ENERGY AUDIT
REPORT

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

ENERGY AUDIT REPORT

of

HIGH ROCK SIXTH GRADE CENTER

77 Ferndale Road
Needham, Massachusetts 02492

PREPARED BY:

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EMG Project #: 98515.11R-005.268

Date of Report: February 12, 2012
On site Date: September 7 and 9, 2011

EMG
DECISION INTELLIGENCE
25th ANNIVERSARY

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1. CERTIFICATION

EMG has completed an Energy Audit of High Rock Sixth Grade Center located at 77 Ferndale Road, Needham, Massachusetts 02492. EMG visited the site on September 7 and September 9, 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 the Greater Boston area. 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: John McLurg, P.E.
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 High Rock Sixth Grade Center and the Town of Needham with a baseline of energy usage and the relative energy efficiency of the facility and specific recommendations for Energy Conservation Measures. Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Federal & Utility grants towards energy conservation, support performance contracting, justify a municipal bond funded improvement program, or as a basis for replacement of equipment or systems.

The school property has a single, three-story building containing approximately 56,599 square feet. The original school building was probably constructed in the 1940's or 1950's. A significant renovation and building addition was completed in 2008. This included a complete replacement of the original building HVAC, plumbing, and electrical systems.

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.

High Rock Sixth Grade Center was constructed with many energy-conservation features. In particular, the building features large areas of glazing which allow abundant natural light inside the building. The new building boilers are (90%) efficient condensing units. Much of the HVAC equipment features motors controlled by Variable-Frequency Drives (VFD) which reduce unnecessary electrical energy consumption. Rooftop Air Handlers make use of CO_2 sensors to minimize outdoor air volume. Rooftop Unit filters have been upgraded to high-efficiency units in recent years. Light fixtures are energy-conserving fluorescent fixtures with electronic ballasts or Compact-Fluorescent (CFL) lamps. Most interior light fixtures are controlled by motion sensors. The building is equipped with solar collectors, mounted on the roof. Finally, the building features water-conserving plumbing fixtures.

Summary of Existing Energy Performance

Building's Annual Energy Consumption	3,339,561 kBtu
Total Annual Energy Costs	$131,777

EMG has identified four 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	$10,205 *(In Current Dollars)*
Estimated Annual Cost Savings Related to ECMs	$2,163 *(In Current Dollars)*
Net Effective ECM Payback	4.72 years
Estimated Annual Energy Savings	1%
Estimated Annual Cost Savings	2%

List of Recommended Energy Conservation Measures High Rock Sixth Grade Center

ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Estimated Annual Water Savings	Total Energy Savings	Total Estimated Annual Cost Savings	Simple Payback
			Natural Gas	Electricity				
		$	Therms	kWh	kgal	MMBtu	$	Years
No/Low Cost Recommendations								
1	Install Automatic Lighting Controls Details: Install Photosensors in Gym, Cafeteria	$282	0	1,810	0	6	$406	0.70
2	Install Energy Savers on Vending, Snack Machines Details: Install Cooler Misers on 3 Electric Water Coolers & 1 Soft Drink Vending Machine	$770	0	3,680	0	13	$826	0.93
Totals for No/Low Cost Items		**$1,052**	**0**	**5,490**	**0**	**19**	**$1,232**	**0.85**
Capital Cost Recommendations								
1	Replace High Intensity Discharge Lamp (HID) with Induction Lighting Details: Replace Gym HID Lamps with Induction Lamps	$3,625	0	2,004	0	7	$498	7.29
2	Install Bi-Level Lighting System In Hallways Details: Control Corridor Linear Fluorescent Lighting with Motion Sensors	$4,196	0	3,006	0	10	$674	6.22
Total For Capital Cost		**$7,821**	**0**	**5010**	**0**	**17**	**$1,172**	**6.67**
	Interactive Savings Discount @ 10%		0	-1,050		-4	-$240	
	Total Contingency Expenses @ 15%	$1,331						
Total for Improvements		**$10,205**	**0**	**9,450**	**0**	**32**	**$2,163**	**4.72**

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 High Rock Sixth Grade Center is performing above the national average level.

Below is the EPA Performance Rating:

High Rock Sixth Grade Center:	58
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: High Rock Sixth Grade Center
77 Sylvan 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: High Rock Sixth Grade Center	
Gross Floor Area Excluding Parking: (ft²)	56,599
Year Built	1940
For 12-month Evaluation Period Ending Date:	May 31, 2011

Facility Space Use Summary

School	
Space Type	K-12 School
Gross Floor Area(ft2)	56,599
Open Weekends?[d]	No
Number of PCs[d]	99
Number of walk-in refrigeration/freezer units[d]	1
Presence of cooking facilities[d]	Yes
Percent Cooled	80
Percent Heated[d]	100
Months[e]	9
High School?[d]	No
School District[e]	N/A

Energy Performance Comparison

	Evaluation Periods		Comparisons		
Performance Metrics	**Current** (Ending Date 05/31/2011)	**Baseline** (Ending Date 01/31/2011)	**Rating of 75**	**Target**	**National Median**
Energy Performance Rating	58	46	75	N/A	50
Energy Intensity					
Site (kBtu/ft²)	65	70	55	N/A	70
Source (kBtu/ft²)	137	153	116	N/A	148
Energy Cost					
$/year	$ 132,005.29	$ 143,780.29	$ 111,538.56	N/A	$ 142,635.77
$/ft²/year	$ 2.33	$ 2.54	$ 1.97	N/A	$ 2.52
Greenhouse Gas Emissions					
$MtCO_2e$/year	294	324	248	N/A	318
$kgCO_2e$/ft²/year	5	6	4	N/A	5

4. INTRODUCTION

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

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, rooftop equipment 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

School is in session 180 days during the year. Teachers and staff work in the school for approximately 185 days during the year. During the school year, the building is accessible to teachers and staff between 6.30am and 10pm. The school building is frequently accessible to the public during evening and weekend hours for various extra-curricular activities such as school plays or night basketball during the school year and also during the summer.

