LEVEL II ENERGY AUDIT

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

DLR GROUP
1050 20th Street, Suite 250
Sacramento, California 95930

PREPARED BY:
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EMG PROJECT #:

136988.19R000-029.268

DATE OF REPORT:

October 29, 2020

ONSITE DATE:

August 7, 2019

ZERO NET ENERGY ASHRAE LEVEL II AUDIT

JAMES W. MARSHALL ELEMENTARY SCHOOL

9525 Goethe Road

Sacramento, California 95827

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Certification

EMG has completed an Energy Audit of James W. Marshall Elementary School located at 9525 Goethe Road in Sacramento, California 95827. EMG visited the site on August 7, 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 95827. 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:

Bhaskar Ale, CEM

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 James W. Marshall Elementary School 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.

Bldg #	Structures Assessed	Building Type	EMG Calculated Area (SF)	Estimated Occupancy
1	Building 001	School Building	5,961	50-70
2	Building P01	Portabe School Building	8,640	70-100
3	Building P02	Portabe School Building	5,280	50-70
4	Building P03	Portabe School Building	6,240	60-80
5	Building P04	Portabe School Building	8,640	80-110
6	Building P05	Portabe School Building	4,320	40-60
7	Building P06	Portabe School Building	3,840	40-60

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 six 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 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)*	$84,537 *(In Current Dollars)*
Estimated Annual Cost Savings *(Current Dollars Only)*	$10,424 *(In Current Dollars)*
ECM Effective Payback	8.11 years
Estimated Annual Energy Savings	13.32%
Estimated Annual Energy Utility Cost Savings *(Excluding Water)*	14.81%
Estimated Annual Water Cost Saving	4.72%

Solar Photovoltaic (PV) Screening for JAMES W. MARSHALL ELEMENTARY SCHOOL

SOLAR ROOFTOP PHOTOVOLTAIC ANALYSIS		
Estimated Number of Panels	548	
Estimated KW Rating	173	KW
Potential Annual kWh Produced	260,950	kWh
% of Current Electricity Uses	98.7%	
FINANCIAL SUMMARY		
Investment Cost	$604,450	
Estimated Energy Cost Savings	$45,666	
Payback without Incentives	13.2	Years
Incentive Payback but without SRECs	8.0	Years
Payback with All Incentives	8.0	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)	28 kBtu/ft^2
Post ECM Site Energy Use Intensity (EUI)	25 kBtu/ft^2
SOURCE ENERGY USE INTENSITY (EUI)	**RATING**
Current Source Energy Use Intensity (EUI)	78 kBtu/ft^2
Post ECM Source Energy Use Intensity (EUI)	66 kBtu/ft^2
BUILDING COST INTENSITY (BCI)	**RATING**
Current Building Cost Intensity	$1.14/ft^2
Post ECM Building Cost Intensity	$0.97/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	163 MMbtu
Total CO_2 Emissions Reduced	14.69 MtCO_2/Yr
Total Cars Off the Road (Equivalent)*	3
Total Acres of Pine Trees Planted (Equivalent)*	3

**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	1,220,842 kBtu
Total Annual Energy Savings for Non-Renewable Energy Measures	162,643 kBtu
Total Annual Energy Savings from Renewable Energy Measures	890,361 kBtu
Total Annual Energy Savings	1,053,004 kBtu
Net Energy Consumption from Grid Post Implementation	167,837 kBtu
% Energy Reduction (Annual Energy-Net Energy) / (Annual Energy)	86%

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 James W Marshall Elementary School

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 Faucet Aerators Location: Restrooms And Classrooms	$564	109	0	19	$293	$0	$293	1.93	4.43	$1,932	10.00
Totals for No/Low Cost Items		**$564**	**109**	**0**	**19**	**$293**	**$0**	**$293**	**1.93**			
Capital Cost Recommendations												
1	Install Timers On Exhaust Fans Location: Administration, Cafeteria, Kitchen (001)	$354	40	309	0	$107	$0	$107	3.32	3.59	$918	15.00
2	Upgrade Building Lighting to LED and Install Automatic Lighting Controls Location: Building Interior And Exterior	$59,486	0	45,411	0	$7,640	$2,128	$9,768	6.09	1.96	$57,119	15.00
3	Install Low Flow Tankless Restroom Fixtures Location: Restrooms	$9,286	0	0	150	$1,123	$0	$1,123	8.27	1.44	$4,122	15.00
4	Retrofit Apartment Tank Toilets to Dual Flush Location: Portables	$2,046	0	0	21	$160	$0	$160	12.75	1.17	$341	20.00
5	Replace Existing Water Heater With New Energy Efficient Units Location: Building 001	$1,776	98	0	0	$132	$0	$132	13.45	1.02	$41	18.00
Total For Capital Cost		**$72,947**	**138**	**45,720**	**171**	**$9,162**	**$2,128**	**$11,290**	**6.46**			
	Interactive Savings Discount @ 10%		-25	-4,572	-19	-$945	-$213	-$1,158				
	Total Contingency Expenses @ 15%	$11,027										
Total for Improvements		**$84,537**	**222**	**41,148**	**172**	**$8,509**	**$1,915**	**$10,424**	**8.11**			

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 James W Marshall Elementary School

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	Replace Rooftop Package Unit Location: Administration, Cafeteria, Kitchen (001) - Rooftop	$12,475	61	713	0	$203	$10	$213	58.51	0.25	-$9,303	20.00
Total for Improvements		**$12,475**	**61**	**713**	**0**	**$203**	**$10**	**$213**	**58.51**			

2. Introduction

The purpose of this Energy Audit is to provide James W. Marshall Elementary School 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	38
Estimated Facility Occupancy	465
% of Male Occupants	50%

POINT OF CONTACT	
Point of Contact Name	Dennis Smith
Point of Contact Title	Plant manager
Point of Contact – Contact Number	916.628.7861

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

Description:

Heating and cooling to portable classrooms is primarily provided by wall mounted gas/electric package units. The administration building is served by a packaged roof top unit (RTU) with a secondary makeup air unit for heating. The administration building is also supplementary served by a central AC split system utilizing natural gas for heating.

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

BUILDING CENTRAL HEATING SYSTEM	
Primary Heating System	Gas/Electric Wall Mount Units
Secondary Heating System	Packaged RTU
Hydronic Distribution System	Not Applicable
Primary Heating Fuel	Natural Gas
Heating Mode Set-point	69 °F
Heating Mode- Set-back Temperature	53 °F

BUILDING COOLING SYSTEM	
Primary Cooling System	Wall Mount Packaged Units
Secondary Cooling System	Packaged RTU
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.

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
$0.17 /kWh	$1.35/therm	$7.49/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.

