ENERGY AUDIT
REPORT

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

ENERGY AUDIT REPORT

of

HILLSIDE ELEMENTARY SCHOOL

28 Glen Gary Road
Needham, Massachusetts 02492

PREPARED BY:

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EMG Project #: 98515.11R-003.268
Date of Report: February 12, 2012
On site Date: September 6, 2011

EMG
DECISION INTELLIGENCE
25th ANNIVERSARY

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1. CERTIFICATION

EMG has completed an Energy Audit of Hillside Elementary School located at 28 Glen Gary Road in Needham, Massachusetts. EMG visited the site on September 6, 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: Abdul Basit
Energy Auditor
Project Manager

Reviewed by: 

Brett Byers, Reviewer for
Kalyana Vadala
Program Manager

2. EXECUTIVE SUMMARY

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

Hillside Elementary School is a two-story building containing 39,300 square feet; this includes classrooms, offices, kitchen and cafeteria, and a gymnasium; attached to the building is a modular section that includes additional classrooms. The site area is approximately 4 acres. The original construction of the property was completed in 1960, with additions in 1963 and 1990; the modular section was added in 1968. Significant renovations to the mechanical system include replacing the domestic hot water heaters in 2011, and also replacing the condensation system in 2010 including the steam traps. Significant renovations to the building structure included replacement of the roof in 2006.

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

Based on conversations with the client contacts (and confirmed during the site visit), the client is pursuing an aggressive energy management program of town-owned facilities. This has included installing motion sensors, installing energy efficient lighting (such as T-8 lighting), and controlling building temperature with a building management system.

According to the client, the school will be demolished and a new school will be built; this will commence in around 2017. Since the school will be reconstructed, this study will focus on those energy recommendations that will provide a payback in less than 5 years.

Summary of Existing Energy Performance

Building's Annual Energy Consumption	5,160,411 kBtu
Total Annual Energy Costs	$142,848

EMG has identified six 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	$ 4,129 *(In Current Dollars)*
Estimated Annual Cost Savings Related to ECMs	$1,228 *(In Current Dollars)*
Net Effective ECM Payback	3.36 years
Estimated Annual Energy Savings	0.63%
Estimated Annual Cost Savings	0.85%

Detailed Summary of Recommended Energy Conservation Measures

List of Recommended Energy Conservation Measures For Hillside Elementary School										
ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Total Energy Savings	Estimated Annual Water Savings	Estimated Cost Savings	Estimated Annual O&M Savings	Total Estimated Annual Cost Savings	Simple Payback
		$	Gallons	kWh	MMBtu	kgal	$	$	$	Years
No/Low Cost Recommendations										
1	Replace Incandescent Lamps With CFL's Details: Replace Incandescent lamps with CFL's in Storage Areas and Kitchen	$26	0	78	0	0	$15	$1	$15	1.72
2	Install Timers On Rooftop Exhaust Fans Details: Install Timers on Rooftop Exhaust Fans	$284	0	2280	8	0	$430	$0	$430	0.66
3	Control External Air Leakage In The Building Details: Install weatherstripping on entrance doors	$395	56	0	8	0	$145	$7	$152	2.59
4	Insulate Hot Surfaces And Tanks Details: Insulate Condensate Tank in Boiler Room	$515	71	0	10	0	$185	$0	$185	2.79
5	Install Automatic Lighting Controls Details: Install Photo-sensors on Lighting Fixtures near Windows	$885	0	1404	5	0	$265	$0	$265	3.34
Totals for No/Low Cost Items		**$2,106**	**127**	**3,762**	**30**	**0**	**$1,040**	**$8**	**$1,047**	**2.01**

Capital Cost Recommendations										
1	Replace High Intensity Discharge Lamp (HID) with Induction Lighting Details: Install Induction lighting for Parking and Exterior Building Lighting	$1,485	0	1614	6	0	$305	$12	$317	4.69
Total For Capital Cost		**$1,485**	**0**	**1614**	**6**	**0**	**$305**	**$12**	**$317**	**4.69**
	Interactive Savings Discount @ 10%		-13	-538	-4		-$134	-$2	-$136	
	Total Contingency Expenses @ 15%	$539								
Total for Improvements		**$4,129**	**114**	**4,838**	**32**	**0**	**$1,210**	**$18**	**$1,228**	**3.36**

Apart from the above recommended measures, EMG has analyzed the following 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 are recommended either at the time of equipment replacement or renovation.

Detailed List of Measures Evaluated For Consideration Hillside Elementary School										
ECM #	Description of ECM	Initial Investment	Annual Energy Savings		Total Energy Savings	Annual Water Savings	Cost Savings	Estimated Annual O&M Savings	Total Estimated Annual Cost Savings	Payback
		$	Gallons	kWh	MMBtu	kgal	$	$	$	Years
1	Replace Existing Freezers With High Efficiency Freezers Details: Replace Freezer in Kitchen with High Efficiency Freezer	$442	0	85	0.29	0	$16	$0	$16	27.58
Total for Improvements		**$442**	**0**	**85**	**0**	**0**	**$16**	**$0**	**$16**	**27.58**

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.

Based on this analysis, the Hillside Elementary School is performing below the national average level.

Below is the EPA Performance Rating:

Hillside Elementary School:	12
National Average K-12 School:	50
Rating required to apply for Energy Star Certification:	75

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. The building's Statement of Energy Performance follows. Associated energy performance documents may be found in Appendix H.

Facility
Needham: Hillside Elementary School
28 Glen Gary 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: Hillside Elementary School	
Gross Floor Area Excluding Parking: (ft²)	39,300
Year Built	1960
For 12-month Evaluation Period Ending Date:	June 30, 2011

Facility Space Use Summary

School	
Space Type	K-12 School
Gross Floor Area(ft²)	39,300
Open Weekends?[d]	No
Number of PCs[d]	69
Number of walk-in refrigeration/freezer units	2
Presence of cooking facilities[d]	Yes
Percent Cooled[d]	100
Percent Heated	40
Months[d]	9
High School?	No
School District[d]	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	12	12	75	N/A	50
Energy Intensity					
Site (kBtu/ft²)	132	132	69	N/A	89
Source (kBtu/ft²)	210	210	110	N/A	141
Energy Cost					
$/year	$ 144,041.30	$ 144,041.30	$ 75,743.51	N/A	$ 96,859.68
$/ft²/year	$ 3.67	$ 3.67	$ 1.93	N/A	$ 2.47
Greenhouse Gas Emissions					
MtCO$_2$e/year	430	430	226	N/A	289
kgCO$_2$e/ft²/year	11	11	6	N/A	7

4. INTRODUCTION

The purpose of this Energy Audit is to provide Hillside 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, Make-Up Air Units, 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.

ENERGY AND WATER USING EQUIPMENT

- EMG has surveyed the common areas, office areas, classrooms, 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 paybacks based on current utility rates and expected annual savings.

5. FACILITY OVERVIEW AND EXISTING CONDITIONS

5.1. BUILDING OCCUPANCY

Typically, 430 people, on average, occupy the facility during normal operating hours. After hours occupants include approximately 10 or more people. The building is open from 6 AM to 5 PM during the school year; in addition, portions of the building maybe opened after hours for special events. Thus, the building can be operational until 10pm. During the summer, the school normally does not remain open; however, the school, including the gym, may be opened for special events or for rental purposes.

Facility Occupancy (avg. people/day)	430
Standard Operating Hours/day	10 hours
Maintenance/ Staff Hours/day	10 hours

Summary of Facility Operating Hours

	Hours Open to the Public	Hours Open to Employees
Monday-Friday	7 AM to 4 PM	6 AM to 5 PM
Saturday	closed	closed
Sunday	closed	closed

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.

According to the structural drawings, the foundations consist of a conventional, reinforced concrete, slab-on-grade foundation. Also, based on the structural drawings, the second floor is pre-cast concrete.

Further, according to the structural drawings, the primary roofs are both flat and steeply sloped. The flat roofs are finished with aggregate over a built-up membrane. Beneath the flat roof, there is approximately two to three-inches of tapered insulation. The only portion of the roof that is sloped is the gymnasium area; here, the roof is sloped with a flat stock insulation.

The exterior walls are brick and panel. The east, west and south sides of the building are brick and panel while the north side is brick. According to the structural drawings, the exterior walls have 1.5-inches of rigid insulation, and the interior wall is four-inch CMU. There was no reported air infiltration issues with the brick or panel exteriors and these structures appeared to be in good condition.

Item	Construction Type
Foundation	Slab-on-grade
Structure	Concrete
Exterior Walls	Brick and Panel
Roof	Flat and sloped with gravel

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

Building Element	Type Observed	Observed R-values
Roof	Rigid	R - 10
Floors	Not Accessible	
Exterior Walls Above Grade	Rigid – 1.5 inches	R - 6
Basement Walls	Not Applicable	
Windows	Single and Double Pane	R-0.91
Exterior Doors	Metal Insulated Doors	R-15

The windows are both aluminum-framed and wood-framed; this includes single-pane glazed and double-pane glazed units. The caulking was in fair condition. Air infiltration was not reported near the windows.

The main entrance doors (and other entrance doors) are insulated steel doors. The glazing is double-paned. Weather stripping was observed around the door openings. The weather stripping was observed to be in fair to good condition.

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

Hillside elementary school has a central heating system, window units in classrooms, two roof top packaged heat pump units for the modular section, and electric baseboard heaters in the modular section.

The central heating system uses two low pressure steam boilers (Weil McLain, model #1488, 31 GPH #2 oil, 1989) to supply steam to unit ventilators in the classrooms and other areas of the building (such as the cafeteria and the library). The boilers operate on a lead-lag schedule; each month, one boiler is the lead boiler and the following month the lead is shifted to the other boiler. Thus, one boiler normally provides enough heat for the building.

During the on site visit, it was observed that the unit vents were providing air at about 0.67 cfm/square foot. The room temperatures averaged about 74 to 76 degrees F, and the relative humidity was 52%.

The heating system was retrofitted with new actuators and valves in 2010. The steam boilers combustion chambers were cleaned within the last year; and further, the boilers are annually maintained; and the steam traps were replaced in 2010.

The boilers and unit ventilators are controlled by a central building management system (Lon works) that maintains room temperature. The boilers are controlled by outside air and will only turn on if the outside air temperature falls below 60 ^{0}F.

The steam from the boilers, which is at 8-9 psi, is also sent to two air handling units which serve the gymnasium and the cafeteria. During the week of the on site visit, since steam is not being used, the pressure was minimal (0.2 psi according to the BMS system). During the winter, each air handling unit brings in outside air and brings the temperature to 68 degrees F. During the summer, the boilers will not operate, and fresh outside air is brought in unconditioned. The air handling unit for the gymnasium will start at 4am since there is a lack of insulation in the gym and this requires the air handling unit sufficient time to heat the area.

Normally, about 20% outside air is brought into the building; the amount of outside air is based on the temperature requirements inside the building.

In addition to the central heating system, the classrooms have window units for cooling. The window units (10,000 BTUH and 28,000 BTUH) are manually controlled by the teachers. During the on site visit, only one unit was operating in classroom #8 – the room temperature was 67 degrees F which was about 7-8 degrees less than the rest of the building. The window units use R-22 refrigerant.

