LEVEL II ENERGY AUDIT

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT
5735 47th Avenue
Sacramento, California 95824

DLR GROUP
1050 20th Street, Suite 250
Sacramento, California 95902

ZERO NET ENERGY ASHRAE LEVEL II AUDIT

MAINTENANCE AND OPERATIONS

425 1st Avenue
Sacramento, California 95818

PREPARED BY:
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EMG PROJECT #:
136988.19R000-001.268

DATE OF REPORT:
November 8, 2019

ONSITE DATE:
September 4, 2019

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Certification

EMG has completed an Energy Audit of Maintenance and Operations located at 425 1st Avenue in Sacramento, California 95818. EMG visited the site on September 4, 2019.

The assessment was performed at the Client's request using methods and procedures consistent with ASHRAE Level II Energy Audit and using methods and procedures as outlined in EMG's Proposal.

This report has been prepared for and is exclusively for the use and benefit of the Client identified on the cover page of this report. The purpose for which this report shall be used shall be limited to the use as stated in the contract between the client and EMG.

This report, or any of the information contained therein, is not for the use or benefit of, nor may it be relied upon by any other person or entity, for any purpose without the advance written consent of EMG. Any reuse or distribution without such consent shall be at the client's or recipient's sole risk, without liability to EMG.

Estimated installation costs are based on EMG's experience on similar projects and industry standard cost estimating tools including *RS Means and Whitestone CostLab*. In developing the installed costs, EMG also considered the area correction factors for labor rates for Sacramento, California 95818. Since actual installed costs may vary widely for particular installation based on labor & material rates at time of installation, EMG does not guarantee installed cost estimates and shall in no event be liable should actual installed costs vary from the estimated costs herein. We strongly encourage the owner to confirm these cost estimates independently. EMG does not guarantee the costs savings estimated in this report. EMG shall in no event be liable should the actual energy savings vary from the savings estimated herein.

EMG certifies that EMG has no undisclosed interest in the subject property and that EMG's employment and compensation are not contingent upon the findings or estimated costs to remedy any deficiencies due to deferred maintenance and any noted component or system replacements.

Any questions regarding this report should be directed to Kaustubh Anil Chabukswar at 800.733.0660, ext. 7512.

Prepared by: Noah Strafford
Energy Auditor
Project Manager

Reviewed by:

Aren Hofland

Technical Report Reviewer for

Kaustubh Anil Chabukswar, CEM CRM
Program Manager

1. Executive Summary

The purpose of this Energy Audit is to provide Sacramento City Unified School District and Maintenance and Operations with a baseline of energy usage and the relative energy efficiency of the facility and specific recommendations for Energy Conservation Measures. Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Federal & Utility grants towards energy conservation, support performance contracting, justify a municipal bond funded improvement program, or as a basis for replacement of equipment or systems.

BUILDING #	STRUCTURES ASSESSED	BUILDING TYPE	EMG CALCULATED AREA (SF)	ESTIMATED OCCUPANCY
1	Building 001	Operations Building	31,715	50
2	Building 0BW	Storage Building	7,500	
3	Building P01	Office Spaces	1,000	

The study included a review of the building's construction features, historical energy and water consumption and costs, review of the building envelope, HVAC equipment, heat distribution systems, lighting, and the building's operational and maintenance practices.

1.1. Energy Conservation Measures

EMG has identified nine Energy Conservation Measures (ECMs) for this property. The savings for each measure is calculated using standard engineering methods followed in the industry, and detailed calculations for ECM are provided in Appendix E for reference. A 10% discount in energy savings was applied to account for the interactive effects amongst the ECMs. In addition to the consideration of the interactive effects, EMG has applied a 15% contingency to the implementation costs to account for potential cost overruns during the implementation of the ECMs.

The following table summarizes the recommended ECMs in terms of description, investment cost, energy consumption reduction, and cost savings.

Summary of Financial Information for Recommended Non-Renewable Energy Conservation Measures

ITEM	ESTIMATE
Net Initial ECM Investment *(Current Dollars Only)*	$200,034 *(In Current Dollars)*
Estimated Annual Cost Savings *(Current Dollars Only)*	$34,903 *(In Current Dollars)*
ECM Effective Payback	5.73 years
Estimated Annual Energy Savings	39.88%
Estimated Annual Energy Utility Cost Savings *(Excluding Water)*	49.84%
Estimated Annual Water Cost Saving	26.12%

Solar Photovoltaic (PV) Screening for MAINTENANCE AND OPERATIONS

SOLAR ROOFTOP PHOTOVOLTAIC ANALYSIS		
Estimated Number of Panels	126	
Estimated KW Rating	40	KW
Potential Annual kWh Produced	61,346	kWh
% of Current Electricity Uses	23.2%	
FINANCIAL SUMMARY		
Investment Cost	$138,600	
Estimated Energy Cost Savings	$9,024	
Payback without Incentives	15.4	Years
Incentive Payback but without SRECs	9.3	Years
Payback with All Incentives	9.3	Years

Key Metrics to Benchmark the Subject Property's Energy Usage Profile

- Building Site Energy Use Intensity - The sum of the total site energy use in thousands of Btu per unit of gross building area. Site energy accounts for all energy consumed at the building location only not the energy consumed during generation and transmission of the energy to the site.
- Building Source Energy Use Intensity – The sum of the total source energy use in thousands of Btu per unit of gross building area. Source energy is the energy consumed during generation and transmission in supplying the energy to your site.
- Building Cost Intensity - This metric is the sum of all energy use costs in dollars per unit of gross building area.
- Greenhouse Gas Emissions - Although there are numerous gases that are classified as contributors to the total for Greenhouse Emissions, the scope of this energy audit focuses on carbon dioxide (CO_2). Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement).

SITE ENERGY USE INTENSITY (EUI)	RATING
Current Site Energy Use Intensity (EUI)	57 kBtu/ft^2
Post ECM Site Energy Use Intensity (EUI)	34 kBtu/ft^2
SOURCE ENERGY USE INTENSITY (EUI)	**RATING**
Current Source Energy Use Intensity (EUI)	111 kBtu/ft^2
Post ECM Source Energy Use Intensity (EUI)	56 kBtu/ft^2
BUILDING COST INTENSITY (BCI)	**RATING**
Current Building Cost Intensity	$1.44/ft^2
Post ECM Building Cost Intensity	$0.72/ft^2

Summary of the Greenhouse Gas Reductions from Recommended Non-Renewable Energy Conservation Measures

The following table provides a summary of the projected Greenhouse Gas Emissions reductions as a result of the recommended Energy Conservation Measures:

GREENHOUSE GAS EMISSIONS REDUCTION	
Estimated Annual Thermal Energy Reduction	920 MMbtu
Total CO_2 Emissions Reduced	72.72 $MtCO_2/Yr$
Total Cars Off the Road (Equivalent)*	13
Total Acres of Pine Trees Planted (Equivalent)*	17

**Equivalent reductions per DOE emissions calculation algorithms*

Zero Net Energy Analysis for Renewable and Non-Renewable Recommended Measures

ZERO NET ENERGY ANALYSIS	
Building Annual Net Energy Consumption	2,307,446 kBtu
Total Annual Energy Savings for Non-Renewable Energy Measures	920,294 kBtu
Total Annual Energy Savings from Renewable Energy Measures	209,313 kBtu
Total Annual Energy Savings	1,129,607 kBtu
Net Energy Consumption from Grid Post Implementation	1,177,839 kBtu
% Energy Reduction (Annual Energy-Net Energy) / (Annual Energy)	49%

Energy Conservation Measures Screening:

EMG screens ECMs using two financial methodologies. ECMs which are considered financially viable must meet both criteria.

1. Simple Payback Period –The number of years required for the cumulative value of energy or water cost savings less future non-fuel or non-water costs to equal the investment costs of the building energy or water system, without consideration of discount rates. ECMs with a payback period greater than the Expected Useful Life (EUL) of the project are not typically recommended, as the cost of the project will not be recovered during the lifespan of the equipment. These ECMs are recommended for implementation during future system replacement. At that time, replacement may be evaluated based on the premium cost of installing energy efficient equipment.

$$Simple\ Payback = \frac{Initial\ Cost}{Annual\ Savings}$$

2. Savings-to-Investment Ratio (SIR) – The savings-to-investment ratio is the ratio of the present value savings to the present value costs of an energy or water conservation measure. The numerator of the ratio is the present value over the estimated useful life (EUL) of net savings in energy or water and non-fuel or non-water operation and maintenance costs attributable to the proposed energy or water conservation measure. The denominator of the ratio is the present value of the net increase in investment and replacement costs less salvage value attributable to the proposed energy or water conservation measure. It is recommended that energy efficiency recommendations should be based on a calculated SIR, with larger SIRs receiving a higher priority. A project is typically only recommended if SIR is greater than or equal to 1.0, unless other factors outweigh the financial benefit.

$$SIR = \frac{Present\ Value\ (Annual\ Savings, i\%, EUL)}{Initial\ Cost}$$

List of Recommended Energy Conservation Measures For Maintenance and Operations

ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Estimated Annual Water Savings	Estimated Cost Savings	Estimated Annual O&M Savings	Total Estimated Annual Cost Savings	Simple Payback	S.I.R.	Life Cycle Savings	Expected Useful Life (EUL)
			Natural Gas	Electricity								
		$	Therms	kWh	kgal	$	$	$	Years		$	Years
No/Low Cost Recommendations												
1	Install Low Flow Restroom Flush Tank Toilets Location: Restrooms And Locker Rooms	$949	0	0	42	$416	$0	$416	2.28	6.52	$5,240	20.00
2	Install Low Flow Faucet Aerators Location: Restrooms And Classrooms	$213	50	0	6	$127	$0	$127	1.68	5.07	$869	10.00
Totals for No/Low Cost Items		**$1,162**	**50**	**0**	**48**	**$543**	**$0**	**$543**	**2.14**			
Capital Cost Recommendations												
1	Reduce HVAC Hours of Operation Location: Throughout	$1,597	1,787	22,535	0	$5,710	$0	$5,710	0.28	42.68	$66,564	15.00
2	Install Timers On Exhaust Fans Location: Throughout	$2,831	241	7,348	0	$1,403	$0	$1,403	2.02	5.92	$13,923	15.00
3	Control External Air Leakage In Commercial Buildings Location: Extrior Doors	$3,009	586	3,143	0	$1,248	$62	$1,311	2.30	5.20	$12,638	15.00
4	Install Outside Air Temperature Reset Controls For Hot Water Boilers Location: 001	$1,219	333	0	0	$446	$0	$446	2.74	3.12	$2,583	10.00
5	Upgrade Building Lighting to LED and Install Automatic Lighting Controls Location: Building Interior And Exterior	$146,116	0	141,845	0	$20,867	$6,283	$27,149	5.38	2.22	$177,988	15.00
6	Re-Commission The Building & Its Control Systems Location: Throughout	$18,007	1,085	5,200	0	$2,220	$0	$2,220	8.11	1.47	$8,490	15.00
Total For Capital Cost		**$172,780**	**4,032**	**180,070**	**0**	**$31,893**	**$6,345**	**$38,238**	**4.52**			
	Interactive Savings Discount @ 10%		-408	-18,007	-5	-$3,244	-$635	-$3,878				
	Total Contingency Expenses @ 15%	$26,091										
Total for Improvements		**$200,034**	**3,673**	**162,063**	**43**	**$29,193**	**$5,711**	**$34,903**	**5.73**			

In addition to the above measures, EMG has identified the following measure(s) but has not recommended as they fail to meet the above-mentioned financial criteria of SIR>1.0. Thus, EMG has classified the measure(s) as recommended for consideration.

List of Recommended For Consideration Energy Conservation Measures For Maintenance and Operations

ECM #	Description of ECM	Initial Investment	Annual Energy Savings		Annual Water Savings	Cost Savings	Estimated Annual O&M Savings	Total Estimated Annual Cost Savings	Payback	S.I.R.	Life Cycle Savings	Expected Useful Life (EUL)
		$	Natural Gas	Electricity	kgal	$	$	$	Years		$	Years
1	Upgrade Insulation Location: Attic/Ceiling Throughout	$102,040	1,675	8,979	0	$3,567	$0	$3,567	28.61	0.61	-$39,935	25.00
2	Install Low Flow Tankless Restroom Fixtures Location: Restrooms	$8,235	0	0	0	$346	$0	$346	23.78	0.50	-$4,101	15.00
3	Replace Inefficient Heating Plant Location: Boiler Room	$49,367	1,011	0	0	$1,354	$68	$1,422	34.71	0.50	-$24,603	25.00
Total for Improvements		**$102,040**	**1,675**	**8,979**	**0**	**$3,567**	**$0**	**$3,567**	**28.61**			

2. Introduction

The purpose of this Energy Audit is to provide Maintenance and Operations and Sacramento City Unified School District with a baseline of energy usage, the relative energy efficiency of the facility, and specific recommendations for Energy Conservation Measures. Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Federal and Utility grants towards energy conservation, as well as support performance contracting, justify a municipal bond-funded improvement program, or as a basis for replacement of equipment or systems.

The energy audit consisted of an onsite visual assessment to determine current conditions, itemize the energy consuming equipment (i.e. Boilers, Make-Up Air Units, DWH equipment); review lighting systems both exterior and interior; and review efficiency of all such equipment. The study also included interviews and consultation with operational and maintenance personnel. The following is a summary of the tasks and reporting that make up the Energy Audit portion of the report.

The following is a summary of the tasks and reporting that make up the Energy Audit portion of the report.

ENERGY AND WATER USING EQUIPMENT

- EMG has surveyed the common areas, office areas, rooms, maintenance facilities and mechanical rooms to document utility-related equipment, including heating systems, cooling systems, air handling systems and lighting systems.

BUILDING ENVELOPE

- EMG has reviewed the characteristics and conditions of the building envelope, checking insulation values and conditions. This review also includes an inspection of the condition of walls, windows, doors, roof areas, insulation and special use areas

RECOMMENDATIONS FOR ENERGY SAVINGS OPPORTUNITIES

- Based on the information gathered during the on site assessment, the utility rates, as well as recent consumption data and engineering analysis, EMG has identified opportunities to save energy and provide probable construction costs, projected energy/utility savings and provide a simple payback analysis.

ANALYSIS OF ENERGY CONSUMPTION

- Based on the information gathered during the on-site assessment, EMG has conducted an analysis of the energy usage of all equipment, and identified which equipment is using the most energy and what equipment upgrades may be necessary. As a result, equipment upgrades, or replacements are identified that may provide a reasonable return on the investment and improve maintenance reliability.

ENERGY AUDIT PROCESS

- Interviewing staff and review plans and past upgrades
- Performing an energy audit for each use type
- Performing a preliminary evaluation of the utility system
- Analyzing findings, utilizing ECM cost-benefit worksheets
- Making preliminary recommendations for system energy improvements and measures
- Estimating initial cost and changes in operating and maintenance costs based on implementation of energy efficiency measures
- Ranking recommended cost measures, based on the criticality of the project and the largest payback

REPORTING

The EMG Energy Audit Report includes:

- A comprehensive study identifying all applicable Energy Conservation Measures (ECMs) and priorities, based on initial cost and payback
- A narrative discussion of building systems/components considered and a discussion of energy improvement options;
- A summary of ECMs including initial costs and simple paybacks, based on current utility rates and expected annual savings.