According to the latest available information, 448 students are assigned to High Rock Sixth Grade Center. The school has 19 classes. Assuming 21 teachers and an equivalent number of staff yields a normal building occupancy of 490 persons. After-hours programs might result in an equal occupancy, assuming activities involving the Multi-Purpose room and the Gymnasium.

Facility Occupancy (avg. people/day)	490
Standard Operating Hours/day	15.5
Maintenance/ Staff Hours/day	6.30 AM-10 PM

Summary of Facility Operating Hours

	Hours Open to the Public	Hours Open to Employees
Monday-Friday	8 AM – 3 PM	6.30 AM – 10 PM
Saturday	By Arrangement	By Arrangement
Sunday	By Arrangement	By Arrangement

5.2. BUILDING ENVELOPE

According to the structural drawings, the building foundation consists of a conventional, reinforced concrete, slab-on-grade foundation with exterior wall and column footings.

The building has structural steel columns and masonry bearing walls supporting the main level floor, upper level floor and roof. Both the main level floor and upper level floor have a concrete-topped metal deck supported by open-web joists.

The primary roofs are classified as flat. The roofs are finished with stone ballast over a single ply membrane which is laid over solid roof insulation panels.

The exterior walls are finished with brick masonry veneer or metal siding. No cracks or infiltration issues were observed.

Item	Construction Type
Foundation	Slab-on-grade or crawl-space with Column Footings and Wall footings.
Structure	Steel-framed or bearing wall with open-web joists and roof trusses.
Exterior Walls	Masonry Cavity Walls, CMU with brick veneer or metal siding
Roof	Metal Roof Deck with membrane and stone ballast over open-web joists.

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

Building Element	Type Observed	Observed R-values
Roof, Attic	Not Accessible	Not accessible
Floors	Not Accessible	Not accessible
Exterior Walls Above Grade	2" rigid (2008 Addition)	R-28
Basement Walls, Slab Perimeter	Rigid slab perimeter insulation	Not accessible
Windows	Not Accessible	Not accessible
Exterior Doors	Not Accessible	Not accessible

The windows are part of an aluminum framed storefront system incorporating the entry doors. The windows are glazed with insulated panes set in metal frames. The entrance doors are fully glazed aluminum-framed set in the storefront framing system. Caulking and weather stripping are in good condition.

The curtain wall windows are aluminum-framed double-pane glazed units. The caulking was in good condition. Air infiltration was not reported near the windows. No window issues such as infiltration or condensation were observed.

The main entrance doors are fully glazed aluminum-framed units set in metal frames. The glazing is double-paned. Weather stripping was observed around the door openings. The weather stripping was observed to be in good condition. Caulking was observed at the perimeter of the door frames. The caulking was observed to be in good condition.

The additional entrance doors were full-glass panel doors. Service doors were insulated steel. Caulking and weatherstripping were observed to be in good condition.

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

Building Automation System (BAS)

The building HVAC system is controlled by a Building Automation System (BAS). During occupied hours, the BAS controls all HVAC equipment to maintain a winter indoor temperature setpoint of 70ºF or a summer temperature setpoint of 75ºF. During a normal school day, the BAS controls the HVAC system so that Rooftop Units and Exhaust Fans shut off at 4 PM. The HVAC equipment reverts to normal operation at 6.30 AM in the morning of the next school day. When requests are received to operate the HVAC equipment outside of regular hours for extra-curricular activities, the BAS is programmed to run the HVAC equipment during those hours.

Building Heating

The building hydronic system heats water and distribute it through piping to heating equipment located throughout the building which then heats the air inside the space. The rooftop air-handler units have heating water coils which heat air directly and blow the heated air into ductwork and then into the fan-powered boxes units and, finally, into the space.

The building has three gas-fired hot water boilers located in Room 133. The boilers operate during heating season, only. Under normal circumstances, only one boiler will operate and the others remain in standby. The boilers rotate monthly between standby and on-line operation. The BAS controls the boilers so that they maintain a leaving water temperature of 140ºF. However, if one boiler is unable to maintain this temperature setpoint, the BAS will bring another boiler on line. If two boilers are unable to maintain 140ºF leaving water temperature (LWT), the BAS will bring the third boiler on-line. Two 5-horsepower (150gpm @ 75′) pumps circulate heated water through a two-pipe system to the hydronic heating equipment located throughout the building spaces. Normally, only one pump will operate but both pumps will operate when the heating system requires maximum flow. The circulating pump motors feature Variable Frequency Drives (VFD). The VFD units control the speed of the pump motors and heated water flow to match demand, thus reducing unnecessary electrical energy consumption. Hydronic heating devices in the building space include fin-tube units, unit heaters, cabinet unit heaters and fan-powered boxes.