The modular section has two classrooms that are conditioned by two electric roof top packaged heat pump units. During the on site visit, a ladder was not available to observe the model number and size of the units. Based on the size of the units, it appears that the units are about 5 tons each. There are also two electric radiator units and also a wall unit heater; all of these units are located in the hallway of the modular section.

The stair wells, bathrooms, and other areas are ventilated by mechanical exhaust fans. Large capacity ventilation fans are mounted on the roof and are connected by concealed ducts to each ventilated space.

Item	Measured Values
Major Heating system type/capacity	Two Steam Boilers, 31 GPH #2 Oil each
Major Cooling System type/capacity	Window Units, 10,000 and 28,000 BTUH
Heating hot water supply temperature	Not Applicable - Steam
Chilled water supply/return temperatures	Not applicable
Condenser water supply/return temperatures	Not applicable
Outside Air temperature & Relative Humidity (%) at time of audit	76 degrees F and 52%
Interior space temperatures & Relative Humidity (RH%)	76 degrees F and 52%
Supply Air Temperature (SAT)/Return Air Temperature (RAT)	SAT: 68 degrees in Winter
Avg. Supply Air rate (CFM/Sq.ft)	0.67 CFM/Sq.ft

Item	Measured Values
Avg. Interior space thermostat set-point	68 degrees F
Avg. Outside Air rate (% & CFM/Sq.ft or CFM/person)	20%

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

5.4. BUILDING LIGHTING

All of the lighting in the classrooms, hallways, and other common areas is T-8 lighting; the only exception is the gymnasium has large 400 watt fixtures. The classrooms, offices, restrooms, and the library are controlled by a wireless motion sensor system. The hallways the boiler room are controlled by light switches.

Based on the light readings, it is recommended that lighting near windows in classrooms should be controlled with photo-sensors. If there is enough light from the outside then the perimeter lights will not turn on; if the light levels go below a programmed level, the perimeter lights will come on. The lights will still be controlled by the motion sensors and will not turn on when the classroom is not occupied.

In addition, there are several areas with incandescent bulbs (kitchen and storage rooms) that can be converted to fluorescent lighting.

There are several different exterior building lighting systems. This includes fluorescent lighting and metal halide lighting; these are controlled by timers.

There is one pole with two 200-watt metal halide lights for the parking area.

Space type	Measured Light Levels (Lux/foot candles)	ASHRAE/IESNA Recommended Levels (foot candles)
Lower level Hallway	200 Lux/18.6 FC	15
Classroom areas	300 Lux/28 FC	30
Office areas	175 Lux/16 FC	50
Gymnasium	150 Lux/14 FC	60
Avg. Building Lighting Density, W/Sq.Ft	0.658 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

Not applicable. There are no elevators or conveying systems.

5.6. BUILDING DOMESTIC HOT WATER

There are two 67-gallon oil-fired water heaters located in the boiler room that supply domestic hot water. The water heaters and circulation pumps (1/25 hp) were installed in 2011. Only one water heater is needed to supply water to the building. It was noted during the on site visit that the domestic hot water is set at 140 degrees F for both the restrooms and the kitchen.

The common area restrooms have commercial-grade fixtures and accessories, including water closets and lavatories. The water closets are equipped with manual flush valves. The typical flush volume was 1.6 GPF. The lavatories are equipped with aerators rated at 0.5 GPM. In addition, each classroom has a sink with a 2.0 GPM faucet aerator.

DHW type	Oil-fired Self-storing
Storage Tank Capacity	67 gallons
Heating/tank set-point	140°F
DHW temperature at faucet	130°F
Building faucets, GPM	0.5 and 2.0
Water closets/toilets, GPF	1.6

5.7. BUILDING NATURAL GAS AND ELECTRICITY

The electrical supply lines run underground from pole-mounted transformers to interior-mounted electrical meters.

The main electrical service size is 1,000 amps 120/240-volt single-phase three-wire alternating current (AC). The electrical wiring is copper, installed in metallic conduit cable. Circuit breaker panels are located throughout the building.

The facility is master-metered for electricity. There are a total of two electric meters at the property.

Mounting	pole-mounted
Location	Meter – interior, transformer - rear of building
Main Building Electric service	Yes
Primary Volts	240
Secondary Volts	120/208
Phase	3
Wire	4
Amp	1000
On site Generator (Y/N)	No
Generator Capacity, KVA	N/A
Generator Fuel Type	N/A

Electric Meter type (Master/Sub/Direct)	Master	Natural Gas Meter type (Master/Sub/Direct)	Not Applicable
Meter Location	Electric Room	Meter Location	N/A
Main meter number	05022542 and 04022543	Main meter number	N/A

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-uses throughout the buildings. The Historical Data Analysis breaks down utilities by consumption, cost and annual profile.

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

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

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

Based upon the utility information provided about the Hillside Elementary School, the following energy rates are utilized in determining existing and proposed energy costs.

Utility Rates used for Cost Analysis

Electricity (Blended Rate)	No. 2 Oil
$0.19/kWh	$2.60 /gallon

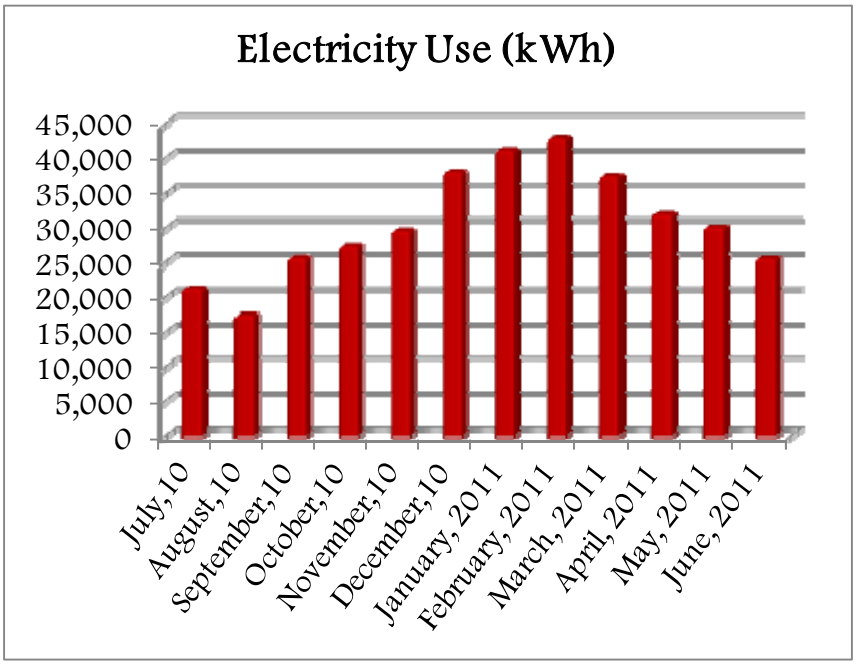
The data analyzed provides the following information: 1) breakdown of utilities by consumption, 2) cost and annual profile, 3) baseline consumption in terms of energy/utility at the facility, 4) the Energy Use Index, or Btu/sq ft, and cost/sq ft. For multiple water meters, the utility data is combined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

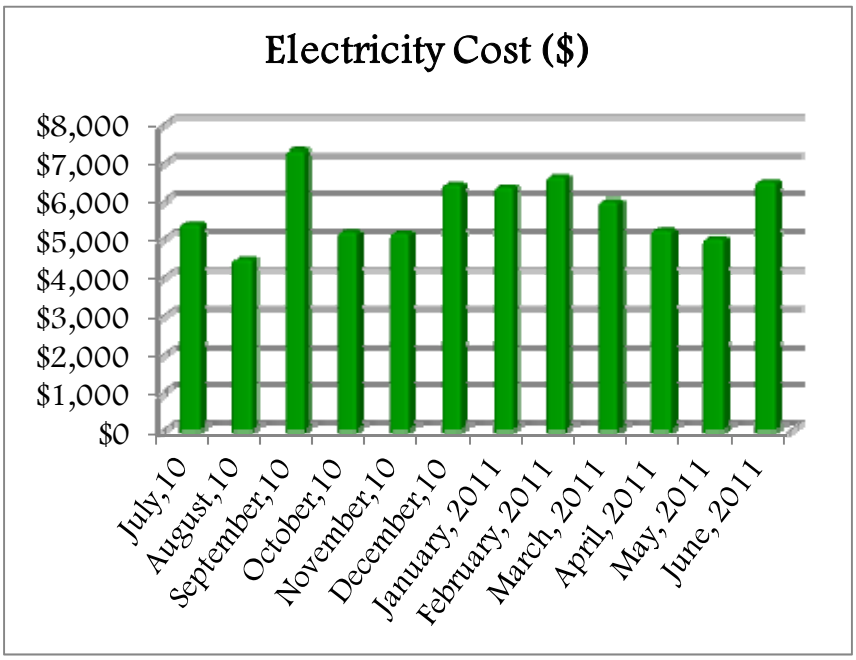
6.1. ELECTRICITY

NStar satisfies the electricity requirements of the facility. According to the monthly consumption, electrical usage increases during the school year since the school is open. Based on the 2010-2011 electric usage & costs, the average price paid during the year was $0.19 per kWh. The total annual electricity consumption for the 12-month period analyzed is 368,912 for a total cost of $69,628.

Electricity Consumption and Cost Data

Billing Month	Consumption (kWh)	Unit Cost/kWh	Total Cost
July,10	21,256	$0.25	$5,390.67
August,10	17,496	$0.26	$4,492.87
September,10	25,616	$0.29	$7,320.08
October,10	27,376	$0.19	$5,180.71
November,10	29,656	$0.17	$5,148.27
December,10	38,176	$0.17	$6,415.04
January, 2011	41,136	$0.15	$6,344.46
February, 2011	42,976	$0.15	$6,627.50
March, 2011	37,576	$0.16	$6,002.75
April, 2011	31,936	$0.16	$5,226.73
May, 2011	30,176	$0.17	$4,991.97
June, 2011	25,536	$0.25	$6,487.25
Total	**368,912**	**$0.19**	**$69,628.30**


Electricity Use (kWh)
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
July,10
August,10
September,10
October,10
November,10
December,10
January, 2011
February, 2011
March, 2011
April, 2011
May, 2011
June, 2011


Electricity Cost ($)
$8,000
$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, 2011
February, 2011
March, 2011
April, 2011
May, 2011
June, 2011

