ENERGY AUDIT
REPORT

Town of Needham
Department of Public Facilities
1471 Highland Avenue
Needham, Massachusetts 02492
Kate Fitzpatrick

ENERGY AUDIT REPORT

of

BROADMEADOW ELEMENTARY SCHOOL

120 Broad Meadow Road
Needham, Massachusetts 02492

PREPARED BY:

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EMG Project #: 98515.11R-001.268
Date of Report: February 12, 2012
On site Date: August 18 and 19, 2011

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1. CERTIFICATION

EMG has completed an Energy Audit of Broadmeadow Elementary School located at 120 Broad Meadow Road in Needham, Massachusetts. EMG visited the site on August 18 and 19, 2011.

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 is exclusively for the use and benefit of the Client identified on the first 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 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.

Estimated installation costs are based on EMG's experience on similar projects and industry standard cost estimating tools including *RS Means*. In developing the installed costs, EMG also considered the area correction factors for labor rates for Needham, MA. 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 Kalyana Vadala at 800.733.0660, ext. 6236.

Prepared by: Luke Jacques
Energy Auditor
Project Manager

Reviewed by: Kalyana Vadala
Program Manager

2. EXECUTIVE SUMMARY

The purpose of this Energy Audit is to provide the Town of Needham and Broadmeadow 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.

The school property has one, 2-story building containing 78,592 square feet consisting of offices, classrooms, auditorium, cafeteria, gym, mechanical and storage rooms. The site area is approximately 7 acres. Construction of the property was completed in 2001.

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

Broadmeadow Elementary School currently has a central BMS system controlling the HVAC systems at the school.

Summary of Existing Energy Performance

Building's Annual Energy Consumption	6,269,345 kBtu
Total Annual Energy Costs	$203,629

EMG has identified 11 Energy Conservation Measures (ECMs) for this property. The savings for each measure are calculated using standard engineering methods followed in the industry, and detailed calculations for ECM are provided in Appendix G 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 Energy Conservation Measures

Item	Estimate
Total Projected Initial ECM Investment	$74,035 *(In Current Dollars)*
Estimated Annual Cost Savings Related to ECMs	$28,495 *(In Current Dollars)*
Net Effective ECM Payback	2.60 years
Estimated Annual Energy Savings	14%
Estimated Annual Cost Savings	14%

List of Recommended Energy Conservation Measures For Broadmeadow School								
ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Estimated Annual Water Savings	Total Energy Savings	Total Estimated Annual Cost Savings	Simple Payback
			Natural Gas	Electricity				
		$	Therms	kWh	kgal	MMBtu	$	Years
No/Low Cost Recommendations								
1	Lower Domestic Hot water Temperature Set-Points Details: Reduce Water Temp. for Building From 132 Deg. F to 120 Deg. F	$0	1,075	0	0	107	$1,162	0.00
2	Replace High Flow Faucet Aerators To Low Flow Faucet Aerators Details: Replace 2.2 GPM Aerators w/ 1 GPM Aerators in All Bathroom Sinks	$111	37	0	3	4	$66	1.67
3	Install Automatic Lighting Controls Details: Use Photo sensors in 2 Main Stairwells	$126	0	5,805	0	20	$1,163	0.11
4	Convert Gas Pilot Stoves To Electronic Ignition Stoves Details: Add to Kitchen Stove and Oven Unit	$158	34	0	0	3	$37	4.30
5	Install Energy Savers on Vending, Snack Machines Details: Soda Machine in Faculty Lounge	$200	0	1,610	0	5	$323	0.62
6	Reduce Light Levels By Delamping of Lamps Details: Remove excess lamps above perimeter bulkhead in Main Room in the Library	$205	0	7,363	0	25	$1,475	0.14
7	Install Timers On Rooftop Exhaust Fans Details: Restroom Exhaust Fans	$379	0	1,547	0	5	$310	1.22
8	Install Outside Air (OA) Temperature Reset Controls for Hot Water Boilers Details: Utilize Outside Air Reset in Central BMS HVAC Control System	$645	3,107	0	0	311	$3,361	0.19
Totals for No/Low Cost Items		**$1,825**	**4,253**	**16,325**	**3**	**481**	**$7,897**	**0.23**

List of Recommended Energy Conservation Measures For Broadmeadow School								
ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Estimated Annual Water Savings	Total Energy Savings	Total Estimated Annual Cost Savings	Simple Payback
			Natural Gas	Electricity				
		$	Therms	kWh	kgal	MMBtu	$	Years
Capital Cost Recommendations								
1	Replace High Intensity Discharge Lamp (HID) with Induction Lighting Details: Outside Pole Lights, Gym Lights, and Auditorium Lights	$9,784	0	20,369	0	69	$4,267	2.29
2	Install Automatic Lighting Controls Details: Install Motion & Occupancy Sensors throughout building	$22,120	0	65,690	0	224	$13,160	1.68
3	Retro-Commission The Building HVAC & Control System Details: Balance Flows and Verify Proper Operation of all Equipment	$30,650	1,554	23,250	0	235	$6,338	4.84
Total For Capital Cost		**$62,554**	**1,554**	**109,309**	**0**	**528**	**$23,764**	**2.63**
	Interactive Savings Discount @ 10%		-581	-12,563		-101	-$3,166	
	Total Contingency Expenses @ 15%	$9,657						
Total for Improvements		**$74,035**	**5,226**	**113,071**	**3**	**908**	**$28,495**	**2.60**

Apart from the above recommended measures, EMG has analyzed the following three measures for consideration and long term capital planning. These measures are not recommended at the current time due to high initial investment and long payback yielding negative life cycle savings, but recommend for at time of equipment replacement.

Detailed List of Measures Evaluated For Consideration For Broadmeadow School

ECM #	Description of ECM	Initial Investment	Annual Energy Savings		Annual Water Savings	Total Energy Savings	Total Estimated Annual Cost Savings	Payback
		$	Therms	kWh	kgal	MMBtu	$	Years
1	Install Variable Frequency Drives (VFD) Details: on (2) 10 Hp Boiler Hot Water Recirculation Pumps	$10,469	0	18,124	0	62	$3,631	2.88
2	Improve Insulation Levels in Attic Details: Add Insulation to Ceiling of Auditorium, Cafeteria, and Gym	$38,000	554	884	0	58	$785	48.43
3	Replace Inefficient Heating Plant Details: Add one 3,200 MBH/97% Eff. High Efficiency Condensing Boiler as Primary Boiler at time of replacement	$86,800	2777	0	0	278	$3,153	27.53
4	Replace Existing RTUs with High Efficiency Units with Variable Speed Oil Free Compressors Details: Install High Efficiency units at time of replacement	$440,000	0	98000	0	334	$20,221	$22
Total for Improvements		**$575,269**	**3331**	**117008**	**0**	**732**	**$27,790**	**20.70**

3. BENCHMARKING/ENERGY PERFORMANCE SUMMARY

3.1. ENERGY STAR PORTFOLIO MANAGER FACILITY SUMMARY

EMG uses the Portfolio Manager tool developed by the Federal Environmental Protection Agency to track relative energy uses of buildings by property type. This tool allows the input of a facility's historic utility data to be compared with normalized data of a large database of its peer facilities.

Facility
Needham: Broadmeadow School
120 Broadmeadow Road
Needham, MA 02492

Facility Owner
N/A

Primary Contact for this Facility
Bill Champion
222 Schilling Circle Suite 275
Hunt Valley, MD 21031

General Information

Needham: Broadmeadow School	
Gross Floor Area Excluding Parking: (ft²)	78,592
Year Built	2001
For 12-month Evaluation Period Ending Date:	June 30, 2011

Facility Space Use Summary

School	
Space Type	K-12 School
Gross Floor Area(ft2)	78,592
Open Weekends?	No
Number of PCs[d]	138
Number of walk-in refrigeration/freezer units	2
Presence of cooking facilities[d]	Yes
Percent Cooled	80
Percent Heated[d]	100
Months[e]	N/A
High School?[d]	No
School District[e]	N/A

Energy Performance Comparison

	Evaluation Periods		Comparisons		
Performance Metrics	Current (Ending Date 06/30/2011)	Baseline (Ending Date 06/30/2011)	Rating of 75	Target	National Median
Energy Performance Rating	38	38	75	N/A	50
Energy Intensity					
Site (kBtu/ft²)	80	80	57	N/A	73
Source (kBtu/ft2)	167	167	118	N/A	151
Energy Cost					
$/year	$ 200,044.70	$ 200,044.70	$ 140,988.62	N/A	$ 180,301.32
$/ft²/year	$ 2.55	$ 2.55	$ 1.80	N/A	$ 2.30
Greenhouse Gas Emissions					
$MtCO_2e$/year	500	500	352	N/A	451
$kgCO_2e/ft^2$/year	6	6	4	N/A	5

3.2. EPA ENERGY STAR RATING

The national energy performance rating is a type of external benchmark that helps energy managers to assess how efficiently their buildings use energy, relative to similar buildings nationwide. The rating system's 1-100 scale allows everyone to understand quickly how a building is performing. For example, a rating of 50 indicates an average energy performance, while a rating of 75 or better indicates top performance. The higher the rating, the better the building is performing. Organizations can evaluate energy performance among the buildings in their portfolio, while also comparing their performance with other similar buildings nationwide. Additionally, building owners and managers can use the performance ratings to help identify buildings that offer the best opportunity for energy improvement and recognition.

To receive the energy performance rating, facility-related data entered into the Portfolio Manager, must adhere to a series of operating and energy use conditions. If one or more of these conditions are not met, the facility will receive "N/A" (Not Available) as a rating. "NA" means that the Portfolio Manager is unable to calculate a rating for that particular period ending date, given the operating and energy use conditions provided.

A building must obtain a rating of 75 or better to be eligible to apply for the Energy Star Certification. However, a rating of 75 does not necessarily mean that a building will qualify.

3.3. SOURCE ENERGY AND SITE ENERGY

Buildings use a variety of forms of energy, including electricity, natural gas, fuel oil, and district steam. In order to provide an un-biased rating, the methodology must add together all of the energy used in a building. To combine energy in an equitable way, the ratings use source energy. Source energy is the energy that is consumed at the site, in addition to the energy used in generation and transmission.

The purpose of the conversion from site energy to source energy is to provide an equitable assessment of building-level energy efficiency. Because billed site energy use includes a combination of primary and secondary forms of energy, a comparison using site energy does not provide an equivalent thermodynamic assessment for buildings with different fuel mixes. In contrast, source energy incorporates all transmission, delivery, and production losses, which accounts for all primary fuel consumption and enables a complete assessment of energy efficiency in a building. When source energy is used to evaluate energy performance, an individual building's performance does not receive either a credit or a penalty for using any particular fuel type.

4. INTRODUCTION

The purpose of this Energy Audit is to provide Broadmeadow Elementary School 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 on site visual assessment to determine current conditions, itemize the energy consuming equipment (i.e. Boilers, roof-top-cooling units (RTU), DHW 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, classrooms, 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. Where we anticipated significant losses, we utilized infrared thermographs to analyze heat loss across the envelope.

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 and a minimum of one year of utility billing history, 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 payback based on current utility rates and expected annual savings.

5. FACILITY OVERVIEW AND EXISTING CONDITIONS

5.1. BUILDING OCCUPANCY

Typically, 650 students & 90 staff occupy the facility during normal operating hours. After hours occupants include approximately 30 people. School is generally occupied 100% in winter and 30% in summer. The Gym is open until 10PM everyday M-F during winter.

Summary of Facility Operating Hours

	Hours Open to the Public	Hours Open to Employees
Monday-Friday (Winter)	8 AM-5 PM	6 AM-10 PM
Saturday/Sunday (Gym only in winter)	8 AM-6 PM	
Summer (Gym only)	6 AM-8 AM everyday	

5.2. BUILDING ENVELOPE

The building envelope consists of the exterior shell, made up of the walls, windows, roof, and floor. The envelope provides building integrity and separates the exterior from the interior conditioned space.

Based on actual facility architectural drawings provided, the foundations consist of cast-in-place concrete perimeter wall footings with CMU foundation walls. The foundation systems include reinforced concrete column pads. The building has load-bearing, concrete masonry unit walls and interior steel columns. The upper floors and roofs are constructed with steel reinforced concrete with metal decking. The building structure appears to be in good condition.

The School has a 4 Ply Built-Up Pitched Roofing System with flood coat and aggregate surfacing. The built-up roof is over 2 ½″ of polyisocyanurate insulation board. The roofs are in fair condition.

The exterior walls are concrete masonry units with 2 inches of rigid insulation in the air gap between the block interior and brick veneer exterior. The entry doors are commercial double pane steel doors in steel frames. All of the doors appear to be in good operating order although the door threshold seals on some of the exit doors (North End) have deteriorated weather seals indicating air leakage.

The following table describes the observed or reported insulation levels at the property:

Item	Construction Type
Foundation	Continuous Reinforced Concrete Slab
Structure	Block with Steel Substructure and Concrete Decks
Exterior Walls	Brick/tile veneer/6" fiberglass batt on metal studs/5/8th in. gyp board
Roof	4 Ply Built-Up Pitched Built-Up-Roofing System with flood coat and aggregate surfacing

The following table describes the insulation levels of different surfaces at the property based on provided facility drawings:

Building Element	Estimated Insulation
Roof	R – 20
Floors	R – 30
Walls Above Grade	R – 19.3

5.3. BUILDING HEATING, VENTILATION AND AIR-CONDITIONING (HVAC)

Heating is provided by two Weil-McLain "Series 88" cast iron sectional gas-fired hot water boilers operating in the lead-lag mode. The boilers were installed in 2001 during the original construction of the building and are in good condition. These are standard efficiency units with manufacturer rated values of 85.6% thermal efficiency and 72.2% IBR efficiency. The boilers are operational during the winter months and are turned off in summer. Based on facility natural gas profile, the boilers are operational from October through May. Hot water is circulated throughout the building by two 10 HP recirculation pumps. The hot water from the boilers is supplied to the baseboard hydronic heating system located along the exterior walls and the reheat coils in the VAV boxes located throughout the building. Currently the pumps do not have Variable Frequency Drive (VFD) controllers and run at constant speed all the time with the flow regulated by 3-Way valves in the hydronic coils in VAV boxes and perimeter radiators. The boilers have a water treatment system to maintain the water at its optimal pH level and prevent premature wear on pipes and boilers. The overall condition and maintenance of boiler/burner, pumps and piping is good. Opportunities exist to add one 3200 MBH condensing natural gas-fired boiler and operate it as primary boiler to carry the school majority of the season and use the existing boiler system as pure back-up as peak support system during extreme days.

The building is pre-heated and cooled by five McQuay Roof Top Packaged Units ranging in size from 40 to 90 tons. The roof top units are equipped with natural gas furnaces, DX coils, and several with CO_2 sensors. The CO_2 sensors regulate the amount of outside air introduced into the spaces based on occupancy. Most units are also equipped with VFD's on the supply and return fans. Though the overall condition of the roof top units is good, these units currently have only five (5) years of remaining useful life per ASHRAE Expected useful Life (EUL) chart. So retrofits on these units is not cost feasible at this time. But EMG recommends during the replacement that these units be replaced with high efficiency variable speed magnetic compressor driven units with COP of 12 or higher. The data/server rooms are cooled by two 3 ½ ton mini-split system air-conditioning units ranging in size from 1 to 3 tons.