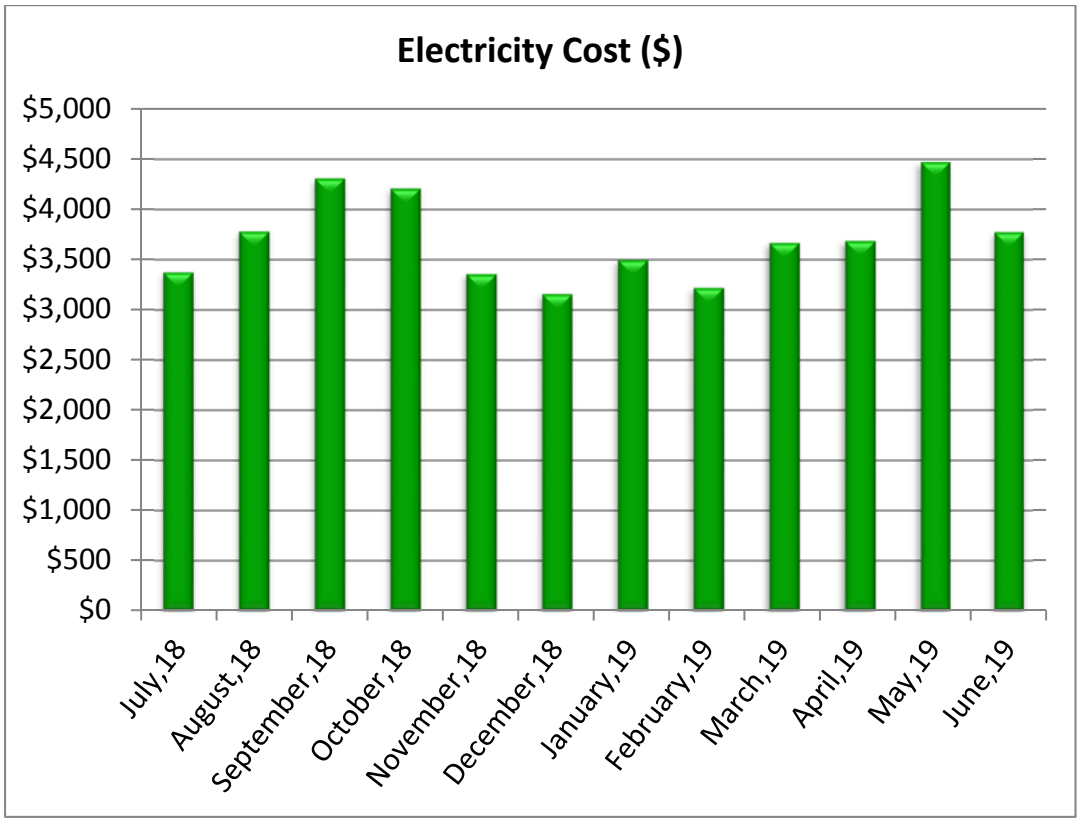
4.1. Electricity

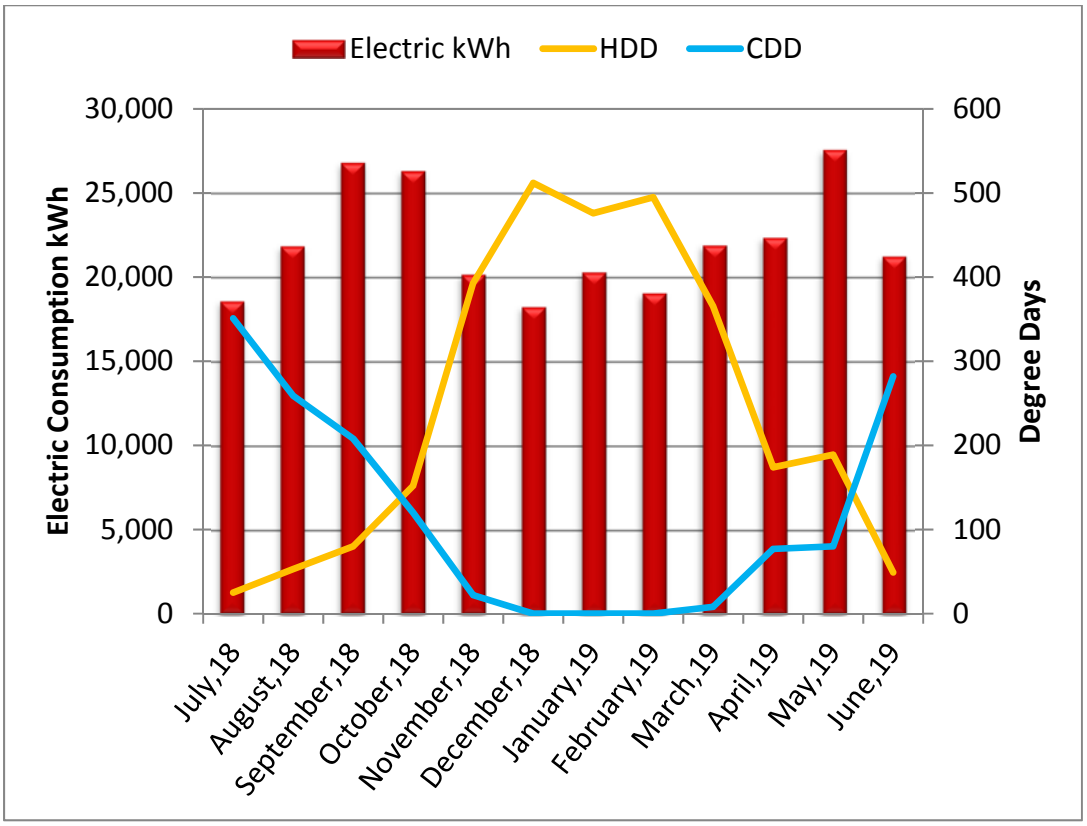
SMUD satisfies the electricity requirements for the facility. The primary end uses for electric utility compromises of lighting, cooling, office/school equipment, and appliances in the break room.

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	18,584	$0.18	$3,371
August,18	21,845	$0.17	$3,778
September,18	26,790	$0.16	$4,306
October,18	26,296	$0.16	$4,206
November,18	20,163	$0.17	$3,353
December,18	18,246	$0.17	$3,155
January,19	20,298	$0.17	$3,495
February,19	19,063	$0.17	$3,216
March,19	21,893	$0.17	$3,665
April,19	22,355	$0.16	$3,684
May,19	27,570	$0.16	$4,472
June,19	21,240	$0.18	$3,771
Total/average	**264,344**	**$0.17**	**$44,472**


Electricity Cost ($)
$5,000
$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