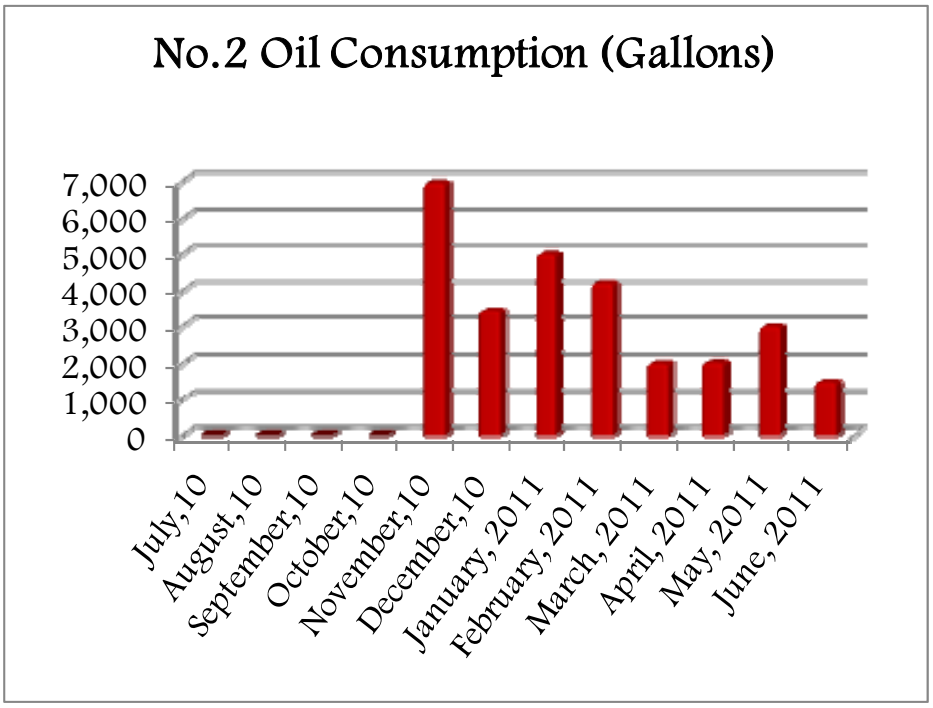
6.2. FUEL OIL

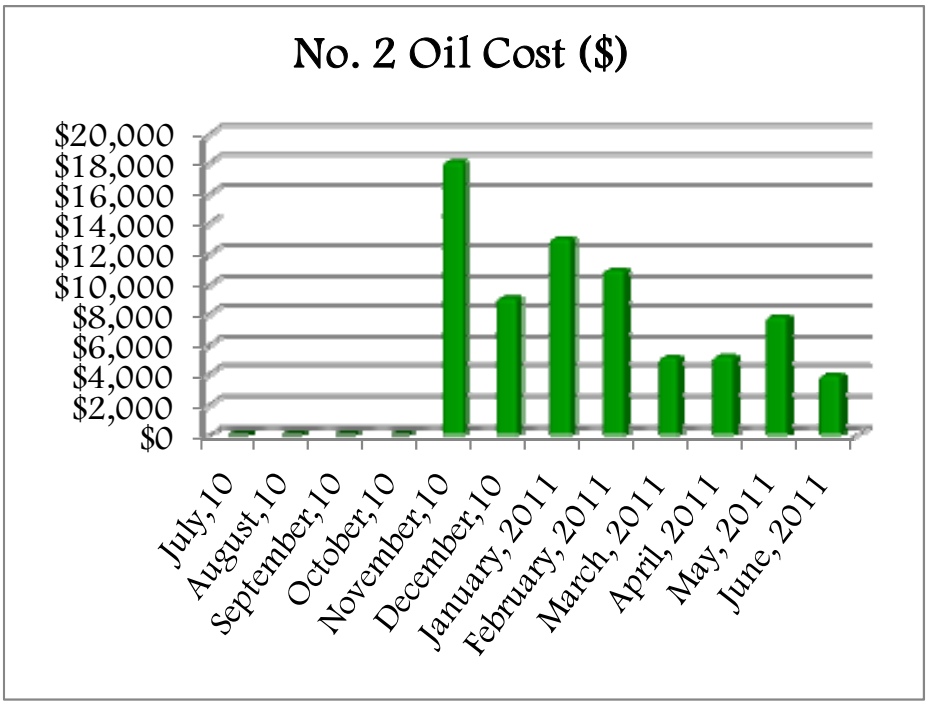
Local fuel oil suppliers provide the No. 2 Fuel Oil for the facility. Deliveries are made as needed.

Based on the 2010-2011 delivery records and receipts, the average price paid during the year was $2.60 per-gallon. The total annual propane//fuel oil deliveries for the 12-month period analyzed was 28,171 gallons for a total cost of $73,220.

Fuel Oil Consumption and Cost Data

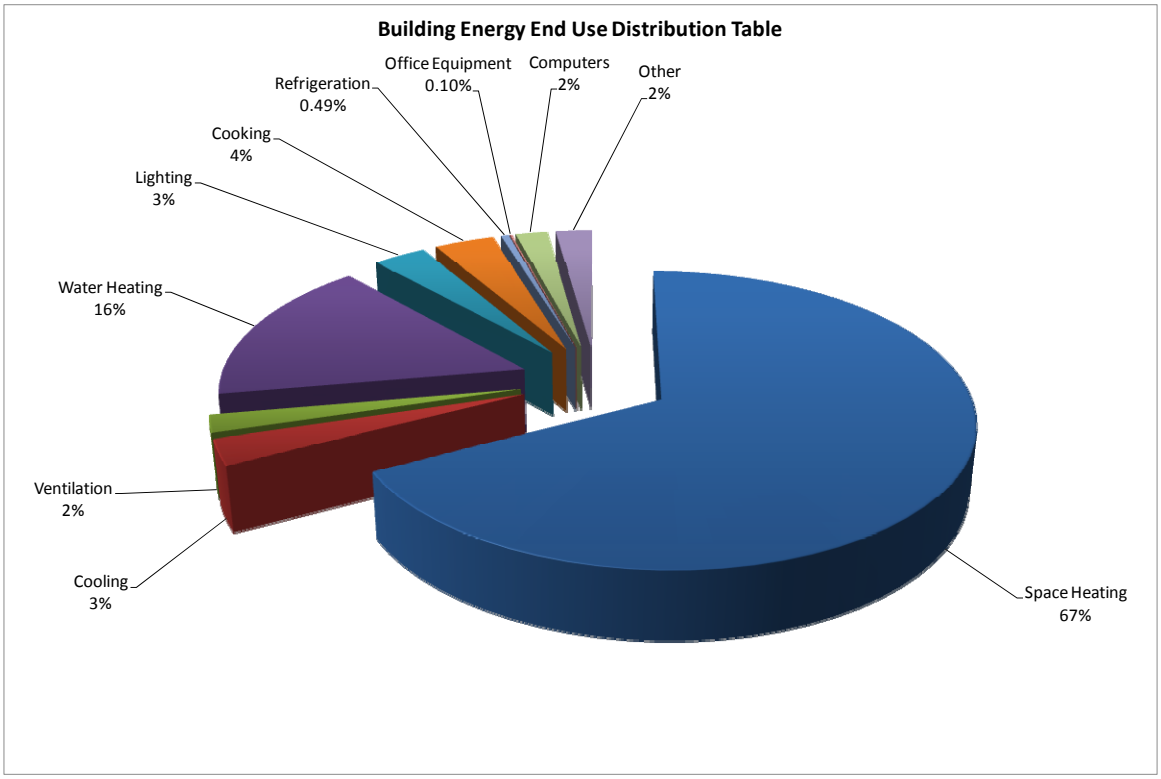
Month	Delivery (gallons)	Unit Cost	Total Cost
July,10	0	0	$0.00
August,10	0	0	$0.00
September,10	0	0	$0.00
October,10	0	0	$0.00
November,10	6,960	$2.60	$18,090.00
December,10	3,470	$2.60	$9,018.00
January, 2011	5,000	$2.60	$12,995.00
February, 2011	4,217	$2.60	$10,962.00
March, 2011	2,000	$2.60	$5,198.00
April, 2011	2,024	$2.60	$5,260.00
May, 2011	3,000	$2.60	$7,799.00
June, 2011	1,500	$2.60	$3,898.00
Total	**28,171**	**$2.60**	**$73,220**


No.2 Oil Consumption (Gallons)
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,2011
February,2011
March,2011
April,2011
May,2011
June,2011


No. 2 Oil Cost ($)
$20,000
$18,000
$16,000
$14,000
$12,000
$10,000
$8,000
$6,000
$4,000
$2,000
$0
July,10
August,10
September,10
October,10
November,10
December,10
January,2011
February,2011
March,2011
April,2011
May,2011
June,2011

7. END USE ENERGY DISTRIBUTION

Components of Annual Energy Use												
	Electricity (1 kWh = 3.412 kBtu)				#2 Fuel Oil				Total Energy		Total Cost	
	%	kWh	kBtu	Cost	%	Gallons	kBtu	Cost	MBtu	% Total	Total- $	% Total
Space Heating	***32.3%***	119,159	406,569	$22,489.94	***78.7%***	*22,171*	3,070,684	57,645	3477.3	***67.4%***	$80,135	***56.1%***
Cooling	***11.8%***	43,532	148,530	$8,216.14				0	148.5	***2.9%***	$8,216	***5.8%***
Ventilation	***8.0%***	29,513	100,698	$5,570.26				0	100.7	***2.0%***	$5,570	***3.9%***
Water Heating	***0.2%***	738	2,517	$139.26	***21.3%***	*6,000*	831,000	15,600	833.5	***16.2%***	$15,739	***11.0%***
Lighting	***13.2%***	48,696	166,152	$9,190.94				0	166.2	***3.2%***	$9,191	***6.4%***
Cooking	***15.0%***	55,337	188,809	$10,444.25				0	188.8	***3.7%***	$10,444	***7.3%***
Refrigeration	***2.0%***	7,378	25,175	$1,392.57				0	25.2	***0.5%***	$1,393	***1.0%***
Office Equipment	***0.4%***	1,549	5,287	$292.44				0	5.3	***0.1%***	$292	***0.2%***
Computers	***8.0%***	29,513	100,698	$5,570.26				0	100.7	***2.0%***	$5,570	***3.9%***
Other	***9.0%***	33,350	113,789	$6,294.40				0	113.8	***2.2%***	$6,294	***4.4%***
Total	100.0%	**368,764**	1,258,224	$69,600.4	*100.0%*	***28,171***	3,901,684	73,245	**5159.9**	100.0%	**$142,845**	100.0%



8. ENERGY CONSERVATION MEASURES (ECM)

EMG has identified a total of six 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 equal to or 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)	131 kBtu/ft^2
Post ECM Site Energy Use Intensity (EUI)	130 kBtu/ft^2
Source Energy Use Intensity (EUI)	**Rating**
Current Source Energy Use Intensity (EUI)	207 kBtu/ft^2
Post ECM Source Energy Use Intensity (EUI)	205 kBtu/ft^2
Building Cost Intensity (BCI)	**Rating**
Current Building Cost Intensity	$3.63/ft^2
Post ECM Building Cost Intensity	$3.60/ft^2

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	4838	kWh
Estimated Annual Thermal Energy Reduction	114	Gallons
Total CO_2 Emissions Reduced	2	$MtCO_2/yr$
Total Cars Off The Road (Equivalent)*	0	
Total Acres of Pine Trees Planted (Equivalent)*	0	

*Equivalent reductions per DOE emissions calculation algorithms.