During occupied periods, the fin-tube units are designed to maintain a space temperature of 70ºF. Fin tubes are mounted at floor level around the perimeter walls of the building. When the space thermostat calls for heat, the three-way control valve opens to allow the flow of heated water through the fin tube unit.

Cabinet Unit Heaters are located in the vestibules, stairwells and corridors. These units are mounted flush with the interior wall surfaces and are designed to maintain a space temperature of 70°F. These units operate on the same principle as the fin tube units with the exception that the cabinet unit heaters have fans which blow the heated air into the space.

Unit Heaters are located in the elevator machine room, storage rooms, kitchen and mechanical rooms. These units are similar to the cabinet unit heaters but they are used in areas where aesthetic appearance is not important.

Many offices are heated by fan-powered boxes equipped with heating water reheat coils. The units are supplied with Return Air from the space as well as conditioned air from the Rooftop Air Handlers. The air entering the unit is heated by the hot-water reheat coils to the desired temperature and then it is blown into the space and mixes with the air in the space to maintain the space temperature setpoint of 70°F.

Rooftop Air Handlers draw outside or "fresh" air from the atmosphere and mix it with air drawn from the interior spaces ("return" air). The mixed air is then drawn through the air handler heating water coils. This heated air then passes through the supply fan which pumps the air into the building ductwork. The heated air then passes through the fan-powered units where it is reheated, if necessary, to maintain room setpoint (+/-2ºF). The air then passes through ceiling diffusers and mixes with the room air to maintain the room temperature at the setpoint as controlled by the BAS. Two of the Rooftop Air Handlers are "Variable Air Volume" (VAV) systems.

Each unit supply and return fan is controlled by a Variable Frequency Drive (VFD) which modulates the fan to control the volume of air supplied to the various fan-powered units in response to space heating demand. The VAV systems are much more energy-efficient when compared with Constant Volume (CV) systems.

Ventilation

Roof top exhaust fans provide ventilation to restrooms. This includes the emergency generator room, kitchen, gym and restrooms. The restroom exhaust fans operate between 6.30 AM and 4 PM but they are interlocked with the restroom lights which are controlled by occupancy sensors. These fans only operate when they are actually required which reduces unnecessary energy consumption. General ventilation is provided by the Rooftop units which exhaust a fraction of the return air into the atmosphere. This exhaust air is replaced with outside or "fresh" air which is drawn into the air handler. Each air handler outside air damper is modulated in response to CO_2 concentrations in the spaces served by the air handler. This reduces the volume of outside air drawn into the Rooftop Unit to what is actually required for occupants' health and comfort. Usually, more energy is required to heat or cool Outside Air when compared with Return Air and minimizing the quantity of Outside Air will reduce energy consumption.

Air-conditioning

Cooling air is supplied to the building spaces by the packaged Rooftop Units. Additional cooling is provided by small split-system units. Return air is drawn through the air handler supply fan which circulates the cooled air into the building ductwork. The cooled air passes through the fan-powered box units and then through ceiling diffusers so that it mixes with the room air to maintain the room temperature at the set point (75ºF). As mentioned above, two of the Rooftop Air Handlers are "Variable Air Volume" (VAV) systems. In response to space cooling load, the fan-powered unit damper modulates to control the volumetric flow of cooled air into the space. The interaction of the various fan-powered unit dampers causes changes in duct static pressure. Sensors located in the ductwork transmit the static pressure reading to the air handler control system which controls the VFD supply fans in the Rooftop Unit. The supply fans will then control the amount of air flowing into the ductwork. The return fans are equipped with VFD units and they operate so as to track the supply fans to maintain the duct static pressure setpoint.

The Technology Classroom and Head End room are cooled by ductless split-systems. The Technology Classroom is cooled by a 3-ton unit and the Head-End room is cooled by a 2-ton unit. These units are required because the Technology Classroom and Head-End room require year-round cooling.

Item	Measured Values
Major Heating system type/capacity	Boilers /2,700 MBH, total
Major Cooling System type/capacity	RTU1,2,3,4,5,6/ 163 tons, total
Heating hot water supply temperature	160ºF

Item	Measured Values
Chilled water supply/return temperatures	Not applicable (DX units)
Condenser water supply/return temperatures	Not applicable (air-cooled condensers)
Outside Air temperature & Relative Humidity (%) at time of audit	61-63^{o}F/ 94%
Interior space temperatures & Relative Humidity (RH%)	71^{o}F
Supply Air Temperature (SAT)/Return Air Temperature (RAT)	60-63^{o}/74^{o}F
Avg. Supply Air rate (CFM/Sq.ft)	0.9
Avg. Interior space thermostat set-point	70^{o} (winter)/75^{o}F(summer)
Avg. Outside Air rate (% & CFM/Sq.ft or CFM/person)	.3cfm/square-foot; 41cfm/person

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

During the energy audit some of the occupants of the administrative offices expressed their opinions that their offices were uncomfortably cold during the winter. These offices are located on the main level and they adjoin the south exterior wall of the building. It is possible that the fan-powered units serving these areas are not operating correctly. The operation of these units should be observed under winter conditions to determine if they are functioning correctly.