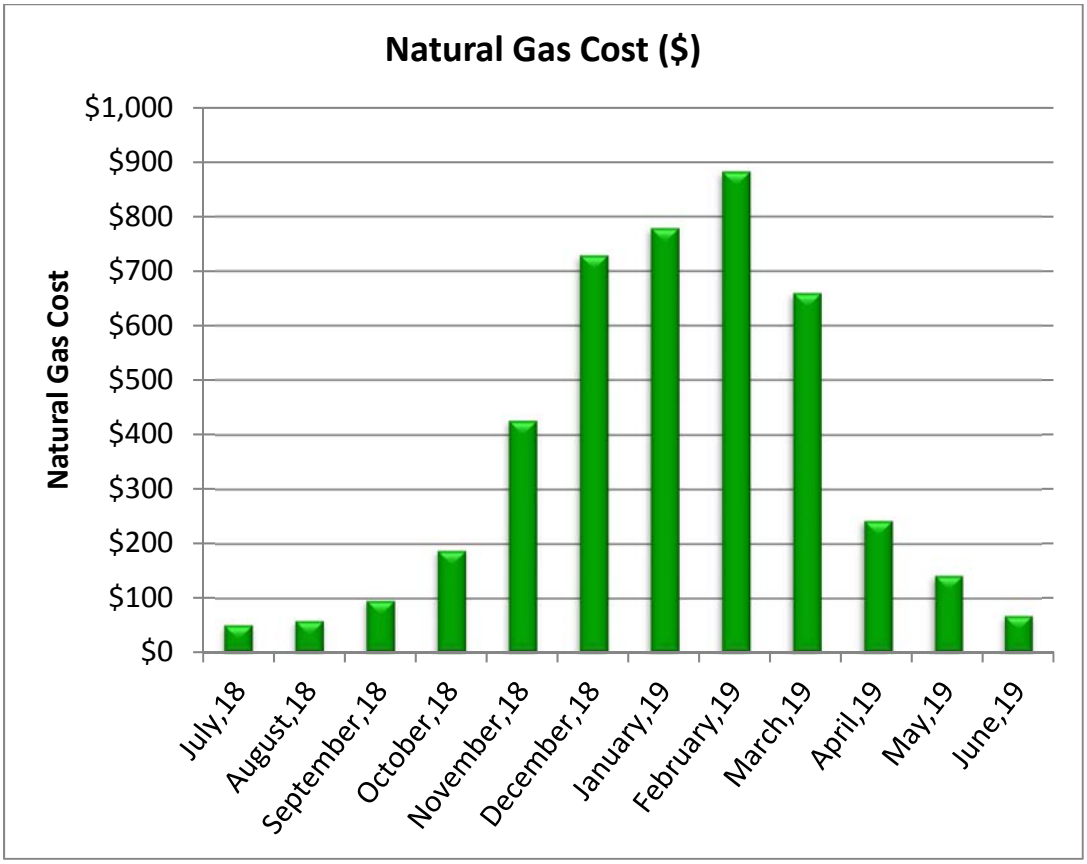
4.2. Natural Gas

PGE 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	18	$2.71	$50
August,18	27	$2.18	$58
September,18	66	$1.45	$96
October,18	150	$1.25	$188
November,18	345	$1.24	$427
December,18	519	$1.40	$729
January,19	592	$1.32	$779
February,19	656	$1.34	$882
March,19	483	$1.37	$660
April,19	189	$1.29	$243
May,19	102	$1.40	$142
June,19	43	$1.58	$67
Total/average	**3,189**	**$1.35**	**$4,320**


Natural Gas Cost ($)
Natural Gas Cost
$1,000
$900
$800
$700
$600
$500
$400
$300
$200
$100
$0
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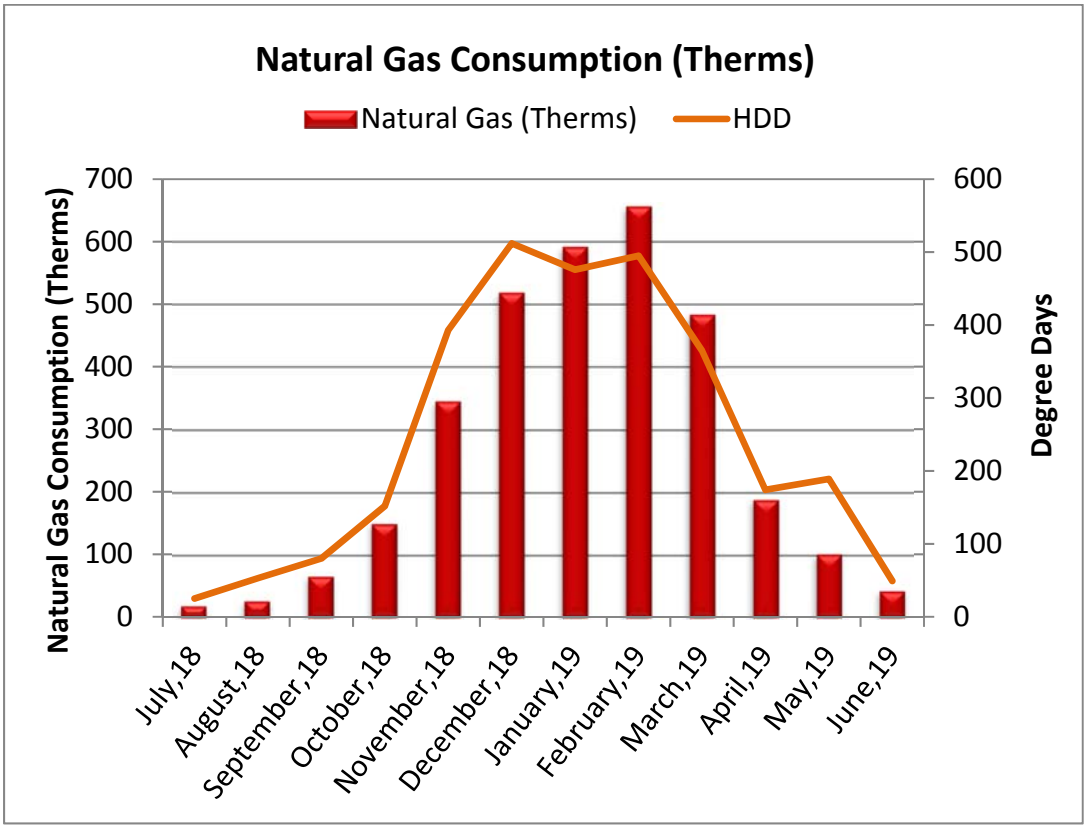
January,19
February,19
March,19
April,19
May,19
June,19


Natural Gas Consumption (Therms)
Natural Gas (Therms)
HDD
Natural Gas Consumption (Therms)
Degree Days
700
600
500
400
300
200
100
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