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

List of Recommended Energy Conservation Measures For Hillside Elementary School

ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Total Energy Savings	Estimated Annual Water Savings	Estimated Cost Savings	Estimated Annual O&M Savings	Total Estimated Annual Cost Savings	Simple Payback	S.I.R.	Life Cycle Savings	Expected Useful Life (EUL)
		$	Gallons	kWh	MMBtu	kgal	$	$	$	Years		$	Years
No/Low Cost Recommendations													
1	Replace Incandescent Lamps With CFL's Details: Replace Incandescent lamps with CFL's in Storage Areas and Kitchen	$26	0	78	0	0	$15	$1	$15	1.72	3.49	$65	7
2	Install Timers On Rooftop Exhaust Fans Details: Install Timers on Rooftop Exhaust Fans	$284	0	2280	8	0	$430	$0	$430	0.66	18.06	$4,853	15
3	Control External Air Leakage In The Building Details: Install weatherstripping on entrance doors	$395	56	0	8	0	$145	$7	$152	2.59	3.13	$842	10
4	Insulate Hot Surfaces And Tanks Details: Insulate Condensate Tank in Boiler Room	$515	71	0	10	0	$185	$0	$185	2.79	4.28	$1,689	15
5	Install Automatic Lighting Controls Details: Install Photo-sensors on Lighting Fixtures near Windows	$885	0	1404	5	0	$265	$0	$265	3.34	3.58	$2,279	15
Totals for No/Low Cost Items		**$2,106**	**127**	**3,762**	**30**	**0**	**$1,040**	**$8**	**$1,047**	**2.01**			
Capital Cost Recommendations													
1	Replace High Intensity Discharge Lamp (HID) with Induction Lighting Details: Install Induction lighting for Parking and Exterior Building Lighting	$1,485	0	1614	6	0	$305	$12	$317	4.69	2.45	$2,151	15
Total For Capital Cost		**$1,485**	**0**	**1614**	**6**	**0**	**$305**	**$12**	**$317**	**4.69**			
	Interactive Savings Discount @ 10%		-13	-538	-4		-$134	-$2	-$136				
	Total Contingency Expenses @ 15%	$539											
Total for Improvements		**$4,129**	**114**	**4,838**	**32**	**0**	**$1,210**	**$18**	**$1,228**	**3.36**			

If all of the above mentioned ECM's are implemented, Hillside Elementary School could potentially save approximately $1,228 per year with an investment of $ 4,129 yielding a net effective payback of 3.36 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 55 hours per week.
- The facility occupancy is assumed to be 430 people.
- Annual Heating Equipment Operating Hours are derived from actual consumption and equipment input rates to be 2,500 hours/year
- Annual Cooling Equipment Operating Hours are derived from actual consumption and equipment input rates to be 300 hours/year
- Typical lighting operating hours are assumed to be 8 per day or 40 hours per year.

8.2. NO/LOW COST ECM DESCRIPTIONS

EMG has identified five 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.

8.2.1. Replace Incandescent Lighting with Fluorescent Lighting

Fluorescent lighting is recommended for areas where color sensitivity is an important criterion (e.g., offices or small parts assembly rooms). Screw-in fluorescent lamps are available to replace incandescent lamps. Power savings are typically 60%. Screw-in self-contained lamps, with a 10,000-hour life, can replace flood lights that have a 7,000-hour life. Screw-in circle light fixtures are also available.

Screw-in fluorescent lamps are generally not compatible with dimmers. New energy-efficient fluorescent lamps are continually being introduced. It is important to stay abreast of this technology so that the most efficient products may be used.

Hillside elementary school has seven, 60 watt incandescent lamps located in various storage rooms and the kitchen area. EMG recommends replacing all the incandescent lamps with CFL lamps as specified in the lighting ECM work sheet attached in the Appendix. Based on the calculations from the EMG lighting work sheet, it is estimated that the proposed retrofit of the specified incandescent lamps shall result in an annual energy savings of 78 kWh.

8.2.2. Install Timers on Exhaust Fans on Roof

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.

Hillside elementary school has (six) rooftop fans that are estimated to be running for 16 hours a day. The normal hours at the school are from 7:00 AM till 5:00 pm, where as the facility is completely deserted by 10:00 PM. Hence EMG recommends installing mechanical timers on rooftop fans such that they are turned off after 10:00 PM until 3:00 AM in the morning. This shall save approx 5 hours of daily operational time, resulting in considerable energy savings.

8.2.3. Replace Weatherstripping in various entrance doors

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

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

It was noted during the on site visit that some of the doors had some weather-stripping missing; it is recommended that weather stripping should be installed.

8.2.4. Insulate Condensate Tank

There is an un-insulated condensate tank located in the boiler room. The condensate is fed back into the boiler as makeup water. If the tank is insulated, less heat energy is required to return it to the vapor phase, hence lowering fuel consumption. It is recommended that the condensate tank be insulated to reduce heat losses.

8.2.5. Install Photo-sensors on Perimeter Lighting in Classrooms

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.

During the on site visit, it was observed that a number of classrooms had light fixtures that were within 10 feet of windows. It was also observed that there was sufficient light from the outside so that light fixtures close to the window would not have to be turned on unless there was insufficient natural light. It is recommended that photo-sensors should be installed on the light fixtures near the windows since this would reduce the hours of operation of the classroom lighting.

8.3. CAPITAL COST ECM DESCRIPTIONS

EMG has identified one Capital Cost Energy Conservation Measure (ECM) for this property. This list includes the recommended measure which has an estimated implementation cost greater than $1,000. The following paragraphs describe the ECM.

8.3.1. Replace Exterior Building and Parking Lighting with Induction Lighting

An induction light is similar to a fluorescent light in that mercury in a gas fill inside the bulb is excited; emitting UV radiation that in turn is converted into visible white light by the phosphor coating on the bulb. Like fluorescent, the phosphor coating determines the color qualities of the light. Fluorescent lamps use electrodes to strike the arc and initiate the flow of current through the lamp, which excites the gas fill. Each time voltage is supplied by the ballast and the arc is struck, the electrodes degrade a little, eventually causing the lamp to fail. Induction lamps do not use electrodes. Instead of a ballast, the system uses a high-frequency generator with a power coupler.

The generator produces a radio frequency magnetic field to excite gas fill. With no electrodes, the lamp lasts longer. Induction lamps, in fact, last up to 100,000 hours, with the lamp producing 70% of its light output at 60,000 hours. In other words, their rated life is 5-13 times longer than metal halide (7,500 to 20,000 hours at 10 hours/start).

Induction lamps are ideally suited for high-ceiling applications where the lamps are difficult, costly or hazardous to access. They are also ideally suited for such applications where the advantages of fluorescent lighting are sought but a light source is needed that can start and operate efficiently in extremely cold temperatures. As a result, induction lighting is a suitable for a wide range of applications, including not only warehouses, industrial buildings, cafeterias, gymnasiums, etc., but also signage, tunnels, bridges, roadways, outdoor area and security fixtures, parking garages, public spaces, and freezer and cold storage lighting.

The increased costs occurs in the induction systems themselves – which could be 5 to 6 times more than metal halide systems, and also in new fixtures, which can inflate payback periods and reduce return on investment. But you also generally get a 30% reduction in capital and operating costs immediately from the reduced number of fixtures made possible by the higher light output. You also get 15% more efficiency just because the induction system (lamp and electronic ballast) is more efficient. Apply that over ten years plus reduced replacement and maintenance costs compared to metal halide and other HID lamps and suddenly it makes a lot of sense to go into induction lighting systems.

- Long Service Life: up to 100,000hrs (5 times the lamp life of Metal Halides)
- Energy Saving: save up to 40% compared to metal halides, 13 times more efficient than incandescent light bulbs, and up to twice as efficient as compact fluorescent lights
- Instant On/Off: no waiting time between re-strike
- High Efficiency: lighting efficiency ＞80lm/w
- High Lumens Maintenance: ＞70% after 60,000 hrs
- Wide Selection of Color Temperature:2720K- 6500K
- High Power Factor Ballast: λ＞0.95
- Flicker-free : high frequency (250KHz) creates a better and more comfortable light for users and prevents eye injury when viewed directly
- Wide Temperature Tolerance: can operate between -40 ℃ ～ ＋50 ℃
- Optional Dimmable Ballast for Integrated Control: linearly dimmable to 30%

There are three 100 watt metal halide type lamps on the building exterior and also two 200 watt metal halide type lamps for the parking area. These lights can be replaced with induction lighting to further reduce energy costs.

There are also seven 400-watt HID fixtures, but based on their hours of operation if they were replaced with induction lighting, the payback is longer than five years and therefore not recommended.

8.4. ECMs Evaluated For Consideration

EMG has identified one Energy Conservation Measure (ECM) which was evaluated for this property but not recommended based on financial criteria. EMG screens ECMs using two financial methodologies described at the beginning of Section 8. ECMs which are considered financially viable must meet both criteria.

The following paragraphs describe the ECM.

8.4.1. Replace Chest Freezer with Energy Star Freezer

Some offices/homes have deep freezers which are used to store food in frozen state for days together. The deep freezers have to maintain temperatures below freezing and hence consume a lot of energy. Having a low energy consuming freezer thus results in a considerable reduction in the annual energy costs. On an average a useful life of any freezer is the life of its compressor. Hence EMG recommends replacing the existing freezer at the end of its useful life with a new energy star certified energy efficient freezer.

The facility currently has one freezer. The current freezer has auto defrost function, with a single door chest type configuration. The freezer was manufactured in 1990 and has a storage volume of 20 cubic feet. EMG recommends replacing it with an energy star certified chest-type energy efficient freezer.

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 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.

Building Envelope

1. Caulking and weather stripping is functional and effective at all times.
2. Walls observed weekly and holes are patched in the building envelope as required.
3. It was noted that several windows in the cafeteria area were cracked and should be replaced.

Heating and Cooling

1. The burners are cleaned and fuel/air ratios optimized during routine maintenance checks.
2. Boiler tubes are inspected and cleaned annually. The client follows through on the proper maintenance schedule for the boilers.
3. Temperature settings are reduced in unoccupied areas and set points seasonally adjusted by using the building management system.
4. Control valves and dampers are checked for functionality monthly and repaired when needed.
5. Equipment inspected for worn or damaged parts as part of a monthly maintenance check.
6. Ductwork visually inspected and checked for leaks or damaged insulation as part of a monthly maintenance check.

Domestic Hot Water

1. Domestic hot water heater temperature set to the minimum temperature required
2. Hot water piping checked routinely for damaged insulated and leaks

Lighting

1. Only energy-efficient replacement lamps used and in-stock for replacement
2. Lighting fixture reflective surfaces and translucent covers clean
3. Walls clean and bright to maximize lighting effectiveness
4. Timers are operating correctly on exterior lighting
5. It is recommended that photo-sensors should be installed on light fixtures near windows that provided sufficient natural light. It is also recommended that some of the exterior building lighting and the parking lighting can be replaced with induction lighting.