Air is circulated throughout the building via air ducts supplied by the McQuay roof top units. The temperature in the classrooms and offices is controlled by perimeter hydronic radiators and VAV boxes w/reheat coils in the ceilings controlled by individual thermostats that are tied into an off site central Building Automation System, Invensys Network 8000 DDC control system.

Currently the buildings occupied/un-occupied set points for cooling are 75°F/85°F and for heating are 68°F/58°F. The control system appears to be properly commissioned and well maintained.

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

Item	Measured Values
Major Heating system type/capacity	2 Boilers for Hydronic heating (3,270 MBH ea.) and 5 gas-fired furnaces on RTU's for forced hot air (1000-1750 MBH)
Major Cooling System type/capacity	5 RTU's with DX Coils (40-90 Ton)
Heating hot water supply temperature	140°F before mixing valve, 132°F after mixing valve
Outside Air temperature & Relative Humidity (%) at time of audit	85°F, 36% RH
Interior space temperatures & Relative Humidity (RH%)	75°F,36% RH
Supply Air Temperature (SAT)/Return Air Temperature (RAT)	Supply Air Temperature: 66°F Return Air Temperature: 75°F
Avg. Supply Air rate (CFM/Sq.ft)	0.78 CFM/Sq. ft
Avg. Interior space thermostat set-point	75°F
Avg. Outside Air rate (% & CFM/Sq.ft or CFM/person)	0% Outside Air, Dampers Closed at time of audit

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

5.4. Building Lighting

Interior lighting in the classrooms, offices, cafeteria, library, bathrooms, hallways, storage, and utility rooms are primarily lit by 2 bulb, 32 watt, T8 fluorescent light fixtures with electronic ballasts. Areas throughout the school are also lit with 3 bulb, 32 watt, T8 fluorescent light fixtures, 2 bulb 26 watt 4-pin quad-tube recessed light fixtures, and 2 bulb indirect lights with 40 watt compact fluorescent tubes.

The gym uses 400 watt metal halide light fixtures. It is being recommended to convert the 400 watt metal halide to 200 watt induction bulbs. The auditorium uses a combination of 100w metal halide and 90 watt halogen light fixtures for the overhead lighting. It is being recommended to convert the 100 watt metal halide to 35 watt LED fixtures, and convert the 90 watt halogen bulbs to 26 watt fluorescent flood lights.

The lighting in the building is controlled predominantly by two-way manual switches. The office in the health suite is the only room in the whole school that is equipped with a motion sensor to control the lighting. New style passive infrared motion sensors not only detect motion but also body heat. EMG recommends installing dual technology wall-mounted motion sensors in all rooms including storage rooms, electrical panel rooms, and bathrooms and ceiling-mounted occupancy sensors for all offices and classrooms.

Site lighting is provided by property-owned 200 & 400 watt metal halide light poles and 2 bulb 26 watt CFL wall pack light fixtures. It is being recommended to convert the 200 watt and 100 watt metal halide to 100 watt and 50 watt induction bulbs respectively. Exterior lighting remains on from 4:00 PM through 11:00 PM and 6:00 AM through 7:30 AM.

Space type	Measured Light Levels (Lux/foot candles)	ASHRAE/IESNA Recommended Levels (foot candles)
Classroom	420 Lux/39 FC	30
Office	550 Lux/51 FC	50
Auditorium	290 Lux/27 FC	10
Gym	610 Lux/57 FC	60
Restroom	600 Lux/56 FC	10
Avg. Building Lighting Density, W/Sq.Ft	1.92 W/Sq.Ft	1.2 W/Sq.Ft

Note: 1 foot candle = 10.764 lux

The Lighting Systems Schedules in Appendix F contain a summary of the Existing Lighting Systems at the property, along with proposed Lighting Energy Conservation Measures.

5.5. Building Elevators and Conveying Systems

There is one hydraulic service elevator. The elevator has a rated capacity of 3,500 pounds. The elevator machinery is located in a room adjacent to the shaft on the ground floor. The elevator is powered by a 25 HP submersible hydraulic pump.

5.6. BUILDING DOMESTIC HOT WATER

The water meter is located in the boiler room.

One 400-gallon gas-fired water heater supplies domestic hot water to the building. The water heater is located in the boiler room. The 140 Deg F water from the hot water heater passes through a mixing valve assembly to provide 132 Deg F water to the bathrooms and sinks in the school. The hot water is circulated through the building with 3 1/8 hp pipe mounted circulation pumps. It is being recommended to turn the temperature of the water at the mixing valve back to 120 Deg F. Also in summer months when school is rarely occupied, it may also be considered to completely turn off the water heater or drop the set point further to 100 Deg F or lower. This will save both natural gas consumption to heat water as well as pumping energy costs.

The common area restrooms have commercial-grade fixtures and accessories, including water closets and lavatories. The toilets consist of 1.6 GPF flush valves. The flush volume of the urinals is 3.5 GPF. The lavatories are equipped with aerators rated at 2.2 GPM. The lavatories are operated by automatic controls.

DHW type	Natural Gas
Storage Tank Capacity	400-gallon
Heating/tank set-point	140 Deg F
DHW temperature at faucet	132 Deg F
Building faucets, GPM	2.2 GPM
Water closets/toilets, GPF	1.6 GPF

5.7. BUILDING NATURAL GAS AND ELECTRICITY

The building is connected to the natural gas utility (Nstar). The gas main on the adjacent public street supplies the natural gas service. The gas meter and regulators are located in a vault in front of the building. The gas distribution piping within the building is malleable steel (black iron). The facility is master-metered for natural gas.

The electrical supply lines run underground pad-mounted transformer to an interior-mounted electrical meter. The main electrical service size is 2,000 amps, 480/277-volt, three-phase, four-wire alternating current (AC). A step-down transformer is located in the main electrical room. The electrical wiring is copper, installed in metallic conduit. Circuit breaker panels are located throughout the building. The facility is master-metered for electricity.

A natural gas-engine-driven 750 kVA emergency electrical generator is located in a room inside of the boiler room. The generator provides back-up power for elements of the fire and life safety systems. The generator is powered by natural gas.

Electrical Transformer Type (Wye, Delta)	Delta
Mounting	Pad-mounted
Location	Front of School by Parking Lot
Main Building Electric service	Receptacles, Emergency Systems and Lights
Primary Volts	480 V
Secondary Volts	277 V
Phase	3
Wire	4
Amp	Unknown
On site Generator (Y/N)	Y
Generator Capacity, KVA	750
Generator Fuel Type	Natural Gas

Electric Meter type (Master/Sub/Direct)	Master	Natural Gas Meter type (Master/Sub/Direct)	Master
Meter Location	Electric Room	Meter Location	Street Vault
Main meter number	08503030	Main meter number	Unknown

6. 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-users 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 Broadmeadow Elementary School, 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
$0.20/kWh	$1.08 /therm	$9.00 /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.

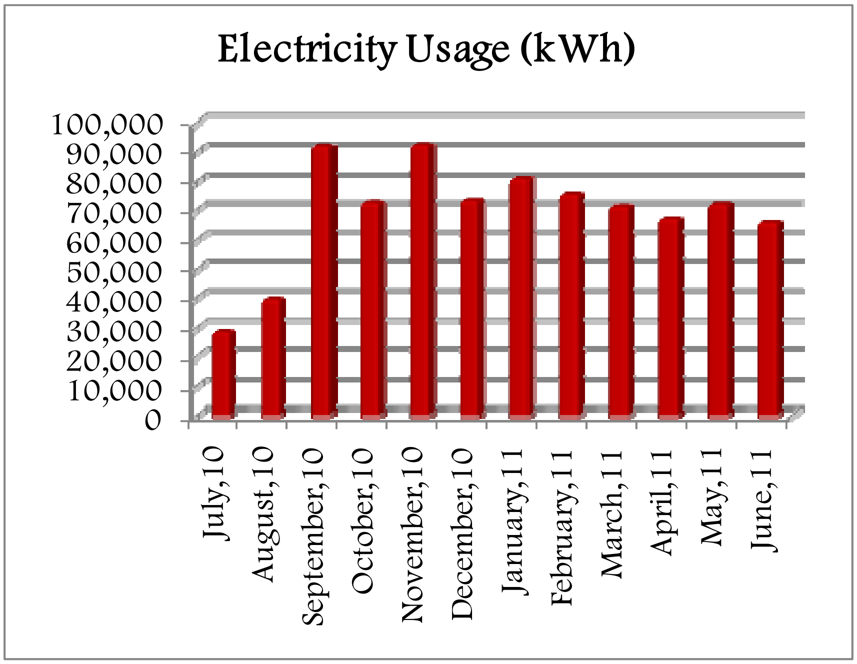
6.1. ELECTRICITY

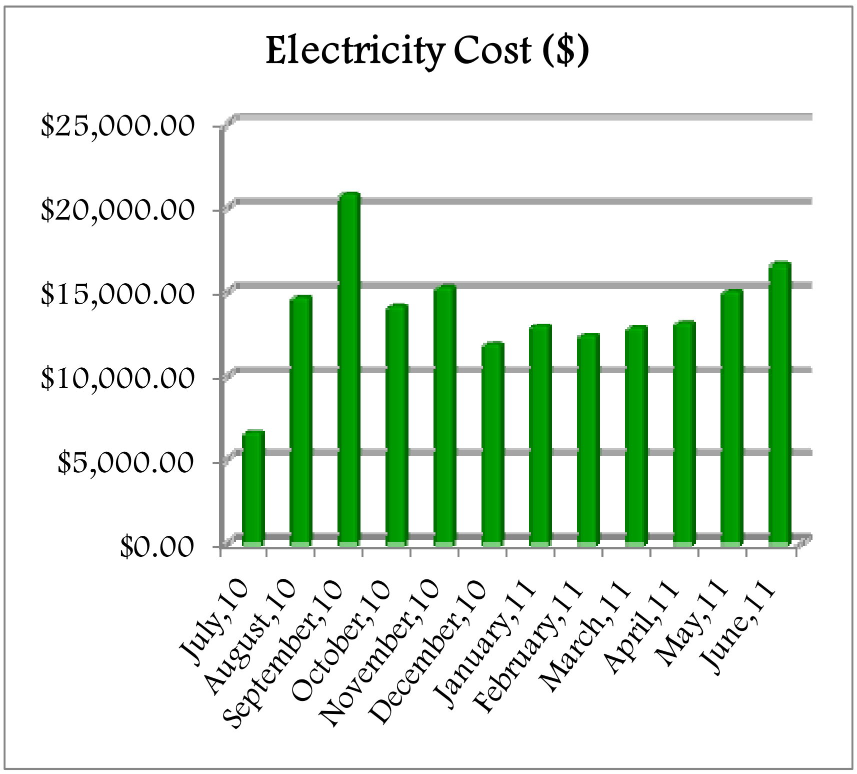
Nstar satisfies the electricity requirements of the facility. The rise in the electricity usage during the summer months is due to the use of electric driven air-conditioning equipment. The lighting is a large component of the electrical base-load because of both the number and inefficiency of fixtures and bulbs. The kitchen appliances, computers, and copying machines also add significant amounts to the base-load.

Based on the 2010-11 electric usage & costs, the average price paid during the year was $0.20 per kWh. The total annual electricity consumption for the 12-month period analyzed is 831,080 for a total cost of $166,491.

Electricity Consumption and Cost Data

Start Date	Electricity Consumption (kWh)	Unit Cost/kWh	Total Cost
July,10	28,580	$0.23	$6,636.00
August,10	39,480	$0.37	$14,648.00
September,10	91,880	$0.23	$20,820.00
October,10	72,500	$0.19	$14,101.00
November,10	92,280	$0.17	$15,274.00
December,10	73,240	$0.16	$11,870.00
January,11	81,000	$0.16	$13,018.00
February,11	75,460	$0.16	$12,431.00
March,11	71,140	$0.18	$12,876.00
April,11	67,400	$0.20	$13,184.00
May,11	71,940	$0.21	$15,017.00
June,11	66,180	$0.25	$16,616.00
Total	**831,080**	**$0.20**	**$166,491.00**


Electricity Usage (kWh)
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
July,10
August,10
September,10
October,10
November,10
December,10
January,11
February,11
March,11
April,11
May,11
June,11


Electricity Cost ($)
$25,000.00
$20,000.00
$15,000.00
$10,000.00
$5,000.00
$0.00
July,10
August,10
September,10
October,10
November,10
December,10
January,11
February,11
March,11
April,11
May,11
June,11

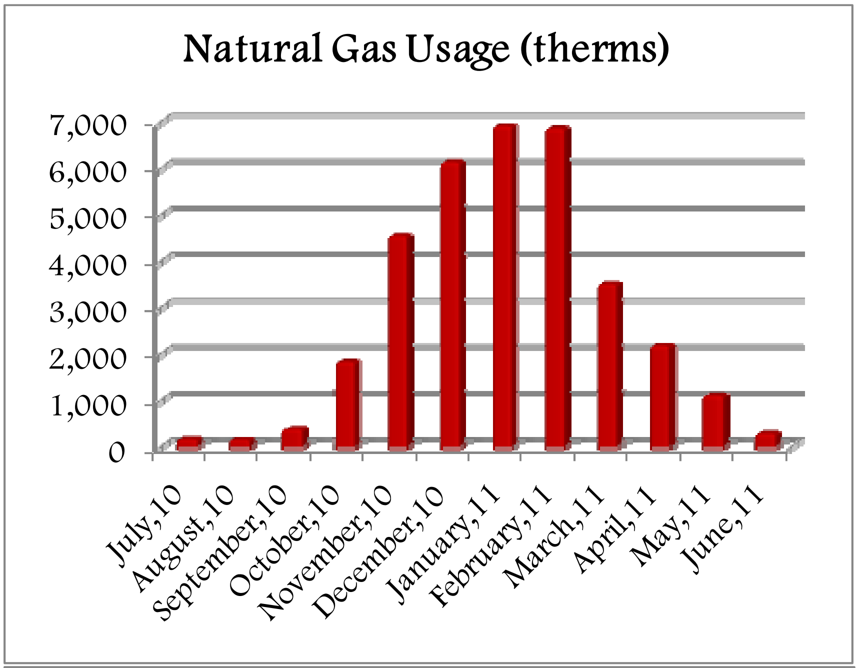
6.2. NATURAL GAS

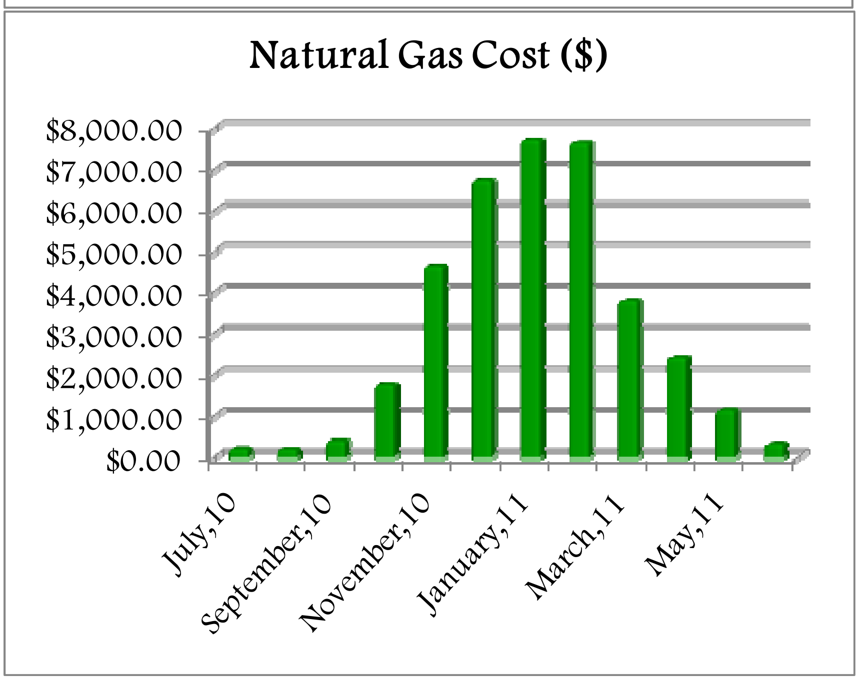
The natural gas requirements of the facility are satisfied by Nstar. The rise in the natural gas usage during the winter months is due to the use of natural gas driven heating equipment. The base-load for the building consists of the domestic hot potable water boiler along with some of the kitchen appliances.