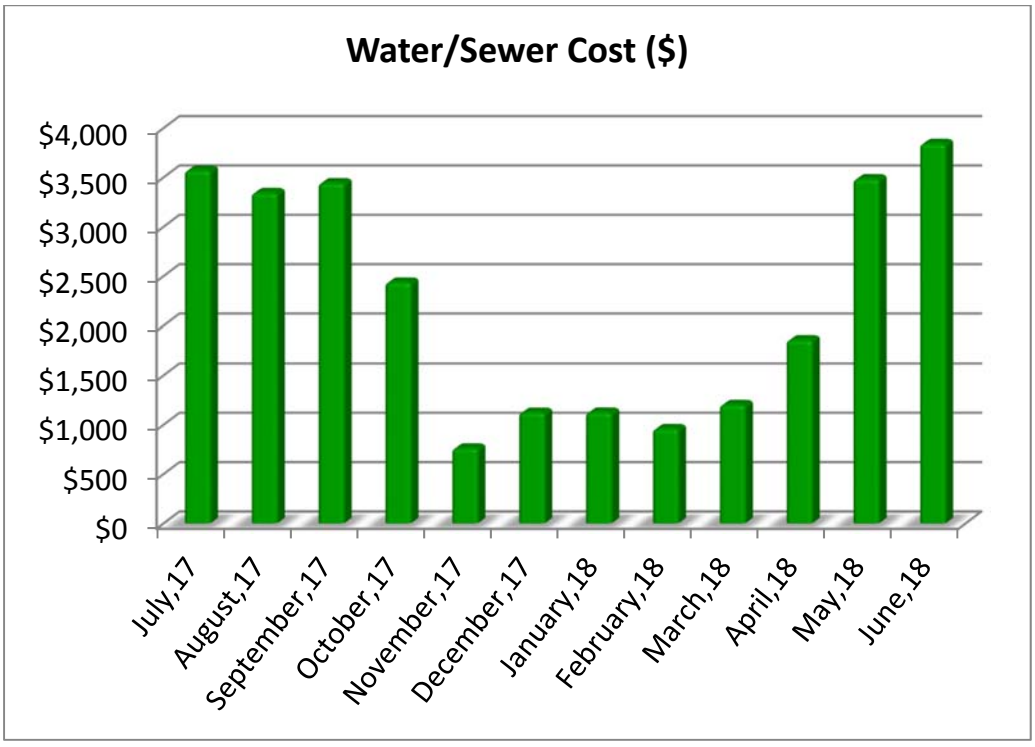
4.3. Water and Sewer

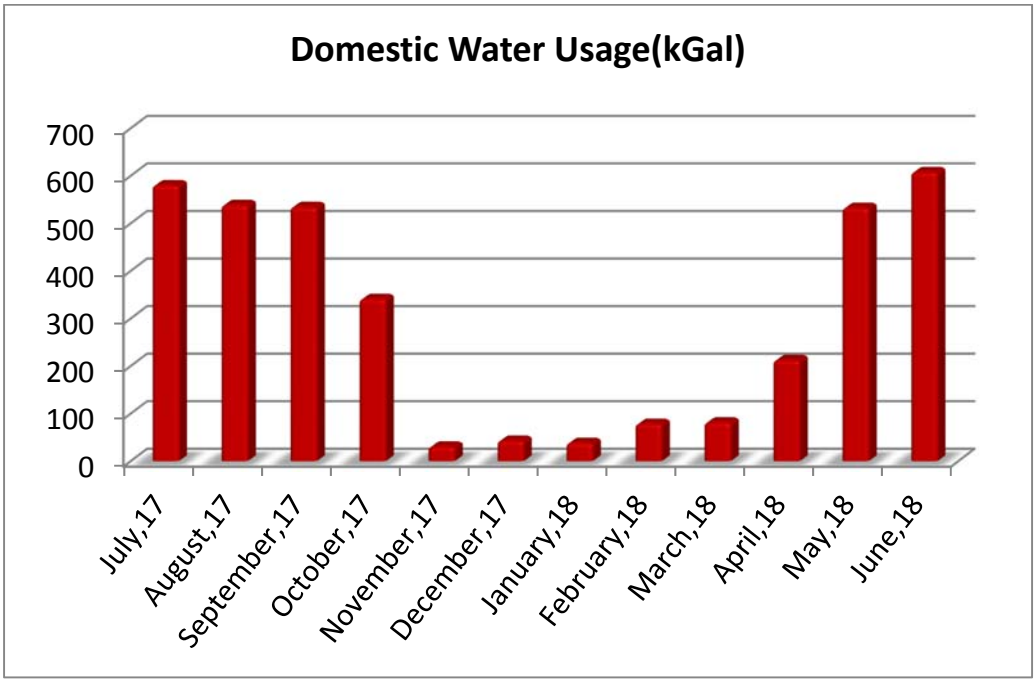
The City of Sacramento satisfies the water requirements for the facility. The primary end use of water is the plumbing fixtures such as staff showers, water closets, and lavatories. The table below provides the twelve continuous months' worth of consumption and cost for water in kGal for the facility.

Note: The utility bills for July 2017 - June 2018 was used instead of July 2018 - June 2019 due to unknown fluctuation in consumption data for the latter.

Water and Sewer Consumption and Cost Data

BILLING MONTH	CONSUMPTION (KGAL)	UNIT COST/KGAL	TOTAL COST
July,17	581	$6.15	$3,576
August,17	540	$6.20	$3,349
September,17	536	$6.44	$3,449
October,17	342	$7.13	$2,442
November,17	32	$24.00	$768
December,17	44	$25.50	$1,130
January,18	40	$28.55	$1,131
February,18	80	$12.09	$964
March,18	83	$14.61	$1,208
April,18	214	$8.72	$1,864
May,18	534	$6.53	$3,489
June,18	609	$6.32	$3,847
Total	3,635	$7.49	$27,217


Water/Sewer Cost ($)
$4,000
$3,500
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$0
July,17
August,17
September,17
October,17
November,17
December,17
January,18
February,18
March,18
April,18
May,18
June,18


Domestic Water Usage(kGal)
700
600
500
400
300
200
100
0
July,17
August,17
September,17
October,17
November,17
December,17
January,18
February,18
March,18
April,18
May,18
June,18