3. Facility Overview and Existing Conditions

3.1. Building Occupancy and Point of Contact

FACILITY SCHEDULE	
Hours of Operations / Week	40
Operational Weeks / Year	52
Estimated Facility Occupancy	50
% of Male Occupants	70%

POINT OF CONTACT	
Point of Contact Name	Mike Taxara
Point of Contact Title	HVAC Technician
Point of Contact – Contact Number	916.264.4075 x 1110

3.2. Building Heating, Ventilating and Air-Conditioning (HVAC)

Description:

Building 001 is primarily heated and cooled by packaged rooftop units utilizing natural gas for heat. Heating is also provided to the building by a cast iron hot water boiler. The building is also served by forced air natural gas furnaces and a gas-fired makeup air unit. The portable building is served by a single wall-mounted heat pump.

The Mechanical Equipment Schedule in Appendix B contains a summary of the HVAC Equipment at the property.

BUILDING CENTRAL HEATING SYSTEM	
Primary Heating System	Central Hot Water Boilers
Secondary Heating System	Rooftop Package Unit
Hydronic Distribution System	Two Pipe
Primary Heating Fuel	Natural Gas
Heating Mode Set-point	69 °F
Heating Mode- Set-back Temperature	53 °F

BUILDING COOLING SYSTEM	
Primary Cooling System	Packaged Units
Secondary Cooling System	Split Systems

BUILDING COOLING SYSTEM	
Hydronic Distribution System	Not Applicable
Cooling Mode Set-point	73 °F
Cooling Mode- Set-back Temperature	93 °F

AIR DISTRIBUTION SYSTEM	
Building Ventilation	Roof-top Exhaust Fans
On-Demand Ventilation System in Use?	No
Energy Recovery Wheel / Enthalpy Wheel Exhaust Fans	No

DOMESTIC HOT WATER SYSTEM	
Primary Domestic Water Fuel	Natural Gas

3.3. Lighting

Description:

The lighting in the school building primarily consists of T8 linear fluorescent lamp fixtures in classrooms and hallways. The fixtures were observed to be operating on bi-level mode in the classrooms. The exterior lights were primarily High Intensity Discharge (HID) fixtures.

The detailed lighting schedule and the proposed LED alternative is provided in Appendix C.

4. Utility Analysis

Establishing the energy baseline begins with an analysis of the utility cost and consumption of the building. Utilizing the historical energy data and local weather information, we evaluate the existing utility consumption and assign it to the various end-uses throughout the buildings. The Historical Data Analysis breaks down utilities by consumption, cost and annual profile.

This data is analyzed, using standard engineering assumptions and practices. The analysis serves the following functions:

- Allows our engineers to benchmark the energy and water consumption of the facilities against consumption of efficient buildings of similar construction, use and occupancy.
- Generates the historical and current unit costs for energy and water
- Provides an indication of how well changes in energy consumption correlate to changes in weather.
- Reveals potential opportunities for energy consumption and/or cost reduction. For example, the analysis may indicate that there is excessive, simultaneous heating and cooling, which may mean that there is an opportunity to improve the control of the heating and cooling systems.

By performing this analysis and leveraging our experience, our engineers prioritize buildings and pinpoint systems for additional investigation during the site visit, thereby maximizing the benefit of their time spent on-site and minimizing time and effort by the customer's personnel.

Based upon the utility information provided about the Sacramento City Unified School District, the following energy rates are utilized in determining existing and proposed energy costs.

Utility Rates used for Cost Analysis

ELECTRICITY (BLENDED RATE)	NATURAL GAS	WATER / SEWER
$0.15 /kWh	$1.34 /therm	$ 10.00 /kGal

The data analyzed provides the following information: 1) breakdown of utilities by consumption, 2) cost and annual profile, 3) baseline consumption in terms of energy/utility at the facility, 4) the Energy Use Index, or Btu/sq ft, and cost/sq ft. For multiple water meters, the utility data is combined to illustrate annual consumption for each utility type.

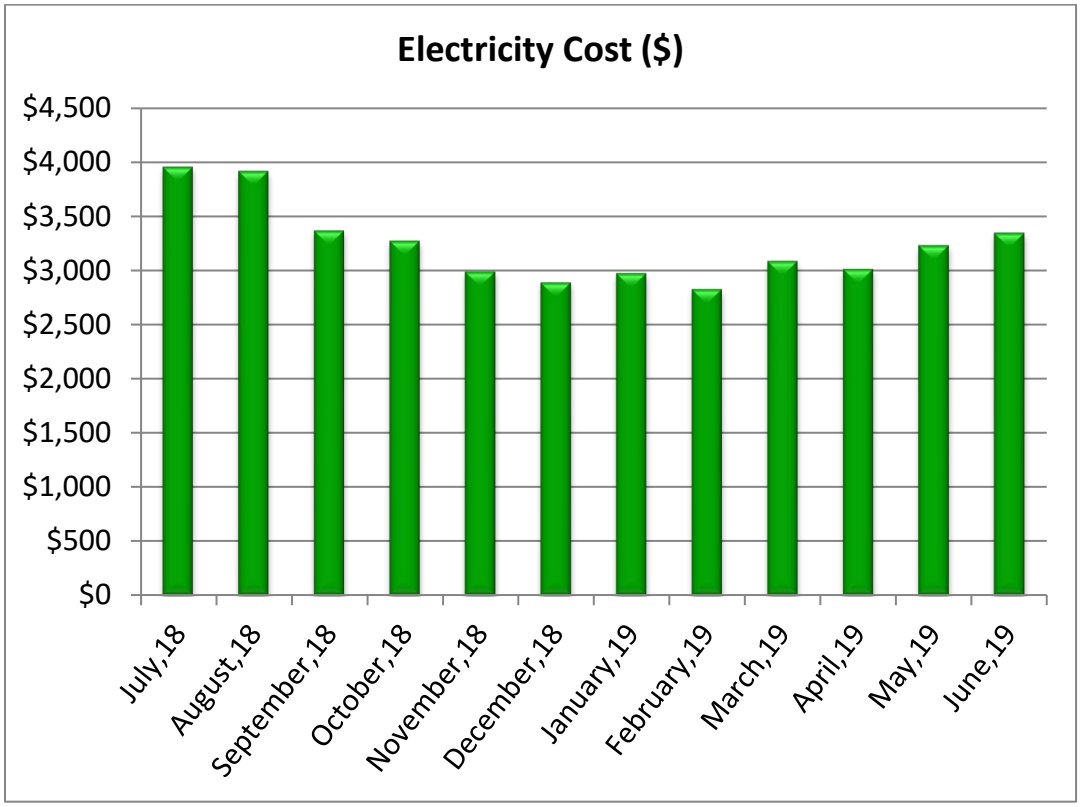
4.1. Electricity

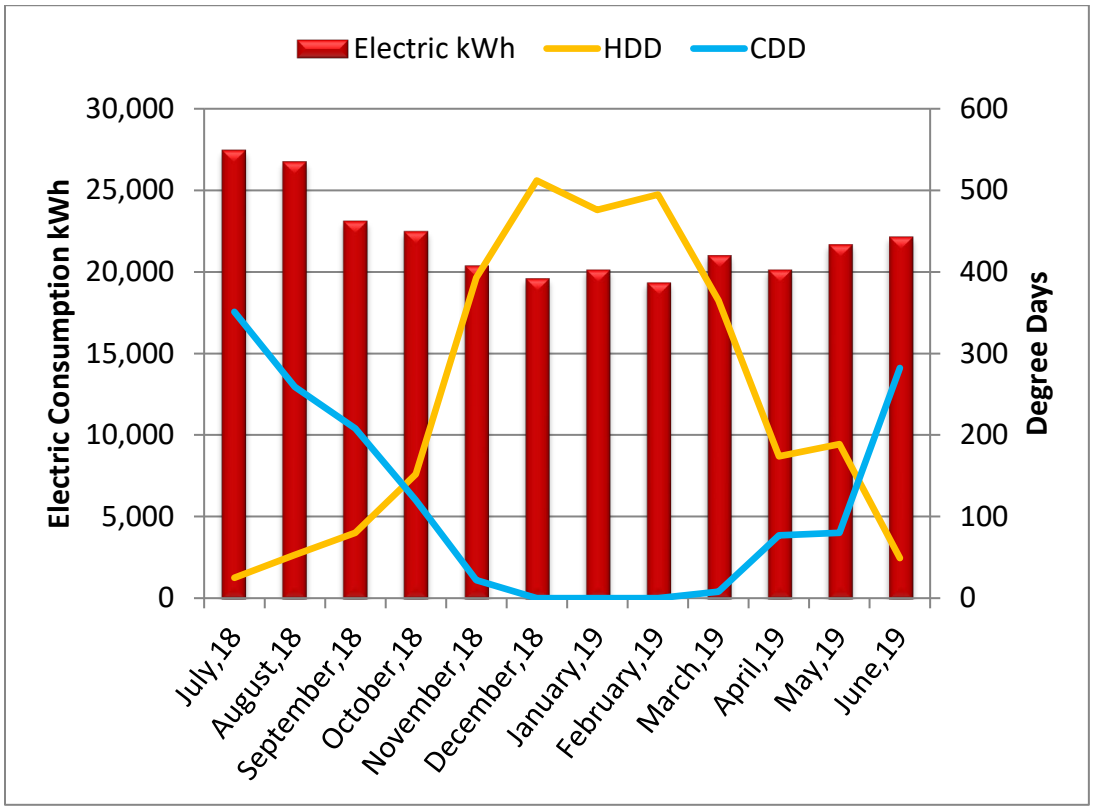
SMUD satisfies the electricity requirements for the facility. The primary end uses for electric utility compromises of lighting, cooling, office/school equipment, and appliances in the break room.

The table below provides the electric use for the period of twelve continuous months.

Electric Consumption and Cost Data

BILLING MONTH	CONSUMPTION (KWH)	UNIT COST/KWH	TOTAL COST
July,18	27,448	$0.14	$3,955
August,18	26,737	$0.15	$3,919
September,18	23,109	$0.15	$3,367
October,18	22,488	$0.15	$3,272
November,18	20,388	$0.15	$2,988
December,18	19,604	$0.15	$2,890
January,19	20,125	$0.15	$2,974
February,19	19,341	$0.15	$2,827
March,19	21,007	$0.15	$3,085
April,19	20,134	$0.15	$3,014
May,19	21,685	$0.15	$3,231
June,19	22,161	$0.15	$3,348
Total/average	**264,228**	**$0.15**	**$38,870**


Electricity Cost ($)
$4,500
$4,000
$3,500
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19


Electric kWh
HDD
CDD
Electric Consumption kWh
Degree Days
30,000
25,000
20,000
15,000
10,000
5,000
0
600
500
400
300
200
100
0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19

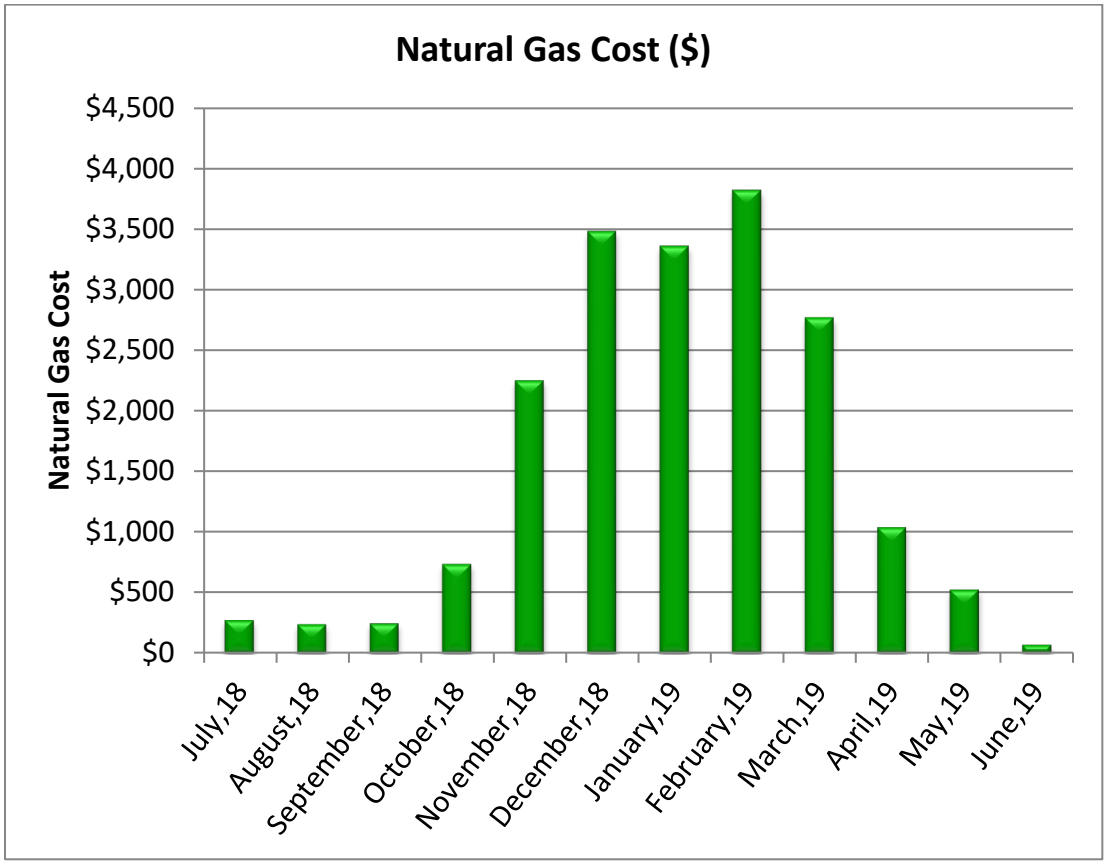
4.2. Natural Gas

PG&E satisfies the natural gas requirements of the facility. The primary end use of natural gas is for building heating, domestic water heating, and cooking in the cafeteria.

The analysis of the 12 months of consumption is provided below.