Based on the 2010-11 natural gas usage & costs, the average price paid during the year was $1.07 per therm. The total annual natural gas consumption for the 12-month period analyzed is 34,840 for a total cost of $37,137.

Natural Gas Consumption and Cost Data

Start Date	Natural gas Consumption (Therms)	Unit Cost/therm	Total Cost
July,10	185	$1.16	$219.00
August,10	176	$1.16	$209.00
September,10	417	$0.97	$412.00
October,10	1,840	$0.93	$1,758.00
November,10	4,587	$1.00	$4,653.70
December,10	6,155	$1.08	$6,739.00
January,11	6,926	$1.10	$7,721.00
February,11	6,872	$1.10	$7,648.00
March,11	3,546	$1.07	$3,836.00
April,11	2,200	$1.09	$2,440.00
May,11	1,122	$1.02	$1,160.00
June,11	311	$1.08	$342.00
Total	**34,337**	$1.08	**$37,137.70**


Natural Gas Usage (therms)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
July,10
August,10
September,10
October,10
November,10
December,10
January,11
February,11
March,11
April,11
May,11
June,11

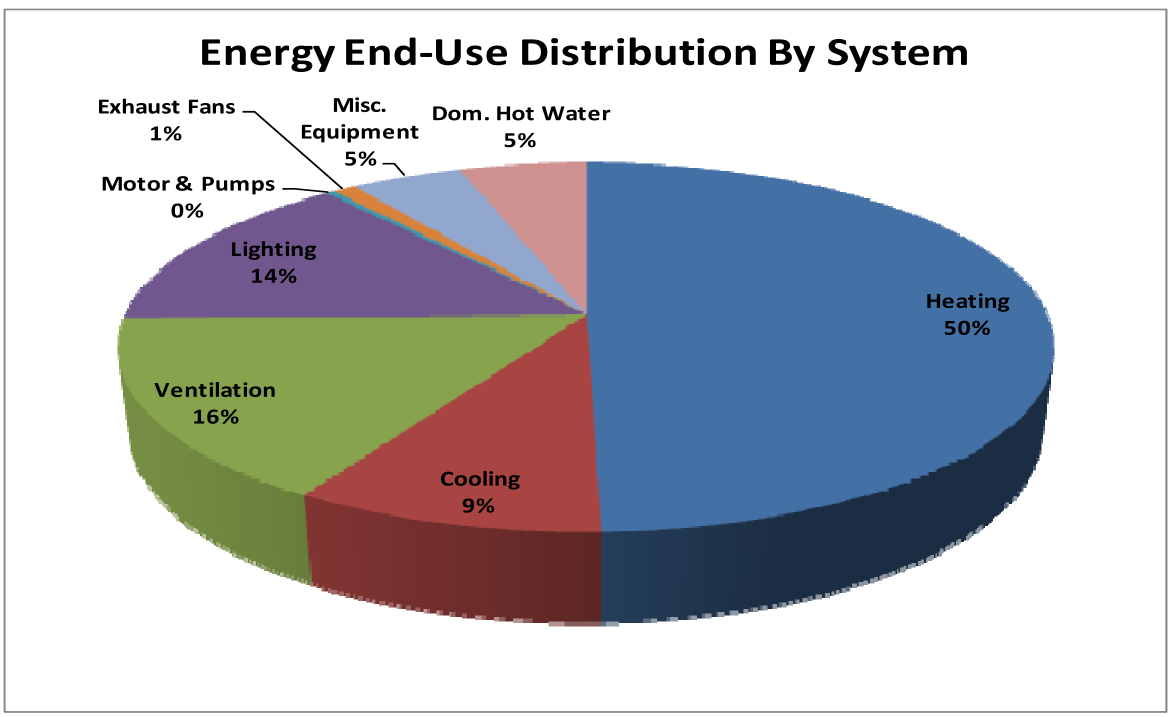

Natural Gas Cost ($)
$8,000.00
$7,000.00
$6,000.00
$5,000.00
$4,000.00
$3,000.00
$2,000.00
$1,000.00
$0.00
July,10
September,10
November,10
January,11
March,11
May,11

7. ENERGY END USE DISTRIBUTION

Following table shows the annual end-use energy distribution by component for FY 2011 (base year) for Broadmeadow School.

	kWh	Therms	kBtu	% of Total
Heating		31,072	3,107,200	50%
Cooling	168,000		573,216	9%
Ventilation	292,395		997,651	16%
Lighting	263,325		898,465	14%
Motor & Pumps	6,266		21,381	0.3%
Exhaust Fans	17,378		59,294	1%
Misc. Equipment	83,716		285,639	5%
Dom. Hot Water		3,265	326,500	5%
Total	**831,080**	**34,337**	**6,269,345**	**100%**

note: FY 2011 (July 2010 – June 2011) is used as baseline year for analysis



8. ENERGY CONSERVATION MEASURES (ECM)

EMG has identified a total of 15 Energy Conservation Measures (ECMs) for this property. All the ECMs are broken into two major categories:

1. **No/Low Cost Recommendations**: No/Low cost is defined as any project with initial investment of less than $1,000
2. **Capital Cost Recommendations**: Capital cost defined as any project with initial investment greater than $ 1,000

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.

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

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 thousand 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 thousand 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)	80	kBtu/ft2
Post ECM Site Energy Use Intensity (EUI)	68	kBtu/ft2
Source Energy Use Intensity (EUI)	Rating	
Current Source Energy Use Intensity (EUI)	166	kBtu/ft2
Post ECM Source Energy Use Intensity (EUI)	143	kBtu/ft2
Building Cost Intensity (BCI)	Rating	
Current Building Cost Intensity	2.59	/ft2
Post ECM Building Cost Intensity	2.23	/ft2

Summary of the Greenhouse Gas Reductions from Recommended 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	Rating	
Estimated kWh Reduction	113,071	kWh
Estimated Annual Thermal Energy Reduction	5,226	Therms
Total CO_2 Emissions Reduced	48	$MtCO_2/yr$
Total Cars Off The Road (Equivalent)*	9	
Total Acres of Pine Trees Planted (Equivalent)*	11	

*Equivalent reductions per DOE emissions calculation algorithms.

The following table describes each recommended ECM in terms of initial investment, electricity and natural gas savings, water savings, annual energy cost and maintenance savings, payback and SIR

List of Recommended Energy Conservation Measures For Broadmeadow School

ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Estimated Annual Water Savings	Total Energy 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	MMBtu	$	$	$	Years		$	Years
No/Low Cost Recommendations													
1	Lower Domestic Hot water Temperature Set-Points Details: Reduce Water Temp. for Building From 132 Deg. F to 120 Deg. F	$0	1,075	0	0	107	$1,162	$0	$1,162	0.00	0.00	$17,292	20.00
2	Replace High Flow Faucet Aerators To Low Flow Faucet Aerators Details: Replace 2.2 GPM Aerators w/ 1 GPM Aerators in All Bathroom Sinks	$111	37	0	3	4	$66	$0	$66	1.67	5.12	$456	10.00
3	Install Automatic Lighting Controls Details: Use Photo sensors in 2 Main Stairwells	$126	0	5,805	0	20	$1,163	$0	$1,163	0.11	91.58	$11,449	12.00
4	Convert Gas Pilot Stoves To Electronic Ignition Stoves Details: Add to Kitchen Stove and Oven Unit	$158	34	0	0	3	$37	$0	$37	4.30	2.78	$281	15.00
5	Install Energy Savers on Vending, Snack Machines Details: Soda Machine in Faculty Lounge	$200	0	1,610	0	5	$323	$0	$323	0.62	19.25	$3,650	15.00
6	Reduce Light Levels By Delamping of Lamps Details: Remove excess lamps above perimeter bulkhead in Main Room in the Library	$205	0	7,363	0	25	$1,475	$0	$1,475	0.14	106.84	$21,739	20.00
7	Install Timers On Rooftop Exhaust Fans Details: Restroom Exhaust Fans	$379	0	1,547	0	5	$310	$0	$310	1.22	9.76	$3,321	15.00
8	Install Outside Air (OA) Temperature Reset Controls for Hot Water Boilers Details: Utilize Outside Air Reset in Central BMS HVAC Control System	$645	3,107	0	0	311	$3,361	$0	$3,361	0.19	77.47	$49,352	20.00
Totals for No/Low Cost Items		**$1,825**	**4,253**	**16,325**	**3**	**481**	**$7,897**	**$0**	**$7,897**	**0.23**			

List of Recommended Energy Conservation Measures For Broadmeadow School													
ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Estimated Annual Water Savings	Total Energy 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	MMBtu	$	$	$	Years		$	Years
Capital Cost Recommendations													
1	Replace High Intensity Discharge Lamp (HID) with Induction Lighting Details: Outside Pole Lights, Gym Lights, and Auditorium Lights	$9,784	0	20,369	0	69	$4,081	$186	$4,267	2.29	4.98	$38,929	15.00
2	Install Automatic Lighting Controls Details: Install Motion & Occupancy Sensors throughout building	$22,120	0	65,690	0	224	$13,160	$0	$13,160	1.68	5.92	$108,872	12.00
3	Retro-Commission The Building HVAC & Control System Details: Balance Flows and Verify Proper Operation of all Equipment	$30,650	1,554	23,250	0	235	$6,338	$0	$6,338	4.84	2.47	$45,013	15.00
Total For Capital Cost		**$62,554**	**1,554**	**109,309**	**0**	**528**	**$23,578**	**$186**	**$23,764**	**2.63**			
	Interactive Savings Discount @ 10%		-581	-12,563		-101	-$3,147	-$19	-$3,166				
	Total Contingency Expenses @ 15%	$9,657											
Total for Improvements		**$74,035**	**5,226**	**113,071**	**3**	**908**	**$28,327**	**$167**	**$28,495**	**2.60**			

If all of the above mentioned ECM's are implemented, Broadmeadow Elementary School could potentially save approximately $28,495 per year with an investment of $74,035, yielding a net effective payback of 2.60 years.

8.1. ECM CALCULATION ASSUMPTIONS

EMG has made the following assumptions in calculation of the Energy Conservation Measures.

- Building operating hours, as detailed in section 5.1 are assumed to be 60 hours per week.
- Annual Heating, Cooling & ventilation Equipment Operating Hours are derived from actual consumption and equipment input rates
- Typical lighting operating hours are assumed to be 12 per day for school season or 2,160 hours per year.

8.2. NO/LOW COST ECM DESCRIPTIONS

EMG has identified 8 No/Low Cost Energy Conservation Measures (ECMs) for this property. This includes all measures which can be implemented below the cost threshold of $1,000. The following paragraphs describe each of these ECMs along with the initial installed costs, annual energy savings, and payback periods.

8.2.1. Lower Domestic Hot Water Temperature Set Point

Lowering the hot water temperature decreases the amount of energy required to heat the water. In addition, distribution piping losses, which are proportional to the temperature difference between the hot water and its surroundings, will be reduced.

Set the water heater thermostat at the lowest temperature at which hot water will meet the occupants' needs. If the demand for hot water fluctuates and a lowered tank temperature will not meet the peak demand, install a mixing valve rather than lowering the tank temperature. If the entire system is set at a high supply temperature to serve the needs of a piece of equipment, consider reducing the tank temperature and installing a booster heater to serve that specific piece of equipment. Note that water in excess of 138°F can cause skin burns.

In the case of Broadmeadow Elementary School the water temperature in the bathrooms was measured at 132°F. The temperature can be adjusted in the boiler room with the mixing valves on the wall with substantial savings and zero cost. EMG strongly recommends the resetting of the temperature to 120°F to save energy. In addition at an elementary school 132°F water could be a hazard.

8.2.2. Install Timers on Rooftop Exhaust Fans

Ventilation systems bring fresh outdoor air into the building to provide the occupants with oxygen and to dilute internally-generated air pollutants. Reducing the operating times for discrete ventilation exhaust systems saves fan energy. Curtailing ventilation air reduces heating or cooling loads, except under economizer operation. When a building zone is unoccupied, the ventilation system should be turned off, unless it is "flushing" the building in an economizer mode. Coordinate changes to ventilation air supply with changes to exhaust systems to maintain air balance in the space. 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. Kitchen exhaust fans and make-up air units should only operate while cooking is in progress. This can be accomplished with timers and manual overhead switches. Manual timers are applicable to bathroom exhaust fans. Sensors may be used to shut down fans in intermittently occupied rooms. Care should be exercised in controlling the exhaust from fume hoods used to vent toxic gases in laboratories.

The building has 8 rooftop exhaust fans that are estimated to be continuously running for 9.5 hours a day. The normal hours at the school are from 6:00 AM till 4:30 pm (Monday-Friday). EMG recommends installing a mechanical timer on each rooftop restroom exhaust fan such that it is turned off a few minutes after the restroom lights are turned "off" by the motion sensor. Assuming that the exhaust fan run time is reduced to 4 hours a day, annual run time will be reduced to 1,018 hours each year.

8.2.3. Install Low Flow Aerators in Water Faucets

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 3 to 5 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.

In the case of Broadmeadow Elementary School the bathrooms are equipped with 2.2 GPM aerators. EMG strongly recommends the replacement of the aerators with 1 GPM units.

8.2.4. Install Photo Control Sensors in Stairwells

One of the best ways to save energy is to turn off lights that are not needed. This saves energy, as well as extends the replacement time on lamps. (While frequent switching may in some cases shorten lamp life, the savings in electrical power will more than compensate).