5.4. BUILDING LIGHTING

High Rock has a very advanced lighting system which has many energy-conserving features,

The emergency light fixtures and "exit" fixtures are continuously energized. In the event of a power failure, the building emergency generator will be activated to power these fixtures. The remainder of the building light circuits are activated at 6.30 AM each school day and deactivated at 10 PM. The building has a lighting control system (LCS) used to activate lighting circuits for extra-curricular activities occurring outside the normal hours. Exterior lighting is energized and de-energized by the lighting control system (LCS). At the time of the energy audit, the exterior light fixtures were programmed to activate at 5 AM in the morning and deactivate at 6.30 AM. In the evening, the lights were set to activate at 6 PM and deactivate at 10.30 PM. These times can be adjusted to accommodate the change of the seasons and extra-curricular activities.

Inside the building, corridor lighting circuits are controlled by a central circuit box. Other rooms such as the Gym are controlled by local lighting control panels. Some rooms such as the Mechanical Rooms and janitor closets have lights controlled by wall switches. The majority of the rooms, including the classrooms, restrooms, and most offices are controlled by motion detectors. Each motion detector will switch the room lights "off" if it does not detect motion within a 15-minute interval. This conserves energy by turning light fixtures "off" when the room is unoccupied. Classrooms have 4-switch gang switches mounted on the wall. These switches allow the teacher to adjust the room lighting by turning individual lighting circuits "on" or "off" until the desired light level is achieved. As mentioned above, the room motion sensor will turn the lights "off" when the room is unoccupied. Most private offices use a similar method of control.

Offices are lighted by pendant-mounted linear-fluorescent fixtures with T5 or T8 lamps, reflectors and electronic ballasts. Classrooms have similar fixtures. Additional lighting is furnished by recessed "can" fixtures using (mostly 26W) CFL lamps and/or cove lighting in the form of T8 fixtures. Corridor and stair lighting features wall sconce fixtures with 26W CFL lamps. Gym lighting is provided by 150W metal-halide fixtures and linear-fluorescent fixtures. Surface-mounted CFL light fixtures on the exterior walls provide the exterior of the building with site illumination. Recessed CFL light fixtures are located in the exterior soffits. Parking lot lighting is provided by property-owned 70W or 100W metal-halide fixtures. The poles are spaced along the drive aisles throughout the parking areas.

Generally speaking, building lighting is adequate. No burned out lamps were observed. During the energy audit, light levels were taken in the majority of the rooms. The various rooms have been grouped by function such as classrooms, dining, hallways, restrooms and gymnasium. For each functional group, the light readings were averaged and the results obtained appear in the following table along with recommended light levels:

Space type	Measured Light Levels (Lux/foot candles)	ASHRAE/IESNA Recommended Levels (foot candles)
Classrooms	419 Lux/39 FC	50
Student Dining	569 Lux/53 FC	20
Hallways	204 Lux/19 FC	20
Restrooms	129 Lux/12 FC	20
Gym	494 Lux/46 FC	30
Avg. Building Lighting Density, W/Sq.Ft	0.673 W/Sq.Ft	1.2 W/Sq.Ft

Note: 1 foot candle = 10.764 lux

The table shows that building lighting levels are generally adequate when compared with recommended levels. Some spaces in the building are exposed to natural light and additional energy savings could be realized by reducing artificial lighting at times when natural light is adequate. This is particularly true for some of the corridors and stairways. Other spaces with natural light include the Dining Room and sections of the corridors.

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

5.5. BUILDING ELEVATORS AND CONVEYING SYSTEMS

There is one hydraulic passenger elevator. The elevator machinery is located in Room 138.

5.6. BUILDING DOMESTIC HOT WATER

Domestic water is supplied to the building from the Town of Needham. The building water meter is located in Room 133.

Three 100-gallon gas-fired condensing water heaters supply domestic hot water. Each water heater is located in the Lower Level Mechanical Room. Each water heater has a rated input capacity of 150,000 BTUH and an efficiency of 90%.

The heated water passes from the water heater tanks and into a mixing valve which reduces the temperature of the water pumped to the wash basins and showers to a safe temperature of 130ºF (maximum). The water pumped to the dishwasher in the kitchen is heated to a higher temperature (170ºF-180ºF) by a booster unit at the dishwasher. The water is circulated through each piping loop by a 1/8HP, 10gpm circulating pump. DHW piping is well-insulated. The hot water temperature measured at one washbasin was 106ºF.

The common area restrooms have commercial-grade fixtures and accessories, including water closets and lavatories. The toilets are equipped with flushometers which have two flush settings. The typical flush volume (maximum setting) was 1.6 GPF. The lavatories are equipped with aerators rated at 2.2 GPM. The classroom lavatories are operated by manual hand valves but those in restrooms are equipped with sensors which allow water flow only when the sensor detects the user's hands under the faucet. Restrooms are equipped with ADA fixtures.

DHW type	Gas
Storage Tank Capacity	300-gallon
Heating/tank set-point	140ºF
DHW temperature at faucet	106ºF
Building faucets, GPM	2.2 GPM
Water closets/toilets, GPF	1.6 (maximum)

5.7. BUILDING NATURAL GAS AND ELECTRICITY

The building is connected to the natural gas utility (NStar). The gas main on the adjacent public street supplies the natural gas service. The gas meter and regulator is located along the exterior wall of the building. The gas distribution piping within the building is malleable steel (black iron).