Natural Gas Consumption and Cost Data

BILLING MONTH	CONSUMPTION (THERMS)	UNIT COST/THERM	TOTAL COST
July,18	186	$1.48	$276
August,18	153	$1.57	$240
September,18	170	$1.46	$249
October,18	626	$1.18	$738
November,18	1,790	$1.26	$2,256
December,18	2,479	$1.41	$3,484
January,19	2,501	$1.34	$3,363
February,19	2,810	$1.36	$3,822
March,19	2,034	$1.36	$2,773
April,19	845	$1.23	$1,043
May,19	410	$1.29	$527
June,19	54	$1.34	$72
Total/average	**14,059**	**$1.34**	**$18,843**


Natural Gas Cost ($)
Natural Gas Cost
$4,500
$4,000
$3,500
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$0
July,18
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October,18
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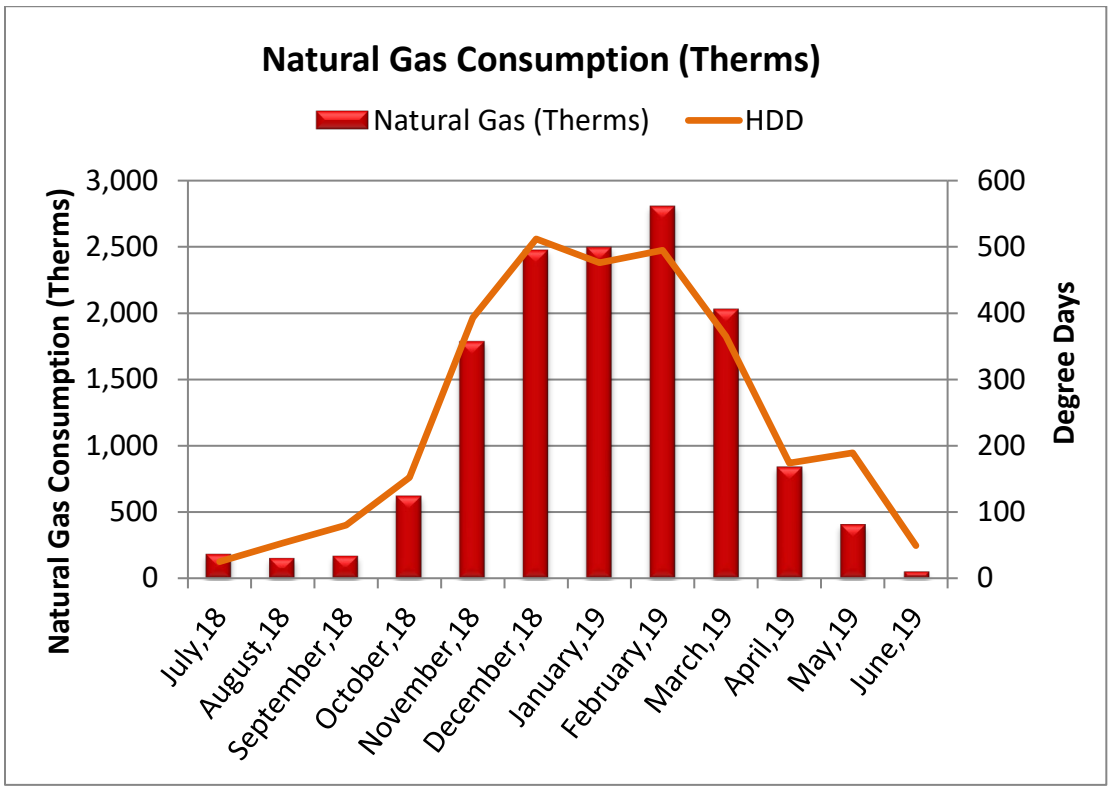
December,18
January,19
February,19
March,19
April,19
May,19
June,19


Natural Gas Consumption (Therms)
Natural Gas (Therms)
HDD
Natural Gas Consumption (Therms)
3,000
2,500
2,000
1,500
1,000
500
0
600
500
400
300
200
100
0
Degree Days
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19

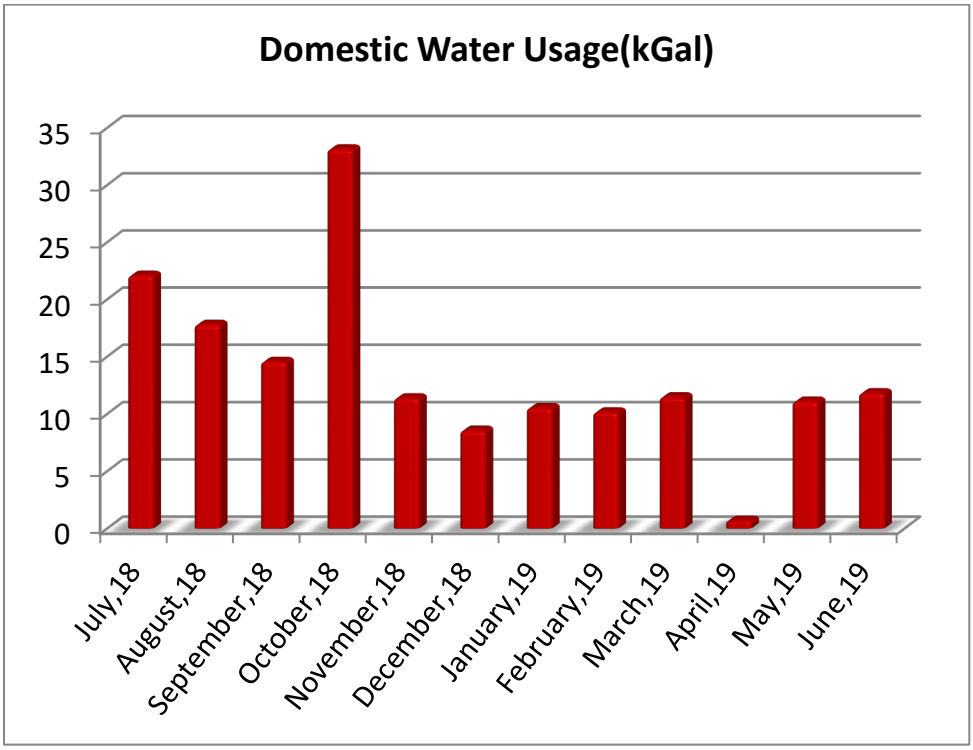
4.3. Water and Sewer

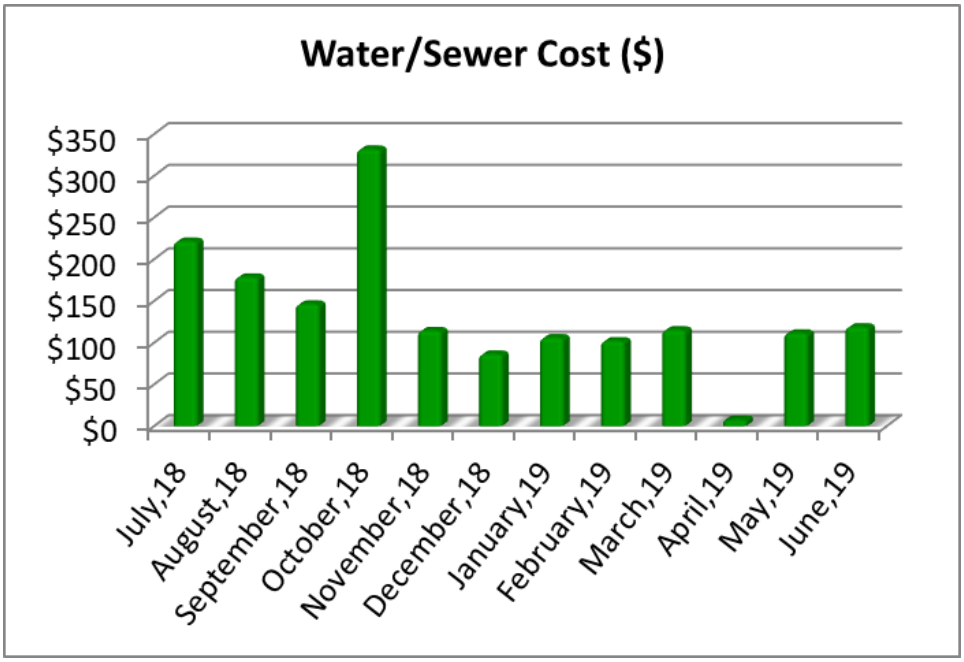
The City of Sacramento satisfies the water requirements for the facility. The primary end use of water is the plumbing fixtures such as staff showers, water closets, and lavatories. The table below provides the twelve continuous months' worth of consumption and cost for water in kGal for the facility.

Note: The utility rate was assumed to be at $10.00/kGal based on other similar sites within the school portfolio.

Water and Sewer Consumption and Cost Data

BILLING MONTH	CONSUMPTION (KGAL)	UNIT COST ($/KGAL)	TOTAL COST
July,18	22	$10.00	$221
August,18	18	$10.00	$179
September,18	15	$10.00	$146
October,18	33	$10.00	$332
November,18	11	$10.00	$114
December,18	9	$10.00	$86
January,19	11	$10.00	$106
February,19	10	$10.00	$102
March,19	12	$10.00	$115
April,19	1	$10.00	$7
May,19	11	$10.00	$112
June,19	12	$10.00	$119
Total	**164**	**$10.00**	**$1,640**


Domestic Water Usage(kGal)
35
30
25
20
15
10
5
0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19


Water/Sewer Cost ($)
$350
$300
$250
$200
$150
$100
$50
$0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19

5. Renewable Energy Discussions

5.1. Rooftop Solar Photovoltaic Feasibility

Solar Energy Feasibility

A photovoltaic array is a linked collection of photovoltaic modules, which are in turn made of multiple interconnected solar cells. The cells convert solar energy into direct current electricity via the photovoltaic effect. The power that one module can produce is seldom enough to meet requirements of a home or a business, so the modules are linked together to form an array. Most PV arrays use an inverter to convert the DC power produced by the modules into alternating current that can plug into the existing infrastructure to power lights, motors, and other loads. The modules in a PV array are usually first connected in series to obtain the desired voltage; the individual strings are then connected in parallel to allow the system to produce more current. Solar arrays are typically measured by the peak electrical power they produce, in watts, kilowatts, or even megawatts.

When determining if a site is suitable for a solar application, two basic considerations must be evaluated:

- At minimum, the sun should shine upon the solar collectors from 9 AM to 3 PM. If less, the application may still be worthwhile, but the benefit will be less.
- The array should face south and be free of any shading from buildings, trees, rooftop equipment, etc. If the array is not facing directly south, there will be a penalty in transfer efficiency, reducing the overall efficiency of the system.

SOLAR PV QUESTIONNAIRE	RESPONSE
Does the property have a south, east, or west facing roof or available land of more than 250 square feet per required Solar Array Panel?	Yes
Is the area free from any shading such as trees, buildings, equipment etc throughout the whole day?	Yes
Can the panels be mounted at an incline of roughly 25-45 degrees? (equal to latitude of property)	Yes
Is the property in an area with acceptable average monthly sunlight levels?	Yes
Has the roofing been replaced within the past 3-5 years?	No
Is the roof structure sufficient to hold solar panels?	Additional study required
Is the property located in a state eligible for net metering?	Yes

A solar feasibility analysis of the site has resulted in the building containing more than sufficient amount of roof area for solar electricity generation. The analysis through the use of National Renewable Energy Laboratory's solar photovoltaic software assisted in calculating the potential electricity generated from the allocated land and roof area set for solar photovoltaic installment. The allocated roof area was through looking at the roof and surrounding areas at a bird's eye view. Also detailed in the report are incentives and rebates that can potentially bring down the installation cost of the ECMs and result in a higher return on investment and quicker payback period.

The approach taken in the solar photovoltaic (PV) roof analysis begins with surveying the roof and determine areas on the roof where solar PV panels can potentially be installed.

1) Conducting a preliminary sizing of solar PV panels on the roofs and on the ground and its potential electricity production for its first year of installment using the National Renewable Energy Laboratory (NREL) PV WATTS Version 2 Software.

2) Calculate energy and cost savings for the site as a sole proprietor of the system capable of collecting state, local, and federal tax credits and incentives and interconnecting and selling the renewable energy electrical production to the building.

SOLAR ROOFTOP PHOTOVOLTAIC ANALYSIS		
Estimated Number of Panels	126	
Estimated KW Rating	40	KW
Potential Annual kWh Produced	61,346	kWh
% of Current Electricity Uses	23.2%	
FINANCIAL SUMMARY		
Investment Cost	$138,600	
Estimated Energy Cost Savings	$9,024	
Payback without Incentives	15.4	Years
Incentive Payback but without SRECs	9.3	Years
Payback with All Incentives	9.3	Years

A photovoltaic array is a linked collection of photovoltaic modules, which are in turn made of multiple interconnected solar cells. The cells convert solar energy into direct current. Modules of cells are linked together to form an array. Most PV arrays use an inverter to convert the DC power produced by the modules into alternating current that can connect to existing AC infrastructure to power lights, motors, and other loads.

Cost of production has fallen years with increasing demand and through production and technological advances. The cost dropped from $8–10/watt in 1996 to $4–7/watt in 2006. The market is diversifying with new types of panels suited to unique installation methods including stick on sheets and PV spray coating. The solar PV cost used in the analysis was set at $7.0/Watt which includes design, construction, administration, and installation and maintenance cost throughout the life of the solar panels.

One breakthrough for PV is “Net Metering”. When more PV electric power is generated than is consumed on site, the electric service meter reverses to “sell” the excess power directly back onto the power grid. The economics of PV for commercial industrial installations become attractive when coupled with incentives from Federal and state agencies, as well utility companies.

A kilowatt-hour costing $0.15 might be valued at $0.30 when produced by PV and sent to the grid. The economics of PV for commercial industrial installations become attractive when coupled with incentives from Federal and state agencies, as well utility companies.

The low payback period is highly dependent on the marketing potential of selling Solar Renewable Certificates to electricity generated providers who are under state regulations to contain a certain percentage of their electricity generation derived from renewable energy such as wind and solar.

Solar facilities are encouraged to sell their SRECs on the market (either spot market or through long-term contracts). Utilities may use SRECs for compliance under the state RPS for the year in which they are generated. Utilities may purchase up to 10% more SRECs than they require for compliance and "bank" those surplus SRECs for compliance during the following two years. Any SRECs pricing can range from $300 - $450/MWh and can be sold across state borders to other utility providers looking to purchase SRECs. EMG has selected to use the market value of $300/MWh minus 5% administrative fee in the analysis.

A number of states and corresponding electrical utility supplier are required under regulation to have a certain percentage of its electricity be produced by solar energy. To offset that they allow other utility companies to buy Renewable Energy Credits (REC) credit off their customers and facilities that produce their own solar energy. Typically the national market, the utility market is $400 per MWh to Utility Suppliers for not meeting this standard percentage so these REC credits are sold for $350 per MWH. (1 REC credit = 1 MWH).

State charges these utility companies to meet their state compliance of 0.2% of the entire electricity consumption from solar energy by 2022 (from.005% in 2008 aggregated up to 0.2% by 2022). The REC credits correspond to these percentages as they aggregate each year.

6. Operations and Maintenance Plan

The quality of the maintenance and the operation of the facility's energy systems have a direct effect on its overall energy efficiency. Energy-efficiency needs to be a consideration when implementing facility modifications, equipment replacements, and general corrective actions. The following is a list of activities that should be performed as part of the routine maintenance program for the property.

Building Envelope

- ✓ Ensure that the building envelope has proper caulking and weather stripping.
- ✓ Patch holes in the building envelope with foam insulation and fire rated caulk around combustion vents
- ✓ Inspect building vents semiannually for bird infestation
- ✓ Inspect windows monthly for damaged panes and failed thermal seals
- ✗ Repair and adjust automatic door closing mechanisms as needed.