The operating time of lighting systems can be reduced either automatically or manually. Automated controls are more reliable for ensuring that energy savings are achieved. Local switches can be labeled to encourage occupants to turn off lights when leaving an area. Individual switches in perimeter offices permit occupants to reduce lighting levels on sunny days. Sophisticated lighting control systems are available, but they are costly to retrofit. They should be considered when the lighting system is being replaced. With the exception of security lights, storeroom lighting can be placed on timed switches that shut off after the selected interval. All exterior lighting, as well as interior lighting in glass-enclosed vestibules, should be placed on photocell and/or timer control.

In the case of Broadmeadow Elementary School the stairwell lights are on during the day when the windows and skylights let in sufficient light to properly illuminate the area for safe travel. EMG strongly recommends the installation of photo control sensors in these areas.

8.2.5. Convert Gas Pilot Stove Top and Over to Electronic Ignition Stove Top and Oven

Having gas pilots continually lit 24/7 can be a substantial waste of energy. This is especially true on large commercial units in schools and restaurants. Using electronic ignition on stoves and ovens instead of gas pilots can completely eliminate this waste. Kits are available for the conversion of old commercial units that are in good condition and likely to have many more years of usage.

In the case of Broadmeadow Elementary School the stove top and oven unit has gas pilots. EMG strongly recommends the conversion to Electronic Ignition in this case.

8.2.6. Install Vending Controls on Soda Machine in Teachers Lounge

Vending machines are usually designed to operate all day round irrespective of the occupancy level in the office. This means that the vending machines operate for more than 12 hours a day when not required in case of commercial establishments.

There are two types of vend misers; one has a timer in it, which is programmed to turn off or tune down the vending machines after the office hours and bring it back up a hour before the office opens. The other is a motion sensor based system that tunes down the machines upon detecting un-occupancy for a pre-programmed duration of time. In the case of vending machines storing chilled products, the vend miser doesn't turn off the machine entirely, but reduces the operating time of the compressor, such that the machine maintains the products at a minimum tolerable temperature.

In the case of Broadmeadow Elementary School there is 1 soda vending located in the teachers lounges, of which all are non-energy star certified. EMG recommends installing vend misers on these vending machines, which shall automatically reduce the running time of these machines during weekends and unoccupied hours.

8.2.7. Remove Linear Fluroscent 32W T8 Lamps Above Perimeter Bulkhead in Library

The lighting in office and common areas often tends to warm and bright. Whereas when the LUX readings taken at these locations, are compared to the IESNA lighting standard, it is often observed that the lighting levels are over the prescribed levels. In such circumstances EMG advises to go for de-lamping of individual light fixtures, such that the LUX levels post de-lamping would be in a close range to that of the prescribed limit. The result of de-lamping is reduction in the brightness in the specific areas, but would always be slightly above the recommended IESNA levels. The light readings are taken by hand held light meter, at an approximately table top height from the floor. The advantage of de-lamping is reduction in the demand load as well as the annual lighting energy consumption. EMG recommends taking de-lamping trials at different locations before implementing it across the entire space. When removing fluorescent or HID lamps, also remove or disconnect the ballast to prevent them from continuing to consume energy.

In the case of Broadmeadow Elementary School the lighting above the bulkhead is indirect and more for architectural accents. EMG strongly recommends the decommissioning of these lights since the light levels in the library are above acceptable limits without them.

8.2.8. Utilize Outside Air Temperature Reset Control System in Central BMS System to Control the Boiler

HVAC equipment is usually sized to meet conditions at the design peak load. Coil 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 or chilled 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 or chilled 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, chilled water temperature is adjusted upward and hot water temperature is adjusted downward. Alternatively, a more accurate method is to reset the water temperature based on instrumentation readings. For further discussion on the reset strategies and the selection algorithms of the hot and chilled water temperature set points, refer to a report by the National Bureau of Standards, Control Algorithms for Building Management and Control Systems--Hot Deck/Cold Deck/ Supply Air Reset, Day/Night Setback, Ventilation Purging, and Hot and Chilled Water Reset (NBS 1984a).

In the case of Broadmeadow Elementary School the BMS is not utilizing the outside air reset control to its full advantage. The system is designed to be able to use an incremental temperature reset that would significantly reduce the energy requirements of the boiler. EMG strongly recommends the reprogramming of this feature in the BMS system.

8.3. CAPITAL COST ECM DESCRIPTIONS

EMG has identified 4 Capital Cost Energy Conservation Measures (ECMs) for this property. This list includes recommended measures which have an estimated implementation cost of greater than $1,000. The following paragraphs describe each of these ECMs, in addition to their initial installed costs, annual energy savings, and payback periods.

8.3.1. Replace Metal Halide Lighting in Gym, Auditorium and Exterior Site Lighting w/ Induction Lights

Induction lighting has the advantage of giving off the same amount of light with half the wattage of a metal halide or high pressure sodium light. Induction lights also last several times longer than the typical HID light. The other advantage to induction lighting is that it is instant on and dimmable, it therefore can be put on motion sensors when equipped with bi-level ballast and operate at 40% power when there is no motion detected and still give substantial site lighting.

In the case of Broadmeadow Elementary School the gym, auditorium, exterior parking lot lighting currently use metal halide lamps. EMG strongly recommends the installation of induction lighting in these areas.

8.3.2. Install PIR Motion & Occupancy Sensors Throughout the School to control lighting

Lighting systems consume large amounts of energy in most buildings. Energy is saved by reducing both lighting power consumption and the additional cooling load imposed by lighting. In winter, lights do help heat the building; however, in most cases, lighting is a less efficient heating source than the building HVAC system. The lights should be turned off when an area is unoccupied, even if only for a short period. Rooms with intermittent use, such as storerooms, lavatories, etc., should have labeled, individual manual switches so that lights can be turned off when the room is not in use. Occupancy sensors are also effective in spaces that are used intermittently. EMG recommends installing ceiling-mounted occupancy sensors for controlling lighting in large areas and conference rooms and wall-mounted occupancy sensors in individual offices, copy rooms and restrooms.

In the case of Broadmeadow Elementary School there was one occupancy sensor in the whole school. EMG strongly recommends the installation of occupancy sensors throughout the school.

8.3.3. Recommision HVAC and BMS System

Retro Commissioning (RCx) of HVAC and control systems is a good maintenance practice every five years, especially for Variable Air Volume (VAV) systems. Systems have tendency to go out of balance over a period of time due to changing set-points, maintenance and adjustments. RCx will bring all hydronic and air balancing to original design intent to meet current occupant comfort conditions. Outside Air rates will also balanced accordingly.

Broadmeadow Elementary School has several roof top air handlers distributing air via VAV-reheat distribution system. Hot water is circulated via two pumps and throttled by 3-way valves. Per discussions with site management, the school systems were never rebalanced and/or RCx'd since 2001 when the School was built. EMG strongly recommends making necessary improvements as recommended and retro-commission the building and HVAC systems and air balance the entire VAV distribution to optimize equipment performance and attain energy savings.

8.4. MEASURES RECOMMENDED FOR CONSIDERATION

8.4.1. Install VFD's on Motors on Boiler Circulation Pumps

Variable speed drives save energy by sensing the load requirements and changing the motor's power and speed to meet these requirements.

There are two types of variable speed drives: mechanical and electronic. Mechanical variable speed drives consist of either magnetic clutches or variable ratio belt drives that allow the motor to run at a constant speed, while the motor-driven equipment speed varies. Electronic variable speed drives adjust the speed of the motors they control by electronically varying the input voltage and frequency to the motor. Both systems have enormous conservation potential. The electronic drives are more energy efficient than the mechanical, but are also more costly (Usibelli et al. 1985). Centrifugal devices are the best candidates for variable speed drives. Centrifugal fans and pumps for water, sewage, refrigerant, and air are typical applications. Centrifugal devices whose flow rates and pressures are normally controlled by throttling can be replaced with variable speed drives. The more operating time below full load, the greater the payback potential of variable speed drives (NCEL 1984c).

In the case of Broadmeadow Elementary School the two 10 HP recirculation pumps on the boiler do not currently have VFD's. EMG strongly recommends the addition of VFD's to these recirculation pumps and regulate pump speed and in-turn energy consumption relative to actual facility load.

8.4.2. Insulate Ceiling and Roofs

The amount of heat conduction through ceiling and roof is proportional to its overall heat transfer coefficient (commonly called the U-factor) and the temperature difference between the conditioned space and its surrounding, modified by the effect of solar intensity and wind velocity on the exterior surfaces. One of the most effective ways to reduce heat transfer through ceilings and roofs is to retard heat conduction by adding insulation.

Where the existing roof is sound and directly accessible from an attic or ceiling void, polyurethane foam or mineral fiber may be sprayed on the underside, with rigid batt or other applicable insulation for the inside surface. Insulation, typically fiber-glass batt, may also be laid on the top of a ceiling, taking care not to cover up light fixtures. It is generally not practical to insulate the exterior of the roof unless the roof needs to be replaced. In this case, rigid insulation may be used, and protected with a new roof membrane. As buildings become more insulated, the heat transfer through structural members becomes more significant, especially for buildings with metal structural members. Un-insulated structural members can degrade the performance of the insulation up to 20%, and resultant condensation can cause the structure to deteriorate. Therefore, care should be taken to properly insulate the structural members. Often more energy can be conserved by insulating the ceiling rather than the roof unless the attic is being used for special storage, frequent access is required, or a moderate attic temperature is desired. However, if only the ceiling is insulated, any ducting or piping should be insulated to avoid excessive heat transfer or freezing. It is important to be sure that the attic is ventilated by providing one to two inches of ventilation area per square foot of attic.

In the case of Broadmeadow Elementary School the only insulation in the gym, auditorium, and cafeteria is the rigid insulation under the 4 ply Bituminous roofing system with an R-13 value. EMG strongly recommends the addition of R-19 fiberglass insulation properly encapsulated in a polyethylene membrane to significantly reduce energy losses. This project has relatively less energy cost savings compared to high initial investment. So we are recommending this project under capital improvement category for improved occupant comfort.

8.4.3. Replace existing RTUs with High Efficiency Oil free Compressor driven RTUs

Existing Roof top units have passed 75% of ASHRAE Expected Useful Life (EUL) and have about five years of Remaining Useful Life (RUL). EMG does not recommend replacing the units at this time as they are relatively in good operating condition. Also compressors and other major components for some units have been replaced in recent years.

But we recommended replacing the units at end of life (estimated to be 5 years based on ASHRAE EUL chart) with High efficiency units with on board VFDs for supply and return fans and oil free magnetic clutch driven variable speed compressors for cooling. These units cost about 25% more than standard efficiency units but in turn operate much more efficiently. EMG performed a cost feasible analysis and it shows a premium recovery rate of 5.35 years with newer units. This measure is strongly recommended at time of replacement.

8.4.4. Install Pulse or Condensing Boilers/Furnaces

New boilers and furnaces on the markets generally attain efficiencies of above 80%. The efficiencies of pulse and condensing units can be above 90% and reduce the energy requirements considerably.

Boilers or furnaces at or near the end of their service life should be replaced with energy-efficient units. The size of the replacement unit should match the current and projected needs of the installation. Replacing original equipment with modular units with smaller capacities should be considered to reduce the cycling losses.

In the case of Broadmeadow Elementary School the two boilers currently in use are 85.6% efficient per manufacturer specifications. Adding a new boiler or replacing one of existing boilers is not cost effective at this time. So EMG recommends installing one condensing boiler when one of the two boilers is up for replacement. As in the RTU situation, the condensing boilers cost about 25-30% more than standard efficiency boilers and the premium recovery rate is about 7 years which makes the project attractive at that time. EMG strongly recommends at least one of the new replacement boilers be fully condensing and fully pulsating type.

9. IMPLEMENTION OF AN 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 (or added as necessary to existing O&M or Preventative Maintenance plan) as part of the routine maintenance program for the property. These actions, which have been divided into specific and general recommendations, will insure that the energy conservation measures identified in this report will remain effective. The following general recommendations should be continued or implemented.

The Broadmeadow school is currently employing good maintenance practices to run the equipment and distribution system in optimal conditions. These practices should be continued along with following checklist items to ensure proper occupant comfort and attain projected energy savings.

Building Envelope

1. Check Caulking and weather stripping throughout the envelope
   – Currently in good condition. No immediate need noted.
2. Windows inspected periodically for damaged panes and failed thermal seals
   – Currently all windows, doors and seals in good condition.
3. Automatic door closing mechanisms repaired and adjusted as needed
   – Currently all doors closing properly.
4. Roof and insulation checked at least annually
   – Currently in good condition. New insulation improvements recommended for cafeteria and gym.

Heating and Cooling

1. The burners cleaned and fuel/air ratios optimized during routine maintenance checks
   – Boiler not running at time of audit. But per maintenance burners are cleaned and A/F adjusted annually.
2. Boiler and RTUs inspected and cleaned annually
   – Currently in practice.
3. Temperature settings reduced in unoccupied areas and set points seasonally adjusted.
   – Currently occupied/unoccupied set points maintained by BMS. EMG verified and the system appeared to be monitoring properly. But Retro-commissioning is recommended as an ECM will replace mal functioning sensors.
4. Control valves and dampers checked for functionality semi-annually and repaired, when needed
   – Is recommended as part of retro-commissioning
5. Equipment inspected for worn or damaged parts as part of a monthly maintenance check
   – Currently in practice
6. Ductwork visually inspected and checked for leaks or damaged insulation as part of a semi-annual maintenance check
7. Hot air registers and return air ductwork clean and unobstructed once every 3-5 years
   – Duct work recently cleaned.

8. Air dampers operating correctly
   – Is recommended as part of retro-commissioning. Currently controlled by BMS.
9. Test and balance completed annually to ensure heating uniform throughout the spaces
   – Is recommended as part of retro-commissioning.
10. Evaporator coils and condenser coils regularly checked and cleaned
    – Once every 3-5 years.
11. Air filters inspected monthly and replaced prior to excessive visual buildup (May increase filter costs, but will reduce fan energy costs)
    – Currently in practice.

Domestic Hot Water

1. Domestic hot water heater temperature set to the minimum temperature required
   – Recommended as an ECM
2. Hot water piping checked routinely for damaged insulated and leaks
   – Currently in good condition.

Lighting

1. Over-lit areas managed by bi-level switching or photocell controls or de-lamping
   – Currently recommended
2. Only energy-efficient replacement lamps used and in-stock for replacement
3. Lighting fixture reflective surfaces and translucent covers clean
   – Currently in good condition
4. Walls clean and bright to maximize lighting effectiveness
5. Rooms controlled by motion or occupancy sensors
   – Currently recommended as ECM
6. Timers and/or photocells operating correctly on exterior lighting
   – Operating properly. Currently on timer and EMG recommends combination of photocell and timer to reduce unnecessary operating hours.