The facility is master-metered for natural gas. There is a natural gas meter located near the south-east corner of the building.

The electrical supply lines run underground from a pad-mounted transformer to an interior-mounted electrical meter.

The main electrical service size is 1,200 amps, 480/277-volt three-phase four-wire alternating current (AC). The electrical wiring is copper, installed in metallic conduit. Circuit breaker panels are located throughout the building.

The facility is master-metered for Electricity. There is one electric meter at the property, located in the Lower Level Switchgear Room.

A natural gas-engine-driven 150 kVA emergency electrical generator is located in Room 135. The generator provides back-up power for elements of the fire and life safety systems.

Electrical Transformer Type (Wye, Delta)	Delta
Mounting	Pad-mounted
Location	Visitor Parking Area
Main Building Electric service	Underground
Primary Volts	13,800
Secondary Volts	480/277
Phase	3
Wire	4
Amp	1,200
On site Generator (Y/N)	yes
Generator Capacity, kVA	150
Generator Fuel Type	Natural Gas

Electric Meter type (Master/Sub/Direct)	Master	Natural Gas Meter type (Master/Sub/Direct)	Master
Meter Location	Room 136	Meter Location	Building Exterior
Main meter number		Main meter number	

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 High Rock Sixth Grade Center, the following energy rates are utilized in determining existing and proposed energy costs.

Utility Rates used for Cost Analysis

Electricity (Blended Rate)	Natural Gas
$0.22/kWh	$0.98/therm

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

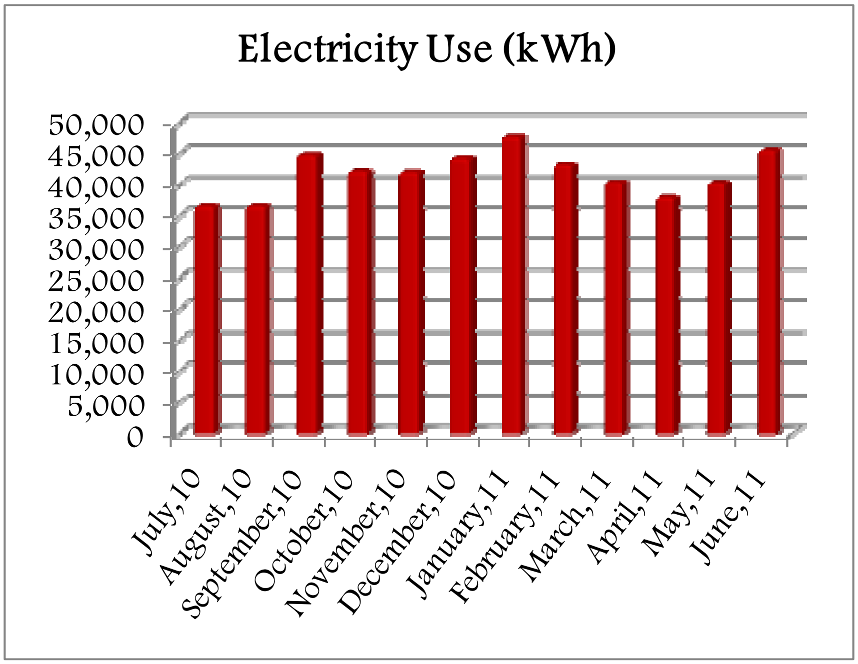
NStar satisfies the Electricity requirements of the facility.

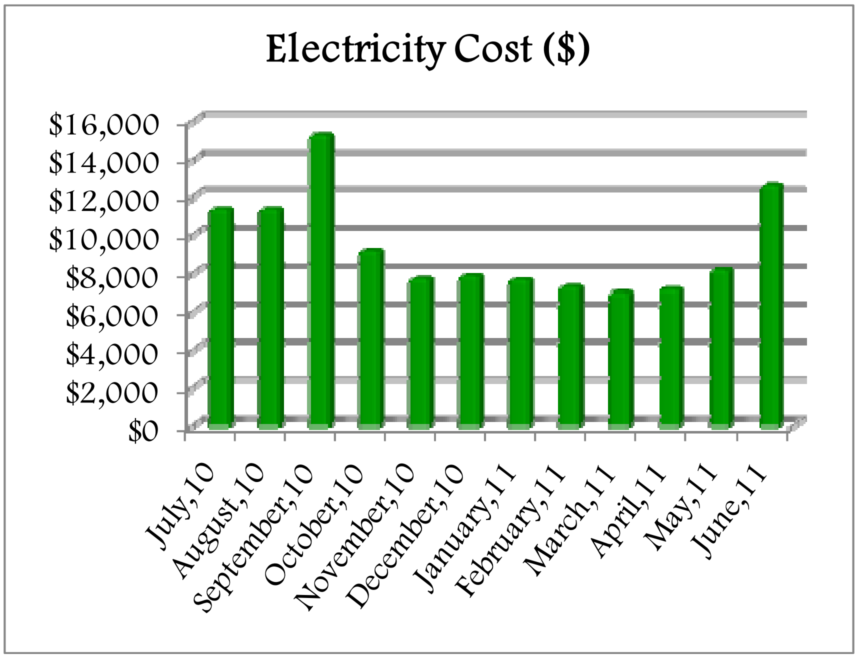
During the school year, lighting comprises the largest component of electrical consumption. The remainder of the consumption is taken up with hard-wired equipment such as fans, pumps, kitchen equipment, freezers, pumps and other equipment. Additional power is consumed by office equipment and appliances connected to receptacles ("plug load") such as computers, copiers, smart boards, etc. All of these loads form the "base load" which remains fairly constant during the school year. The consumption during January, February and March probably approximates the base load. During the warmer months, the air-conditioning chillers operate and this adds significantly to the building electrical power consumption. Examination of the following charts shows that August power consumption was significant even though school was out of session for the summer. This may be indicative of significant extra-curricular activities during the month. Also, unit cost was significantly higher during high-consumption months. This may be a result of peak demand charges during those months.