Heating and Cooling

- ✓ Pilots lights on furnaces and boilers be turned off in summer
- ✓ All preventive maintenance should be performed on all furnaces and boilers, which would include cleaning of burners and heat exchanger tubes.
- ✓ Ensure that the combustion vents exhaust outside the conditioned space and the vent dampers are functional
- ✓ Ensure that the control valves are functioning properly before start of every season
- ✗ Ensure steam traps are functional before start of each heating season
- ✓ Ensure use of chemical treatment for boiler make up water
- ✓ Ensure boiler outside temperature re-set is set to 55F
- ✗ Ensure use of chemical treatment for Colling tower water to prevent corrosion
- ✓ Ensure the duct work in unconditioned space is un-compromised and well insulated
- ✓ Duct cleaning is recommended every 10 years. This should include sealing of ducts using products similar to 'aero-seal'
- ✓ Ensure use of economizer mode is functional and used
- ✓ Ensure that the outside air dampers actuators are operating correctly
- ✓ Ensure air coils in the AHU and FCA's are pressure washed annually
- ✓ Return vents should remain un-obstructed and be located centrally
- ✓ Temperature settings reduced in unoccupied areas and set points seasonally adjusted.
- ✓ Evaporator coils and condenser coils should be regularly cleaned to improve heat transfer
- ✓ Refrigerant pipes should be insulated with a minimum of ¾" thick Elastomeric Rubber Pipe Insulation
- ✓ Ensure refrigerant pressure is maintained in the condensers
- ✓ Change air filters on return vents seasonally. Use only filters with 'Minimum Efficiency Rating Value'(MERV) of 8

Central Domestic Hot Water Heater

- ✓ Never place gas fired water heaters adjacent to return vents so as to prevent flame roll outs
- ✓ Ensure the circulation system is on timer to reduce the losses through re-circulation
- ✓ Ensure all hot water pipes are insulated with fiberglass insulation at all times
- ✓ Replacement water heater should have Energy Factor (EF)>0.9
- ✓ Tank-type water heaters flushed monthly

Lighting Improvements

- ✓ Utilize bi-level lighting controls in stairwells and hallways.
- ✓ Use LED replacement lamps
- ✓ Clean lighting fixture reflective surfaces and translucent covers.
- ✓ Ensure that timers and/or photocells are operating correctly on exterior lighting
- ✓ Use occupancy sensors for offices and other rooms with infrequent occupancy

Existing Equipment and Replacements

- ✓ Ensure that refrigerator and freezer doors close and seal correctly
- ✓ Ensure kitchen and bathroom exhaust outside the building and the internal damper operates properly
- ✓ Ensure that bathroom vents exhaust out
- ✓ Office/ computer equipment either in the “sleep” or “off” mode when not used

7. Appendices

APPENDIX A: GLOSSARY OF TERMS

APPENDIX B: MECHANICAL EQUIPMENT INVENTORY

APPENDIX C: LIGHTING SYSTEM SCHEDULE

APPENDIX D: ECM CHECKLIST

APPENDIX E: ECM CALCULATIONS

APPENDIX F: SOLAR PV

APPENDIX A:
Glossary of Terms

Glossary of Terms and Acronyms

ECM – Energy Conservation Measures are projects recommended to reduce energy consumption. These can be No/Low cost items implemented as part of routine maintenance or Capital Cost items to be implemented as a capital improvement project.

Initial Investment – The estimated cost of implementing an ECM project. Estimates typically are based on R.S. Means Construction cost data and Industry Standards.

Annual Energy Savings – The reduction in energy consumption attributable to the implementation of a particular ECM. These savings values do not include the interactive effects of other ECMs.

Cost Savings – The expected reduction in utility or energy costs achieved through the corresponding reduction in energy consumption by implementation of an ECM.

Simple Payback Period –The number of years required for the cumulative value of energy or water cost savings less future non-fuel or non-water costs to equal the investment costs of the building energy or water system, without consideration of discount rates.

EUL – Expected Useful Life is the estimated lifespan of a typical piece of equipment based on industry accepted standards.

RUL – Remaining Useful Life is the EUL minus the effective age of the equipment and reflects the estimated number of operating years remaining for the item.

SIR - The savings-to-investment ratio is the ratio of the present value savings to the present value costs of an energy or water conservation measure. The numerator of the ratio is the present value of net savings in energy or water and non-fuel or non-water operation and maintenance costs attributable to the proposed energy or water conservation measure. The denominator of the ratio is the present value of the net increase in investment and replacement costs less salvage value attributable to the proposed energy or water conservation measure. It is recommended that energy-efficiency recommendations be based on a calculated SIR, with larger SIRs receiving a higher priority. A project typically is recommended only if the SIR is greater than or equal to 1.0, unless other factors outweigh the financial benefit.

Life Cycle Cost - The sum of the present values of (a) **I**nvestment costs, less salvage values at the end of the study period; (b) Non-fuel operation and maintenance costs: (c) Replacement costs less salvage costs of replaced building systems; and (d) Energy and/or water costs.

Life Cycle Savings – The sum of the estimated annual cost savings over the EUL of the recommended ECM, expressed in present value dollars.

Building Site Energy Use Intensity - The sum of the total site energy use in thousands of Btu per unit of gross building area. Site energy accounts for all energy consumed at the building location only not the energy consumed during generation and transmission of the energy to the site.

Building Source Energy Use Intensity – The sum of the total source energy use in thousands of Btu per unit of gross building area. Source energy is the energy consumed during generation and transmission in supplying the energy to your site.

Building Cost Intensity - This metric is the sum of all energy use costs in dollars per unit of gross building area.

Greenhouse Gas Emissions - Although there are numerous gases that are classified as contributors to the total for Greenhouse Emissions, the scope of this energy audit focuses on carbon dioxide (CO_2). Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement).

APPENDIX B:
Mechanical Equipment Inventory

Mechanical Inventory							
System	Make	Model	Serial Number	Input Capacity	Room Number	Space Served	Quantity
Air Conditioner	Friedrich	No tag/plate found	No tag/plate found	1.5 TON	Building 001	001 Main Building	1
Boiler	Ajax Boiler, Inc.	WG 1250	76 04 12	1,000 MBH	Building 001	001 Main Building	1
Condensing Unit/Heat Pump	Illegible	563CNO36-A	2397E21159	3 TON	Lower roof 001	001 Main Building	1
Domestic Circulation Pump	Marathon Electric	Inaccessible	Inaccessible	.15 HP	B012	001 Main Building	1
Domestic Circulation Pump	A. O. Smith	FJ	312P418	0.5 HP	Building 001	001 Main Building	1
Domestic Circulation Pump	Century	C426V1	331125M	3/4 HP	Building 001	001 Main Building	1
Exhaust Fan	Jenn-Air	242-BCRG	Illegible	1200 CFM	Lower roof 001	001 Main Building	1
Exhaust Fan	No tag/plate found	No tag/plate found	No tag/plate found	100 CFM	Lower roof 001	001 Main Building	1
Exhaust Fan	JennAir	SKBORG	No tag/plate found	400 CFM	L Roof 001	001 Main Building	1
Exhaust Fan	JennAir	101CRH EH	No tag/plate found	100 CFM	Lower roof 001	001 Main Building	1
Exhaust Fan	JennAir	4MC2H EH	No tag/plate found	1000 CFM	Lower roof 001	001 Main Building	1
Exhaust Fan	CentriMaster	P12D2	XB16898 1	1200 CFM	Lower roof 001	001 Main Building	1
Exhaust Fan	No tag/plate found	No tag/plate found	No tag/plate found		Higher roof 001	001 Main Building	1
Exhaust Fan	Dayton Electric	36Y716	05K32035		Higher roof 001	001 Main Building	1
Fan Coil Unit					above ceiling	001 Main Building	1
Furnace	Rheem	Inaccessible	Inaccessible	200 MBH	Building 001	001 Main Building	1
Furnace	Carrier	58MXA080-20	2995A19060	80 MBH	Building 001	001 Main Building	1
Furnace	Carrier	Inaccessible	Inaccessible	60 MBH	Building 001	001 Main Building	1
Heat Pump	No tag/plate found	No tag/plate found	No tag/plate found	3.5 TON	P01	P01 Portable	1
Make-Up Air Unit	Cambridge Engineering	M118	P161189C	10,000 CFM	Higher roof 001	001 Main Building	1
Motor	Dayton	6K122BA	No tag/plate found	0.5 HP	Lower roof 001	001 Main Building	1
Motor	Dayton	2MXU1A	No tag/plate found	1.5 HP	Lower roof 001	001 Main Building	1
Packaged Unit (RTU)	Reznor	No tag/plate found	No tag/plate found	5 Ton	L Roof 001	001 Main Building	1
Packaged Unit (RTU)	B D P	588ANW024060ADAD	1096G11421	5 TON	Lower roof 001	001 Main Building	1
Packaged Unit (RTU)	Carrier	48GS-024040301	4359G10048	2 TON	Lower roof 001	001 Main Building	1
Packaged Unit (RTU)	Rheem	RGEA13036ACD061AA	F341501241	3 TON	L Roof 001	001 Main Building	1
Packaged Unit (RTU)	AAON, Inc.	RQ-004-8-V-GA02-212	201408-AYGD08463	4 TON	Higher roof 001	001 Main Building	1
Packaged Unit (RTU)	Rheem	RGEA13048ACT081AA	F151600079	4 TON	L Roof 001	001 Main Building	1
Packaged Unit (RTU)	AAON, Inc.	Illegible	201408-AYGDO8465	4 TON	Lower roof 001	001 Main Building	1
Packaged Unit (RTU)	AAON, Inc.	RQ-005-8-V-GA02-212	201408-AYGE08464	5 TON	Higher roof 001	001 Main Building	1
Packaged Unit (RTU)	Daikin Industries	PT3-2	99401121200002	7 ton	L Roof 001	001 Main Building	1
Packaged Unit (RTU)	Carrier	48GX-036090501AD	3100G10413	7.5 TON	L Roof 001	001 Main Building	1
Unit Heater	Inaccessible	Inaccessible	Inaccessible	11 MBH	0BW	0BW Warehouse	1
Unit Heater	Herman Nelson	SU 1821A	No tag/plate found	9 MBH	Building 001	001 Main Building	1
Unit Heater	Herman Nelson	TSU 1421A	No tag/plate found	11 MBH	Building 001	001 Main Building	1
Water Heater		22V30-30F	RHLN0606V10908	30 GAL	Building 001	001 Main Building	1
Water Heater	Inaccessible	Illegible	Illegible	5 GAL	C001	P01 Portable	1
Water Heater	A. O. Smith	FGR 40 118D	GL91-0928993-11D	30 - 50 GAL	B012	001 Main Building	1
Motor	Dayton	2MXU1A	No tag/plate found	1.5 HP	Lower roof 001	Bldg 001	1
Motor	Dayton	6K122BA	No tag/plate found	0.5 HP	Lower roof 001	Bldg 001	1
Packaged Unit (RTU)	AAON, Inc.	RQ-005-8-V-GA02-212	201408-AYGE08464	60 MBH	Higher roof 001	Bldg 001	1
Packaged Unit (RTU)	Reznor	No tag/plate found	No tag/plate found	60 MBH	L Roof 001	Bldg 001	1
Packaged Unit (RTU)	Rheem	RGEA13036ACD061AA	F341501241	60 MBH	L Roof 001	Bldg 001	1
Packaged Unit (RTU)	AAON, Inc.	RQ-004-8-V-GA02-212	201408-AYGD08463	60 MBH	Higher roof 001	Bldg 001	1
Packaged Unit (RTU)	Carrier	48GX-036090501AD	3100G10413	88 MBh	L Roof 001	Bldg 001	1
Packaged Unit (RTU)	Carrier	48GS-024040301	4359G10048	40 MBH	Lower roof 001	Bldg 001	1
Packaged Unit (RTU)	B D P	588ANW024060ADAD	1096G11421	56 MBH	Lower roof 001	Bldg 001	1
Packaged Unit (RTU)	Daikin Industries	PT3-2	99401121200002	100 MBH	L Roof 001	Bldg 001	1
Packaged Unit (RTU)	AAON, Inc.	Illegible	201408-AYGDO8465	60 MBH	Lower roof 001	Bldg 001	1
Packaged Unit (RTU)	Rheem	RGEA13048ACT081AA	F151600079	80 MBH	L Roof 001	Bldg 001	1
Unit Heater	Herman Nelson	TSU 1421A	No tag/plate found	11 MBH	Building 001	Bldg 001	1
Unit Heater	Herman Nelson	SU 1821A	No tag/plate found	9 MBH	Building 001	Bldg 001	1
Unit Heater	Inaccessible	Inaccessible	Inaccessible	11 MBH	0BW	Bldg 001	1
Wall Mounted Heat Pump	No tag/plate found	No tag/plate found	No tag/plate found	3.5 TON	P01	Bldg 001	1
Water Heater	Inaccessible	Illegible	Illegible	5 GAL	C001	Bldg 001	1
Water Heater	-	22V30-30F	RHLN0606V10908	30 GAL, 30 MBH	Building 001	Bldg 001	1
Water Heater	A. O. Smith	FGR 40 118D	GL91-0928993-11D	40 Gal, 40 MBH	B012	Bldg 001	1