Existing Equipment and Replacements

1. Refrigerator and freezer doors closed and sealed correctly
   – Currently kitchen freezers are properly weather stripped and in good condition
2. Kitchen exhaust fans only used when needed or sensors installed to limit operation
   – Currently there are no sensors. School was not functioning at time of audit. But EMG recommends kitchen exhaust hood sensor to shut fan off during day when not needed.
3. Office/ computer equipment either in the “sleep” or “off” mode when not used
   – Smart strips are good application.
4. All other recommended equipment specific preventive maintenance actions conducted

In addition, equipment replacement performed assuring that:

1. All equipment replacements not over/undersized for the particular application
2. All equipment replacements with energy conserving and/or high efficiency devices

10. APPENDICES

APPENDIX A: Photographic Record

APPENDIX B: Site Plan

APPENDIX C: Records of Communication

APPENDIX D: Glossary of Terms

APPENDIX E: Mechanical Equipment Inventory

APPENDIX F: Lighting Systems Schedules

APPENDIX G: ECM Calculations

APPENDIX H: Supporting Documents

APPENDIX A:
PHOTOGRAPHIC RECORD

EMG
DUE DILIGENCE FOR THE
LIFE CYCLE OF REAL ESTATE

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-001.268 **Project Name: Broadmeadow Elementary School**

Photo #1: West elevation – center (main entrance)

Photo #2: West elevation - south end (front end of school)

Photo #3: West elevation - south end (front of school)

Photo #4: East elevation - north end (rear of school)

Photo #5: East elevation - south end (rear of school)

Photo #6: East elevation –north end (rear of school)

Photo #7:	Two Weil McLain Boilers - providing heat to building

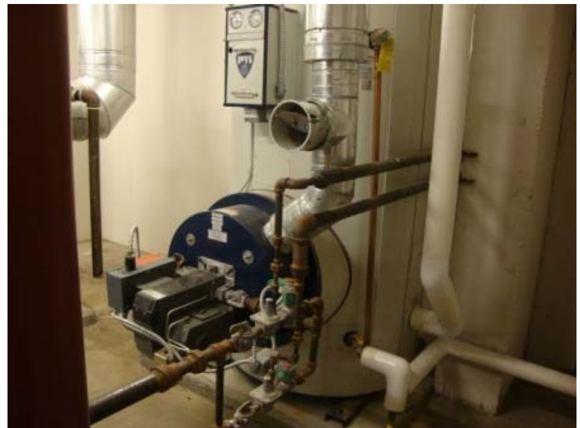


Photo #8:	Buildings hot water heaters

Photo #9:	Hot water recirculation pumps

Photo #10:	VAV boxes in the ceiling of rooms

Photo #11:	Five McQuay rooftop cooling units (RTU) with natural gas furnace

Photo #12:	Split system air conditioning units for cooling data centers

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-001.268 **Project Name: Broadmeadow Elementary School**

Photo #13:	Electrical room showing main panels

Photo #14:	Main electric meter for building

Photo #15:	Domestic hot water recirculation pumps

Photo #16:	Mixing valve for buildings hot water

Photo #17:	Pad-mounted transformer

Photo #18:	Kohler diesel generator

EMG

DUE DILIGENCE FOR THE LIFE CYCLE OF REAL ESTATE

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-001.268 **Project Name: Broadmeadow Elementary School**

Photo #19:	Water meter

Photo #20:	Baseboard hydronic heating unit on exterior walls of rooms

Photo #21:	Elevator oil reservoir with submersible sump pump

Photo #22:	Four ply built up roof system with flood coat and Aggregate Surfacing

Photo #23:	Storage room

Photo #24:	Kitchen

EMG Photographic Record

Project No.: 98515.11R-001.268 **Project Name: Broadmeadow Elementary School**

Photo #25:	Main office area

Photo #26:	Main office area

Photo #27:	Typical classroom

Photo #28:	School cafeteria

Photo #29:	Bathroom

Photo #30:	Main hall at main entrance - do not need Sconce style lights (should be turned off)

EMG

DUE DILIGENCE FOR THE
LIFE CYCLE OF REAL ESTATE

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-001.268 **Project Name: Broadmeadow Elementary School**

Photo #31:	Library

Photo #32:	Main entrance vestibule

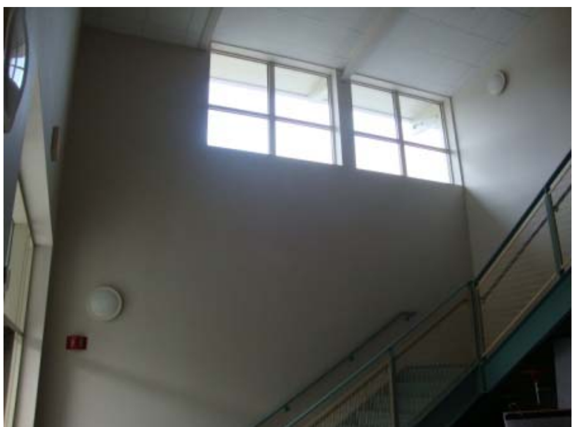


Photo #33:	South stairwell

Photo #34:	Gym has sufficient day lighting to avoid using 400W metal Halide lights

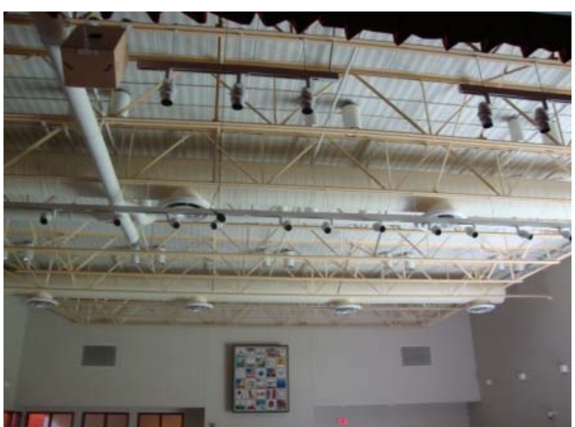


Photo #35:	View of auditorium lighting and duct work

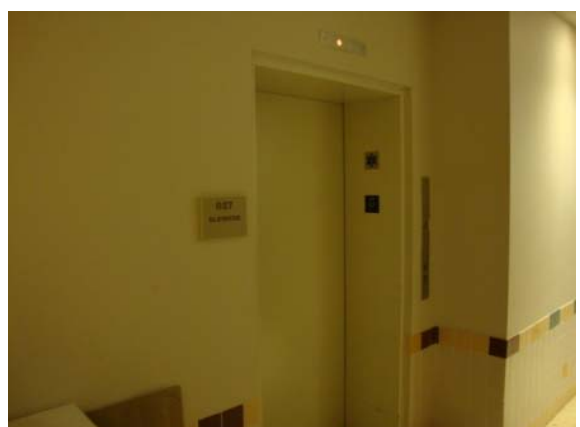


Photo #36:	Elevator in middle section of school

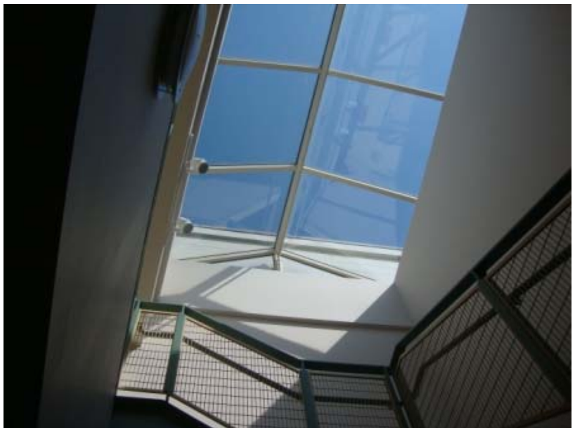


Photo #37:	Central stairwell with skylight in main hall

Photo #38:	Basement hallway

Photo #39:	Kitchen vent discharge

Photo #40:	Space under door at north end emergency exits - 2 doors (needs door sweeps)

Photo #41:	Exterior metal Halide pole lights

Photo #42:	Walk-in freezer

APPENDIX B:
SITE PLAN

Site Plan

Key:

The north arrow indicator is an approximation of 0° North.

Project Number:
98515.11R.001.268

Project Name:
Broadmeadow Elementary School

On-Site Date:
August 18 & 19, 2011

APPENDIX C:
RECORDS OF COMMUNICATION

RECORD OF COMMUNICATION

Date:	**August 18&19, 2011**	**Time:**	**9:00 AM**
Project Number:	**98515.11R-001.268**	**Recorded by:**	**Luke Jacques, Field Observer/Project Manager**
Project Name:	**Broadmeadow Elementary School**		

Communication with: **Chip Laffey**
of: **Needham Township**
Phone: **781-455-0442 x273**

Communication via:

- **Telephone Conversation**
- **X Discussions During Site Assessment**
- **X Office Visitation/Meeting at:**
- **Other:**

RE:

Summary of Communication:
Mr. Laffey assisted during on site assessment and gave insight of building and its operations.

APPENDIX D:
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) Investment 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 thousand 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 thousand 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 E:
MECHANICAL EQUIPMENT INVENTORY

Description	Loc.	Manufacturer Model	Age (Yrs)		Capacity	Fuel / Energy Source	Serves	Operating Hours / Year	Remarks	Expected Useful Life (EUL)	Remaining Useful Life (RUL)
(2) Hot Water Boilers	Boiler Room	Weil-McLain Model 1388	2001	10	3,270 MBTUH	Gas	Buildings Heat	950 FLE	85.6% Eff.	35	25
(2) Burners	Boiler Room	Power Flame WCR3 -G-25	2001	10	3392 MBH	Gas	Buildings Heat	950 FLE		21	11
Hot Water Heater	Boiler Room	PVI Model 750 P 400A-TP	2001	10	600 MBTUH 400 Gal	Gas	Domestic Hot Water	544	80% Eff.	10	0
(2) Hot Water Recirculation Pump Motors	Boiler Room	Baldor Model: H3313T	2001	10	10 HP	Electric	Buildings Heating Hot Water	1820		20	10
RTU-1	Roof	McQuay Model: RPS090CSA	2001	10	90 Ton	Electric	North & East Wing Cooling	1260		15	5
RTU-1 Furnace	Roof	McQuay Model: 140 AHA	2001	10	19,000 CFM 1750 MBH	Natural Gas	North & East Wing Heating			15	5
RTU-2	Roof	McQuay Model: RPS050CSA	2001	10	50 Ton	Electric	Office and Adjacent Cooling	1260		15	5
RTU-2 Furnace	Roof	McQuay Model: 080 AHC	2001	10	10,400 CFM 1,000 MBH	Natural Gas	Office and Adjacent Heating			15	5
RTU-3	Roof	McQuay Model: RPS050CSA	2001	10	50 Ton	Electric	Auditorium Cooling	1260		15	5
RTU-3 Furnace	Roof	McQuay Model: 080 AHC	2001	10	10,400 CFM 1,000 MBH	Natural Gas	Auditorium Heating			15	5
RTU-4	Roof	McQuay Model: RPS040CSA	2001	10	40 Ton	Electric	Kitchen and Cafeteria	1260		15	5
RTU-4 Furnace	Roof	McQuay Model: 080 AHB	2001	10	9,800 CFM 1,000 MBH	Natural Gas	Kitchen and Cafeteria			15	5
RTU-5	Roof	McQuay Model: RPS090CSA	2001	10	90 Ton	Electric	South Wing Cooling	1260		15	5
RTU-5 Furnace	Roof	McQuay Model: 150 AHC	2001	10	19,000 CFM 1750 MBH	Natural Gas	South Wing Heating			15	5
Gym AHU-1	Ceiling	McQuay CAH010FDAC	2001	10	4,500 CFM 253 MBH	Natural Gas	Gym	2100	Qty: 2	15	5
Split System AC Units	Roof	Daikin Model: RZQ42 MVJU	2001	10	3 1/2 Ton	Electric	Office/Data Rm	500	Qty: 2	15	5
Roof Top Ventilators	Roof	Penn Ventilation Model: FX24BFT	2001	10	4400 CFM	Electric	Kitchen	2600		20	10
Roof Ventilator	Roof	Penn Vent Model DX06B	2001	10	Unk	Electric	Bathrooms Misc. Areas	2600	Qty: 15	20	10
Roof Ventilator	Roof	Penn Vent Model DX13B	2001	10	Unk	Electric	Bathrooms Misc. Areas	2600	Qty: 1	20	10
Roof Ventilator	Roof	Penn Vent Model DX24BFT	2001	10	Unk	Electric	Bathrooms Misc. Areas	2600	Qty: 1	20	10
Roof Ventilator	Roof	Penn Vent Model DX30B	2001	10	Unk	Electric	Bathrooms Misc. Areas	2600	Qty: 2	20	10
Domestic Water Recirc. Pumps	Basement	Taco Model 0011-SF4	2001	10	1/8 HP Motors 1.76 Amps	Electric	Domestic Water	544	Qty: 3	10	0
Generator	Front Parking Lot	Kohler Model: 150RZD	2001	10	150 KW 188 KVA	Nat. Gas	Building Emergency			35	25
Elevator Pump Motor	Basement	US Motors Catalogue No.: EZ25S1BZ	2001	10	25 Hp	Electric	Elevator		Qty: 1	20	10

APPENDIX F:
LIGHTING SYSTEMS SCHEDULES

Existing Facilities Program Lighting Form:

Performance Based

[LINK TO EXAMPLE SHEET]

Applicant Name:	98515.11R-001.268
Facility Name:	Broadmeadow Elementary School
Date:	Luke Jacques

COPY AND PASTE TABLES AS EXCEL OBJECT THAT ARE BELOW THE BLUE

Fixture Coding Legend					
Compact Fluorescents		**EXIT Signs**		**Other Bulbs**	
CF_ - " "	Compact Flourescent - "wattage"	E - " "	Exit Signs - "Type of light and wattage"	**H - " "**	Halogen - "wattage"
i.e. CFL26W	*CFL - 26 Watt Compact Fluorescent*	***i.e.*** ELED5W	*Exit Sign with 5 Watt LED*	**HPS - " "**	High Pressure Sodium - "wattage"
i.e. CFQ32W	*CFQ - 32 Watt Quad Compact Fluorescent*	***i.e.*** EI20W	*Exit Sign with 20 Watt Incandescent*	**I - " "**	Incandescent - "wattage"
i.e. CFS13W	*CFS - 13 Watt Spiral Compact Fluorescent*	**Linear Fluorescents**		MV - " "	Mecury Vapor - " wattage"
i.e. CFM56W	*CFM - 56 Watt Biax Compact Fluorescent*	**F- # - T8 - # ft**	F - Wattage - Bulb Type - length of bulb	MH - " "	Metal Halide - "wattage"
i.e. CFD56W	*CFD - 2D Compact fluorescent*	***i.e.*** F30T8-4 ft	*4 foot 30 Watt T8 Linear Fluorescent*	***i.e.*** MV250W	*250 Watt Mercury Vapor Bulb*