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	548	
Estimated KW Rating	173	KW
Potential Annual kWh Produced	260,950	kWh
% of Current Electricity Uses	98.7%	
FINANCIAL SUMMARY		
Investment Cost	$604,450	
Estimated Energy Cost Savings	$45,666	
Payback without Incentives	13.2	Years
Incentive Payback but without SRECs	8.0	Years
Payback with All Incentives	8.0	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	Output Capacity	Room Number	Space Served	Quantity
Water Heater	Rheem	G75-75	RRNG 1101G01051	75 MBH	-	SC01	Cafeteria, Kitchen	1
Packaged Unit (RTU)	Carrier	48HJD014---561	1107G50782	224 MBH	183 MBH	Roof	Administration, Cafeteria, Kitchen (001)	1
Packaged Unit	Bard	WG421-ANBUX4XXX	Inaccessible	75 MBH	59 MBH	P03	Portables Staff Lounge, Library, 033-035 (P03)	1
Make-Up Air Unit	Reznor	RDH-300	BQC3060018694	300 MBH	243 MBH	Roof	Administration, Cafeteria, Kitchen (001)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126A011577126-1	75 MBH	59 MBH	P04	Portables 008-016 (P04)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126A011577130-1	75 MBH	59 MBH	P04	Portables 008-016 (P04)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126C011598079-1	75 MBH	59 MBH	P04	Portables 008-016 (P04)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126C011598060-1	75 MBH	59 MBH	P04	Portables 008-016 (P04)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126C011598067-1	75 MBH	59 MBH	P03	Portables Staff Lounge, Library, 033-035 (P03)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126A011577172-1	75 MBH	59 MBH	P03	Lounge, Library, 033-	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126C011598058-1	75 MBH	59 MBH	P04	Portables 008-016 (P04)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126A011577152-1	75 MBH	59 MBH	P04	Portables 008-016 (P04)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126C011598087-1	75 MBH	59 MBH	P04	Portables 008-016 (P04)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126J011651905-1	75 MBH	59 MBH	P01	Portables 017-025 (P01)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126C011598085-1	75 MBH	59 MBH	P03	Portables Staff Lounge, Library, 033-035 (P03)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126J011651906-1	75 MBH	59 MBH	P03	Portables Staff Lounge, Library, 033-035 (P03)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126C011598081-1	75 MBH	59 MBH	P04	Portables 008-016 (P04)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126J011651910-1	75 MBH	59 MBH	P01	Portables 017-025 (P01)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126K011664967-1	75 MBH	59 MBH	P02	Portables 026-030 and Toilets (P02)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126K011664972-1	75 MBH	59 MBH	P02	Portables 026-030 and Toilets (P02)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126K011664976-1	75 MBH	59 MBH	P01	Portables 017-025 (P01)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126K011664981-1	75 MBH	59 MBH	P01	Portables 017-025 (P01)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126K011664978-1	75 MBH	59 MBH	P03	Portables Staff Lounge, Library, 033-035 (P03)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126K011664998-1	75 MBH	59 MBH	P01	Portables 017-025 (P01)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126K011664994-1	75 MBH	59 MBH	P02	Portables 026-030 and Toilets (P02)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126K011664990-1	75 MBH	59 MBH	P02	Portables 026-030 and Toilets (P02)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126K011664987-1	75 MBH	59 MBH	P01	Portables 017-025 (P01)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126K011665002-1	75 MBH	59 MBH	P02	Portables 026-030 and Toilets (P02)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126K011665001-1	75 MBH	59 MBH	P01	Portables 017-025 (P01)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126K011665003-1	75 MBH	59 MBH	P01	Portables 017-025 (P01)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126L011674290-1	75 MBH	59 MBH	P01	Portables 017-025 (P01)	1
Gas/Electric Packaged Unit	Bard	WG421-ANBUX4XXX	126M001531093-1	75 MBH	59 MBH	P04	Portables 008-016 (P04)	1
Gas/Electric Packaged Unit	Bard	WG481-ANBUX4XXX	236F011629479-1	75 MBH	59 MBH	P06	Portables 001-003, J001 and Toilets (P06)	1
Gas/Electric Packaged Unit	Bard	WG481-ANBUX4XXX	236H021739110-1	75 MBH	59 MBH	P05	Portables 004-007 and Toilets (P05)	1
Gas/Electric Packaged Unit	Bard	WG481-ANBUX4XXX	236H021739115-01	75 MBH	59 MBH	P06	Portables 001-003, J001 and Toilets (P06)	1
Gas/Electric Packaged Unit	Bard	WG481-ANBUX4XXX	236J031827482-1	75 MBH	59 MBH	P05	Portables 004-007 and Toilets (P05)	1
Gas/Electric Packaged Unit	Bard	WD422-ANBUX4XXX	253H031818632-1	75 MBH	59 MBH	P06	Portables 001-003, J001 and Toilets (P06)	1

Mechanical Inventory								
System	Make	Model	Serial Number	Input Capacity	Output Capacity	Room Number	Space Served	Quantity
Gas/Electric Packaged Unit	Bard	WG422-ANBUX4XXX	253H031818656-1	75 MBH	59 MBH	P05	Portables 004-007 and Toilets (P05)	1
Gas/Electric Packaged Unit	Bard	WG422-ANBUX4XXX	253H031918642-1	75 MBH	59 MBH	P05	Portables 004-007 and Toilets (P05)	1
Furnace	Amana	Inaccessible	Inaccessible	175 MBH	-	M001	Administration, Cafeteria, Kitchen (001)	1
Exhaust Fan	Penn Ventilator	No tag/plate found	No tag/plate found	No tag/plate found	-	Roof	Administration, Cafeteria, Kitchen (001)	1
Central AC Split System	Amana	RCE60C2C	0502156768	5 TON	-	BLD 001	Cafeteria, Kitchen	1

APPENDIX C:
Lighting System Schedule

									Lamp Details				Fixture Details				Existing Consumption	
Line No.	Building Name	Interior/ Exterior	Floor	Space Type	Room No.	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	James W Marshall	Interior		OFFICE	001	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	Industrial	3	0	8	2,160	415
2	James W Marshall	Interior		KITCHEN	001	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	78	2x4 Prism Troffer	26	0	8	1,800	4,493
3	James W Marshall	Interior		CAFETERIA	001	-	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	108	2x4 Prism Troffer	36	0	8	2,160	7,465
4	James W Marshall	Interior		STORAGE	001	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	9	2x4 Prism Troffer	3	0	8	684	197
5	James W Marshall	Interior		OFFICE	001	-	1	Ceiling-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	12	2x4 Prism Troffer	6	0	8	684	263
6	James W Marshall	Interior		OFFICE	001	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	16	Industrial	8	0	8	2,160	1,106
7	James W Marshall	Interior		OFFICE	001	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	2x4 Prism Troffer	2	0	8	2,160	276
8	James W Marshall	Interior		OFFICE	001	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	Industrial	1	0	8	2,160	138
9	James W Marshall	Interior		KITCHEN	001	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	2x4 Prism Troffer	3	0	8	1,800	346
10	James W Marshall	Interior		RESTROOM	001	-	1	Light Switch	CFL	CFL - 4 Pin	2' CFL36	1	Sconce-vert	1	0	8	2,160	78
11	James W Marshall	Interior		OFFICE	P06	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	24	2x4 Prism Troffer	12	0	8	2,160	1,659
12	James W Marshall	Interior		RESTROOM	P06	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	8	2,160	553
13	James W Marshall	Interior		CLASSROOM	P06	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	8	1,260	323
14	James W Marshall	Interior		CLASSROOM	P06	-	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	72	2x4 Prism Troffer	24	0	8	1,260	2,903
15	James W Marshall	Interior		OFFICE	P06	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	12	2x4 Prism Troffer	6	0	8	2,160	829
16	James W Marshall	Interior		OFFICE	P05	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	36	2x4 Prism Troffer	12	0	8	2,160	2,488
17	James W Marshall	Interior		RESTROOM	P05	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	2x4 Prism Troffer	2	0	8	2,160	415
18	James W Marshall	Interior		RESTROOM	P05	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	8	2,160	553
19	James W Marshall	Interior		CLASSROOM	P05	-	8	Light Switch	Linear Fluorescent	T8	4' 32W T8	144	2x4 Prism Troffer	48	0	8	1,260	5,806
20	James W Marshall	Interior		CLASSROOM	P05	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	60	2x4 Prism Troffer	20	1	8	1,260	2,419
21	James W Marshall	Interior		CLASSROOM	P04	-	18	Light Switch	Linear Fluorescent	T8	4' 32W T8	324	2x4 Prism Troffer	108	0	8	1,260	13,064
22	James W Marshall	Interior		CLASSROOM	P01	-	18	Light Switch	Linear Fluorescent	T8	4' 32W T8	324	2x4 Prism Troffer	108	0	8	1,260	13,064
23	James W Marshall	Interior		RESTROOM	P02	-	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	27	2x4 Prism Troffer	9	0	8	2,160	1,866
24	James W Marshall	Interior		RESTROOM	P02	-	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	18	2x4 Prism Troffer	6	0	8	2,160	1,244
25	James W Marshall	Interior		RESTROOM	P02	-	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	27	2x4 Prism Troffer	9	0	8	2,160	1,866
26	James W Marshall	Interior		CLASSROOM	P02	-	5	Light Switch	Linear Fluorescent	T8	4' 32W T8	180	2x4 Prism Troffer	60	0	8	1,260	7,258
27	James W Marshall	Interior		CLASSROOM	P03	-	12	Light Switch	Linear Fluorescent	T8	4' 32W T8	216	2x4 Prism Troffer	72	0	8	1,260	8,709
28	James W Marshall	Exterior		HALLWAY	Exterior	-	1	Timer	LED	-	-	50	Shoebox	50	0	8	2,160	-
29	James W Marshall	Exterior		HALLWAY	Exterior	-	1	Timer	CFL	CFL - 4 Pin	CFL42	6	Wallpack-Horizontal	6	0	8	2,160	544
30	James W Marshall	Exterior		HALLWAY	Exterior	-	1	Timer	CFL	CFL - 4 Pin	CFL32	4	Recessed Can-hor6"	4	0	8	2,160	276
31	James W Marshall	Exterior		HALLWAY	Exterior	-	1	Timer	HID	MH	MH250	19	Pole Post Top	19	0	20	2,160	10,260
	Totals											1,815		676			56,088	90,876