APPENDIX C:
Lighting System Schedule

										Lamp Details				Fixture Details				Existing Consumption	
Line No.	Building Name	Interior/ Exterior	Floor	Space Type	Room No.	Additional Area Description	LUX	Control Quantity	Existing Control	Technology	Sub-Technology	Lamp Type	Total Lamps	Fixture Type	Fixture Quantity	24x7 Fixture Count	Fixture Height	Annual Hours	Existing Annual kWh
1	001	Interior	1	OPEN OFFICE	N021		300	3	Light Switch	Linear Fluorescent	T8	4' 30W T8	162	Industrial	54	0	9	2,080	10,109
2	001	Interior	1	STORAGE	S22A		300	2	Light Switch	Linear Fluorescent	T8	4' 30W T8	32	Strip Fixture	16	0	9	832	799
3	001	Interior	1	STORAGE	OPEN		130	1	Light Switch	Linear Fluorescent	T8	8' 54W T8	2	Strip Fixture	2	0	9	832	90
4	001	Interior	1	OPEN OFFICE	N018		280	4	Light Switch	Linear Fluorescent	T8	4' 30W T8	128	1x4 Prism Troffer	32	0	9	2,080	7,987
5	001	Interior	1	OPEN OFFICE	N019		280	2	Light Switch	Linear Fluorescent	T8	4' 30W T8	36	1x4 Prism Troffer	18	0	9	2,080	2,246
6	001	Interior	1	STORAGE	S020		300	4	Light Switch	Linear Fluorescent	T8	8' 86W T8	32	Strip Fixture	8	0	9	832	2,290
7	001	Interior	1	STORAGE	S020		300	2	Light Switch	Linear Fluorescent	T8	4' 30W T8	16	Strip Fixture	8	0	9	832	399
8	001	Interior	1	OFFICE	C22C		250	2	Light Switch	Linear Fluorescent	T8	4' 30W T8	12	1x4 Prism Troffer	6	0	9	2,080	749
9	001	Interior	1	OFFICE	S22E		700	2	Light Switch	Linear Fluorescent	T8	4' 30W T8	80	1x4 Prism Troffer	40	0	9	2,080	4,992
10	001	Interior	1	OFFICE	C22B		600	3	Light Switch	Linear Fluorescent	T8	4' 30W T8	27	1x4 Prism Troffer	9	0	9	2,080	1,685
11	001	Interior	1	STORAGE	S22B		200	4	Light Switch	Linear Fluorescent	T8	4' 30W T8	16	1x4 Prism Troffer	4	0	8	832	399
12	001	Interior	1	STORAGE	S023		150	2	Light Switch	Linear Fluorescent	T8	4' 30W T8	24	1x4 Prism Troffer	12	0	9	832	599
13	001	Interior	1	OPEN OFFICE	S024		300	4	Light Switch	Linear Fluorescent	T8	4' 30W T8	32	1x4 Prism Troffer	8	0	9	2,080	1,997
14	001	Interior	1	OPEN OFFICE	S024		300	4	Light Switch	Linear Fluorescent	T8	8' 59W T8	32	1x4 Parabolic Troffer	8	0	9	2,080	3,927
15	001	Interior	1	STORAGE	S25A		300	2	Light Switch	Linear Fluorescent	T8	4' 30W T8	12	1x4 Prism Troffer	6	0	9	832	300
16	001	Interior	1	STORAGE	S25B		200	2	Light Switch	Linear Fluorescent	T8	4' 30W T8	8	1x4 Prism Troffer	4	0	9	832	200
17	001	Interior	1	STORAGE	S25C		230	2	Light Switch	Linear Fluorescent	T8	4' 30W T8	16	1x4 Prism Troffer	8	0	9	832	399
18	001	Interior	1	OPEN OFFICE	S026		600	3	Light Switch	Linear Fluorescent	T8	4' 30W T8	81	1x4 Prism Troffer	27	0	9	2,080	5,054
19	001	Interior	1	OPEN OFFICE	S026		600	2	Light Switch	Linear Fluorescent	T8	4' 30W T8	16	1x4 Prism Troffer	8	0	9	2,080	998
20	001	Interior	1	OPEN OFFICE	S026		600	4	Light Switch	Linear Fluorescent	T8	8' 86W T8	64	1x4 Parabolic Troffer	16	0	9	2,080	11,448
21	001	Interior	1	OPEN OFFICE	S17D		150	4	Light Switch	Linear Fluorescent	T5	4' 31W T5	320	1x4 Parabolic Troffer	80	0	16	2,080	20,634
22	001	Interior	1	OFFICE	S17E		400	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	90	1x4 Prism Troffer	30	0	11	2,080	5,990
23	001	Interior	1	STORAGE	N17C		150	4	Light Switch	Linear Fluorescent	T8	8' 86W T8	96	1x4 Prism Troffer	24	0	16	832	6,869
24	001	Interior	1	STORAGE	N17C		150	2	Light Switch	Linear Fluorescent	T8	8' 59W T8	12	1x4 Prism Troffer	6	0	7	832	589
25	001	Interior	1	STORAGE	N17C		150	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	1x4 Prism Troffer	4	0	7	832	213
26	001	Interior	1	OFFICE	C17B		125	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	12	1x4 Prism Troffer	6	0	7	2,080	799
27	001	Interior	1	OFFICE	C17B		125	2	Light Switch	Linear Fluorescent	T8	8' 59W T8	4	1x4 Prism Troffer	2	0	7	2,080	491
28	OBW	Interior	1	STORAGE	S002		264	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	1x4 Prism Troffer	2	0	16	832	106
29	OBW	Interior	1	STORAGE	S001		27	2	Light Switch	Incan/H/MR	Incan	I7-Globe	2	Vanity-Direct	2	0	11	832	12
30	OBW	Interior	1	STORAGE	S004		150	1	Light Switch	Incan/H/MR	Incan	I7-Globe	2	Vanity-Direct	2	0	11	832	12
31	OBW	Interior	1	STORAGE	S009		380	2	Light Switch	Linear Fluorescent	T5	4' 31W T5	40	1x4 Prism Troffer	20	0	9	832	1,032
32	OBW	Interior	1	STORAGE	S011		166	2	Light Switch	Linear Fluorescent	T5	4' 31W T5	16	1x4 Prism Troffer	8	0	9	832	413
33	OBW	Interior	1	STORAGE	S010		118	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	32	1x4 Prism Troffer	16	0	9	832	852
34	OBW	Interior	1	STORAGE	S005		68	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	16	1x4 Prism Troffer	8	0	9	832	426
35	OBW	Exterior		CLASSROOM	Exterior		-	1	Timer	HID	MH	MH400	3	Wallpack-Horizontal	3	0	15	4,368	5,242
36	P01	Interior	1	OPEN OFFICE	C001		400	10	Light Switch	Linear Fluorescent	T8	4' 32W T8	48	1x4 Prism Troffer	24	0	8	2,080	3,195
37	P01	Interior	1	OPEN OFFICE	C001		400	5	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	1x4 Parabolic Troffer	4	0	8	2,080	266
38	P01	Exterior		CLASSROOM	Exterior		-	1	Timer	HID	MH	MH400	1	Wallpack-Horizontal	1	0	8	4,368	1,747
39	P01	Exterior		CLASSROOM	Exterior		-	1	Timer	HID	MH	MH400	1	Wallpack-Vertical	1	0	8	4,368	1,747
40	001	Interior	1	OPEN OFFICE	C001		500	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	688	1x4 Prism Troffer	172	0	9	2,080	45,793
41	001	Interior	1	OPEN OFFICE	C001		500	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	28	1x4 Prism Troffer	14	0	8	2,080	1,864
42	001	Interior	1	OFFICE	C011		300	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	1x4 Prism Troffer	4	0	8	2,080	532
43	001	Interior	1	OFFICE	C008		300	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	1x4 Prism Troffer	4	0	8	2,080	532
44	001	Interior	1	OFFICE	C009		300	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	1x4 Prism Troffer	4	0	8	2,080	532
45	001	Interior	1	OFFICE	C012		300	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	1x4 Prism Troffer	4	0	8	2,080	532
46	001	Interior	1	RESTROOM	T08B		380	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	12	1x4 Prism Troffer	6	0	8	832	319
47	001	Interior	1	HALLWAY	H08B		250	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	1	1x4 Parabolic Troffer	1	0	8	2,080	67
48	001	Interior	1	STORAGE	S08C		280	4	Light Switch	Linear Fluorescent	T12	4' 34W T12	16	Industrial	4	0	8	832	453
49	001	Interior	1	STORAGE	S08C		280	2	Light Switch	Linear Fluorescent	T12	8' 60W T12	8	Industrial	4	0	8	832	399
50	001	Interior	1	OPEN OFFICE	N007		250	4	Light Switch	Linear Fluorescent	T5	4' 31W T5	44	Industrial	22	0	8	2,080	2,837
51	001	Interior	1	OPEN OFFICE	N007		250	8	Light Switch	Linear Fluorescent	T8	4' 32W T8	48	1x4 Prism Troffer	12	0	8	2,080	3,195
52	001	Interior	1	OPEN OFFICE	N006		200	6	Light Switch	Linear Fluorescent	T5	4' 31W T5	9	Industrial	3	0	8	2,080	580
53	001	Interior	1	OPEN OFFICE	N006		200	4	Light Switch	Linear Fluorescent	T5	4' 31W T5	16	Industrial	8	0	8	2,080	1,032
54	001	Interior	1	MECHANICAL	Z006		600	2	Light Switch	Linear Fluorescent	T5	4' 31W T5	8	Industrial	4	0	8	832	206
55	001	Interior	1	OPEN OFFICE	N004		800	2	Light Switch	Linear Fluorescent	T5	4' 31W T5	312	Industrial	156	0	14	2,080	20,118
56	001	Interior	1	OFFICE	C010		250	4	Light Switch	Linear Fluorescent	T5	4' 31W T5	48	1x4 Prism Troffer	12	0	7	2,080	3,095
57	001	Interior	1	OFFICE	C007		400	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	16	1x4 Prism Troffer	8	0	8	2,080	1,065
58	001	Interior	1	OFFICE	C007		300	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	64	1x4 Prism Troffer	16	0	8	2,080	4,260
59	001	Interior	1	OFFICE	C004		300	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	1x4 Prism Troffer	4	0	8	2,080	532
60	001	Interior	1	OFFICE	C003		460	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	1x4 Prism Troffer	4	0	8	2,080	532
61	001	Interior	1	OFFICE	Z001		142	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	32	1x4 Prism Troffer	16	0	8	2,080	2,130
62	001	Interior	1	OFFICE	C013		287	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	16	1x4 Prism Troffer	8	0	8	2,080	1,065
63	001	Interior	1	OFFICE	C014		313	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	16	1x4 Prism Troffer	8	0	8	2,080	1,065
64	001	Interior	1	RESTROOM	T009		300	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	1x4 Prism Troffer	4	0	9	832	213
65	001	Interior	1	OPEN OFFICE	I004		255	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	20	1x4 Prism Troffer	10	0	8	2,080	1,331
66	001	Interior	1	OPEN OFFICE	N016		180	4	Light Switch	Linear Fluorescent	T5	4' 31W T5	32	Industrial	16	0	14	2,080	2,063
67	001	Interior	1	OPEN OFFICE	N016		180	2	Light Switch	CFL	CFL - Screw-in	CFL200	3	Vanity-Direct	3	0	14	2,080	1,248
68	001	Interior	1	STORAGE	S014		100	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	1x4 Prism Troffer	2	0	8	832	106
69	001	Interior	1	OPEN OFFICE	N015		437	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	18	Industrial	6	0	8	2,080	1,198
70	001	Interior	1	OPEN OFFICE	S17A		242	4	Light Switch	HID	MH	MH400	8	Highbay	8	0	17	2,080	6,656
71	001	Interior	1	OPEN OFFICE	S17A		242	16	Light Switch	Linear Fluorescent	T8	8' 86W T8	32	Industrial	8	0	17	2,080	5,724
72	001	Interior	1	OPEN OFFICE	S17A		242	16	Light Switch	Linear Fluorescent	T8	4' 32W T8	224	1x4 Prism Troffer	56	0	17	2,080	14,909
73	001	Interior	1	STORAGE	Z004		47	1	Light Switch	CFL	CFL - Screw-in	CFL13	2	Vanity-Direct	2	0	7	832	22
74	001	Interior	1	STORAGE	Z003		368	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	160	1x4 Prism Troffer	40	0	7	832	4,260
75	001	Interior	1	OFFICE	Z002		350	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	32	1x4 Prism Troffer	8	0	7	2,080	2,130
76	001	Interior	1	OFFICE	C17A		217	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	24	1x4 Prism Troffer	12	0	7	2,080	1,597
77	001	Exterior		CLASSROOM	Exterior		-	1	Timer	HID	MH	MH400	16	Wallpack-Horizontal	16	0	10	4,368	27,955
	Totals												3,552		1,226			135,616	269,453