Existing Building Lighting Schedule									
Line Item	**Area Description**	**Floor(s)**	**Type of Bulb**	**Number of Fixtures**	**Lamps per fixture**	**Existing Control**	**Hours of Operation**	**Total KW**	**Total Annual KWh Consumed**
							hrs/week		
1	Classrooms	Grd&1st	F32T8 bulb- 4ft	485	2	Light Switch	60	28.62	89,279
2	Offices	Grd&1st	F32T8 bulb- 4ft	10	2	Light Switch	60	0.59	1,841
3	Offices	Grd&1st	F32T8 bulb- 4ft	12	3	Light Switch	60	1.07	3,332
4	Offices	Grd&1st	CFT40W 0	19	2	Light Switch	60	1.37	4,268
5	Offices	Grd&1st	FU31T8/6 _Utube	3	2	Light Switch	60	0.18	552
6	Bathrooms	Grd&1st	F32T8 bulb- 4ft	27	2	Light Switch	60	1.59	4,970
7	Bathrooms	Grd&1st	CFQ26W 0	15	2	Light Switch	60	0.75	2,340
8	Hallways	Grd&1st	F32T8 bulb- 4ft	97	2	Light Switch	60	5.72	17,856
9	Hallways	Grd&1st	CFQ26W 0	78	2	Light Switch	60	3.90	12,168
10	Hallways	Grd&1st	CFT40W 0	11	2	Light Switch	60	0.79	2,471
11	Hallways	Grd&1st	FU31T8/6 _Utube	7	2	Light Switch	60	0.41	1,289
12	Storage/Misc	Grd&1st	CFT40W 0	54	2	Light Switch	60	3.89	12,131
13	Storage/Misc	Grd&1st	CFQ26W 0	3	2	Light Switch	60	0.15	468
14	Storage/Misc	Grd&1st	CFT40W 0	27	2	Light Switch	60	1.94	6,065
15	Storage/Misc	Grd&1st	FU31T8/6 _Utube	10	2	Light Switch	60	0.59	1,841
16	Receptionist	1st	F32T8 bulb- 4ft	12	3	Light Switch	60	1.07	3,332
17	Conference Rm.	1st	F32T8 bulb- 4ft	6	3	Light Switch	60	0.53	1,666
18	Health Suite	1st	CFQ26W 0	2	2	Light Switch	60	0.10	312
19	Health Suite	1st	F32T8 bulb- 4ft	6	3	Light Switch	60	0.53	1,666
20	Health Suite	1st	CFT40W 0	3	2	Light Switch	60	0.22	674
21	Library	1st	F32T8 bulb- 4ft	52	2	Light Switch	60	3.07	9,572
22	Library	1st	CFQ26W 0	28	2	Light Switch	60	1.40	4,368
23	Library	1st	CFT40W 0	2	2	Light Switch	60	0.14	449
24	Gym	Grd	MH750 W	16	1	Light Switch	60	7.33	22,863
25	Auditorium	1st	CFQ26W 0	13	2	Light Switch	60	0.65	2,028
26	Auditorium	1st	MH175 W	25	1	Light Switch	60	3.20	9,984
27	Auditorium	1st	H90 W	25	1	Light Switch	60	2.25	7,020
28	Boiler Room	Grd	F32T8 bulb- 4ft	16	2	Light Switch	60	0.94	2,945
29	Cafeteria	Grd	F32T8 bulb- 4ft	38	2	Light Switch	60	2.24	6,995
30	Cafeteria	Grd	CF42W 0	7	1	Light Switch	60	0.34	1,048
31	Kitchen	Grd	CFQ26W 0	8	2	Light Switch	60	0.40	1,248
32	Kitchen	Grd	FU31T8/6 _Utube	19	2	Light Switch	60	1.12	3,498
33	Stairwell	Grd&1st	F32T8 bulb- 4ft	8	2	Light Switch	60	0.47	1,473
34	Stairwell	Grd&1st	CFQ26W 0	18	2	Light Switch	60	0.90	2,808
35	Computer Area	Grd	F32T8 bulb- 4ft	24	2	Light Switch	60	1.42	4,418
36	Computer Area	Grd	CFT40W 0	5	2	Light Switch	60	0.36	1,123
43	Break Room	1st	F32T8 bulb- 4ft	3	2	Light Switch	60	0.18	552
44	Break Room	1st	CFQ26W 0	5	2	Light Switch	60	0.25	780
45	Break Room	1st	F32T8 bulb- 4ft	8	3	Light Switch	60	0.71	2,221
40	Break Room	1st	CFT40W 0	1	2	Light Switch	60	0.07	225
41	Exterior Wall Pack Lights	Grd	CFQ26W 0	14	2	Timer	50	0.70	1,820
42	Exterior Pole Lights	Grd	MH175 W	6	1	Timer	50	0.77	1,997
43	Exterior Pole Lights	Grd	MH320 W	7	1	Timer	50	2.07	5,369
-	-	-	**TOTALS**	**1,235**			-	**84.99**	**263,325**

Existing Facilities Program Lighting Form:

Performance Based

Project Number:	98515.11R-001.268
Facility Name:	Broadmeadow Elementary School
Project Manager	Luke Jacques
Date: 8/20/2011	Square Footage (ft2): 87570

Existing Control Legend

LS	Light Switch
PS	Photo sensor
TM	Timer
MOS	Motion/Occupancy Sensor
EC	Emergency Control

INSTRUCTIONS Coding Legend

CF	Compact Fluorescent	I
F	Fluorescent, linear	LED
H	Halogen	MH
HPS	High Pressure Sodium	MV
I	Incandescent	QL

PRE-INSTALLATION

Line	ECM	Type of ECM	Additional	Floor	Area Description	Light	Usage	Existing	Pre Fixt.	Pre Fixt Code	Pre Watts /	Pre kW /	Baseline	Annual kWh
Integer	(Type	ECM CODE	For two ECMs in	Floor	Description of location that matches	Lux	hrs/ week	control device	# of existing	TypWattage Table	Watts/Fixt from	(Pre Watts/Fixt) *	Existing annual	(PreFixt
1	ECM	MS		Grd&1st	Classrooms		60	LS	485	F42ILL	59	28.62	3,120	89,279
2	ECM	MS		Grd&1st	Offices		60	LS	10	F42ILL	59	0.59	3,120	1,841
3	ECM	MS		Grd&1st	Offices		60	LS	12	F43ILL	89	1.07	3,120	3,332
4	ECM	MS		Grd&1st	Offices		60	LS	19	CFT40/2-L	72	1.37	3,120	4,268
5	ECM	MS		Grd&1st	Offices		60	LS	3	FU2LL/T2	59	0.18	3,120	552
6	ECM	MS		Grd&1st	Bathrooms		60	LS	27	F42ILL	59	1.59	3,120	4,970
7	ECM	MS		Grd&1st	Bathrooms		60	LS	15	CFQ26/2-L	50	0.75	3,120	2,340
8	ECM	MS		Grd&1st	Hallways		60	LS	97	F42ILL	59	5.72	3,120	17,856
9	ECM	MS		Grd&1st	Hallways		60	LS	78	CFQ26/2-L	50	3.90	3,120	12,168
10	ECM	MS		Grd&1st	Hallways		60	LS	11	CFT40/2-L	72	0.79	3,120	2,471
11	ECM	MS		Grd&1st	Hallways		60	LS	7	FU2LL/T2	59	0.41	3,120	1,289
12	ECM	MS		Grd&1st	Storage/Misc		60	LS	54	CFT40/2-L	72	3.89	3,120	12,131
13	ECM	MS		Grd&1st	Storage/Misc		60	LS	3	CFQ26/2-L	50	0.15	3,120	468
14	ECM	MS		Grd&1st	Storage/Misc		60	LS	27	CFT40/2-L	72	1.94	3,120	6,065
15	ECM	MS		Grd&1st	Storage/Misc		60	LS	10	FU2LL/T2	59	0.59	3,120	1,841
16	ECM	MS		1st	Receptionist		60	LS	12	F43ILL	89	1.07	3,120	3,332
17	ECM	MS		1st	Conference Rm.		60	LS	6	F43ILL	89	0.53	3,120	1,666
18	ECM	MS		1st	Health Suite		60	LS	2	CFQ26/2-L	50	0.10	3,120	312
19	ECM	MS		1st	Health Suite		60	LS	6	F43ILL	89	0.53	3,120	1,666
20	ECM	MS		1st	Health Suite		60	LS	3	CFT40/2-L	72	0.22	3,120	674
21	ECM	DL		1st	Library		60	LS	52	F42ILL	59	3.07	3,120	9,572
22				1st	Library		60	LS	28	CFQ26/2-L	50	1.40	3,120	4,368
23				1st	Library		60	LS	2	CFT40/2-L	72	0.14	3,120	449
24	ECM	RB	MS	Grd	Gym		60	LS	16	MH400	458	7.33	3,120	22,863
25				1st	Auditorium		60	LS	13	CFQ26/2-L	50	0.65	3,120	2,028
26	ECM	RL		1st	Auditorium		60	LS	25	MH100	128	3.20	3,120	9,984
27	ECM	RL		1st	Auditorium		60	LS	25	H90/1	90	2.25	3,120	7,020
28	ECM	TM		Grd	Boiler Room		60	LS	16	F42ILL	59	0.94	3,120	2,945
29				Grd	Cafeteria		60	LS	38	F42ILL	59	2.24	3,120	6,995
30				Grd	Cafeteria		60	LS	7	CFL42	48	0.34	3,120	1,048
31				Grd	Kitchen		60	LS	8	CFQ26/2-L	50	0.40	3,120	1,248
32				Grd	Kitchen		60	LS	19	FU2LL/T2	59	1.12	3,120	3,498
33	ECM	PS		Grd&1st	Stairwell		60	LS	8	F42ILL	59	0.47	3,120	1,473
34	ECM	PS		Grd&1st	Stairwell		60	LS	18	CFQ26/2-L	50	0.90	3,120	2,808
35	ECM	MS		Grd	Computer Area		60	LS	24	F42ILL	59	1.42	3,120	4,418
36	ECM	MS		Grd	Computer Area		60	LS	5	CFT40/2-L	72	0.36	3,120	1,123
37	ECM	MS		1st	Break Room		60	LS	3	F42ILL	59	0.18	3,120	552
38	ECM	MS		1st	Break Room		60	LS	5	CFQ26/2-L	50	0.25	3,120	780
39	ECM	MS		1st	Break Room		60	LS	8	F43ILL	89	0.71	3,120	2,221
40	ECM	MS		1st	Break Room		60	LS	1	CFT40/2-L	72	0.07	3,120	225
41	ECM	PS		Grd	Exterior Wall Pack Lights		50	TM	14	CFQ26/2-L	50	0.70	2,600	1,820
42	ECM	RB		Grd	Exterior Pole Lights		50	TM	6	MH100	128	0.77	2,600	1,997
43	ECM	RB		Grd	Exterior Pole Lights		50	TM	7	MH250	295	2.07	2,600	5,369
								Total Pre Fixt.	**1,235**		**Total Pre kW**	**85**	**kWh Consumed**	**263,325**

Light Intensity	0.971 Watt/ ft2	**Annual Light Usage Intensity**	3.01 KWh / ft2

Existing Facilities Program Lighting Form:

Performance Based

Existing Control Legend	
LS	Light Switch
PS	Photosensor
T	Timer
MS	Motion Sensor
EC	Emergency Control

INSTRUCTIONS Coding Legend			
CF	Compact Fluorescent	I	Incandescent
F	Fluorescent, linear	LED	Light Emitting Diode
H	Halogen	MH	Metal Halide
HPS	High Pressure Sodium	MV	Mercury Vapor
I	Incandescent	QL	Induction

Project Name: 98515.11R-001.268

Facility Name: Broadmeadow Elementary School

Date: 8/20/2011 Project Manager Luke Jacques

PRE-INSTALLATION												POST-INSTALLATION						
Line Item	**ECM**	**Type of ECM Code** (Refer to ECM Code Worksheet)	**Additional ECM Code** (if applicable)	**Floor**	**Area Description**	**Light Reading** (Record if ECM)	**Usage**	**Baseline Annual Hours**	**Existing Control**	**Pre Fixt. No.**	**Pre Fixt Code**	**Post Fixt No.**	**Pre Fixt Code** (Refer to Wattable Table Worksheet)	**Post Watts/ Fixt**	**Proposed Weekly Hours**	**Proposed Control**	**kW Saved**	**Annual kWh Saved**
Integer line number	(Type 'ECM" if applied)	ECM CODE Worksheet Link	For two ECMs in one line item	Floor fixture is on	Description of location that matches site map	Lux (link to light standards)	hrs/ week	Existing annual hours for the usage group	Pre-installation control device	# of existing fixtures	TypWattage Table Link	# of existing fixtures	TypWattage Table	Watts/Fixt from Wattage Table	hrs / wk	Post-installation control device	Pre kW/Space - Post kW/Space	(PreFixt #*PreWatts/Fixt * Baseline Hrs) - (PostFixt#*PostWatts/Fixt * Proposed Hours)
Ex.		*RB*		*10*	*Men's Room*		*5*	*3,000*	*Light Switch*	*3*	*F44T12*	*3*	*F42T8*	*59*		*Motion Sensor*	*0.26*	*765*
1	ECM	MS - Install Motion Sensors	#N/A	Grd&1st	Classrooms	-	60	3,120	LS	485	F42ILL	485	F42ILL	59	48.00	MS	0.00	17,856
2	ECM	MS - Install Motion Sensors	#N/A	Grd&1st	Offices	-	60	3,120	LS	10	F42ILL	10	F42ILL	59	48.00	MS	0.00	368
3	ECM	MS - Install Motion Sensors	#N/A	Grd&1st	Offices	-	60	3,120	LS	12	F43ILL	12	F43ILL	89	48.00	MS	0.00	666
4	ECM	MS - Install Motion Sensors	#N/A	Grd&1st	Offices	-	60	3,120	LS	19	CFT40/2-L	19	CFT40/2-L	72	48.00	MS	0.00	854
5	ECM	MS - Install Motion Sensors	#N/A	Grd&1st	Offices	-	60	3,120	LS	3	FU2LL/T2	3	FU2LL/T2	59	48.00	MS	0.00	110
6	ECM	MS - Install Motion Sensors	#N/A	Grd&1st	Bathrooms	-	60	3,120	LS	27	F42ILL	27	F42ILL	59	48.00	MS	0.00	994
7	ECM	MS - Install Motion Sensors	#N/A	Grd&1st	Bathrooms	-	60	3,120	LS	15	CFQ26/2-L	15	CFQ26/2-L	50	48.00	MS	0.00	468
8	ECM	MS - Install Motion Sensors	#N/A	Grd&1st	Hallways	-	60	3,120	LS	97	F42ILL	97	F42ILL	59	48.00	MS	0.00	3,571
9	ECM	MS - Install Motion Sensors	#N/A	Grd&1st	Hallways	-	60	3,120	LS	78	CFQ26/2-L	78	CFQ26/2-L	50	48.00	MS	0.00	2,434
10	ECM	MS - Install Motion Sensors	#N/A	Grd&1st	Hallways	-	60	3,120	LS	11	CFT40/2-L	11	CFT40/2-L	72	48.00	MS	0.00	494
11	ECM	MS - Install Motion Sensors	#N/A	Grd&1st	Hallways	-	60	3,120	LS	7	FU2LL/T2	7	FU2LL/T2	59	48.00	MS	0.00	258
12	ECM	MS - Install Motion Sensors	#N/A	Grd&1st	Storage/Misc	-	60	3,120	LS	54	CFT40/2-L	54	CFT40/2-L	72	48.00	MS	0.00	2,426
13	ECM	MS - Install Motion Sensors	#N/A	Grd&1st	Storage/Misc	-	60	3,120	LS	3	CFQ26/2-L	3	CFQ26/2-L	50	48.00	MS	0.00	94
14	ECM	MS - Install Motion Sensors	#N/A	Grd&1st	Storage/Misc	-	60	3,120	LS	27	CFT40/2-L	27	CFT40/2-L	72	48.00	MS	0.00	1,213
15	ECM	MS - Install Motion Sensors	#N/A	Grd&1st	Storage/Misc	-	60	3,120	LS	10	FU2LL/T2	10	FU2LL/T2	59	48.00	MS	0.00	368
16	ECM	MS - Install Motion Sensors	#N/A	1st	Receptionist	-	60	3,120	LS	12	F43ILL	12	F43ILL	89	48.00	MS	0.00	666
17	ECM	MS - Install Motion Sensors	#N/A	1st	Conference Rm.	-	60	3,120	LS	6	F43ILL	6	F43ILL	89	48.00	MS	0.00	333
18	ECM	MS - Install Motion Sensors	#N/A	1st	Health Suite	-	60	3,120	LS	2	CFQ26/2-L	2	CFQ26/2-L	50	48.00	MS	0.00	62
19	ECM	MS - Install Motion Sensors	#N/A	1st	Health Suite	-	60	3,120	LS	6	F43ILL	6	F43ILL	89	48.00	MS	0.00	333
20	ECM	MS - Install Motion Sensors	#N/A	1st	Health Suite	-	60	3,120	LS	3	CFT40/2-L	3	CFT40/2-L	72	48.00	MS	0.00	135
21	ECM	DL - Delamping	#N/A	1st	Library	-	60	3,120	LS	52	F42ILL	12	F42ILL	59	60.00	MS	2.36	7,363
22	-	#N/A	#N/A	-	-	-	-	-	-	-	-	0	-	0	0.00		0.00	0