Based on the 2010/2011 electric usage & costs, the average price paid during the year was $0.22 per kWh. The total annual Electricity consumption for the 12-month period analyzed is 502,128 kWh for a total cost of $112,646. The total consumption shown in the table below represents the combined consumption by the main building as well as the outdoor lights. Since August 2011 consumption includes July & August 2011, we have averaged the total consumption and cost for both months.

Electricity Consumption and Cost Data

Billing Month	Electricity Consumption (kWh)	Unit Cost/kWh	Total Cost
July,10	36,584	$0.31	$11,380.00
August,10	36,584	$0.31	$11,380.00
September,10	44,804	$0.34	$15,228.10
October,10	42,284	$0.22	$9,200.14
November,10	42,164	$0.18	$7,702.67
December,10	44,324	$0.18	$7,861.09
January,11	47,684	$0.16	$7,655.46
February,11	43,364	$0.17	$7,297.47
March,11	40,484	$0.17	$6,997.27
April,11	37,964	$0.19	$7,172.09
May,11	40,364	$0.20	$8,184.21
June,11	45,524	$0.28	$12,587.09
Total	**502,128**	**$0.22**	**$112,645.59**





6.2. NATURAL GAS

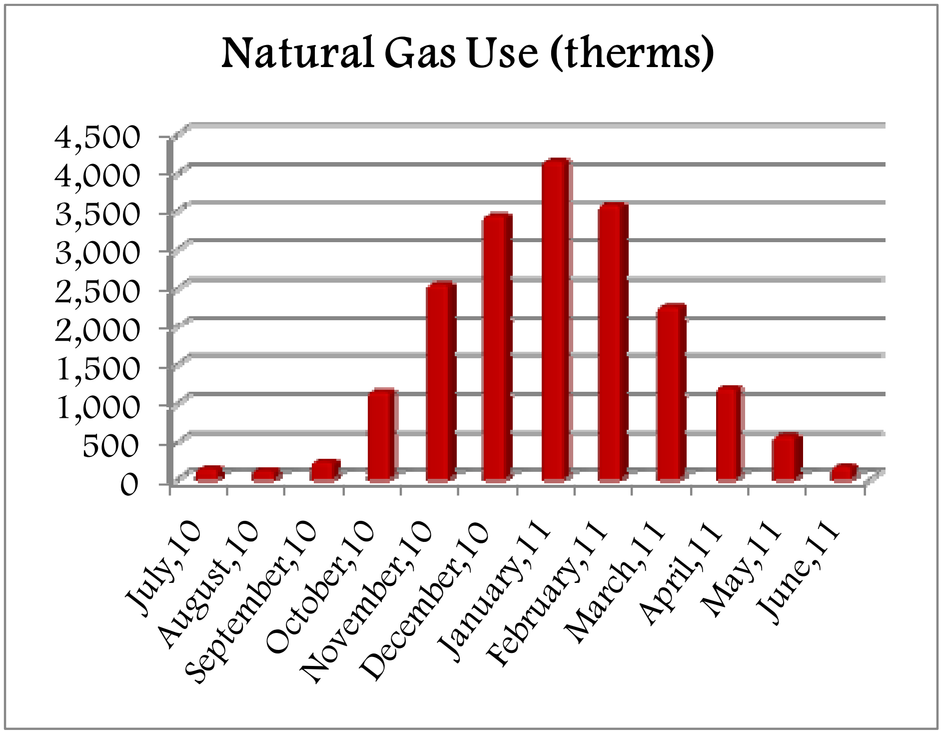
NStar satisfies the natural gas requirements of the facility.