								Fixture Details						Existing Consumption				Proposed- Post Retrofit				
Line No.	Building Name	Interior/ Exterior	Floor	Space Type	Room No.	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	James W Marshall	Interior		OFFICE	001	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; Industrial	3	6	8	2,160	415	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,160	220	194
2	James W Marshall	Interior		KiTCHEN	001	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	26	78	8	1,800	4,493	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,800	2,387	2,106
3	James W Marshall	Interior		CAFETERIA	001	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	36	108	8	2,160	7,465	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,160	3,966	3,499
4	James W Marshall	Interior		STORAGE	001	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	3	9	8	684	197	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	684	105	92
5	James W Marshall	Interior		OFFICE	001	Ceiling-Mounted Sensor	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	6	12	8	684	263	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	684	140	123
6	James W Marshall	Interior		OFFICE	001	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; Industrial	8	16	8	2,160	1,106	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,160	588	518
7	James W Marshall	Interior		OFFICE	001	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	4	8	2,160	276	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,160	147	130
8	James W Marshall	Interior		OFFICE	001	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; Industrial	1	2	8	2,160	138	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,160	73	65
9	James W Marshall	Interior		KITCHEN	001	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	3	6	8	1,800	346	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,800	184	162
10	James W Marshall	Interior		RESTROOM	001	Light Switch	1	CFL	CFL - 4 Pin	2' CFL36; Sconce-vert	1	1	8	2,160	78			Wall Mounted				
11	James W Marshall	Interior		OFFICE	P06	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	12	24	8	2,160	1,659	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,160	881	778
12	James W Marshall	Interior		RESTROOM	P06	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	8	2,160	553	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,160	294	259
13	James W Marshall	Interior		CLASSROOM	P06	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	8	1,260	323	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,260	171	151
14	James W Marshall	Interior		CLASSROOM	P06	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	24	72	8	1,260	2,903	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,260	1,542	1,361
15	James W Marshall	Interior		OFFICE	P06	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	6	12	8	2,160	829	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,160	441	389
16	James W Marshall	Interior		OFFICE	P05	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	12	36	8	2,160	2,488	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,160	1,322	1,166
17	James W Marshall	Interior		RESTROOM	P05	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	6	8	2,160	415	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,160	220	194
18	James W Marshall	Interior		RESTROOM	P05	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	8	2,160	553	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,160	294	259
19	James W Marshall	Interior		CLASSROOM	P05	Light Switch	8	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	48	144	8	1,260	5,806	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,260	3,084	2,722
20	James W Marshall	Interior		CLASSROOM	P05	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	20	60	8	1,260	2,419	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,260	1,285	1,134
21	James W Marshall	Interior		CLASSROOM	P04	Light Switch	18	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	108	324	8	1,260	13,064	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,260	6,940	6,124
22	James W Marshall	Interior		CLASSROOM	P01	Light Switch	18	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	108	324	8	1,260	13,064	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,260	6,940	6,124
23	James W Marshall	Interior		RESTROOM	P02	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	9	27	8	2,160	1,866	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,160	991	875
24	James W Marshall	Interior		RESTROOM	P02	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	6	18	8	2,160	1,244	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,160	661	583
25	James W Marshall	Interior		RESTROOM	P02	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	9	27	8	2,160	1,866	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,160	991	875
26	James W Marshall	Interior		CLASSROOM	P02	Light Switch	5	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	60	180	8	1,260	7,258	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,260	3,856	3,402
27	James W Marshall	Interior		CLASSROOM	P03	Light Switch	12	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	72	216	8	1,260	8,709	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,260	4,627	4,082
28	James W Marshall	Exterior		HALLWAY	Exterior	Timer	1	LED	-		50	50	8	2,160				Retain Existing Controls				
29	James W Marshall	Exterior		HALLWAY	Exterior	Timer	1	CFL	CFL - 4 Pin	CFL42; Wallpack-Horizontal	6	6	8	2,160	544			Retain Existing Controls				
30	James W Marshall	Exterior		HALLWAY	Exterior	Timer	1	CFL	CFL - 4 Pin	CFL32; Recessed Can-hor6"	4	4	8	2,160	276			Retain Existing Controls				
31	James W Marshall	Exterior		HALLWAY	Exterior	Timer	1	HID	MH	MH250; Pole Post Top	19	19	20	2,160	10,260	ECM	RF - Replace Entire Fixture	Retain Existing Controls	54W LED Post	2,160	2,216	8,044
	Totals											1,815									44,566	45,411

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 Faucet Aerators
EAP2-b	**Location**: Restrooms and Classrooms

Property Type:	Commercial	Estimated No. of Operational Weeks	36
		Number of Occupied Days/Week (Max 7)	5

KITCHEN FAUCETS			BATHROOM FAUCETS		
Number of Occupants Affected By Retrofit	465		Number of Occupants Affected by Retrofit	465	
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	23		Total Number of Faucet Aerators To Be Replaced	14	
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	1		Estimated Number of Uses Per Day	1	