PRE-INSTALLATION												POST-INSTALLATION						
Line Item	**ECM**	**Type of ECM Code** (Refer to ECM Code Worksheet)	**Additional ECM Code** (if applicable)	**Floor**	**Area Description**	**Light Reading** (Record if ECM)	**Usage**	**Baseline Annual Hours**	**Existing Control**	**Pre Fixt. No.**	**Pre Fixt Code**	**Post Fixt No.**	**Pre Fixt Code** (Refer to Wattable Table Worksheet)	**Post Watts/ Fixt**	**Proposed Weekly Hours**	**Proposed Control**	**kW Saved**	**Annual kWh Saved**
Integer line number	(Type 'ECM" if applied)	ECM CODE Worksheet Link	For two ECMs in one line item	Floor fixture is on	Description of location that matches site map	Lux (link to light standards)	hrs/ week	Existing annual hours for the usage group	Pre-installation control device	# of existing fixtures	TypWattage Table Link	# of existing fixtures	TypWattage Table	Watts/Fixt from Wattage Table	hrs / wk	Post-installation control device	Pre kW/Space - Post kW/Space	(PreFixt #*PreWatts/Fixt * Baseline Hrs) - (PostFixt#*PostWatts/Fixt * Proposed Hours)
23	-	#N/A	#N/A	-	-	-	-	-	-	-	-	0	-	0	0.00		0.00	0
24	ECM	RB - Replace Bulb	MS - Install Motion Sensors	Grd	Gym	-	60	3,120	LS	16	MH400	16	QL165	170	35.00	MS	4.61	17,913
25	-	#N/A	#N/A	-	-	-	-	-	-	-	-	0	-	0	0.00		0.00	0
26	ECM	#N/A	#N/A	1st	Auditorium	-	60	3,120	LS	25	MH100	25	MH100	128	48.00	MS	0.00	1,997
27	ECM	#N/A	#N/A	1st	Auditorium	-	60	3,120	LS	25	H90/1	25	H90/1	90	48.00	MS	0.00	1,404
28	ECM	TM - Install Timers	#N/A	Grd	Boiler Room	-	60	3,120	LS	16	F42ILL	16	F42ILL	59	48.00	MS	0.00	589
29	-	#N/A	#N/A	-	-	-	-	-	-	-	-	0	-	0	0.00		0.00	0
30	-	#N/A	#N/A	-	-	-	-	-	-	-	-	0	-	0	0.00		0.00	0
31	-	#N/A	#N/A	-	-	-	-	-	-	-	-	0	-	0	0.00		0.00	0
32	-	#N/A	#N/A	-	-	-	-	-	-	-	-	0	-	0	0.00		0.00	0
33	ECM	PS - Install Photo Sensor	#N/A	Grd&1st	Stairwell	-	60	3,120	LS	8	F42ILL	8	F42ILL	59	48.00	MS	0.00	295
34	ECM	PS - Install Photo Sensor	#N/A	Grd&1st	Stairwell	-	60	3,120	LS	18	CFQ26/2-L	18	CFQ26/2-L	50	48.00	MS	0.00	562
35	ECM	MS - Install Motion Sensors	#N/A	Grd	Computer Area	-	60	3,120	LS	24	F42ILL	24	F42ILL	59	48.00	MS	0.00	884
36	ECM	MS - Install Motion Sensors	#N/A	Grd	Computer Area	-	60	3,120	LS	5	CFT40/2-L	5	CFT40/2-L	72	48.00	MS	0.00	225
37	ECM	MS - Install Motion Sensors	#N/A	1st	Break Room	-	60	3,120	LS	3	F42ILL	3	F42ILL	59	48.00	MS	0.00	110
38	ECM	MS - Install Motion Sensors	#N/A	1st	Break Room	-	60	3,120	LS	5	CFQ26/2-L	5	CFQ26/2-L	50	48.00	MS	0.00	156
39	ECM	MS - Install Motion Sensors	#N/A	1st	Break Room	-	60	3,120	LS	8	F43ILL	8	F43ILL	89	48.00	MS	0.00	444
40	ECM	MS - Install Motion Sensors	#N/A	1st	Break Room	-	60	3,120	LS	1	CFT40/2-L	1	CFT40/2-L	72	48.00	MS	0.00	45
41	ECM	PS - Install Photo Sensor	#N/A	Grd	Exterior Wall Pack Lights	-	50	2,600	TM	14	CFQ26/2-L	14	CFQ26/2-L	50	40.00	PS	0.00	364
42	ECM	RB - Replace Bulb	#N/A	Grd	Exterior Pole Lights	-	50	2,600	TM	6	QL55	6	QL55	55	40.00	TM	0.44	1,310
43	ECM	RB - Replace Bulb	#N/A	Grd	Exterior Pole Lights	-	50	2,600	TM	7	QL85	7	QL85	85	40.00	TM	1.47	4,131
									Total Pre Fixt.	**1,120**		**1,080**	**Total Post kW**	**2,535.00**		**Total kW Saved**	**8.88**	**71,495.94**

APPENDIX G:
ECM CALCULATIONS

UIC	**Lower Domestic Hot water Temperature Set-Points**	
EAD1	**Details: Reduce Water Temp. for Building From 132 Deg. F to 120 Deg. F**	

Type of Water Heater Fuel	Natural Gas	(Select)
Insert No. of Domestic Hot Water Heaters To Be Reset:	1	Qty
Estimated/Actual Annual Domestic Water Heating Fuel Supply:	6,000	Therms
Name Plate System Effficiency:	80.00%	
Supply Water Temperature:	65	°F
Current Water Heater Setpoint Temperature:	132	°F
The Proposed Water Heater Setpoint Temperature:	120	°F
Estimated New Annual Energy Consumption At Supply With Reduced Domestic Hot Water Temperature Set Point	4925.37	Therms
Estimated Annual Heating Fuel Savings:	1074.63	Therms
Average Cost/Unit of Heating Fuel $$/ Therms	**$1.08**	$$
Estimated Annual Cost Savings:	$1,162.28	$$
Does The HoT Water Heater Have A Manual Temperature Control?	Yes	
Installed Cost of All Programmable Aquastat:	$0.00	$$
Simple Payback:	0.00	years
Type of Recommendation	No/Low Cost ECM Recommendation	

UIC	Install Timers On Rooftop Exhaust Fans
EAC7A	Details: Restroom Exhaust Fans

EXISTING CONDITION

No. of Fan Motors:	8.00	Qty
Total HP of Fans	2.00	HP
Total kW:	1.492	kW
Existing Annual hours of operation:	1758.00	Hr
Annual kWh:	2622.94	kWh

PROPOSED CONDITION

New Annual Hours With Timers:	740.00	Hr
New Annual kWh:	1104.08	kWh
Annual kWh Savings:	1547.37	kWh

COST ANALYSIS

Cost/kWh:	**$0.20**	$$
Annual Cost savings:	$310	$$
Installed cost/timer:	$60.00	$$
Total Cost of Installment of Timers	$379	$$
Simple Payback:	1.22	Yrs

Type of Recommendation — No/Low Cost ECM Recommendation

UIC	**Install Automatic Lighting Controls**		
EAL5	**Details: Use Photosensors in 2 Main Stairwells**		
	Type of Sensor	Internal Photosensors	
Step: 1	Total Number of Sensors	2	
Step: 2	Purchase Cost/Lighting Control Sensors	$15	
Step: 3	Installation Cost /Sensor	$65	
Step:4	Total Installation Costs	$126.40	
Step:5	Total Energy Savings	5805.00	kWh
Step:6	Electric Tariff Rate	**$0.20**	$
Step:7	Total Cost Savings	$1,162.92	
Step:8	Simple Pay Back Period	0.11	Years
Type of Recommendation		No/Low Cost ECM Recommendation	

UIC	Replace High Flow Faucet Aerators To Low Flow Faucet Aerators
EAP2	Details: Replace 2.2 GPM Aerators w/ 1 GPM Aerators in All Bathroom Sinks

No. of Residents	10		Number of Occupied Days/Week (Max 7)	5	
KITCHEN FAUCETS			**BATHROOM FAUCETS**		
Do You Want To Replace Kitchen Faucets	No	*(Select)*	Do You Want To Replace Bathroom Faucets	Yes	*(Select)*
Total Number of Faucet Aerators To Be Replaced	0		Total Number of Faucet Aerators To Be Replaced	14	
GPM of Existing Faucet Aerators	3.2	GPM	GPM of Existing Faucet Aerators	2.2	GPM
GPM of Proposed Faucet Aerator	2.2	GPM	GPM of Proposed Faucet Aerator	1	GPM
Estimated Number of Uses Per Day	0		Estimated Number of Uses Per Day	10	
Estimated Time Per Faucet Use	0.50	Mins	Estimated Time Per Faucet Use	0.16	Mins
Annual Water Savings From Kitchen Faucets *(Assuming 3 uses/day/person for 365 days a year)*	0.00	kGal	Annual Water Savings From Kitchen Faucets *(Assuming 3 uses/day/person for 213 days a year)*	2.88	kGal
WATER & ENERGY SAVING CALCULATION			**COST SAVING CALCULATION**		
Select Type of Water Heater Fuel:	Natural Gas	(Select)	Heating Fuel Tariff	$1.082	$$
DHW plant efficiency:	80%		Water Tariff ($/1000 Gal)	**$9.00**	$$
Equivalent Heating Energy savings:	3742.53	kBtu	Annual Cost Savings In Form of Water	$26	$$
Equivalent Heating Fuel Savings:	37.43	Therms	Annual Energy Savings From Water Heater	$40	$$
Annual Water Savings *(Assuming 3 uses/day/person for 365 days a year)*	2.88	kGal			
COST BENEFIT ANALYSIS					
Estimated Total Annual Cost Savings	$66	$$	Estimated Total Installation Cost	$111	$$
Simple Payback Period	1.67	Years	*Type of Recommendation*	No/Low Cost ECM Recommendation	

UIC	**Reduce Light Levels By Delamping of Lamps**	
EAL8	**Details: Remove excess lamps above perimeter bulkhead in Main**	
No of Incandescent lamps to be removed	0	Qty
No. of Linear Fluroscent Lamps To Be Removed	80	Qty
No. of Fixtures To Be Delamped	0	Qty
Estimated Cost of Delamping *(Assuming Labor Charge of $65/hr)*		
Delamping of Incandescent Lamps *($65/30 Lamps)* *(Assuming Lamp Location at a 8-10' Ceiling Height)*	$0.00	$
Delamping of Linear Fluroscent Lamps *($65/20 Lamps)* *(Assuming Lamp Location at a 8-10' Ceiling Height)*	$260.00	$
Install Parabolic Reflectors?	**No**	
No of Fixturs To be Installed With Reflectors? *($90/Fixture(Includes instalation)*	0	
Total Estimated Delamping Cost	$205	$
Total Energy Saved	7363.00	kWh
Existing Electric Tariff per kWH	**$0.20**	$
Estimated Annual Cost Savings	$1,475.04	$
Estimated Return on Investment	0.14	Years
Type of Recommendation	No/Low Cost ECM Recommendation	

UIC	**Convert Gas Pilot Stoves To Electronic Ignition Stoves**
EAA5	**Details: Add to Kitchen Stove and Oven Unit**

Cost of conversion from standing gas pilot to electronic ignition for one stove:							
						$158.00	
Enter total number of gas stoves in the project:						1	
Total cost of conversion for all stoves:						$158.00	
Transfer the following information from the Survey:							
a	Estimated total annual natural gas savings/Range:					34.00	therms/yr
b	Estimated Savings From All Ranges					34.00	therms/yr
c	Cost/therm of natural gas:					**$1.08**	$/therm
Estimated annual cost savings through conversion:							
		therms		cost/therm		savings	
		34.00	x	1.08	=	$36.77	$/yr
Calculate payback period:							
		$158.00	/	$36.77	=	4.30	yrs
Type of Recommendation		No/Low Cost ECM Recommendation					

UIC	Install Energy Savers on Vending, Snack Machines
EAC8	Details: Soda Machine in Faculty Lounge

No. of Vending Machines: 1.00 Qty | No. of Chilled Water Fountains: 0.00 Qty

No. of Snack Machines 0.00 Qty

Vending Machines (Cold Beverage Vending Machines)		
Estimated Annual kWh Consumption of Vending Machine:	3500.00	kWh
Estimated Annual kWh of Vending Machine With VendMiser:	1890.00	kWh
Total annual kWh savings:	1610.00	kWh
Total Annual kWh Savings for All Vending Machines:	1610.00	kWh
Beverage Cooling Machines		
Estimated Annual kWh Consumption of Beverage Cooling Machine:	2300.00	kWh
Estimated Annual kWh of Cooling Machine With CoolerMiser:	1610.00	kWh
Total Annual kWh savings:	690.00	kWh
Total Annual kWh Savings For All Cooling Machines:	0.00	kWh
Snack Vending Machines		
Estimated Annual kWh Consumption of Individual Snack Machine:	873.60	kWh
Estimated Annual kWh of Individual Snack Machines With VendMiser:	366.91	kWh
Total Annual kWh savings:	506.69	kWh
Total Annual kWh Savings For All Water Fountain Coolers:	0.00	kWh
Cost Analysis		
Total estimated annual kWh savings withEnergy Misers:	**1610.00**	kWh
Cost/kWh:	**$0.20**	
Estimated Cost of Vendmiser/ Vending Machine:	$200	
Estimated Cost of Coolermiser/ Water cooler:	$190	
Estimated Cost of Vendmiser/ Snack Machine:	$70	
Estimated total installed cost of all VendMisers:	**$200**	
Estimated Total Annual Electricity Savings Using VendingMisers and CoolerMisers:	**$323**	
Simple Payback:	0.62	years

