728	0.504	367	LED Tube retrofit kit, 15W per lamp -2 lamp	9	30.0		728	0.27	197	0.234	170	$40.37	$175	$80	$ 720	$ 1,575	$ 720.00	**$ 855.00**
	D4	9	CFL downlight, 26W	26.0	728	0.234	170	LED screw in	9	7.0		728	0.063	46	0.171	124	$29.50	$4	$5	$ 45	$ 36	$ 25.20	**$ 10.80**
	UC2	1	17W T8	17.0	728	0.017		LED Tube retrofit kit, 9W per lamp -1 lamp	1	9.0		728	0.009	7	0.008	(7)	$0.37	$10	$10	$ 10	$ 10	$ 7.00	**$ 3.00**
Closet	F	1	T5 lamps (2)	56.0	260	0.056	15	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		260	0.03	8	0.026	7	$3.49	$20	$20	$ 20	$ 20	$ 14.00	**$ 6.00**
Kitchen	B	9	T5 lamps (2)	56.0	3285	0.504	1,656	LED Tube retrofit kit, 15W per lamp -2 lamp	9	30.0		3,285	0.27	887	0.234	769	$89.33	$175	$80	$ 720	$ 1,575	$ 720.00	**$ 855.00**
	D2	2	CFL downlight, 26W	26.0	3285	0.052	171	LED screw in	2	7.0		3,285	0.014	46	0.038	125	$14.51	$4	$5	$ 10	$ 8	$ 5.60	**$ 2.40**
	UC2	1	17W T8	17.0	1092	0.017	19	LED Tube retrofit kit, 9W per lamp -1 lamp	1	9.0		1,092	0.009	10	0.008	9	$1.62	$10	$15	$ 15	$ 10	$ 7.00	**$ 3.00**
Library/lounge	B	3	T5 lamps (2)	56.0	3285	0.168	552	LED Tube retrofit kit, 15W per lamp -2 lamp	3	30.0		3,285	0.09	296	0.078	256	$29.78	$175	$80	$ 240	$ 525	$ 240.00	**$ 285.00**
	S	3	Wall Sconce, 26W screw in	26.0	3009	0.078	235	LED screw in	3	7.0		3,009	0.021	63	0.057	172	$20.47	$4	$5	$ 15	$ 12	$ 8.40	**$ 3.60**
Restroom	G2	2	T5 lamps (2) 14 W	28.0	520	0.056	29	LED Tube retrofit kit, 8W per lamp -2 lamp	2	16.0		520	0.032	17	0.024	12	$3.73	$20	$30	$ 60	$ 40	$ 28.00	**$ 12.00**
Patio	E1	1	50W HPS & 35W Qtz	85.0	4380	0.085	372	LED retrofit, 20W	1	20.0		4,380	0.02	88	0.065	285	$30.64	$150	$150	$ 150	$ 150	$ 105.00	**$ 45.00**
Corridor to App Bay	B	3	T5 lamps (2)	56.0	5475	0.168	920	LED Tube retrofit kit, 15W per lamp -2 lamp	3	30.0		5,475	0.09	493	0.078	427	$43.75	$175	$80	$ 240	$ 525	$ 240.00	**$ 285.00**
	BE	1	T5 lamps (2)	56.0	8760	0.056	491	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		8,760	0.03	263	0.026	228	$21.57	$175	$80	$ 80	$ 175	$ 80.00	**$ 95.00**
	X1	2	single face LED exit light	1.2	8760	0.002	21																
Restroom and Shower (2)	D3	2	CFL downlight, 26W	26.0	1092	0.052	57	LED screw in	2	7.0		1,092	0.014	15	0.038	41	$7.69	$4	$20	$ 40	$ 8	$ 5.60	**$ 2.40**
	G2	2	T5 lamps (2) 14 W	28.0	1092	0.056	61	LED Tube retrofit kit, 8W per lamp -2 lamp	2	16.0		1,092	0.032	35	0.024	26	$4.86	$20	$20	$ 40	$ 40	$ 28.00	**$ 12.00**
Janitor	F	1	T5 lamps (2)	56.0	260	0.056	15	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		260	0.03	8	0.026	7	$3.49	$20	$20	$ 20	$ 20	$ 14.00	**$ 6.00**
Decon	F	2	T5 lamps (2)	56.0	1456	0.112	163	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		1,456	0.06	87	0.052	76	$12.07	$20	$20	$ 40	$ 40	$ 28.00	**$ 12.00**
Turnout	UV	2	T5 lamps (2)	56.0	1092	0.112	122	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		1,092	0.06	66	0.052	57	$10.52	$20	$20	$ 40	$ 40	$ 28.00	**$ 12.00**