Existing Equipment and Replacements

1. Refrigerator and freezer doors closed and sealed correctly
2. Kitchen exhaust fans only used when needed or timers installed to limit operation
3. Office/ computer equipment either in the "sleep" or "off" mode when not used
4. All other recommended equipment specific preventive maintenance actions conducted

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 PHOTOGRAPHIC RECORD

Project No.: 98515.11R-003.268 **Project Name: Hillside Elementary School**

Photo #1:	Front of building – facing south

Photo #2:	Front of building – facing south

Photo #3:	Side of building – facing west (lower level is cafeteria and upper level is gym)

Photo #4:	Side of building – facing west

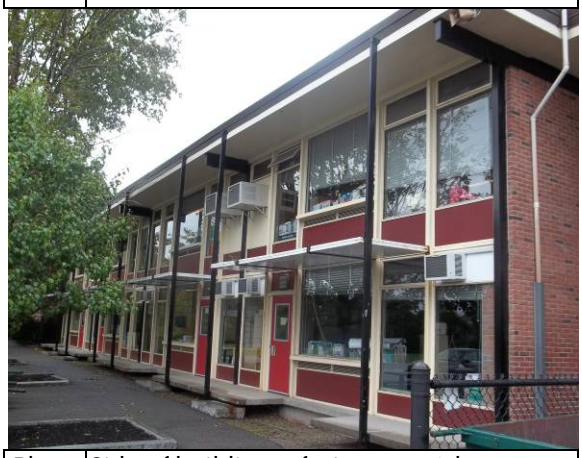


Photo #5:	Side of building – facing west (classrooms on upper and lower levels)

Photo #6:	Entrance to cafeteria

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-003.268 **Project Name: Hillside Elementary School**

Photo #7:	West side of building at the rear of the building

Photo #8:	Modular section – front facing west

Photo #9:	Rear of main building (facing north)

Photo #10:	East side of building

Photo #11:	Additional view of east side of building

Photo #12:	Parking lot at front of building

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-003.268 **Project Name: Hillside Elementary School**

Photo #13:	Playground area

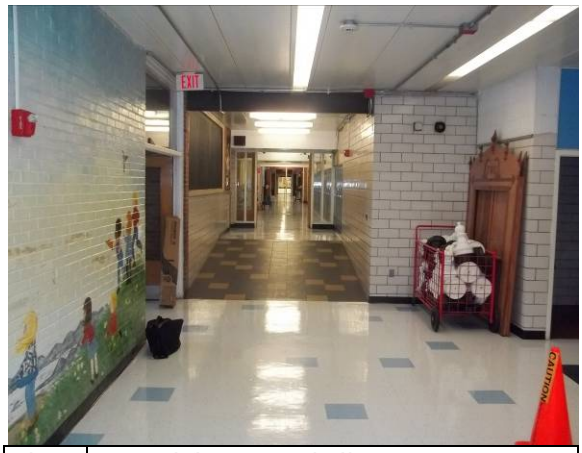


Photo #14:	Ground floor main hallway – uses T-8 lighting

Photo #15:	Additional view of ground floor main hallway

Photo #16:	Modular section hallway – connects to ground floor main hallway

Photo #17:	Exit lighting throughout building

Photo #18:	Classroom on ground floor

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-003.268 **Project Name: Hillside Elementary School**

Photo #19:	Electric baseboard heater in modular section

Photo #20:	Classroom with T-8 lighting - uses wireless motion sensors

Photo #21:	Restroom on ground level

Photo #22:	0.5 GPM faucet

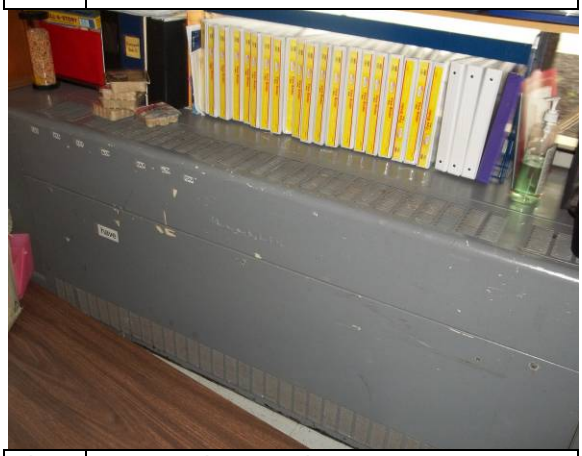


Photo #23:	Unit ventilator in classroom

Photo #24:	Window unit in classroom – 10,000 BTUH

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-003.268 **Project Name: Hillside Elementary School**

Photo #25:	Classroom entrance to outside

Photo #26:	Kitchen on ground level

Photo #27:	Cafeteria

Photo #28:	Domestic hot water heaters – installed in 2011, 1.5 GPH #2 oil

Photo #29:	View of flue for domestic water heaters

Photo #30:	Condensate tank for low pressure steam system

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-003.268 **Project Name: Hillside Elementary School**

Photo #31:	Low pressure steam boilers – operates in a lead lag format

Photo #32:	Domestic water temperature – measured at 140 degrees F during onsite visit

Photo #33:	Condensate pumps – 0.5 hp

Photo #34:	Air handling units with about 20-25% outside air - serves the gym and cafeteria

Photo #35:	Supply fan motor on air handling unit

Photo #36:	Return fan motor on air handling unit

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-003.268 **Project Name: Hillside Elementary School**

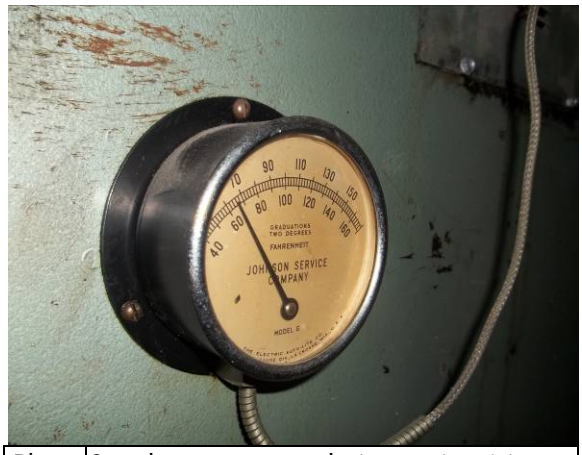


Photo #37:	Supply temperature during onsite visit – providing outside air with no heating

Photo #38:	Actuators located on unit vents

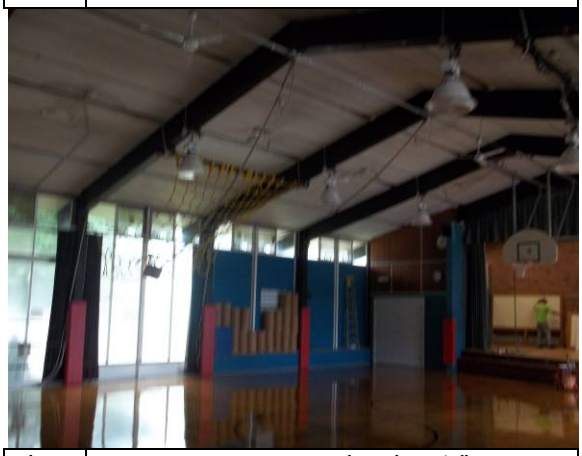


Photo #39:	Gymnasium on upper level - 1st floor

Photo #40:	Office area on upper level

Photo #41:	Kindergarten on upper level

Photo #42:	Upper level main hallway

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-003.268 **Project Name: Hillside Elementary School**

Photo #43:	28,0000 BTUH window unit in classroom

Photo #44:	Roof of building – exhaust fans for bathrooms and kitchen areas

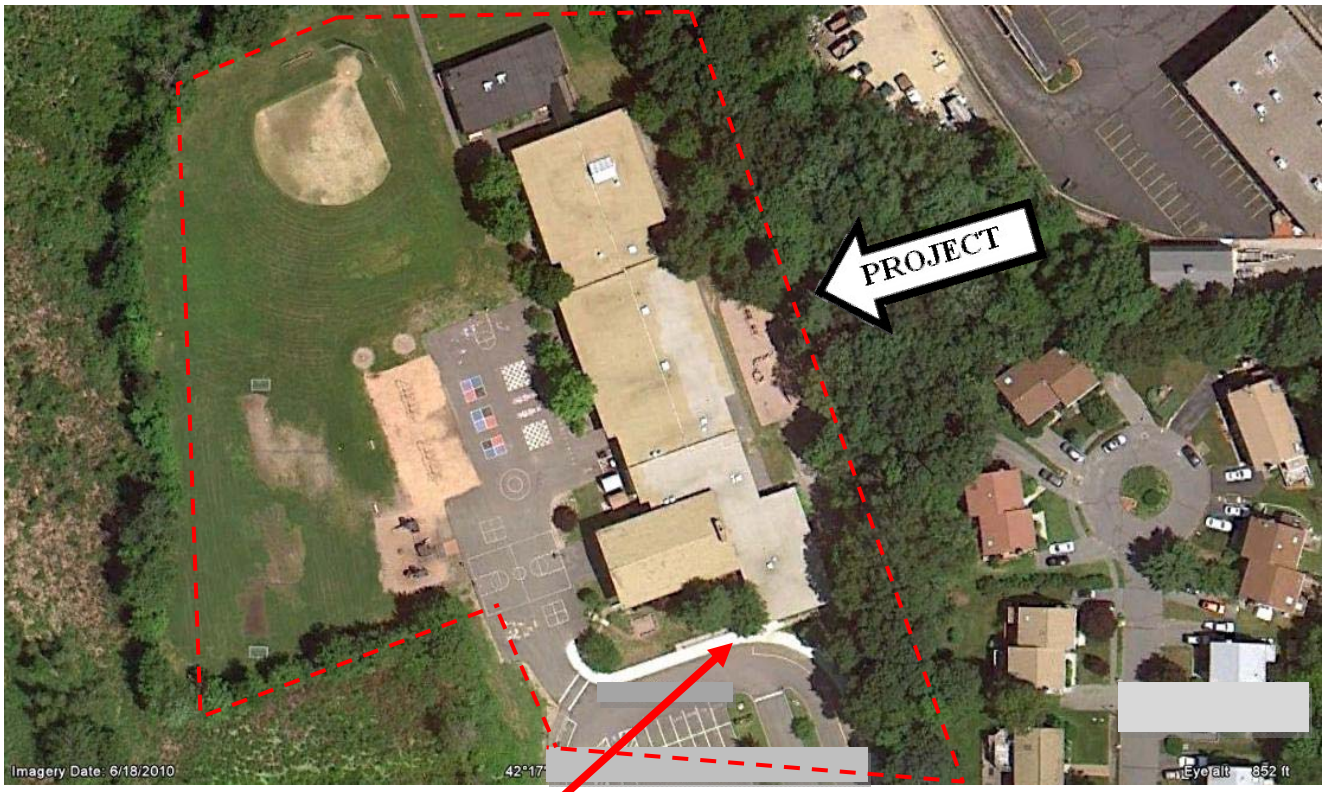
Photo #45:	Kitchen exhaust fans

Photo #46:	Packaged heat pump roof top units for modular section

Photo #47:	Pole mounted transformer

APPENDIX B:
SITE PLAN

Site Plan



Front of Entrance

EMG	**Source:**	**Project Number:** 98515.11R-003.268
N	**The north arrow indicator is an approximation of 0° North.**	**Project Name:** Hillside Elementary School
		On-Site Date: September 6, 2011

APPENDIX C:
RECORDS OF COMMUNICATION

RECORD OF COMMUNICATION

Date:	**9/6/11**	**Time:**	**9 AM**
Project Number:	**98515.11R-003.268**	**Recorded by:**	**Abdul Basit, Field Observer/Project Manager**
Project Name:	**Hillside Elementary School**		

Communication with: **Mr. Chip Laffy**
of: **Town of Needham**
Phone: **781 455 0442 x 273**

Communication via:

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

RE:

Summary of Communication: Discussions of lighting and HVAC systems

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

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

Building Site Energy Use Intensity - The sum of the total site energy use in 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).