Annual Water Savings From Installing Low Flow Aerators: 19.28 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:	0.75	EF	Heating Fuel Tariff	$1.35	$/Therm
Hot Water Discharge Temperature at Faucet	110.00	°F	Water Tariff ($/1000 Gal)	$7.49	$/kGal
Equivalent Heating Fuel Savings:	109	Therms	Annual Cost Savings In Form of Water	$144	$
Savings Discounted by 15% to Account For Cold Water Use					
Annual Water Savings	19.28	kGal	Annual Energy Savings From Water Heater	$148	$

COST BENEFIT ANALYSIS					
Estimated Total Annual Cost Savings	$293	$$	Estimated Total Installation Cost	$564	$$
Simple Payback Period	1.93	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: $564 Estimated Annual Cost Savings: $293 Simple Payback Period (Yrs): 1.93

UIC	Replace Existing Water Heater With New Energy Efficient Units
EAD3	**Location: Building 001**

		Building 001		Specify Location Here		Specify Location Here		Specify Location Here	
Step 1	**Existing Water Heater Details**								
	Number of Water Heaters Being Replaced:	1							
	Select Existing Hot Water Heater Fuel	Natural Gas		Natural Gas		Natural Gas		Electric	
	Insert Energy Factor of Existing Water Heater	0.47	EF		EF		EF		EF
	Input Existing Water Heater Input Rating	75.00	kBtus		kBtus		kBtus		kW
	Select One Method For Calculation	Annual Heating Hours		Annual Heating Hours		Annual DWH Load		Annual DWH Load	
	Insert Average Annual Hours of Operation	600	hrs		hrs		Therms		kWh
	Annual Water Heater Energy Consumption/Heater	450	Therms	0	Therms	#DIV/0!	hrs	#DIV/0!	hrs
	Total Estimated Annual Energy Consumption For all Heaters	450	Therms	0	Therms	0	Therms	0	kWh
	Total Estimated Annual Operating Energy Costs For all Heaters	$610	$	$0	$	$0	$	$0	$
Step 2	**Proposed New Water Heater**								
	Proposed Hot Water Heater Fuel	Natural Gas		Heat Pump		Electric		Natural Gas	
	Capacity of the Proposed New Water Heater	75-Gal,75-kBtu							
	Energy Factor of Proposed Water Heater	0.60	EF	0.00	EF	0.00	EF	0.00	EF
	Proposed Water Heater Input Rating	75.00	kBtuh	0.00	kW	0.00	kW	0.00	kBtuh
	Annual kBtuh Consumption For All The Proposed Water Heaters	35,250	kBtuh	#DIV/0!	kBtuh	#DIV/0!	kBtuh	#DIV/0!	kBtuh
	Estimated Annual Water Heater Fuel Consumption (All Heaters)	353	Therms	0	kWh	0	kWh	0	Therms
	Estimated Total Annual Energy Costs	$478	$	$0		$0		$0	
Step 3	**Energy & Cost Saving Calculation**								
	Estimated Cost of New Water Heater/Unit	$1,190	$	$0	$	$0	$	$0	$
	Total Estimated Installation Cost	$1,776	$	$0	$	$0	$	$0	$
	Total Estimated Annual Cost Savings	$132	$	$0	$	$0	$	$0	$
	Total Annual Cost Savings:	$132		Total Initial Investment::		$1,776			
	Simple Pay Back Period	13.45							
	Type of Recommendation	Capital Cost ECM Recommendation							

ECM SUMMARY:

Electric resistance is the most expensive method for heating domestic hot water. A natural gas or propane fired water system provide more units of heat with direct burning of fuel while high wattage draw is required for electric water heaters to create resistance heat. This electric usage can be seen with the increase power demand for the site and the additional kWh consumption. The installation process of the gas/propane fired water heater requires additional measures with tying a gas line or fuel tank to the system along with installing an exhaust gas vent. This process is not a costly retrofit if a current gas line or tank is at the site. The hot water exhaust duct can be tied to the existing gas fired furnaces or boilers for an easy retrofit.

SUMMARY:

Initial Investment: $1,776 Simple Payback: 13.45 yrs
Annual Cost Savings: $132

UIC	Install Low Flow Tankless Restroom Fixtures
EAP4	Location: Restrooms

ECM FOR DETERMINING WATER SAVINGS IN COMMERCIAL PROPERTIES

Number of Males	235	
Number of Females	230	
Number of Occupied Days Per Week (Max 7)	5	
Number of Occupied Weeks/Year (Max 52)	36	
Number of Urinals To Be Retrofitted	6	
Number of Water Closets To Be Retrofitted	15	
No. of Water Closets With Separate Flush Tank *(Typical Residential Type)*		
Estimated Restroom Usage/Individual/Day *Default is 4 Uses/Day For Residential/Office*	2	(Select)

Urinal Water Savings

Do you Want To Make Any Changes To The Urinals?	No	
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	0.00	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)*	No	
No. of Tankless Water Closets		15	
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%)	0.48	GPF
Estimated Annual Water Savings From Male Users		75.80	kGal
Estimated Annual Water Savings From Female Users		74.19	kGal
Total Water Savings From Water Closets		149.99	kGal

Water & Cost Saving Calculations

Water Savings Calculation

Water Savings By The Use of Low Flow Water Closet Flush Valves/Yr	149.99	kgal
Water Savings By The Use of Low Flow Urinal Flush Valves/ Yr	0.00	kgal
Total Annual Water Savings in kgal	149.99	kgal

Cost Savings Calculations

Enter Water Tariff Rate ($/1000Gal)	$7.49	$$
Estimated Cost Savings From Water	$1,123	$$

Estimated Cost of Retrofit

Cost For Replacing Existing Urinal Fixture With A Low Flow Fixture	$0 *(Includes Labor)*	$$
Cost For Replacing Existing Flush Valves With Low Flow - Dual Flush Valves ($80 Per Unit) *(Up For Liquid Waste And Down For Solid Waste)*	$9,286 *(Includes Labor)*	$$
Estimated Total Cost For Retrofit	$9,286	$$
Simple Pay Back Period	8.27	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:	$9,286	Simple Payback Period:	8.27 Yrs
Annual Cost Savings:	$1,123		

UIC	Retrofit Apartment Tank Toilets to Dual Flush
EAP3	Location: Portables

EXISTING CONDITION

Total Occupants:	116	
Number of Water Closets To Be Replaced	13	
Number of Occupied Days Per Week (Max 7)	5	
Number of Occupied Weeks/Year (Max 52)	36	
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	Retrofit	
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%)* 1.60	GPF
*(Federal Law Requires All Flushes Not To Exceed 1.6 GPF)	*Liquid Waste (80%)* 1.28	GPF

Water & Cost Saving Calculations

Water Savings By The Use of Low Flow Water Closet Flush Valves/Day	119.04	gal
Total Annual Water Savings in gallons	21.43	kgal
Cost Savings Calculations		
Enter Water Tariff Rate ($/1000Gal)	$7.49	$$
Estimated Cost Savings From Water	$160	$$
Estimated Cost of Retrofit		
Estimated Total Cost For Retrofit	$2,046	$$
Simple Pay Back Period	12.75	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.