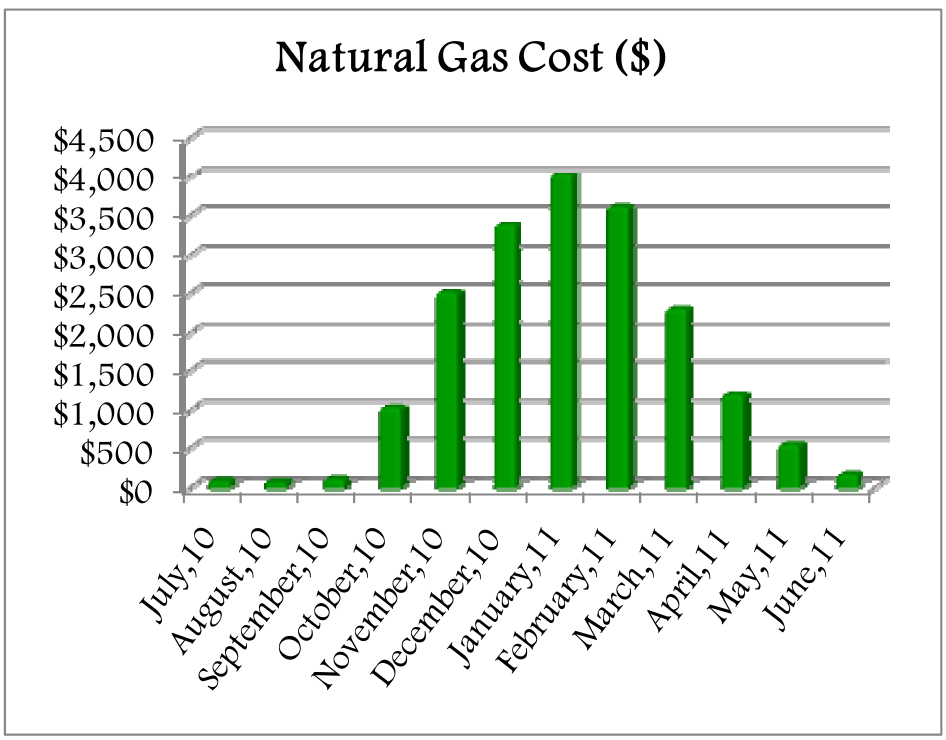
During the school year, the main component of gas consumption is heating. The other main component of gas consumption is for cooking and domestic hot water heating. The cooking and water heating load represents the “base load” which remains relatively constant during the school year. The consumption during the month of September (approximately 230 therms) is probably mostly for cooking and domestic water heating and thus approximates the base load. During the winter months, gas consumption increases markedly and this is, of course, caused by the heating requirements of the boilers.

Based on the 2010/2011 natural gas usage & costs, the average price paid during the year was $0.98 per therm. The total annual natural gas consumption for the 12-month period analyzed is 19,563 for a total cost of $19,131.70.

Natural Gas Consumption and Cost Data

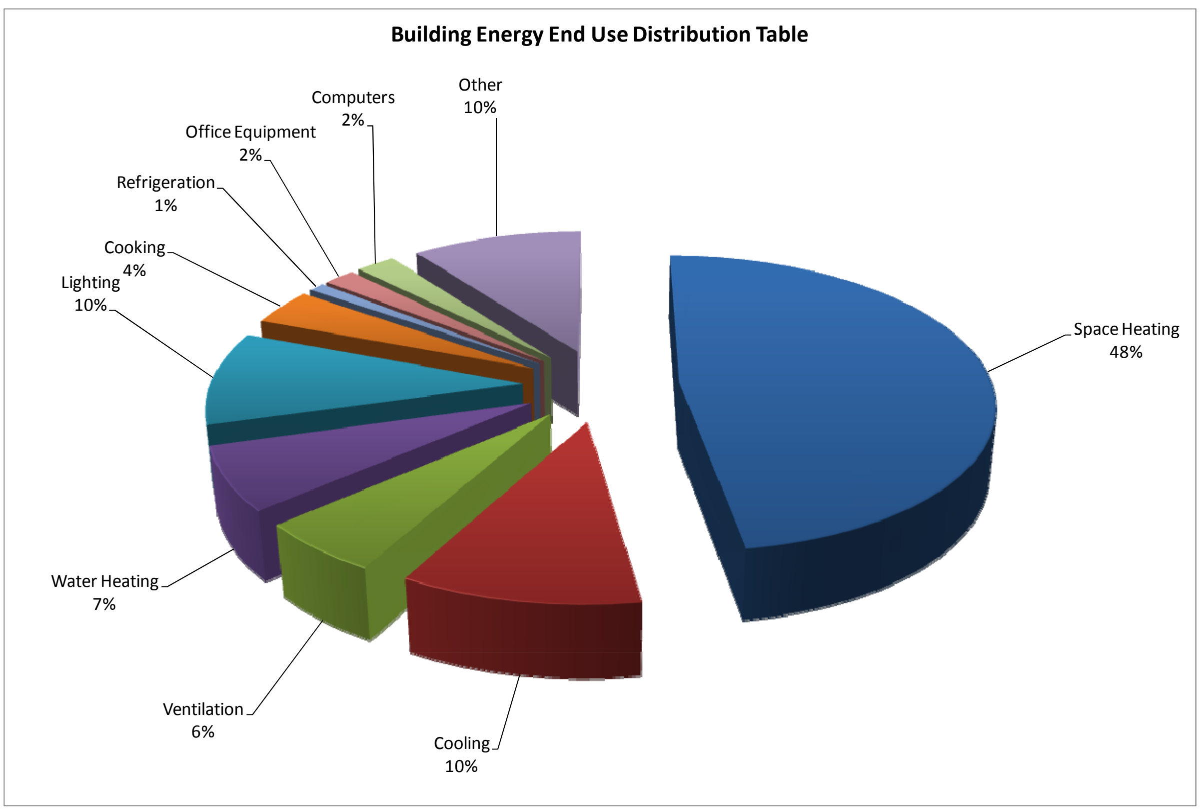
Billing Month	Natural gas Consumption (Therms)	Unit Cost/therm	Total Cost
July,10	138	$0.69	$95.33
August,10	113	$0.73	$82.22
September,10	230	$0.50	$116.10
October,10	1,152	$0.91	$1,042.71
November,10	2,553	$0.99	$2,519.15
December,10	3,431	$0.99	$3,392.42
January,11	4,158	$0.97	$4,024.63
February,11	3,573	$1.01	$3,617.33
March,11	2,269	$1.02	$2,308.28
April,11	1,195	$1.01	$1,207.32
May,11	586	$0.94	$549.64
June,11	165	$1.07	$176.57
Total	**19,563**	$0.98	**$19,131.70**