									Fixture Details						Existing Consumption				Proposed- Post Retrofit				
Line No.	Building Name	Interior/ Exterior	Floor	Space Type	Room No.	Additional Area Description	Existing Control	Control Quantity	Technology	Sub-Technology	Lamp- Fixture	Fixture Quantity	Total Lamps	Fixture Height	Annual Hours	Existing Annual kWh	ECM	ECM Type	Recommended Sensor	LED Lamp Retrofit	Annual Hours of Operation	Proposed Annual kWh	Annual Savings From LED Retrofit
																							kWh
1	001	Interior	1	OPEN OFFICE	N021		Light Switch	3	Linear Fluorescent	T8	4' 30W T8; Industrial	54	162	9	2,080	10,109	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,080	5,728	4,380
2	001	Interior	1	STORAGE	S22A		Light Switch	2	Linear Fluorescent	T8	4' 30W T8; Strip Fixture	16	32	9	832	799	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	832	453	346
3	001	Interior	1	STORAGE	OPEN		Light Switch	1	Linear Fluorescent	T8	8' 54W T8; Strip Fixture	2	2	9	832	90	ECM	RB - Replace Bulb	Ceiling Mounted	8' 40W LED T8	832	67	23
4	001	Interior	1	OPEN OFFICE	N018		Light Switch	4	Linear Fluorescent	T8	4' 30W T8; 1x4 Prism Troffer	32	128	9	2,080	7,987	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	4,526	3,461
5	001	Interior	1	OPEN OFFICE	N019		Light Switch	2	Linear Fluorescent	T8	4' 30W T8; 1x4 Prism Troffer	18	36	9	2,080	2,246	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	1,273	973
6	001	Interior	1	STORAGE	S020		Light Switch	4	Linear Fluorescent	T8	8' 86W T8; Strip Fixture	8	32	9	832	2,290	ECM	RB - Replace Bulb	Ceiling Mounted	8' 40W LED T8	832	1,065	1,225
7	001	Interior	1	STORAGE	S020		Light Switch	2	Linear Fluorescent	T8	4' 30W T8; Strip Fixture	8	16	9	832	399	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	832	226	173
8	001	Interior	1	OFFICE	C22C		Light Switch	2	Linear Fluorescent	T8	4' 30W T8; 1x4 Prism Troffer	6	12	9	2,080	749	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	424	324
9	001	Interior	1	OFFICE	S22E		Light Switch	2	Linear Fluorescent	T8	4' 30W T8; 1x4 Prism Troffer	40	80	9	2,080	4,992	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	2,829	2,163
10	001	Interior	1	OFFICE	C22B		Light Switch	3	Linear Fluorescent	T8	4' 30W T8; 1x4 Prism Troffer	9	27	9	2,080	1,685	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	955	730
11	001	Interior	1	STORAGE	S22B		Light Switch	4	Linear Fluorescent	T8	4' 30W T8; 1x4 Prism Troffer	4	16	8	832	399	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	832	226	173
12	001	Interior	1	STORAGE	S023		Light Switch	2	Linear Fluorescent	T8	4' 30W T8; 1x4 Prism Troffer	12	24	9	832	599	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	832	339	260
13	001	Interior	1	OPEN OFFICE	S024		Light Switch	4	Linear Fluorescent	T8	4' 30W T8; 1x4 Prism Troffer	8	32	9	2,080	1,997	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	1,132	865
14	001	Interior	1	OPEN OFFICE	S024		Light Switch	4	Linear Fluorescent	T8	8' 59W T8; 1x4 Parabolic Troffer	8	32	9	2,080	3,927	ECM	RB - Replace Bulb	Ceiling Mounted	8' 40W LED T8	2,080	2,662	1,265
15	001	Interior	1	STORAGE	S25A		Light Switch	2	Linear Fluorescent	T8	4' 30W T8; 1x4 Prism Troffer	6	12	9	832	300	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	832	170	130
16	001	Interior	1	STORAGE	S25B		Light Switch	2	Linear Fluorescent	T8	4' 30W T8; 1x4 Prism Troffer	4	8	9	832	200	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	832	113	87
17	001	Interior	1	STORAGE	S25C		Light Switch	2	Linear Fluorescent	T8	4' 30W T8; 1x4 Prism Troffer	8	16	9	832	399	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	832	226	173
18	001	Interior	1	OPEN OFFICE	S026		Light Switch	3	Linear Fluorescent	T8	4' 30W T8; 1x4 Prism Troffer	27	81	9	2,080	5,054	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	2,864	2,190
19	001	Interior	1	OPEN OFFICE	S026		Light Switch	2	Linear Fluorescent	T8	4' 30W T8; 1x4 Prism Troffer	8	16	9	2,080	998	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	566	433
20	001	Interior	1	OPEN OFFICE	S026		Light Switch	4	Linear Fluorescent	T8	8' 86W T8; 1x4 Parabolic Troffer	16	64	9	2,080	11,448	ECM	RB - Replace Bulb	Ceiling Mounted	8' 40W LED T8	2,080	5,325	6,124
21	001	Interior	1	OPEN OFFICE	S17D		Light Switch	4	Linear Fluorescent	T5	4' 31W T5; 1x4 Parabolic Troffer	80	320	16	2,080	20,634	ECM	RB - Replace Bulb	Ceiling Mounted	4' 15W LED T5	2,080	9,984	10,650
22	001	Interior	1	OFFICE	S17E		Light Switch	3	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	30	90	11	2,080	5,990	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	3,182	2,808
23	001	Interior	1	STORAGE	N17C		Light Switch	4	Linear Fluorescent	T8	8' 86W T8; 1x4 Prism Troffer	24	96	16	832	6,869	ECM	RB - Replace Bulb	Ceiling Mounted	8' 40W LED T8	832	3,195	3,674
24	001	Interior	1	STORAGE	N17C		Light Switch	2	Linear Fluorescent	T8	8' 59W T8; 1x4 Prism Troffer	6	12	7	832	589	ECM	RB - Replace Bulb	Ceiling Mounted	8' 40W LED T8	832	399	190
25	001	Interior	1	STORAGE	N17C		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	4	8	7	832	213	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	832	113	100
26	001	Interior	1	OFFICE	C17B		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	6	12	7	2,080	799	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	424	374
27	001	Interior	1	OFFICE	C17B		Light Switch	2	Linear Fluorescent	T8	8' 59W T8; 1x4 Prism Troffer	2	4	7	2,080	491	ECM	RB - Replace Bulb	Ceiling Mounted	8' 40W LED T8	2,080	333	158
28	OBW	Interior	1	STORAGE	S002		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	2	4	16	832	106	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	832	57	50
29	OBW	Interior	1	STORAGE	S001		Light Switch	2	Incan/H/MR	Incan	I7-Globe; Vanity-Direct	2	2	11	832	12	ECM	RB - Replace Bulb	Ceiling Mounted	5W LED A18	832	8	3
30	OBW	Interior	1	STORAGE	S004		Light Switch	1	Incan/H/MR	Incan	I7-Globe; Vanity-Direct	2	2	11	832	12	ECM	RB - Replace Bulb	Ceiling Mounted	5W LED A18	832	8	3
31	OBW	Interior	1	STORAGE	S009		Light Switch	2	Linear Fluorescent	T5	4' 31W T5; 1x4 Prism Troffer	20	40	9	832	1,032	ECM	RB - Replace Bulb	Ceiling Mounted	4' 15W LED T5	832	499	532
32	OBW	Interior	1	STORAGE	S011		Light Switch	2	Linear Fluorescent	T5	4' 31W T5; 1x4 Prism Troffer	8	16	9	832	413	ECM	RB - Replace Bulb	Ceiling Mounted	4' 15W LED T5	832	200	213
33	OBW	Interior	1	STORAGE	S010		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	16	32	9	832	852	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	832	453	399
34	OBW	Interior	1	STORAGE	S005		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	8	16	9	832	426	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	832	226	200
35	OBW	Exterior		CLASSROOM	Exterior		Timer	1	HID	MH	MH400; Wallpack-Horizontal	3	3	15	4,368	5,242	ECM	RF - Replace Entire Fixture	Photo Sensor	70W LED Canopy	4,368	917	4,324
36	P01	Interior	1	OPEN OFFICE	C001		Light Switch	10	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	24	48	8	2,080	3,195	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	1,697	1,498
37	P01	Interior	1	OPEN OFFICE	C001		Light Switch	5	Linear Fluorescent	T8	4' 32W T8; 1x4 Parabolic Troffer	4	4	8	2,080	266	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	141	125
38	P01	Exterior		CLASSROOM	Exterior		Timer	1	HID	MH	MH400; Wallpack-Horizontal	1	1	8	4,368	1,747	ECM	RF - Replace Entire Fixture	Photo Sensor	70W LED Canopy	4,368	306	1,441
39	P01	Exterior		CLASSROOM	Exterior		Timer	1	HID	MH	MH400; Wallpack-Vertical	1	1	8	4,368	1,747	ECM	RF - Replace Entire Fixture	Photo Sensor	70W LED Wallpack	4,368	306	1,441
40	001	Interior	1	OPEN OFFICE	C001		Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	172	688	9	2,080	45,793	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	24,328	21,466
41	001	Interior	1	OPEN OFFICE	C001		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	14	28	8	2,080	1,864	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	990	874
42	001	Interior	1	OFFICE	C011		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	4	8	8	2,080	532	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,080	283	250
43	001	Interior	1	OFFICE	C008		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	4	8	8	2,080	532	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,080	283	250
44	001	Interior	1	OFFICE	C009		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	4	8	8	2,080	532	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,080	283	250
45	001	Interior	1	OFFICE	C012		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	4	8	8	2,080	532	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,080	283	250
46	001	Interior	1	RESTROOM	T08B		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	6	12	8	832	319	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	832	170	150
47	001	Interior	1	HALLWAY	H08B		Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 1x4 Parabolic Troffer	1	1	8	2,080	67	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	35	31
48	001	Interior	1	STORAGE	S08C		Light Switch	4	Linear Fluorescent	T12	4' 34W T12; Industrial	4	16	8	832	453	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	832	226	226
49	001	Interior	1	STORAGE	S08C		Light Switch	2	Linear Fluorescent	T12	8' 60W T12; Industrial	4	8	8	832	399	ECM	RB - Replace Bulb	Ceiling Mounted	8' 40W LED T8	832	266	133
50	001	Interior	1	OPEN OFFICE	N007		Light Switch	4	Linear Fluorescent	T5	4' 31W T5; Industrial	22	44	8	2,080	2,837	ECM	RB - Replace Bulb	Ceiling Mounted	4' 15W LED T5	2,080	1,373	1,464
51	001	Interior	1	OPEN OFFICE	N007		Light Switch	8	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	12	48	8	2,080	3,195	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	1,697	1,498
52	001	Interior	1	OPEN OFFICE	N006		Light Switch	6	Linear Fluorescent	T5	4' 31W T5; Industrial	3	9	8	2,080	580	ECM	RB - Replace Bulb	Ceiling Mounted	4' 15W LED T5	2,080	281	300
53	001	Interior	1	OPEN OFFICE	N006		Light Switch	4	Linear Fluorescent	T5	4' 31W T5; Industrial	8	16	8	2,080	1,032	ECM	RB - Replace Bulb	Ceiling Mounted	4' 15W LED T5	2,080	499	532
54	001	Interior	1	MECHANICAL	Z006		Light Switch	2	Linear Fluorescent	T5	4' 31W T5; Industrial	4	8	8	832	206	ECM	RB - Replace Bulb	Ceiling Mounted	4' 15W LED T5	832	100	106
55	001	Interior	1	OPEN OFFICE	N004		Light Switch	2	Linear Fluorescent	T5	4' 31W T5; Industrial	156	312	14	2,080	20,118	ECM	RB - Replace Bulb	Wall Mounted	4' 15W LED T5	2,080	9,734	10,383
56	001	Interior	1	OFFICE	C010		Light Switch	4	Linear Fluorescent	T5	4' 31W T5; 1x4 Prism Troffer	12	48	7	2,080	3,095	ECM	RB - Replace Bulb	Ceiling Mounted	4' 15W LED T5	2,080	1,498	1,597
57	001	Interior	1	OFFICE	C007		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	8	16	8	2,080	1,065	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	566	499
58	001	Interior	1	OFFICE	C007		Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	16	64	8	2,080	4,260	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,080	2,263	1,997
59	001	Interior	1	OFFICE	C004		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	4	8	8	2,080	532	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,080	283	250
60	001	Interior	1	OFFICE	C003		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	4	8	8	2,080	532	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,080	283	250
61	001	Interior	1	OFFICE	Z001		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	16	32	8	2,080	2,130	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,080	1,132	998
62	001	Interior	1	OFFICE	C013		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	8	16	8	2,080	1,065	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	566	499
63	001	Interior	1	OFFICE	C014		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	8	16	8	2,080	1,065	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	566	499
64	001	Interior	1	RESTROOM	T009		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	4	8	9	832	213	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	832	113	100
65	001	Interior	1	OPEN OFFICE	I004		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	10	20	8	2,080	1,331	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,080	707	624
66	001	Interior	1	OPEN OFFICE	N016		Light Switch	4	Linear Fluorescent	T5	4' 31W T5; Industrial	16	32	14	2,080	2,063	ECM	RB - Replace Bulb	Wall Mounted	4' 15W LED T5	2,080	998	1,065
67	001	Interior	1	OPEN OFFICE	N016		Light Switch	2	CFL	CFL - Screw-in	CFL200; Vanity-Direct	3	3	14	2,080	1,248	ECM	RB - Replace Bulb	Wall Mounted	15W LED A19	2,080	94	1,154
68	001	Interior	1	STORAGE	S014		Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	2	4	8	832	106	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	832	57	50
69	001	Interior	1	OPEN OFFICE	N015		Light Switch	3	Linear Fluorescent	T8	4' 32W T8; Industrial	6	18	8	2,080	1,198	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,080	636	562
70	001	Interior	1	OPEN OFFICE	S17A		Light Switch	4	HID	MH	MH400; Highbay	8	8	17	2,080	6,656	ECM	RF - Replace Entire Fixture	Wall Mounted	220W LED Highbay	2,080	3,661	2,995
71	001	Interior	1	OPEN OFFICE	S17A		Light Switch	16	Linear Fluorescent	T8	8' 86W T8; Industrial	8	32	17	2,080	5,724	ECM	RB - Replace Bulb	Wall Mounted	8' 40W LED T8	2,080	2,662	3,062
72	001	Interior	1	OPEN OFFICE	S17A		Light Switch	16	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	56	224	17	2,080	14,909	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,080	7,921	6,989
73	001	Interior	1	STORAGE	Z004		Light Switch	1	CFL	CFL - Screw-in	CFL13; Vanity-Direct	2	2	7	832	22	ECM	RB - Replace Bulb	Ceiling Mounted	6W LED A19	832	18	3
74	001	Interior	1	STORAGE	Z003		Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	40	160	7	832	4,260	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	832	2,263	1,997
75	001	Interior	1	OFFICE	Z002		Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	8	32	7	2,080	2,130	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	1,132	998
76	001	Interior	1	OFFICE	C17A		Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	12	24	7	2,080	1,597	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,080	849	749
77	001	Exterior		CLASSROOM	Exterior		Timer	1	HID	MH	MH400; Wallpack-Horizontal	16	16	10	4,368	27,955	ECM	RF - Replace Entire Fixture	Photo Sensor	70W LED Canopy	4,368	4,892	23,063
	Totals												3,552									127,608	141,845

APPENDIX D:
ECM Checklist

NA	In Place	Evaluate	ECM Description
	✓		Add Reflective Coating To Exterior Windows
	✓		Replace External Windows
		✓	Upgrade Insulation
		✓	Control External Air Leakage In Commercial Buildings
✓			Install Reflective Insulation Between Radiators And External Wall
✓			Replace Existing Motors With High Efficiency Motors
✓			Install On-Demand Ventilation on Air Handlers
		✓	Reduce HVAC Hours of Operation
✓			Install Variable Frequency Drives (VFD)
		✓	Install Outside Air Temperature Reset Controls For Hot Water Boilers
✓			Install Chilled Water Reset Control
		✓	Install Timers On Exhaust Fans
✓			Install Energy Savers on Vending, Snack Machines
✓			Install Building Energy Management System and Replace Terminal Units
		✓	Re-Commission The Building & Its Control Systems
		✓	Replace Inefficient Heating Plant
✓			Replace Inefficient Cooling Plant
✓			Replace Existing Air Conditioners with Energy Star Air Conditioners
✓			Replace Unit Electric Heaters with Natural Gas Fired Unit Heaters
	✓		Convert From Gas Pilot to Electronic Ignition for Boilers
✓			Insulate Hot Water Pipes
	✓		Insulate Refrigerant Lines
	✓		Insulate Hot Surfaces And Tanks
	✓		Insulate Air Ducts
✓			Replace Defective Steam Traps
✓			Upgrade Electric Heating System To Heat Pumps
✓			Replace Inefficient Furnace System
✓			Replace Rooftop Package Unit
	✓		Install Energy Recovery Wheel on Air Handling Unit
✓			Replace Existing Water Heater With New Energy Efficient Units
		✓	Replace Incandescent/Halogen Lamps With Energy Efficient Lamps
		✓	Upgrade Inefficient Linear Fluorescent Lamps And Fixtures
✓			Upgrade EXIT SIGNS With LED EXIT Signs
✓			Bilevel and Tandem Linear Fluorescent Lighting ECM
		✓	Replace High Intensity Discharge (HID) Lamps With Energy Efficienct Lamps
✓			Replace Existing Refrigerator(s) With Energy Star Certified Refrigerator(s)
✓			Replace Existing Freezers With High Efficiency Freezers
✓			Install Low Flow Shower Heads
		✓	Install Low Flow Faucet Aerators
		✓	Install Low Flow Restroom Flush Tank Toilets
		✓	Install Low Flow Tankless Restroom Fixtures

APPENDIX E:
ECM Calculations

UIC	Install Low Flow Restroom Flush Tank Toilets
EAP3	Location: Restrooms and Locker Rooms

EXISTING CONDITION

Total Occupants:	50	
Number of Water Closets To Be Replaced	1	
Number of Occupied Days Per Week (Max 7)	5	
Number of Occupied Weeks/Year (Max 52)	52	
Estimated Restroom Usage/Individual/Day *5.05 flushes/person/day@American Water Works Association (AWWA)*	4	(Select)

PROPOSED RETROFIT/REPLACEMENT

Existing Gallons Per Flush Ratings For Water Closet Flushes		1.60	GPF
Replace or Retrofit Toilets With Dual Flush Toilets		Replace	
Replace			
Proposed Toilet		0.8GPF -Floor Mount, 10" Rough-In	
GPF of Proposed New Low Flow Water Closet Fixture*		0.80	GPF
Retrofit			
Dual Flush - Retrofit Setup Valve for Flush Tank Toilet	*Solid Waste (20%)*	0.80	GPF
**(Federal Law Requires All Flushes Not To Exceed 1.6 GPF)*	*Liquid Waste (80%)*	0.80	GPF

Water & Cost Saving Calculations

Water Savings By The Use of Low Flow Water Closet Flush Valves/Day	160.00	gal
Total Annual Water Savings in gallons	41.60	kgal
Cost Savings Calculations		
Enter Water Tariff Rate ($/1000Gal)	$10.00	$$
Estimated Cost Savings From Water	$416	$$
Estimated Cost of Retrofit		
Estimated Total Cost For Retrofit	$949	$$
Simple Pay Back Period	2.28	Yrs
Type of Recommendation	No/Low Cost ECM Recommendation	

ECM EXPLANATION:

The highest water utilization at any home/office occurs in the restrooms. It is estimated that on an average a normal human being uses the restroom at least four times a day. Keeping with the global water conservation objectives, federal law prohibits use of any new water closet flushes over 1.6 GPF.

Existing toilets can be retrofitted with pressure-assisted flush technology to reduce the flush rate to 1.0 GPF or less. Though water efficient these toilets make considerable amount of noise as this involves release of pressurized air during the course of flushing. Thus making them unpopular among residential properties.