Shop & Mudroom	F	3	T5 lamps (2)	56.0	364	0.168	61	LED Tube retrofit kit, 15W per lamp -2 lamp	3	30.0		364	0.09	33	0.078	28	$11.13	$20	$20	$ 60	$ 60	$ 42.00	$ **18.00**
Corridor	B	2	T5 lamps (2)	56.0	5475	0.112	613	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		5,475	0.06	329	0.052	285	$29.17	$175	$80	$ 160	$ 350	$ 160.00	$ **190.00**
	BE	1	T5 lamps (2)	56.0	8760	0.056	491	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		8,760	0.03	263	0.026	228	$21.57	$175	$80	$ 80	$ 175	$ 80.00	$ **95.00**
EMS Storage	F	2	T5 lamps (2)	56.0	364	0.112	41	LED Tube retrofit kit, 15W per lamp -2 lamp	2	30.0		364	0.06	22	0.052	19	$7.42	$20	$20	$ 40	$ 40	$ 28.00	$ **12.00**
Report Room 210	B	6	T5 lamps (2)	56.0	4380	0.336	1,472	LED Tube retrofit kit, 15W per lamp -2 lamp	6	30.0		4,380	0.18	788	0.156	683	$73.53	$20	$20	$ 120	$ 120	$ 84.00	$ **36.00**
Apparatus Bay	A-off day	16	T5 HO lamps (4)	216.0	2839	3.456	9,812	LED Tube retrofit kit, 24W per lamp -4 lamp	16	96.0		2,839	1.536	4,361	1.920	5,451	$662.92	$200	$100	$ 1,600	$ 3,200	$ 1,600.00	$ **1,600.00**
	AE	2	T5 HO lamps (4)	216.0	8760	0.432	3,784	LED Tube retrofit kit, 24W per lamp -4 lamp	2	96.0		8,760	0.192	1,682	0.240	2,102	$199.14	$200	$100	$ 200	$ 400	$ 200.00	$ **200.00**
	X1	2	single face LED exit light	1.2	8760	0.002	21																
	E2	10	CFL downlight, 42W	42.0	2839	0.420	1,192	LED screw in	10	15.0		1,420	0.15	213	0.270	980	$110.65	$4	$5	$ 50	$ 40	$ 28.00	$ **12.00**
Mezzanine																							
Stairs	M	3	CFL downlight, 26W	26.0	8760	0.078	683	LED screw in	3	7.0		8,760	0.021	184	0.057	499	$47.30	$4	$5	$ 15	$ 12	$ 8.40	$ **3.60**
Server/radio	FE	1	T5 lamps (2)	56.0	260	0.056	15	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		260	0.03	8	0.026	7	$3.49	$20	$20	$ 20	$ 20	$ 14.00	$ **6.00**
weight room	F	5	T5 lamps (2)	56.0	2184	0.280	612	LED Tube retrofit kit, 15W per lamp -2 lamp	5	30.0		2,184	0.15	328	0.130	284	$37.92	$175	$80	$ 400	$ 875	$ 400.00	$ **475.00**
	FE	1	T5 lamps (2)	56.0	2184	0.056	122	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		2,184	0.03	66	0.026	57	$7.58	$175	$80	$ 80	$ 175	$ 80.00	$ **95.00**
Mech	F	1	T5 lamps (2)	56.0	260	0.056	15	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		260	0.03	8	0.026	7	$3.49	$175	$80	$ 80	$ 175	$ 80.00	$ **95.00**
	FE	1	T5 lamps (2)	56.0	260	0.056	15	LED Tube retrofit kit, 15W per lamp -2 lamp	1	30.0		260	0.03	8	0.026	7	$3.49	$175	$80	$ 80	$ 175	$ 80.00	$ **95.00**
							78,452								28.329	44,969	$6,879.38			$18,180.00	$36,360.00	$17,137.00	$19,223.00

Energy Rate	$0.0818260	/kWh
Demand Rate	$9.41237	/kW-month
Annual Bill Savings	**$6,879**	**/Year**
Estimated Project Cost	**$36,360**	
Estimated Rebate	**$17,137**	
Estimated Net Cost	**$19,223**	
Simple Payback, after rebate	**2.79**	**Years**

*2/3 demand savings

Note: The information included in this and any related documents has been developed for purposes of energy analysis and preliminary cost estimating. This information is based on our general experience with similar past projects. Actual costs may vary based on local conditions and more recent equipment prices. The installation contractor is responsible for verifying all existing equipment quantities and characteristics.

NCAT Energy Analyst
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