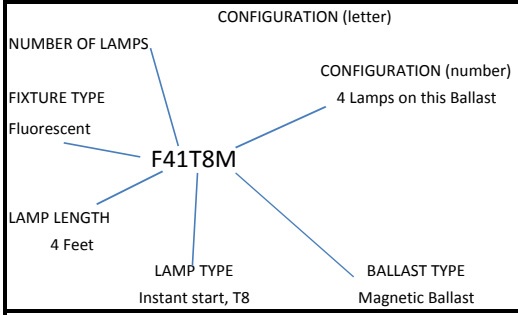
APPENDIX E:
MECHANICAL EQUIPMENT INVENTORY

Mechanical Equipment Inventory								
Equipment	**Manufacture**	**Age**	**Location**	**Model/ Type**	**Capacity**	**Serves**	**Operating Hours/Yr**	**Remarks**
Steam boilers	Weil McLain	1995	Boiler room	1488	31 gph #2 oil	Heating for building	2500	
Condensate Return Pumps	Skidmore		Boiler Room		½ hp estimated	Condensate	2500	
Air Handler – Gym	Unknown	Unk	AHU Room	Unknown	1/6 hp return blower motor and ½ hp supply	Gym	2800	
Air Handler - Cafeteria	Unknown	Unk	AHU room	Unknown	1/6 hp return blower motor and ½ hp supply	Cafeteria	2800	
Window Unit type 1	Electrolux	varies	Class	FAC105P	10,000 BTUH, 9 EER	Classroom cooling	300	
Window Unit type 2	Freidrich	varies	Class	SL28J30A	28,000 BTUH, 9 EER	Classroom cooling	300	
Unit Heater – Modular Section	Dayton	1996	Modular Hallway	24YU71	10 kW	Modular Section Hall way	500	
Heat Pump RTU – Modular	Unknown	1996	Modular Section Ro of	Unk	Unknown	Modular Section	2800	Ladder not available
Refrigerator	True		Kitchen		T-49F	Kitchen refrigerator		
Chest Freezer	Unknown	1990	Cafeteria		Unk			
Domestic Hot Water Heater	Loch Water Heaters	2011	Boiler Room	72E	1.5 GPH	DHW		
DHW circulation Pump	Taco	2011	Boiler Room		1/25 hp	DHW circulation		
Air Vent Actuator	T.A.C.	2010	Air Vent	MS51-7103				

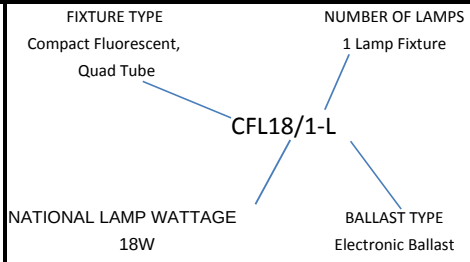
APPENDIX F:
LIGHTING SYSTEMS SCHEDULES

Fixture Code Legend and Notes

Sample Linear Fluorescent Fixture Code



Sample of Other Fixture Code:



Code Explanations

Fixture Type

CF	Compact Fluorescent
CFD	Compact Fluorescent, double-D shape
CFS	Compact Fluorescent, Spiral
CFT	Compact Fluorescent, Twin tube (including "Biaxial" fixtures)
CFQ	Compact Fluorescent, Quad tube
ECF	Exit sign, Compact Fluorescent
EI	Exit sign, Incandescent
ELED	Exit sign, LED
F	Fluorescent, linear
FC	Fluorescent, Circline
FU	Fluorescent, U-tube
H	Halogen
HLV	Halogen, Low Voltage
HPS	High Pressure Sodium
I	Incandescent
LED	Light Emitting Diode (LED) traffic signal
MH	Metal Halide
MHPS	Metal Halide, Pulse Start
MV	Mercury Vapor
QL	Induction

Lamp Type

for fluorescent fixtures

A	"F25T12" - 25 watt, 4ft, T12 lamp
IL or T8	T8, Instant start
SIL	T8, Instant start, Super 30 watt
SSIL or T8N	T8, rapid start, Super 28 watt
L	T8, rapid start
T5	T5, standard
T5HO	T5, standard, High output lamp
T12	T12, Energy efficient
EH	T12, Energy efficient, High output lamp
EI	T12, Energy efficient, Instant start
EV	T12, Energy efficient, Very high output
T12M	T12, Standard magnetic
SIL	T12, Standard, Instant start
HO	T12, Standard, High output lamp
SV	T12, Standard, Very high output lamp
T	T10, Standard

Ballast Type

for fluorescent fixtures

E	Electronic
M	Standard magnetic

Configuration (letter)

T	Tandem wired fixture
DL	Delamped fixture, i.e. some lamps permanently removed but ballasts remain

Configuration (number)

for delamped fixtures

Number signifies the total number of ballasts in the fixture: e.g. An "F42EEID2" is an "F44EE" with two lamps removed so that there is one extaneous ballast

for tandem wired ballasts

Number signifies the total number of lamps being run by the ballast: e.g. An "F42LLIT4" would indicate that a four-lamp ballast is wired to run two-lamp fixtures.

with no preceding letter

Number indicates the number of ballasts in an ambiguous multiple ballast fixture: e.g. An "F43ILU2" indicates a three-lamp fixture with two ballasts (as is often the case if there is A/B switching).

Notes:

1) The column labeled Watts/Fixtures in the data table includes ballast loads.

2) The fixture wattage values represent an average value, rounded to the nearest whole watt.

Existing Facilities Program Lighting Form:

Performance Based

Project Number:	98515.11R-003.268		
Facility Name:	Hillside Elementary School		
Project Manager	Abdul Basit		
Date: 9/6/2011	Square Footage (ft2)	52726	

Existing Control Legend

LS	Light Switch
PS	Photosensor
TM	Timer
MS	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 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	Existing Control	Pre Fixt. No.	Pre Fixt Code (Refer to Wattable Table Worksheet)	Pre Watts / Fixt	Pre kW / Space	Baseline Annual Hours	Annual kWh Consumed
Integer line number	(Type 'ECM' for lighting retrofit)	ECM CODE Worksheet Link	For two ECMs in one line item	Floor fixture is on	Description of location that matches site map	Lux	hrs/ week	control device (refer to legend above)	# of existing fixtures	TypWattage Table	Watts/Fixt from Wattage Table	(Pre Watts/Fixt) * (Pre Fixt No.)	Existing annual hours used	(PreFixt #*PreWatts/Fixt * Baseline Hrs)
1					Ground Floor Hallway		40	LS	30	F41T8	31	0.93	2,080	1,934
2					Ground Floor Hallway		40	LS	23	F42T8	59	1.36	2,080	2,823
3					Ground Floor Hallway		40	LS	11	F44T8	112	1.23	2,080	2,563
4					Classroom Lighting		24	MS	14	F44T8	112	1.57	1,248	1,957
5					Classroom Lighting		24	MS	72	F42T8	59	4.25	1,248	5,302
6	ECM	PS			Classroom Lighting		24	MS	30	F42T8	59	1.77	1,248	2,209
7					Kitchen Lighting		20	MS	9	F42T8	59	0.53	1,040	552
8	ECM	RB			Incandescent Ltg - various		5	LS	7	I60/1	60	0.42	260	109
9					Cafeteria Lighting		10	MS	64	F41T8	31	1.98	520	1,032
10					Girl's Restroom		10	MS	1	F44T8	112	0.11	520	58
11					Girl's Restroom		10	MS	2	F42T8	59	0.12	520	61
12					Boy's Restroom		10	MS	1	F41T8	31	0.03	520	16
13					Boy's Restroom		10	MS	2	F44T8	112	0.22	520	116
14					Custodian		24	MS	4	F42T8	59	0.24	1,248	295
15					Office		10	MS	5	F42T8	59	0.30	520	153
16					Boiler Room		5	LS	6	F42T8	59	0.35	260	92
17					Air Handling Room		5	MS	3	F42T8	59	0.18	260	46
18					Upper Level Hallway		40	LS	20	F41T8	31	0.62	2,080	1,290
19					Upper Level Hallway		40	LS	7	F42T8	59	0.41	2,080	859
20					Office Lobby Area		30	MS	50	F41T8	31	1.55	1,560	2,418
21					Offices		24	MS	30	F41T8	31	0.93	1,248	1,161
22					Offices		24	MS	8	F41T8	31	0.25	1,248	310
23					Kindergarten		24	MS	45	F41T8	31	1.40	1,248	1,741
24					Kindergarten		24	MS	40	F41T8	31	1.24	1,248	1,548
25					Upper Level Classroom		24	MS	33	F42T8	59	1.95	1,248	2,430
26					Upper Level Classroom		24	MS	36	F41T8	31	1.12	1,248	1,393
27	ECM	PS			Upper Level Classroom		24	MS	69	F41T8	31	2.14	1,248	2,669
28					Library		24	MS	32	F42T8	59	1.89	1,248	2,356
29					Office		24	MS	6	F41T8	31	0.19	1,248	232
30	ECM	RB			Gymnasium		15	MS	7	MH400	458	3.21	780	2,501
31					Stage Lighting		10	MS	12	F41T8	31	0.37	520	193
32					Stairwell Lighting		40	LS	2	F42T8	59	0.12	2,080	245

PRE-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	Existing Control	Pre Fixt. No.	Pre Fixt Code (Refer to Wattable Table Worksheet)	Pre Watts / Fixt	Pre kW / Space	Baseline Annual Hours	Annual kWh Consumed
Integer line number	(Type 'ECM' for lighting retrofit)	ECM CODE Worksheet Link	For two ECMs in one line item	Floor fixture is on	Description of location that matches site map	Lux	hrs/ week	control device (refer to legend above)	# of existing fixtures	TypWattage Table	Watts/Fixt from Wattage Table	(Pre Watts/Fixt) * (Pre Fixt No.)	Existing annual hours used	(PreFixt #*PreWatts/Fixt * Baseline Hrs)
33					Stairwell Lighting		40	LS	4	CFL26	33	0.13	2,080	275
34					Exit Lighting		168	EC	12	ELED5/2	10	0.12	8,736	1,048
35					Exterior Lighting		80	PS	11	CFL26	33	0.36	4,160	1,510
36					Exterior Lighting		80	PS	5	CFL13	17	0.09	4,160	354
37					Exterior Lighting		80	PS	5	CFL26	33	0.17	4,160	686
38	ECM	RB			Exterior Lighting		80	PS	3	MH100	128	0.38	4,160	1,597
39	ECM	RB			Parking Lighting		80	PS	2	MH200	232	0.46	4,160	1,930
								Total Pre Fixt.	**723**		**Total Pre kW**	**35**	**kWh Consumed**	**48,064**

Light Intensity	0.658 Watt/ ft2	**Usage Intensity**	0.91 KWh / ft2

Existing Facilities Program Lighting Form:

Performance Based

Project Name: 98515.11R-003.268

Facility Name: Hillside Elementary School

Date: 9/6/2011 Project Manager Abdul Basit

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

									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.**	**Post 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*
6	ECM	PS - Install Photo Sensor		-	Classroom Lighting	-	24	1,248	MS	30	F42T8	30	F42T8	59	16.00		0.00	736
8	ECM	RB - Replace Bulb		-	Incandescent Ltg - various	-	5	260	LS	7	I60/1	7	CFL13	17	5.00		0.30	78
27	ECM	PS - Install Photo Sensor		-	Upper Level Classroom	-	24	1,248	MS	69	F41T8	69	F41T8	31	18.00	PS	0.00	667
30	ECM	RB - Replace Bulb		-	Gymnasium	-	15	780	MS	7	MH400	7	QL250	258	15.00	MS	1.40	1,092
38	ECM	RB - Replace Bulb		-	Exterior Lighting	-	80	4,160	PS	3	MH100	3	QL70	70	80.00	TM	0.17	724
39	ECM	RB - Replace Bulb		-	Parking Lighting	-	80	4,160	PS	2	MH200	2	QL120	125	80.00	TM	0.21	890
									Total Pre Fixt.	**118**		**118**	**Total Post kW**	**560.00**		**Total kW Saved**	**2.09**	**4,188.03**

APPENDIX G:
ECM CALCULATIONS

UIC	Control External Air Leakage In The Building
EAE4	Details: Install weatherstripping on entrance doors

ENTER EXISTING CONDITION

Insert Existing Estimated Air Change Rate/Hr (ACH 1): *(Existing Air Changes Per Hour, 3 is very leaky and 0.35 ideal)*	1.50		Cubic Feet/Min (CFM 1):	250.00	
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	1.25		Cubic Feet/Min (CFM 2):	208.33	
Estimated Space Volume Under Consideration	10000.00	Cu.Ft	Is The Building Cooled?	No	(Select)

WINTER			SUMMER		
Select Type of Heating Fuel	Oil	(Select)	Select Type of Cooling Fuel	**ELECTRICITY**	(Default)
Estimated Annual Heating Plant Efficiency	80.00	%	Estimated Annual Cooling Plant Efficiency	0	EER
Annual Heating Degree Days(HDD):	5724		Annual Cooling Degree Days(CDD):	992	
Estimated Total Annual Input Heating Energy Savings	55.79	Gallons	Estimated Total Annual Input Cooling Energy Savings	0.00	kWh
Cost/Unit of Heating Fuel: Gallons	$2.60	$$	Cost/Unit For Electricity	$0.19	$$
Estimated Annual Heating Cost Savings	145.01	$$	Estimated Annual Cooling Cost Savings	0.00	$$

Cost Analysis

Estimated Annual O&M Savings	$7.25	Estimated Installation Cost (Including Labor)	$500.00
Total Estimated Annual Cost Savings	$152.27	Total Cost For Controlling Air Leakage	$395
Simple Pay Back Period	2.59	*Type of Recommendation*	No/Low Cost ECM Recommendation

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

EXISTING CONDITION		
No. of Fan Motors:	6.00	Qty
Total HP of Fans	1.50	HP
Total kW:	1.119	kW
Existing Annual hours of operation:	6000.00	Hr
Annual kWh:	6714.00	kWh

PROPOSED CONDITION		
New Annual Hours With Timers:	4000.00	Hr
New Annual kWh:	4476.00	kWh
Annual kWh Savings:	2280.02	kWh

COST ANALYSIS		
Cost/kWh:	**$0.19**	$$
Annual Cost savings:	$430	$$
Installed cost/timer:	$60.00	$$
Total Cost of Installing Timers	$284	$$
Simple Payback:	0.66	Yrs

Type of Recommendation — No/Low Cost ECM Recommendation

UIC	Insulate Hot Surfaces And Tanks
EAH7	Details: Insulate Condensate Tank in Boiler Room

ENTER EXISTING CONDITION

No. of Tanks	1				
Type of Heating Fuel	Oil	(Select)	Enter Estimated Surface Area of Tank (Sq.Ft)	40.00	Sq.Ft
Average Ambient Space Temperature Around The ExposedTank (˚F)	78.00	◦F	Average Temperature of Fluid In The Tank (◦F)	160.00	◦F
Estimated Annual Heating Plant Efficiency (%):	80%		Estimated Annual Hours of Operation (Hrs)	3000.00	Hrs

EXISTING STATE			PROPOSED		
Enter The Existing Net Effective R-Value of The Tank Insulation	1.00	Sq.Ft deg F.hr/btu	Enter The Proposed Net Effective R-Value of The Tank Insulation	5.00	Sq.Ft deg F.hr/btu
Annual Conduction Losses From Existing Insulation	9840.00	kBtu/Yr	Annual Conduction Losses From Proposed Insulation	1968.00	kBtu/Yr

ENERGY SAVINGS

Estimated Energy Savings	7872.00	kBtu	Estimated Total Annual Input Heating Energy Savings	9840.00	kBtu
Cost of Heating Fuel/Unit:	$2.60	$$	Estimated Total Annual Input Heating Energy Savings	71.05	Gallons

COST ANALYSIS

Estimated Cost For Adding Insulation	$515	$$	Total Annual Estimated Cost Savings	$185	$$
Simple Pay Back Period	2.79	Years	*Type of Recommendation*	No/Low Cost ECM Recommendation	

UIC	Replace Incandescent Lamps With CFL's			
EAL 1A	Details: Replace Incandescent lamps with CFL's in Storage Areas and			
Step:1	Number of Lamps to Be Replaced		7	
Step:2	Current Wattage of Lamp		60.00	watt
Step:3	Proposed Replacement		13.00	watt
Step:4	Total labor Cost For Replacing lamps *Estimated Rate of $35/hr To Replace 20 Lamps/Hr*		$12.25	
Step:5	Estimated Cost Per Lamp	*(Select)*	$3.00	$$
Step:6	**Total Cost For Retrofit**		$26.27	
Step:7	Estimated Annual Energy Savings		78.00	kWh
Step:8	Current Electric Tarriff Per kWh		**$0.19**	$$
Step:9	Existing Annual Usage *(For O&M Savings)*		100	hrs
	Proposed Annual Usage Post Retrofit *(For O&M Savings)*		100	hrs
	Estimated Annual O&M Savings		$0.53	$$
Step:10	Estimated Annual Cost Savings		$15.25	
Step:11	Simple Pay back Period		1.72	Yrs
Type of Recommendation	No/Low Cost ECM Recommendation			

UIC	**Install Automatic Lighting Controls**		
EAL5	**Windows**		
	Type of Sensor	Internal Photosensors	
Step: 1	Total Number of Sensors	14	
Step: 2	Purchase Cost/Lighting Control Sensors	$15	
Step: 3	Installation Cost /Sensor	$65	
Step:4	Total Installation Costs	$884.80	
Step:5	Total Energy Savings	1404	kWh
Step:6	Electric Tariff Rate	**$0.19**	$
Step:7	Total Cost Savings	$264.99	
Step:8	Simple Pay Back Period	3.34	Years
Type of Recommendation		No/Low Cost ECM Recommendation	

UIC	Replace High Intensity Discharge Lamp (HID) with Induction Lighting		
EAL9	Details: Install Induction lighting for Parking and Exterior Building Lighting		
Step:1	Number of 60-100W HID Lamps Replaced by 40W Induction	0	
	Number of 100-150W HID Lamps Replaced by 70W Induction	3	
	Number of 150-200W HID Lamps Replaced by 85W Induction	2	
	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	0	
	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	$0	
Step:3	Subtotal Cost of 70 Watt Induction Retrofit	$1,110	
Step:4	Subtotal Cost of 85 Watt Induction Retrofit	$770	
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	$0	
Step:8	Subtotal Cost of 300 Watt Induction Retrofit	$0	
Step:9	**Total Cost For Retrofit**	$1,485	
	Energy & Cost Saving Analysis		
Step:10	Estimated Annual Energy Savings	1614.00	kwh
Step:11	Current Electric Price Per kWh	$0.19	$
Step:12	Estimated Annual Cost Savings	$305	
Step:13	Existing Annual Usage *(For O&M Savings)*	3000	hrs
	Proposed Annual Usage Post Retrofit *(For O&M Savings)*	3000	hrs
	Estimated Annual O&M Savings	$12	$$
Step:14	Total Estimated Annual Cost Savings *(Energy & O&M Savings)*	$317	$$
Step:15	Simple Pay back Period	4.69	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 Freezers With High Efficiency Freezers
EAA2	Details: Replace Freezer in Kitchen with High Efficiency Freezer

Number of Freezers To Be Replaced			1 Qty	
Details of Existing Freezers:	20 CF	1995 YEAR	519.00 Kwh/Year	
Proposed New Freezers	20 CF	Y Energy Star (Y/N)	434.00 Kwh/Year	
Annual Kwh Savings Per Unit (Kwh/year)			85	kWh
Total Annual Kwh Savings (Kwh/year)			85	kWh
Current Electrical Tariff ($/Kwh)			**$0.19**	$$
Annual Cost Savings From All Freezers ($$)			$16.04	$$

Total Installation Cost Including, Eco Friendly Disposal Of Existing Freezers ($$)

No. of Units	Disposal Tax	Unit Cost	Total Cost	
1	$50.00	$510.00	$442.40	$$

Simple Return on Investment: 27.58 Yrs

Note- *Average Life of a Freezer is 15 Years*

Type of Recommendation: No/Low Cost ECM Recommendation

APPENDIX H:
SUPPORTING DOCUMENTS

OMB No. 2060-0347

STATEMENT OF ENERGY PERFORMANCE
Needham: Hillside Elementary School

Building ID: 2857158
For 12-month Period Ending: June 30, 2011[1]
Date SEP becomes ineligible: N/A
Date SEP Generated: October 10, 2011

Facility
Needham: Hillside Elementary School
28 Glen Gary Road
Needham, MA 02492

Facility Owner
N/A

Primary Contact for this Facility
N/A

Year Built: 1990
Gross Floor Area (ft²): 52,726

Energy Performance Rating[2] (1-100) 52

Site Energy Use Summary[3]

Electricity - Grid Purchase(kBtu)	1,258,728
Fuel Oil (No. 2) (kBtu)	3,907,050
Natural Gas - (kBtu)[4]	0
Total Energy (kBtu)	5,165,778

Energy Intensity[5]

Site (kBtu/ft²/yr)	98
Source (kBtu/ft²/yr)	155

Emissions (based on site energy use)

Greenhouse Gas Emissions ($MtCO_2e$/year)	427

Electric Distribution Utility
NSTAR Electric Co

National Average Comparison

National Average Site EUI	100
National Average Source EUI	158
% Difference from National Average Source EUI	-2%
Building Type	K-12 School

Stamp of Certifying Professional

Based on the conditions observed at the time of my visit to this building, I certify that the information contained within this statement is accurate.

Certifying Professional
N/A

Meets Industry Standards[6] **for Indoor Environmental Conditions:**

Ventilation for Acceptable Indoor Air Quality	**N/A**
Acceptable Thermal Environmental Conditions	**N/A**
Adequate Illumination	**N/A**

Notes:
1. Application for the ENERGY STAR must be submitted to EPA within 4 months of the Period Ending date. Award of the ENERGY STAR is not final until approval is received from EPA.
2. The EPA Energy Performance Rating is based on total source energy. A rating of 75 is the minimum to be eligible for the ENERGY STAR.
3. Values represent energy consumption, annualized to a 12-month period.
4. Values represent energy intensity, annualized to a 12-month period.
5. Based on Meeting ASHRAE Standard 62 for ventilation for acceptable indoor air quality, ASHRAE Standard 55 for thermal comfort, and IESNA Lighting Handbook for lighting quality.