Thus EMG recommends replacing the existing high flow toilets with new low flow 1.28GPF rated flush tank toilets, which are comparatively more water efficient at the same time considerably quiter as compared to the pressure assisted technology retrofitted toilets.

Summary:

Initial Investment:	$949			
		Simple Payback:	2.28	Years
Annual Cost Saving:	$416			

UIC	Install Low Flow Faucet Aerators
EAP2-b	**Location**: Restrooms and Classrooms

Property Type:	Commercial	Estimated No. of Operational Weeks	52
		Number of Occupied Days/Week (Max 7)	5

KITCHEN FAUCETS			BATHROOM FAUCETS		
Number of Occupants Affected By Retrofit	50		Number of Occupants Affected by Retrofit	50	
Do You Want To Replace Kitchen Faucets Aerators	Yes	*(Select)*	Do You Want To Replace Bathroom Faucets Aerators	Yes	*(Select)*
Total Number of Faucet Aerators To Be Replaced	9		Total Number of Faucet Aerators To Be Replaced	5	
Total Number of Faucets To Be Replaced:	0		Total Number of Faucets To Be Replaced:	0	
GPM of Existing Faucet Aerators	2.2	GPM	GPM of Existing Faucet Aerators	2.2	GPM
GPM of Proposed Faucet Aerator	1.5	GPM	GPM of Proposed Faucet Aerator	0.5	GPM
Estimated Number of Uses Per Day	2		Estimated Number of Uses Per Day	2	

Annual Water Savings From Installing Low Flow Aerators: 5.99 kGal

WATER & ENERGY SAVING CALCULATION			COST SAVING CALCULATION		
Select Type of Water Heater Fuel:	Natural Gas	(Select)	Property Location in United States	North Central Localities	
Energy Factor of Domestic Hot Water Heater:	0.51	EF	Heating Fuel Tariff	$1.34	$/Therm
Hot Water Discharge Temperature at Faucet	110.00	°F	Water Tariff ($/1000 Gal)	$10.00	$/kGal
Equivalent Heating Fuel Savings:	50	Therms	Annual Cost Savings In Form of Water	$60	$
Savings Discounted by 15% to Account For Cold Water Use					
Annual Water Savings	5.99	kGal	Annual Energy Savings From Water Heater	$67	$

COST BENEFIT ANALYSIS				
Estimated Total Annual Cost Savings	$127	$$	Estimated Total Installation Cost	$213 $$
Simple Payback Period	1.68	Years	*Type of Recommendation*	No/Low Cost ECM Recommendation

ECM EXPLANATION:

By reducing the flow of water coming from the restroom faucets, aerators can generate energy savings at low cost and with easy installation. The savings generated would be in the form of reduced water and sewer costs and at the same time aerators would save energy by reducing the demand for hot water. The average faucet has a flow rate of about 2 to 4 GPM. Adding a screw-in faucet aerator reduces the flow to 0.5 to 1.5 GPM in the bathroom and 2.2 GPM in the kitchen. In addition to saving energy and water, the "foamier" water that comes from faucet aerators wets objects better than water from a faucet with no aerator, which tends to bounce off the object rather than thoroughly wetting it.

EMG recommends replacing the proposed faucet aerators with new low flow aerators as mentioned above. The proposed ECM shall also result in an annual energy saving in form of reduction in water heating bills.

Summary:

Initial Investment: $213 Estimated Annual Cost Savings: $127 Simple Payback Period (Yrs): 1.68

UIC	Reduce HVAC Hours of Operation
EAC3	Location: Throughout

No of Programmable Thermostats To Be Installed : 1 Qty.

Select Type of Programmable Thermostat Recommended: Centrally Controlled Thermostats For Multi-Unit Property -(BMS) *(Select)*

(Selection Based on Type of Property)

Heating Load Calculation

Select Type of Heating Fuel: Natural Gas *(Select)*

Estimated Current Annual Energy Consumption For Winter Heating: 10,422 Therms

	Weekdays	Weekends
Day Time Set Back Hours	7.00	0.00
Night Time Set Back Hours	5.00	0.00
Hours Without Set Back	12.00	24.00

Typical Indoor Temp	69.00	°F
Temp Set Point With Set Back During Day Time	53.00	°F
Temp Set Point With Set Back During Night Time	53.00	°F
Average Heating Set Point	63.29	°F
Savings Per Degree Set Back For Heating Season *(Industry Standard, 2004)*	3%	
Estimated Annual Heating Energy Consumption	1,042,200	kBtu
Estimated New Annual Heating Energy Consumption	863,537	kBtu
Estimated Annual Heating Energy Savings	1,787	Therms

Cooling Load Calculation

Select Type of Cooling Fuel: Electric *(Default)*

Estimated Current Annual Energy Consumption For Summer Cooling: 52,581 kWh

	Weekdays	Weekends
Day Time Set Back Hours	7.00	0.00
Night Time Set Back Hours	5.00	0.00
Hours Without Set Back	12.00	24.00

Typical Indoor Temp	73.00	°F
Temp Set Point With Set Back During Day Time	93.00	°F
Temp Set Point With Set Back During Night Time	93.00	°F
Average Cooling Set Point	80.14	°F
Savings Per Degree Set Back For Cooling Season *(Industry Standard, 2004)*	6%	
Estimated Annual Cooling Energy Consumption	179,406	kBtu
Estimated New Annual Cooling Energy Consumption	102,518	kbtu
Estimated Annual Cooling Energy Savings	22,535	kWh

Cost Analysis

Average Annual Cost of Heating Fuel:	$1.34	$/Therm
Average Annual Cost of Electricity:	$0.15	$/kWh
Estimated Annual Heating Cost Savings:	$2,395	$$
Estimated Annual Cooling Cost Savings:	$3,315	$$

Estimated Installation Cost Per Thermostats: *(Includes Material, Labor & Installation Costs)*	$1,070	$$
Total Estimated Cost For All Programmable Thermostats	$1,597	$$
Total Estimated Cost Savings From All Programmable Thermostats	$5,710	
Estimated Simple Pay Back Period	0.28	Yrs

Type of Recommendation: Capital Cost ECM Recommendation

ECM DESCRIPTION:

Turning off energy-consuming systems when they are not needed is the most basic energy conservation technique. When a building is occupied intermittently, energy savings can be realized by minimizing the time the heating or cooling system is operated when the building is closed. Building control algorithms should be implemented to delay startup until the last moment and to shut down as early as possible.

Because of the thermal inertia of both the building structure and its heating and cooling equipment, preheat or precool time is almost always required to raise or lower the space temperature to the desired level before the occupants return. This start-up time depends on the outdoor environment, the thermal response of the building, and the thermal performance of the space conditioning equipment. Similarly, the thermal inertia of the building maintains the indoor temperature at a comfortable level for a short period of time after the equipment is shut off. It allows the system to be turned off before the end of an occupied period. An optimum start/stop control accounts for these factors.

SUMMARY

Initial Investment: $1,597 Simple Payback Period: 0.28 Yrs

Annual Energy Cost Savings: $5,710

UIC	Install Timers On Exhaust Fans
EAC7A	Location: Throughout

Type of Exhaust Fan: Rooftop Exhaust Fans

EXISTING CONDITION

No. of Timers to Be Installed:	8	Qty	HP of Individual Fan Motor:	0.25	HP
No. of Exhaust Fans:	8		Total kW:	1.49	kW
Existing Daily Hours of Operation/Exhaust Fan:	20.00	Hrs/Day	Annual kWh For All Fans:	10,892	kWh

PROPOSED CONDITION

New Daily Hours With Timers/Exhaust Fan:	9.00	Hrs/Day	New Annual kWh For All Fans:	4,901	kWh
Type of Heating Fuel:	Natural Gas		Is The Property Cooled?	Yes	

Only For Apt. Bathroom Exhaust Fans			Only For Roof Top Exhaust Fans- Commerical Spaces		
CFM for Individual Bathroom Exhaust Fans *(For bathrooms<100Sqft)*	90	CFM	No. of Water Closets In Building	6	
			No. of Urinals In Building	2	
Total Exhuast CFM From All Fans	720	CFM	Total CFM for All Restroom Exhaust	400	CFM
Annual Heating Energy Savings	0	kbtu	Annual Heating Energy Savings	19,008	kbtu
Annual Cooling Energy Savings	0	kbtu	Annual Cooling Energy Savings	9,504	kbtu

Energy & Cost Savings

Estimated Annual Heating Plant Efficiency	79.00	%	Estimated Annual Cooling Plant Efficiency	7.00	EER
Annual Heating Energy Savings	241	Therms	Annual Cooling Energy Savings	1,358	kWh
Annual Electric Fan Motor Savings	5,990	kWh			

COST ANALYSIS

Electric Rate:	$0.15	$/kWh	Total Annual Electric Savings	7,348	kWh
Material Cost For Timers:	$1,354	$	Total Annual Non Electric Savings	241	Therms
Total Cost for Installing Timers	$2,831	$	Annual Cost savings:	$1,403	$
Simple Payback:	2.02	Yrs			

Type of Recommendation Capital Cost ECM Recommendation

ECM DESCRIPTION:

Exhaust fans are generally used in areas with high concentrations of pollutants generated from occupants' activities. These exhaust requirements are rarely continuous, and the fans should operate only as needed. Continuous operations of bathroom exhaust fans results in exhausting conditioned air out. This causes low pressures in the conditioned space, which is filled up by infiltrated air from unconditioned spaces. Air infiltration leads to increase loads on heating and cooling system increasing the energy consumed to condition the space. In addition to this the fan motor is also consumes energy to operate, though insignificant as compared to the HVAC losses.

In case of the residential properties with individual exhaust fans in the bathrooms, EMG recommends installing timer switches on each bathroom fan to control the fan operations. Bathroom fans are essential to exhaust out the excess humidity and odor control. The timer switch will limit the operation time to 20 mins.

In case of central exhaust systems that have roof top or side wall mounted exhaust fans, EMG recommends a single electronic timer control to restrict the exhaust fan operations to typical building occupancy hours +/- 2 hrs. A single electronic timer would be able to control all the exhaust fans.

Summary:

Initial Investment: $1,354
Energy Cost Savings: $1,403

Simple Payback: 2.02 Years

UIC	Control External Air Leakage In Commercial Buildings
EAE4A	Location: Extrior Doors

ENTER EXISTING CONDITION

Insert Existing Estimated Air Change Rate/Hr (ACH 1): *(Existing Air Changes Per Hour, 3 is very leaky and 0.35 ideal)*	1.00	Cubic Feet/Min (CFM 1):	6,032
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.90	Cubic Feet/Min (CFM 2):	5,429
Estimated Space Volume Under Consideration	361,935.00 Cu.Ft		

WINTER			SUMMER		
Select Type of Heating Fuel	Natural Gas (Select)		Is The Building Cooled?	Yes	
Estimated Annual Heating Plant Efficiency	79.00	%	Estimated Annual Cooling Plant Efficiency	7.00	EER
Annual Heating Degree Days(HDD):	2,963		Annual Cooling Degree Days(CDD):	1,407	
Estimated Total Annual Input Heating Energy Savings	586	Therms	Estimated Total Annual Input Cooling Energy Savings	3,143	kWh
Cost/Unit of Heating Fuel:	$1.34	$/Therm	Cost/Unit For Electricity	$0.15	$$
Estimated Annual Heating Cost Savings	$786	$$	Estimated Annual Cooling Cost Savings	$462	$$

Cost Analysis

Install Flush Mounted, Vinyl Door Sweeps ?	Yes	Total Length of Door Sweeps to Be Installed: *(3.5' Standard Width Door)*	165 LF
Install Window Air Conditioner Covers For Winter:	No	Number of Air Conditioner Covers To Be Installed: *(Covers would meet HUD Chapter-12 Energ Conservation Compliance Section 329C)*	0
Estimated Annual O&M Savings	$62	Estimated Length of Joints To Be Re-Caulked: *(Includes Demolition and Re-Caulking)*	0 LF
Total Estimated Annual Cost Savings	$1,311	Total Cost For Controlling Air Leakage	$3,009
Simple Pay Back Period	2.30 Yrs	*Type of Recommendation*	Capital Cost ECM Recommendation

ECM DESCRIPTION:

One of the most commonly used methods for reducing air leakage through building structures is caulking and weather stripping.

Particularly effective measures include caulking cracks around windows and door frames and weather stripping around windows and doors. Weather-stripping and caulking of doors and windows, helps in thermally isolating of the building with the outside atmosphere. This prevents the infiltration of external un-conditioned air along with moisture and humidity into the conditioned space at the same time, prevents the conditioned air from escaping out. A precisely thermally isolated building directly affects the cooling and heating load on the facilities HVAC system as it has to put in less effort in maintaining the desired temperature inside the facility. As per ASHRAE a well insulated and ventilated building should have an air change rate not more than 0.35 per hour.

In order to ensure proper thermal isolation of the property, EMG recommends ensuring that the weather-stripping and caulking of all external doors and windows remains intact. Its also recommended that door sweeps be installed under all the doors opening into conditioned space. Any visible cracks between the window frame and wall should be plugged by caulking.

In case of building with window airconditioners, EMG recommends use of interior/exterior window airconditioner covers so as to prevent cold air drafts into the conditioned space during the winter so as to save on heating costs.

SUMMARY:

Initial Investment:	$3,009	Simple Pay Back Perio	2.30 Yrs
Annual Energy Cost Savings	$1,311		

UIC	**Install Outside Air Temperature Reset Controls For Hot Water Boilers**
EAC5	**Location: 001**

Select Type of Heating Fuel	Natural Gas (Select)	
Select The Number of Outside Air Temperature Controls To Be Installed:	1	
Estimate Actual Heating Fuel Used Annually	4,157	Therms
Total Estimated Energy Savings By Use of OA Temperature Reset Control:	8%	
Estimated New Heating Fuel Consumption With Improved System Efficiency:	3,824	Therms
Estimated Annual Heating Fuel Savings:	333	Therms
Cost Per Unit of Heating Fuel:	**$1.34**	$/Therm
Estimated Annual Cost Savings:	$446	
Installed cost of a OA Reset controller:	$1,219	
Simple Payback:	2.74	years
Type of Recommendation	Capital Cost ECM Recommendation	

ECM DESCRIPTION:

HVAC equipment is usually sized to meet conditions at the design peak load. Hot water temperature set points are also chosen to meet the design load. However, during most hours of operation, the equipment operates at part-load. Use of design set points on water loops at part-load results in unnecessary thermal losses and equipment inefficiencies. Resetting the set point reduces energy consumption by matching hot water supply set points to the actual equipment load.

Reset of supply water temperature may be based on the outside air temperature or on the hot water demand. Except for buildings with dominant internal loads, the space load generally may be considered to be a function of the outdoor temperature. For example, as the outside air temperature rises, hot water temperature is adjusted downward. Alternatively, a more accurate method is to reset the water temperature based on instrumentation readings. Such an instrument is known as an outside air temperature rest control. The sensor shall modulate the supply water temperature based on the outside temperature, thus resulting in considerable energy savings, without manual intervention.