Type of Recommendation No/Low Cost ECM Recommendation

UIC	Install Outside Air (OA) Temperature Reset Controls for Hot Water Boilers
EAC5	**Details: Utilize Outside Air Reset in Central BMS HVAC Control System**

Select Type of Heating Fuel	Natural Gas	(Select)	
Estimate Actual Heating Fuel Used Annually		31,072	Therm
Total Estimated Energy Savings By Use of OA Temperature Reset Control:		10%	%
Estimated New Heating Fuel Consumption With Improved System Efficiency:		27964.80	Therm
Estimated Annual Heating Fuel Savings:		3107.20	Therm
Cost Per Unit of Heating Fuel:	$$/ Therm	**$1.08**	$$
Estimated Annual Cost Savings:		$3,361	
Installed cost of a OA Reset controller:		$645	
Simple Payback:		0.19	years
Type of Recommendation	No/Low Cost ECM Recommendation		

UIC	Install Low Flow Restroom Fixture
EAP4	Details: Replace Urinals in all Male Bathrooms w/ Low Flow Fixtures

ECM FOR DETERMINING WATER SAVINGS IN COMMERCIAL PROPERTIES

Number of Males		340	
Number of Females		340	
Number of Occupied Days Per Week (Max 7)		5	
Number of Urinals To Be Retrofitted		4	
Number of Water Closets To Be Retrofitted		0	
No. of Water Closets With Separate Flush Tank *(Typical Residential Type)*		0	
Estimated Restroom Usage/Individual/Day *Default is 4 Uses/Day For Residential/Office*		1	(Select)

Urinal Water Savings

Do You Want To Make Any Changes To The Urinals?	*(Select)*	Yes	
Estimated Existing Use of Urinal/Day/Man		80%	
Existing Gallons Per Flush Ratings For Urinal Flushes		3.50	GPF
GPF of Proposed Urinal Flush Valve** ***(1992 EpACT Energy Act Mandates 1.0GPF Max on Urinals)*	*(Select)*	1.00	GPF
Estimated Annual Water Savings From Urinal		102.00	kGal

Water Closet Water Savings

Tankless Water Closets			
Do The Water Closet Need To Be Retrofitted?	*(Select)*	No	
Existing Gallons Per Flush Ratings For Water Closet Flushes		3.40	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 WaterClosets		0	
GPF of Proposed Dual Flush- Water Closet Valve*	*Solid Waste (20%)*	3.40	GPF
**(Fedral Law Requires All Flushes Not To Exceed 1.6 GPF)*	*Liquid Waste (80%)*	1.02	GPF
Estimated Annual Water Savings From Male Users		19.42	kGal
Estimated Annual Water Savings From Female Users		97.10	kGal
Total Water Savings From Water Closets		0.00	kGal

Water & Cost Saving Calculations

Water Savings Calculation		
Water Savings By The Use of Low Flow Water Closet Flush Valves/Yr	0.00	kgal
Water SavingsBy The Use of Low Flow Urinal Flush Valves/ Yr	102.00	kgal
Total Annual Water Savings in kgal	102.00	kgal
Cost Savings Calculations		
Enter Water Tariff Rate ($/1000Gal)	$9.00	$$
Estimated Cost Savings From Water	$918	$$

Estimated Cost of Retrofit		
Cost For Replacing Existing Urinal Fixture With A Low Flow Fixture	$700.50 *(Includes Labor)*	$$
Cost For Replacing Existing Flush Valves With Low Flow - Dual Flush Valves ($80 Per Unit) *(Up For Liquid Waste And Down For Solid Waste)*	$0.00 *(Includes Labor)*	$$
Estimated Total Cost For Retrofit	$700	$$
Simple Pay Back Period	0.76	Yrs
Type of Recommendation	No/Low Cost ECM Recommendation	

UIC	Install Variable Frequency Drives (VFD)
EAC4	Details: on (2) 10 Hp Boiler Hot Water Recirculation Pumps

Cost/kWh: $0.20

Install VFD on

No. of Motors:	2		No. of VFD To Be Installed	2
Individual Motor HP:	10	HP	Motor Effiecincy:	87.50%
Load Factor:	85%		Annual hrs of operation:	2500.00
Full load input power:	7.25	kW	Cost of new motor & VFD (Excluding Installation)	$3,550.00
			Estimated Labor cost:	$1,684.50

% Load	% hours	Hours	VFD Factor	Full Load kW	Fraction of full load power (kW) with VFD	kW Reduction with VFD	kWh Savings with VFD
0%	0%	-	-	7.25	0.00	7.25	-
10%	1%	25	0.03	7.25	0.22	7.03	176
20%	2%	50	0.07	7.25	0.51	6.74	337
30%	2%	50	0.13	7.25	0.94	6.30	315
40%	5%	125	0.21	7.25	1.52	5.73	716
50%	20%	500	0.30	7.25	2.17	5.07	2,536
60%	20%	500	0.41	7.25	2.97	4.28	2,138
70%	20%	500	0.54	7.25	3.91	3.33	1,667
80%	15%	375	0.68	7.25	4.93	2.32	870
90%	10%	250	0.83	7.25	6.01	1.23	308
100%	5%	125	1.00	7.25	7.25	-	-
Total		**2,500**					**9,062**

Total Instalation Cost:	$10,469	
Average kW Reduction:	5.50	
Annual kWh Savings Per Motor:	9062.19	per VFD

Select Type Of Motor Configuration: Motors Run Parallel/Series

Total Savings From All Motors: 18124.39 kWh (total for all VFDs)

Estimated annual cost savings: $3,631 $$

Simple payback: 2.88 years

Type of Recommendation: Capital Cost ECM Recommendation

UIC	**Install Automatic Lighting Controls**		
EAL5	**building**		
	Type of Sensor	Ceiling Mounted Occupancy Sensor	
Step: 1	Total Number of Sensors	140	
Step: 2	Purchase Cost/Lighting Control Sensors	$135	
Step: 3	Installation Cost /Sensor	$65	
Step:4	Total Installation Costs	$22,120.00	
Step:5	Total Energy Savings	65690.00	kWh
Step:6	Electric Tariff Rate	**$0.20**	$
Step:7	Total Cost Savings	$13,159.74	
Step:8	Simple Pay Back Period	1.68	Years
Type of Recommendation		Capital Cost ECM Recommendation	

UIC	Retro-Commission The Building HVAC & Control System	
EAC10	Details: Balance Flows and Verify Proper Operation of all Equipment	

Enter the Total Area of The Facility	87,570	SqFt
Select the Type of Heating Fuel:	**Natural Gas**	*(Select)*
Estimated Annual Heating Fuel Consumption:	31,072	Therms
Is the Property Cooled?	**Yes**	*(Select)*
Estimated Annual Electrical Energy Consumed For Cooling & Ventilation:	465,000	kWh
Estimated Energy Savings From Re-Commissining on Building Systems: *(LBNL 2009 Report on Building Commissioning)*	5%	
Estimated Heating Energy Saving Post Re-Commissioning:	1,554	Therms
Estimated Cooling Energy Saving Post Re-Commissioning:	23,250	kWh
Average Heating Fuel Rate Paid By The Property:	$1.08	$/Therm
Average Electrical Rate Paid By The Property:	$0.20	$/kWh
Annual Energy Cost Savings:	$6,338	$
Estimated Cost For Re-Commissioning The Facility: *(LBNL 2009 Report on Building Commissioning)*	$30,650	$
Simple Payback Period:	4.84	Yrs

Type of Recommendation Capital Cost ECM Recommendation

UIC	Replace Inefficient Heating Plant
EAH 1A	Details: Add one 3,200 MBH/97% Eff. High Efficiency Condensing Boiler as Primary

Select Type of Heating Fuel		Natural Gas	(Select)
No. of Heating Units To Be Replaced:		1	Qty
Estimated Actual Heating Fuel Used For Heating:		31,072	Therms
Existing Average Annual Heating Plant Efficiency:		85.6%	%
Improved/New Heating Plant Efficiency:		94.0%	%
Estimated New Heating Fuel Consumption With Improved Efficiency:		28,295	Therms
Estimated Heating Fuel Savings:		2,777	Therms
Average Cost/Unit For Heating Fuel:	$$/ Therms	**$1.08**	$$
Estimated Annual Cost Savings:		$3,003	$$
Estimated Annual O&M Savings:		$150	$$
Removal of Existing Heating Equipment Cost:		$0	
Installation Labor Cost of Installing New Equipment:		$10,000	
Material Cost of New Equipment:		$76,800	
Overhead, Profit, and Contingency Costs:		$0	
Estimated Cost of New Heating Plant (or Cost of Improvement)		$86,800	$$
Estimated Total Cost For Replacing All Heating Plants:		$86,800	
Simple Payback:		27.53	years
Type of Recommendation		Capital Cost ECM Recommendation	

UIC	Improve Insulation Levels in Attic
EAE3	Details: Add Insulation to Ceiling of Auditorium, Cafeteria, and Gym

ENTER EXISTING CONDITION

Select Climatic Zone Related To The Property Location:	Zone-5	(Select)	ASHRAE 90.1 Attic- Insulation Requirement:	R-38	
Enter Total Surface Area Under Consideration:	13518.00	Sq.Ft	Existing Net Effective R-Value: (Sq.Ft deg F/btu)	20	
Proposed Type of Insulation To Be Added:	Batt Insulation	(Select)	Proposed Insulation Recommendation:	Partial Upgrade	(Select)
Recommended Level of Insulation To Be Added:	R-30		Proposed Net Effective R-Value: (Sq.Ft deg F/btu)	40	

ENTER CLIMATIC & SYSTEM DATA

Annual Cooling Degree Days (CDD):	1199.00		Estimated Annual Cooling Plant Efficiency (EER):	11.00	EER
Annual Heating Degree Days (HDD):	5469.00		Estimated Annual Heating Plant Efficiency: %	80.00	%

WINTER			SUMMER		
Select Type of Heating Fuel	Natural Gas	(Select)	Is the Property Cooled ?	Yes	(Select)
Annual Conduction Losses From Existing Insulation	88715.93	kBtu	Annual Conduction Losses From Existing Insulation	19449.70	Kbtu
Annual Conduction Losses From Proposed Insulation	44357.97	kBtu	Annual Conduction Losses From Proposed Insulation	9724.85	kBtu
Savings In Conduction Losses After Adding Insulation	44357.97	kBtu	Savings In Conduction Losses After Adding Insulation	9724.85	kBtu
Estimated Total Annual Input Heating Energy Savings	554.47	Therms	Estimated Total Annual Input Cooling Energy Savings	884.08	kWh
Cost of Heating Fuel/Unit: Therms	$1.08	$$	Cost of Electricity/Unit	$0.20	$$
Annual Heating Cost Savings	$599.70	$$	Annual Cooling Cost Savings	$177.11	$$

COST ANALYSIS

Estimated O&M Savings	$7.77	$$	Estimated Cost To Add Insulation on	$18,114.12	
Total Estimated Annual Cost Savings	$785	$$	Estimated Total Installation Cost	$38,000	$$
Simple Pay Back Period	48.43	Years	*Type of Recommendation*	Capital Cost ECM Recommendation	

UIC	Replace High Intensity Discharge Lamp (HID) with Induction Lighting
EAL9	Details: Outside Pole Lights, Gym Lights, and Auditorium Lights

Step:1	Number of 60-100W HID Lamps Replaced by 40W Induction	6	
	Number of 100-150W HID Lamps Replaced by 70W Induction	0	
	Number of 150-200W HID Lamps Replaced by 85W Induction	7	
	Number of 200-250W HID Lamps Replaced by 120W Induction	0	
	Number of 250-300W HID Lamps Replaced by 165W Induction	0	
	Number of 300-400W HID Lamps Replaced by 250W Induction	16	
	Number of 1000W HID Lamps Replaced by (2)300W Induction Lamps	0	
	Installation Cost Analysis		
Step:2	Subtotal Cost of 40 Watt Induction Self Ballast Retrofit	$810	
Step:3	Subtotal Cost of 70 Watt Induction Retrofit	$0	
Step:4	Subtotal Cost of 85 Watt Induction Retrofit	$2,695	
Step:5	Subtotal Cost of 120 Watt Induction Retrofit	$0	
Step:6	Subtotal Cost of 165 Watt Induction Retrofit	$0	
Step:7	Subtotal Cost of 250 Watt Induction Retrofit	$8,880	
Step:8	Subtotal Cost of 300 Watt Induction Retrofit	$0	
Step:9	**Total Cost For Retrofit**	$9,784	
	Energy & Cost Saving Analysis		
Step:10	Estimated Annual Energy Savings	20369.00	kwh
Step:11	Current Electric Price Per kWh	$0.20	$
Step:12	Estimated Annual Cost Savings	$4,081	
Step:13	Existing Annual Usage *(For O&M Savings)*	1440	hrs
	Proposed Annual Usage Post Retrofit *(For O&M Savings)*	1440	hrs
	Estimated Annual O&M Savings	$186	$$
Step:14	Total Estimated Annual Cost Savings *(Energy & O&M Savings)*	$4,267	$$
Step:15	Simple Pay back Period	2.29	Yrs

Type of Recommendation — Capital Cost ECM Recommendation

NOTE: Induction Lamps contain 3 to 4 times the life of HID lamps where significant Operation and Maintanence Savings are attained through minimizing frequency of bulb and ballast replacements

UIC	Replace Existing RTUs with High Efficiency Units with Variable Speed Oil Free Compressors
EAH9	Details: Install High Efficiency units at time of replacement

Please input the total number of RTUss in the building: 1.00 Cost/kWh: **$0.20**

Existing RTUs		New RTUs with Oil free variable Speed Compressors	
Please enter the total tons (capacity) of the RTUs:	350.00	Please enter the capacity of the new High Eff. RTUs	350.00
Please input the existing EER the RTUs:	10.00	Please input the design achievable EER of the new RTUs:	24.00
Existing kW/ton:	1.20	New kW/ton:	0.50
Estimated annual operating hours:	400.00	Estimated new annual operating hours:	400.00
Existing annual kWh consumption for the RTUs:	168000.00	Annual kWh consumption for the new High Eff. RTUs with oil free variable speed compressors:	70000.00

ew RTUs

Multi-Mod design Energy Saving Results

Annual kWh savings with new RTUs:	98,000
Estimated total annual cost savings:	$19,632.43
Estimated Annual O&M Savings:	$588.97
Total Annual Cost Savings:	$20,221
Estimated cost to install new RTUs	$440,000
Simple Payback (years):	21.76

Type of Recommendation

Capital Cost ECM Recommendation

Incremental Cost Vs Standard efficiency units:	$105,000
Simple Payback (years) for premium recovery:	5.35

APPENDIX H:
SUPPORTING DOCUMENTS

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