ENERGY STAR® Data Checklist for Commercial Buildings

In order for a building to qualify for the ENERGY STAR, a Professional Engineer (PE) or a Registered Architect (RA) must validate the accuracy of the data underlying the building's energy performance rating. This checklist is designed to provide an at-a-glance summary of a property's physical and operating characteristics, as well as its total energy consumption, to assist the PE or RA in double-checking the information that the building owner or operator has entered into Portfolio Manager.

Please complete and sign this checklist and include it with the stamped, signed Statement of Energy Performance.
NOTE: You must check each box to indicate that each value is correct, OR include a note.

CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	☑
Building Name	Needham: Hillside Elementary School	Is this the official building name to be displayed in the ENERGY STAR Registry of Labeled Buildings?		☐
Type	K-12 School	Is this an accurate description of the space in question?		☐
Location	28 Glen Gary Road, Needham, MA 02492	Is this address accurate and complete? Correct weather normalization requires an accurate zip code.		☐
Single Structure	Single Facility	Does this SEP represent a single structure? SEPs cannot be submitted for multiple-building campuses (with the exception of acute care or children's hospitals) nor can they be submitted as representing only a portion of a building		☐
School (K-12 School)				
CRITERION	**VALUE AS ENTERED IN PORTFOLIO MANAGER**	**VERIFICATION QUESTIONS**	**NOTES**	☑
Gross Floor Area	52,726 Sq. Ft.	Does this square footage include all supporting functions such as kitchens and break rooms used by staff, storage areas, administrative areas, elevators, stairwells, atria, vent shafts, etc. Also note that existing atriums should only include the base floor area that it occupies. Interstitial (plenum) space between floors should not be included in the total. Finally gross floor area is not the same as leasable space. Leasable space is a subset of gross floor area.		☐
Open Weekends?	No (Default)	Is this building normally open at all on the weekends? This includes activities beyond the work conducted by maintenance, cleaning, and security personnel. Weekend activity could include any time when the space is used for classes, performances or other school or community activities. If the building is open on the weekend as part of the standard schedule during one or more seasons, the building should select ?yes? for open weekends. The ?yes? response should apply whether the building is open for one or both of the weekend days.		☐
Number of PCs	92 (Default)	Is this the number of personal computers in the K12 School?		☐
Number of walk-in refrigeration/freezer units	1 (Default)	Is this the total number of commercial walk-in type freezers and coolers? These units are typically found in storage and receiving areas.		☐
Presence of cooking facilities	Yes (Default)	Does this school have a dedicated space in which food is prepared and served to students? If the school has space in which food for students is only kept warm and/or served to students, or has only a galley that is used by teachers and staff then the answer is "no".		☐
Percent Cooled	100 % (Default)	Is this the percentage of the total floor space within the facility that is served by mechanical cooling equipment?		☐
Percent Heated	100 % (Default)	Is this the percentage of the total floor space within the facility that is served by mechanical heating equipment?		☐
Months	N/A(Optional)	Is this school in operation for at least 8 months of the year?		☐

High School?	No	Is this building a high school (teaching grades 10, 11, and/or 12)? If the building teaches to high school students at all, the user should check 'yes' to 'high school'. For example, if the school teaches to grades K-12 (elementary/middle and high school), the user should check 'yes' to 'high school'.		☐

ENERGY STAR® Data Checklist for Commercial Buildings

Energy Consumption

Power Generation Plant or Distribution Utility: NSTAR Electric Co

Fuel Type: Electricity		
Meter: 25921061005 (kWh (thousand Watt-hours)) **Space(s):** Entire Facility **Generation Method:** Grid Purchase		
Start Date	**End Date**	**Energy Use (kWh (thousand Watt-hours))**
06/01/2011	06/30/2011	24,880.00
05/01/2011	05/31/2011	29,520.00
04/01/2011	04/30/2011	31,280.00
03/01/2011	03/31/2011	36,920.00
02/01/2011	02/28/2011	42,320.00
01/01/2011	01/31/2011	40,480.00
12/01/2010	12/31/2010	37,520.00
11/01/2010	11/30/2010	29,000.00
10/01/2010	10/31/2010	26,720.00
09/01/2010	09/30/2010	24,960.00
08/01/2010	08/31/2010	16,840.00
07/01/2010	07/31/2010	20,600.00
25921061005 Consumption (kWh (thousand Watt-hours))		**361,040.00**
25921061005 Consumption (kBtu (thousand Btu))		**1,231,868.48**
Meter: 25921071004 (kWh (thousand Watt-hours)) **Space(s):** Entire Facility **Generation Method:** Grid Purchase		
Start Date	**End Date**	**Energy Use (kWh (thousand Watt-hours))**
06/01/2011	06/30/2011	656.00
05/01/2011	05/31/2011	656.00
04/01/2011	04/30/2011	656.00
03/01/2011	03/31/2011	656.00
02/01/2011	02/28/2011	656.00
01/01/2011	01/31/2011	656.00
12/01/2010	12/31/2010	656.00
11/01/2010	11/30/2010	656.00
10/01/2010	10/31/2010	656.00
09/01/2010	09/30/2010	656.00
08/01/2010	08/31/2010	656.00
07/01/2010	07/31/2010	656.00
25921071004 Consumption (kWh (thousand Watt-hours))		**7,872.00**

25921071004 Consumption (kBtu (thousand Btu))	**26,859.26**
Total Electricity (Grid Purchase) Consumption (kBtu (thousand Btu))	**1,258,727.74**
Is this the total Electricity (Grid Purchase) consumption at this building including all Electricity meters?	☐

Fuel Type: Fuel Oil (No. 2)

Meter: Fuel Oil (Gallons)
Space(s): Entire Facility

Start Date	End Date	Energy Use (Gallons)
06/01/2011	06/30/2011	1,500.00
05/01/2011	05/31/2011	3,000.00
04/01/2011	04/30/2011	2,024.00
03/01/2011	03/31/2011	2,000.00
02/01/2011	02/28/2011	4,217.00
01/01/2011	01/31/2011	5,000.00
12/01/2010	12/31/2010	3,470.00
11/01/2010	11/30/2010	6,960.00
10/01/2010	10/31/2010	0.00
09/01/2010	09/30/2010	0.00
08/01/2010	08/31/2010	0.00
07/01/2010	07/31/2010	0.00

Fuel Oil Consumption (Gallons)	**28,171.00**
Fuel Oil Consumption (kBtu (thousand Btu))	**3,907,050.08**
Total Fuel Oil (No. 2) Consumption (kBtu (thousand Btu))	**3,907,050.08**
Is this the total Fuel Oil (No. 2) consumption at this building including all Fuel Oil (No. 2) meters?	☐

Additional Fuels	
Do the fuel consumption totals shown above represent the total energy use of this building? Please confirm there are no additional fuels (district energy, generator fuel oil) used in this facility.	☐

On-Site Solar and Wind Energy	
Do the fuel consumption totals shown above include all on-site solar and/or wind power located at your facility? Please confirm that no on-site solar or wind installations have been omitted from this list. All on-site systems must be reported.	☐

Certifying Professional

(When applying for the ENERGY STAR, the Certifying Professional must be the same PE or RA that signed and stamped the SEP.)

Name: _____ Date: _____

Signature: _____

Signature is required when applying for the ENERGY STAR.

FOR YOUR RECORDS ONLY. DO NOT SUBMIT TO EPA.

Please keep this Facility Summary for your own records; do not submit it to EPA. Only the Statement of Energy Performance (SEP), Data Checklist and Letter of Agreement need to be submitted to EPA when applying for the ENERGY STAR.

Facility
Needham: Hillside Elementary School
28 Glen Gary Road
Needham, MA 02492

Facility Owner
N/A

Primary Contact for this Facility
N/A

General Information

Needham: Hillside Elementary School	
Gross Floor Area Excluding Parking: (ft^2)	52,726
Year Built	1990
For 12-month Evaluation Period Ending Date:	June 30, 2011

Facility Space Use Summary

School	
Space Type	K-12 School
Gross Floor Area(ft^2)	52,726
Open Weekends?[d]	No
Number of PCs[d]	92
Number of walk-in refrigeration/freezer units[d]	1
Presence of cooking facilities[d]	Yes
Percent Cooled[d]	100
Percent Heated[d]	100
Months[o]	N/A
High School?	No
School District[o]	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 Average**
Energy Performance Rating	52	52	75	N/A	50
Energy Intensity					
Site (kBtu/ft^2)	98	98	78	N/A	100
Source (kBtu/ft^2)	155	155	123	N/A	158
Energy Cost					
$/year	$ 142,853.78	$ 142,853.78	$ 114,113.88	N/A	$ 145,915.87
$/$ft^2$/year	$ 2.71	$ 2.71	$ 2.16	N/A	$ 2.77
Greenhouse Gas Emissions					
$MtCO_2e$/year	427	427	341	N/A	436
$kgCO_2e/ft^2$/year	8	8	6	N/A	8

More than 50% of your building is defined as K-12 School. Please note that your rating accounts for all of the spaces listed. The National Average column presents energy performance data your building would have if your building had an average rating of 50.

Notes:
o - This attribute is optional.
d - A default value has been supplied by Portfolio Manager.

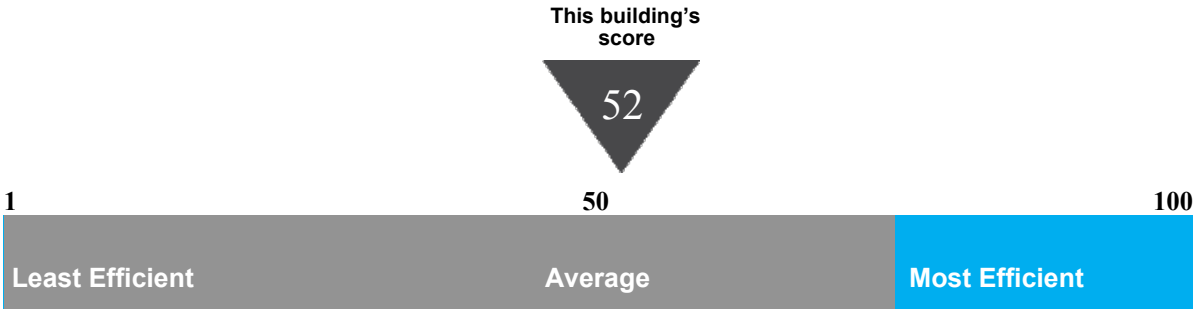
Statement of Energy Performance

2011

Needham: Hillside Elementary School
28 Glen Gary Road
Needham, MA 02492

Portfolio Manager Building ID: 2857158

The energy use of this building has been measured and compared to other similar buildings using the Environmental Protection Agency's (EPA's) Energy Performance Scale of 1–100, with 1 being the least energy efficient and 100 the most energy efficient. For more information, visit energystar.gov/benchmark.



This building uses 155 kBtu per square foot per year.*

*Based on source energy intensity for the 12 month period ending June 2011

Buildings with a score of 75 or higher may qualify for EPA's ENERGY STAR.

I certify that the information contained within this statement is accurate and in accordance with U.S. Environmental Protection Agency's measurement standards, found at energystar.gov

Date of certification

EPA United States Environmental Protection Agency

Date Generated: 10/10/2011