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: $2,046

Simple Payback: 12.75 Years

Annual Cost Saving: $160

UIC	Install Timers On Exhaust Fans
EAC7A	Location: Administration, Cafeteria, Kitchen (001)

Type of Exhaust Fan: Rooftop Exhaust Fans

EXISTING CONDITION

No. of Timers to Be Installed:	1	Qty	HP of Individual Fan Motor:	0.17	HP
No. of Exhaust Fans:	1		Total kW:	0.13	kW
Existing Daily Hours of Operation/Exhaust Fan:	20.00	Hrs/Day	Annual kWh For All Fans:	926	kWh

PROPOSED CONDITION

New Daily Hours With Timers/Exhaust Fan:	18.00	Hrs/Day	New Annual kWh For All Fans:	833	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	5	
			No. of Urinals In Building	2	
Total Exhuast CFM From All Fans	90	CFM	Total CFM for All Restroom Exhaust	350	CFM
Annual Heating Energy Savings	0	kbtu	Annual Heating Energy Savings	3,024	kbtu
Annual Cooling Energy Savings	0	kbtu	Annual Cooling Energy Savings	1,512	kbtu

Energy & Cost Savings

Estimated Annual Heating Plant Efficiency	75.00	%	Estimated Annual Cooling Plant Efficiency	7.00	EER
Annual Heating Energy Savings	40	Therms	Annual Cooling Energy Savings	216	kWh
Annual Electric Fan Motor Savings	93	kWh			

COST ANALYSIS

Electric Rate:	$0.17	$/kWh	Total Annual Electric Savings	309	kWh
Material Cost For Timers:	$169	$	Total Annual Non Electric Savings	40	Therms
Total Cost for Installing Timers	$354	$	Annual Cost savings:	$107	$
Simple Payback:	3.32	Yrs			

Type of Recommendation No/Low 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:	$169	Simple Payback:	3.32	Years
Energy Cost Savings	$107			

UIC	Replace Rooftop Package Unit
EAH12-B	Location: Administration, Cafeteria, Kitchen (001) - Rooftop

Estimated Annual Cooling Hours:	200	Hrs	Estimated Annual Heating Hours:	100	Hrs
Units to Replace	Air Conditioning: Yes	Heating System: Yes	Existing Type of Heating Fuel:	Natural Gas	

Existing Package System

	Cooling	Heating	Total Combined Units
Number of Package Units to be Replaced:	1	1	1

Capacity of the air conditioner:	13	Tons	EER of the Existing Air Conditioner:	7.75	
Capacity of Existing Heating System:	224	MBH	Input Existing AFUE for the Furnace:	79%	
Estimated Annual Cooling Consumption: *(For All Units)*	3,871	kWh	Estimated Annual Heating Consumption : *(For All Units)*	284	Therms

Proposed Package System

Capacity of the Proposed Air Conditioner:	13	Tons	EER of the Proposed Air Conditioner:	9.50	EER
Capacity of Proposed Heating System:	Gas Fired -200MBH	MBH	AFUE of Proposed Heating System:	90%	%
Estimated Annual Energy Consumption With New Package Units Annual Electric Fuel Consumption:	3,158	kWh	Annual Heating Fuel Consumption:	222	Therms

Energy and Cost Analysis

Average Electric Rate:	$0.17	$/kWh	Average Heating Rate:	$1.35	$/Therm
Estimated Annual Electric Savings : *From All New Package Systems*	713	kWh	Estimated Annual Heating Savings : *From All New Package Systems*	6,132	kBtus
Annual Electric Cost Savings: *From All New Package Systems*	$120		Annual Electric Cost Savings: *From All New Package Systems*	$83	$

Proposed Type of System to be installed:	Cooling Only		
Estimated Material and Labor Cost Including Overheads and Profits For All Units:		$12,475.00	$
Estimated Total Energy Cost Savings From New HVAC System:		$203	$
Estimated O&M Savings:		$10	
Estimated Simple Pay Back Period:	58.5142347 Yrs		

Capital Cost ECM Recommendation

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	27	615	1,754	45,411	$7,638.18	$2,127.82

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	0	0	0	0	$0	$0
Circiline	T9	0	0	0	0	$0	$0
Incan/H/MR	H	0	0	0	0	$0	$0
Incan/H/MR	Incan	0	0	0	0	$0	$0
Incan/H/MR	MR	0	0	0	0	$0	$0
HID	HPS	0	0	0	0	$0	$0
HID	MH	1	19	19	8,044	$1,353	$352
HID	MV	0	0	0	0	$0	$0
HID	QL	0	0	0	0	$0	$0
Linear Fluorescent	T8	26	596	596	37,367	$6,285	$1,775
Linear Fluorescent	T12	0	0	0	0	$0	$0
Linear Fluorescent	T8 U	0	0	0	0	$0	$0
Linear Fluorescent	T12 U	0	0	0	0	$0	$0
Linear Fluorescent	T5	0	0	0	0	$0	$0
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	0	Ceiling Mounted	78
Wall Mounted	22		

Initial Investment			**Equipment Rentals**	
Material Cost	$19,212.00		Scissor Lift 26' - Interior Spaces	$0.00
Labor Cost	$38,323.79		Bucket Truck - Exterior Spaces	$1,950.00
Local Electric Rate:	$0.17	$/kWh	Estimated Annual Energy Savings:	45,411
Hourly Labor Rate For Electrician:	$82.45		Estimated Annual Energy Cost Savings:	$7,638
Budgeted Initial Investment:	$59,486		Estimated Annual O&M Cost Savings:	$2,128
Estimated Return on Investment: *(Including O&M Savings)*	6.09	Years	Estimated Annual Cost Savings:	$9,766

APPENDIX F:
Solar PV

UIC	Install Fixed Tilt Solar Photovoltaic System
EAR-2	Details: James Marshall Elementary

Select State: Northern California **Electric Rate:** $0.18 $/KWH Annual Electric Consumption: 264,344 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	47.80	48	152	72,226	72,226	$12,640	$167,300	13.2	$0	$50,190	$1,589	$0	8.0
2	Building 2	1	99	99	314	149,287	149,287	$26,125	$345,800	13.2	$0	$103,740	$3,284	$0	8.0
3	Building 3	1	26	26	83	39,437	39,437	$6,901	$91,350	13.2	$0	$27,405	$868	$0	8.0
		3		**173**	**548**	**260,950.0**	**260,950**	**$45,666**	**$604,450**	**13.24**	**$0**	**$181,335**	**$5,741**	**$0**	**8.01**

Solar Rooftop Photovoltaic Analysis		
Total Number of Roofs	3	
Estimated Number of Panels	548	
Estimated KW Rating	173	KW
Potential Annual KWh Produced	260,950	KWh
% of Current Electricity Load	98.7%	

Financial Analysis		
Investment Cost	$604,450	
Estimated Energy Cost Savings	$45,666	
Potential Rebates	$181,335	
Potential Annual Incentives	$5,741	
Payback without Incentives	13.2	years
Incentive Payback but without SRECS	8.0	years
Payback with All Incentives	8.0	years