SUMMARY:

Initial Investment $1,219 Simple Payback: 2.74
Energy Cost Savings: $446

UIC	**Upgrade Building Lighting to LED and Install Automatic Lighting Controls**
EAL10	**Location: Building Interior and Exterior**

	No. of ECMs	No. of Fixtures	No. of Lamps	KWh Saved	Energy Cost Saving	O & M Savings
Upgrade Lighting to LED	77	1,226	3,552	141,845	$20,865.37	$6,282.63

Existing Technology	**Sub-Technology**	No. of ECMs	No. of Fixtures	No. of Lamps	KWh Saved	Energy Cost Saving	O & M Savings
CFL	CFL - 2 Pin	0	0	0	0	$0	$0
CFL	CFL - 4 Pin	0	0	0	0	$0	$0
CFL	CFL - Screw-in	2	5	5	1,158	$170	$43
Circiline	T9	0	0	0	0	$0	$0
Incan/H/MR	H	0	0	0	0	$0	$0
Incan/H/MR	Incan	2	4	4	7	$1	$213
Incan/H/MR	MR	0	0	0	0	$0	$0
HID	HPS	0	0	0	0	$0	$0
HID	MH	5	29	29	33,265	$4,893	$1,055
HID	MV	0	0	0	0	$0	$0
HID	QL	0	0	0	0	$0	$0
Linear Fluorescent	T8	56	851	851	80,212	$11,799	$3,509
Linear Fluorescent	T12	2	8	8	359	$53	$44
Linear Fluorescent	T8 U	0	0	0	0	$0	$0
Linear Fluorescent	T12 U	0	0	0	0	$0	$0
Linear Fluorescent	T5	10	329	329	26,844	$3,949	$1,420
Linear Fluorescent	T6	0	0	0	0	$0	$0
Linear Fluorescent	T10	0	0	0	0	$0	$0

Proposed Controls	**No. of Controls**		**No. of Controls**
Photo Sensor	4	Ceiling Mounted	160
Wall Mounted	53		

Initial Investment			**Equipment Rentals**	
Material Cost	$66,643.46		Scissor Lift 26' - Interior Space	$1,335.00
Labor Cost	$78,137.87		Bucket Truck - Exterior Spaces	$0.00
Local Electric Rate:	$0.17	$/kWh	Estimated Annual Energy Savings:	141,845
Hourly Labor Rate For Electrician:	$72.40		Estimated Annual Energy Cost Savings:	$20,865
Budgeted Initial Investment:	$146,116		Estimated Annual O&M Cost Savings:	$6,283
Estimated Return on Investment: *(Including O&M Savings)*	5.38	Years	Estimated Annual Cost Savings:	$27,148

UIC	Re-Commission The Building & Its Control Systems
EAC10	Location: Throughout

Enter the Total Area of The Facility	40,215	SqFt
Select the Type of Heating Fuel:	Natural Gas	*(Select)*
Estimated Annual Heating Fuel Consumption:	10,853	Therms
Is the Property Cooled?	Yes	*(Select)*
Estimated Annual Electrical Energy Consumed For Cooling:	52,000	kWh
Estimated Energy Savings From Re-Commissioning on Building Systems:	10%	*(Select)*
Estimated Heating Energy Saving Post Re-Commissioning:	1,085	Therms
Estimated Cooling Energy Saving Post Re-Commissioning:	5,200	kWh
Average Heating Fuel Rate Paid By The Property:	$1.34	$/Therm
Average Electrical Rate Paid By The Property:	$0.15	$/kWh
Annual Energy Cost Savings:	$2,220	$
Estimated Cost For Re-Commissioning The Facility: *(LBNL 2009 Report on Building Commissioning)*	$18,007	$
Simple Payback Period:	8.11	Yrs

Type of Recommendation — Capital Cost ECM Recommendation

ECM DESCRIPTION

The goal of commissioning of a facility is to ensure that the equipments in the facility are performing as per the desired standards or as per design standards. The role of commissioning in existing buildings is to identify the almost inevitable "drift" from where things should be and puts the things back on track. Based on the LBNL 2009 Report on Building Commissioning the average re-commissioning of existing buildings yielded atleast 16% of energy savings across the facility. This average has been developed based on over 643 buildings that were commissioned across United States in different climatic zones.

Thus EMG strongly recommends re-commissioning of all existing buildings in order to ensure that all the sensors, equipments and control systems are working as per the design conditions.

SUMMARY:

Initial Investment:	$18,007	Simple Payback:	8.11	Years
Energy Cost Savings:	$2,220			

UIC	**Upgrade Insulation**
EAE3B	**Location: Attic/Ceiling Throughout**

ENTER EXISTING CONDITION

Property Zone	Surface Under Consideration	Min. R-Value
Zone-3	**Ceiling/Attic**	R-30

Source: 2009 IECC For Residential Bldgs

"-" Not Specified

Enter Total Surface Area Under Consideration:	40,215	Sq.Ft	Existing Net Effective R-Value: (Sq.Ft deg F/btu)	13
			Proposed Net Effective R-Value: (Sq.Ft deg F/btu)	30

ENTER CLIMATIC & SYSTEM DATA

Annual Cooling Degree Days (CDD):	1,407		Estimated Annual Cooling Plant Efficiency (EER):	7.00	EER
Annual Heating Degree Days (HDD):	2,963		Estimated Annual Heating Plant Efficiency: %	79.00	%

WINTER

Select Type of Heating Fuel: **Natural Gas** (Select)

Annual Conduction Losses From Existing Insulation	227,689	kBtu
Annual Conduction Losses From Proposed Insulation	95,326	kBtu
Savings In Conduction Losses After Adding Insulation	132,363	kBtu
Estimated Total Annual Input Heating Energy Savings	1,675	Therms
Cost of Heating Fuel/Unit:	$1.34	$/Therm
Annual Heating Cost Savings	$2,246	$$

SUMMER

Is the Property Cooled ? **Yes** (Select)

Annual Conduction Losses From Existing Insulation	108,119	Kbtu
Annual Conduction Losses From Proposed Insulation	45,266	kBtu
Savings In Conduction Losses After Adding Insulation	62,853	kBtu
Estimated Total Annual Input Cooling Energy Savings	8,979	kWh
Cost of Electricity/Unit	$0.15	$/kWh
Annual Cooling Cost Savings	$1,321	$$

COST ANALYSIS

Estimated O&M Savings	$0.00	$$	Estimated Cost To Add Insulation/Sqft	$1.70
Total Estimated Annual Cost Savings	$3,567	$$	Estimated Total Installation Cost	$102,040 $$
Simple Pay Back Period	28.61	Years	*Type of Recommendation*	Capital Cost ECM Recommendation

UIC	Install Low Flow Tankless Restroom Fixtures
EAP4	Location: Restrooms

ECM FOR DETERMINING WATER SAVINGS IN COMMERCIAL PROPERTIES

Number of Males	35	
Number of Females	15	
Number of Occupied Days Per Week (Max 7)	5	
Number of Occupied Weeks/Year (Max 52)	52	
Number of Urinals To Be Retrofitted	2	
Number of Water Closets To Be Retrofitted	6	
No. of Water Closets With Separate Flush Tank *(Typical Residential Type)*	1	
Estimated Restroom Usage/Individual/Day *Default is 4 Uses/Day For Residential/Office*	4	(Select)

Urinal Water Savings

Do you Want To Make Any Changes To The Urinals?	Yes	
Estimated Existing Use of Urinal/Day/Man	80%	
Existing Gallons Per Flush Ratings For Urinal Flushes	1.00	GPF
Proposed Urinal	0.125 GPF -Wall Mount	
GPF of Proposed Urinal Flush Valve** ***(1992 EpACT Energy Act Mandates 1.0GPF Max on Urinals)*	0.125	GPF
Estimated Annual Water Savings From Urinal	25.48	kGal

Water Closet Water Savings

Tankless Water Closets

Do The Water Closet Need To Be Retrofitted?	*(Select)*	Yes	
Existing Gallons Per Flush Ratings For Water Closet Flushes		1.60	GPF
Are The Existing Water Closet Being Replaced? *(If No; Then Only The Flush Valve Would Be Replaced With Dual Flush Retrofit Kit)*	*(Select)*	Yes	
No. of Tankless Water Closets		5	
GPF of Proposed Dual Flush- Water Closet Valve* **(Federal Law Requires All Flushes Not To Exceed 1.6 GPF)*	*Solid Waste (20%)*	1.60	GPF
	Liquid Waste (80%)	1.10	GPF
Estimated Annual Water Savings From Male Users		2.91	kGal
Estimated Annual Water Savings From Female Users		6.24	kGal
Total Water Savings From Water Closets		9.15	kGal

Water & Cost Saving Calculations

Water Savings Calculation

Water Savings By The Use of Low Flow Water Closet Flush Valves/Yr	9.15	kgal
Water Savings By The Use of Low Flow Urinal Flush Valves/ Yr	25.48	kgal
Total Annual Water Savings in kgal	34.63	kgal

Cost Savings Calculations

Enter Water Tariff Rate ($/1000Gal)	$10.00	$$
Estimated Cost Savings From Water	$346	$$

Estimated Cost of Retrofit

Cost For Replacing Existing Urinal Fixture With A Low Flow Fixture *(Includes Labor)*	$2,601	$$
Cost For Replacing Existing Water Closet With A New Water Closet And- Dual Flush Valves *(Up For Liquid Waste And Down For Solid Waste)* *(Includes Labor)*	$5,634	$$
Estimated Total Cost For Retrofit	$8,235	$$
Simple Pay Back Period	23.78	Yrs
Type of Recommendation	Capital Cost ECM Recommendation	

ECM EXPLANATION:

The highest water utilization at any home/office occurs in the restrooms. It is estimated that on an average a normal human being uses the restroom at least four times a day. Keeping with the global water conservation objectives, federal law prohibits use of any new water closet flushes over 1.6 GPF. At the same time the '1992 EpACT' mandates all new Urinals to have a maximum 1.0 GPF flush valves on urinals.

EMG recommends replacing all urinals above 1.0 GPF with a new 0.5 GPF or lesser urinals. At the same time EMG also recommends replacing all the water closets having a GPF rating of 1.6 and over with low flow water closet fixtures equipped with dual flush valves.

In case the property doesn't wish to replace the entire water closet fixtures, EMG recommends retrofitting all the tankless water closet flush fixtures with new dual flush fixtures that would result in a 30% water savings per flush for liquid wastes, while retaining the same flush rate for solid wastes.

SUMMARY:

Initial Investment:	$8,235	Simple Payback Period:	23.78 Yrs
Annual Cost Savings:	$346		

UIC	Replace Inefficient Heating Plant
EAH1A	Location: Boiler Room

Existing System

Select Type of Heating Fuel	Natural Gas	Existing Boiler Type:	Cast Iron
No. of Heating Units To Be Replaced:			1 Qty
Rated Heating Capacity of Each Existing Boilers:			501-1000 MBH
Estimated Actual Heating Fuel Used For Heating:			6,000 Therms
Existing Average Annual Heating Plant Efficiency:			79% %
Cost For Demolition of Existing Heating System:			$1,638

Proposed Heating System

Proposed Heating Fuel	Natural Gas	Proposed Boiler Type:	Condensing Boiler

	MBH	Qty	Total No. of New Boilers
Proposed Boiler Type-1	1,050	1	1 Qty
Proposed Boiler Type-2	0	0	
Proposed Boiler Type-3	0	0	

Proposed Heating Plant Efficiency:	95% %
Estimated Fuel Consumption With Improved Efficiency:	4,989 Therms

Financial Analysis

Existing Annual Heating Cost:	$8,042	Proposed Annual Heating Cost:	$6,687 $
Annual Energy Cost Savings	$1,354	Estimated Annual O&M Savings:	$68 $
Total Annual Cost Savings:	$1,422 $		

Cost of Type-1 New Boilers (Material + Installation):	$44,370 $
Cost of Type-2 New Boilers (Material + Installation):	$0 $
Cost of Type-3 New Boilers (Material + Installation):	$0 $
Total For Material +Installation+Demolition:	**$46,009** $
Estimated Engineering and Architecture Fees:	$3,359 $

Install New Gas Line & Gas Meter?	No	
Estimated Cost For Installing New Gas Line & Gas Meter :		$0 $
(The Above Cost is the cost for gas pipeline from gas meter to heating plant only ie. within the property)		
Estimated Cost For Extending Gas Pipeline To The Property:		$
Estimated Total Cost For Replacing All Heating Plants:		$49,367 $
Simple Payback:		34.71 years

Type of Recommendation — Capital Cost ECM Recommendation

ECM DESCRIPTION

Standard boilers on the market generally attain operating efficiencies around 80% (Output MBH / Input MBH). The operating efficiencies for condensing boilers are above 90% and reduce the energy requirements for heating significantly. Condensing boilers utilize the latent heat of condensing exhaust gasses to extract additional heat from the input fuel, thus achieving a significantly higher operating efficiency. Additionally, many condensing boilers have the ability to modulate the input rate to meet a reduced heating demand, which boiler cycling on days of moderate temperature. . A properly-sized modulating condensing boiler will reduce the input energy required for heating and will provide ability for the boiler to turn-down the firing rate during periods of reduced heating load, further conserving heating energy. Sizing analysis and design for replacement by a local professional engineer is recommended prior to replacement of the heating equipment. This step will ensure that the new boilers are properly sized and configured to meet the building hot water demands and operate in the most efficient manner. In addition to reducing the energy consumption, the increased efficiency may also allow for a decrease in the required input capacity.

SUMMARY:

Initial Investment: $49,367 Simple Payback: 34.71 Yrs

Energy Cost Savin $6,687

APPENDIX F:
Solar PV

UIC	Install Fixed Tilt Solar Photovoltaic System
EAR-2	Details: Maintenance and Operations

Select State: Northern California **Electric Rate:** $0.15 $/KWH Annual Electric Consumption: 264,227 KWh

Roof No.	Description	Number of Roofs	DC System Size Per Roof	PV System Sizing For All Roofs	Estimated Number of 315 Watt PV Panels:	Total Estimated Annual Electricity Generated/ Roof	Total Estimated Electricity Generated (All Roofs)	Total Cost Savings	Installation Cost: ($3.5/Watt)	Simple Pay Back Period without Incentives	One Time Potential Utility or State Incentives	One Time Potential Federal Incentives	Annual Potential Incentives and Rebates		Simple Pay Back Period with All Incentives
			kW	kW		kWh	kWh			Yrs		Dept. of Treasury Renewable Grant (30%)	Federal REPI Incentive	Solar Renewable Certificates (SRECS)- (~$0/MWH)	Years
												30%	$0.02	$0	
1	Building 1	1	39.60	40	126	61,346	61,346	$9,024	$138,600	15.4	$0	$41,580	$1,350	$0	9.3
		1		**40**	**126**	**61,346.0**	**61,346**	**$9,024**	**$138,600**	**15.36**	**$0**	**$41,580**	**$1,350**	**$0**	**9.26**

Solar Rooftop Photovoltaic Analysis		
Total Number of Roofs	1	
Estimated Number of Panels	126	
Estimated KW Rating	40	KW
Potential Annual KWh Produced	61,346	KWh
% of Current Electricity Load	23.2%	

Financial Analysis		
Investment Cost	$138,600	
Estimated Energy Cost Savings	$9,024	
Potential Rebates	$41,580	
Potential Annual Incentives	$1,350	
Payback without Incentives	15.4	years
Incentive Payback but without SRECS	9.3	years
Payback with All Incentives	9.3	years