Natural Gas Use (therms)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
July,10
August,10
September,10
October,10
November,10
December,10
January,11
February,11
March,11
April,11
May,11
June,11


Natural Gas Cost ($)
$4,500
$4,000
$3,500
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$0
July,10
August,10
September,10
October,10
November,10
December,10
January,11
February,11
March,11
April,11
May,11
June,11

7. END USE ENERGY DISTRIBUTION

Components of Annual Energy Use												
	Electricity (1 kWh = 3.412 kBtu)				Natural Gas				Total Energy		Total Cost	
	%	kWh	kBtu	Cost	%	therms	kBtu	Cost	MBtu	% Total	Total- $	% Total
Space Heating	***5.0%***	25,106	85,663	$5,632.28	***84.9%***	*16,606*	1,659,936	16,233	1745.6	***47.6%***	$21,866	***16.6%***
Cooling	***22.4%***	112,477	383,770	$25,232.61			0	0	383.8	***10.5%***	$25,233	***19.2%***
Ventilation	***12.0%***	60,255	205,591	$13,517.47			0	0	205.6	***5.6%***	$13,517	***10.3%***
Water Heating	***1.0%***	5,021	17,133	$1,126.46	***12.1%***	*2,365*	236,405	2,312	253.5	***6.9%***	$3,438	***2.6%***
Lighting	***21.8%***	109,464	373,491	$24,556.74			0	0	373.5	***10.2%***	$24,557	***18.6%***
Cooking	***5.0%***	25,106	85,663	$5,632.28	***3.0%***	*592*	59,176	579	144.8	***3.9%***	$6,211	***4.7%***
Refrigeration	***2.0%***	10,043	34,265	$2,252.91			0	0	34.3	***0.9%***	$2,253	***1.7%***
Office Equipment	***4.0%***	20,085	68,530	$4,505.82			0	0	68.5	***1.9%***	$4,506	***3.4%***
Computers	***5.0%***	25,106	85,663	$5,632.28			0	0	85.7	***2.3%***	$5,632	***4.3%***
Other	***21.8%***	109,213	372,634	$24,500.42			0	0	372.6	***10.2%***	$24,500	***18.6%***
Total	100.0%	**501,877**	1,712,404	$112,589.3	*100.0%*	***19,563***	1,955,517	19,124	**3667.9**	100.0%	**$131,713**	100.0%



8. ENERGY CONSERVATION MEASURES (ECM)

EMG has identified a total of five 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)	65	kBtu/ft2
Post ECM Site Energy Use Intensity (EUI)	64	kBtu/ft2
Source Energy Use Intensity (EUI)	**Rating**	
Current Source Energy Use Intensity (EUI)	137	kBtu/ft2
Post ECM Source Energy Use Intensity (EUI)	135	kBtu/ft2
Building Cost Intensity (BCI)	**Rating**	
Current Building Cost Intensity	$2.33	/ft2
Post ECM Building Cost Intensity	$2.29	/ft2

Summary of the Greenhouse Gas Reductions from Recommended Energy Conservation Measures

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

Greenhouse Gas Emissions Reduction	Rating	
Estimated kWh Reduction	9,450	kWh
Estimated Annual Thermal Energy Reduction	0	Therms
Total CO_2 Emissions Reduced	0.12	$MtCO_2$/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 natural gas savings, water savings, annual energy cost and maintenance savings, payback and SIR:

List of Recommended Energy Conservation Measures High Rock Sixth Grade Center													
ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Estimated Annual Water Savings	Total Energy Savings	Estimated Cost Savings	Estimated Annual O&M Savings	Total Estimated Annual Cost Savings	Simple Payback	S.I.R.	Life Cycle Savings	Expected Useful Life (EUL)
			Natural Gas	Electricity									
		$	Therms	kWh	kgal	MMBtu	$	$	$	Years		$	Years
No/Low Cost Recommendations													
1	Install Automatic Lighting Controls Details: Install Photosensors in Gym, Cafeteria	$282	0	1,810	0	6	$406	$0	$406	0.70	17.16	$4,565	15
2	Install Energy Savers on Vending, Snack Machines Details: Install Cooler Misers on 3 Electric Water Coolers & 1 Soft Drink Vending Machine	$770	0	3,680	0	13	$826	$0	$826	0.93	12.80	$9,085	15
Totals for No/Low Cost Items		**$1,052**	**0**	**5,490**	**0**	**19**	**$1,232**	**$0**	**$1,232**	**0.85**			
Capital Cost Recommendations													
1	Replace High Intensity Discharge Lamp (HID) with Induction Lighting Details: Replace Gym HID Lamps with Induction Lamps	$3,625	0	2,004	0	7	$450	$48	$498	7.29	1.48	1741.78	15
2	Install Bi-Level Lighting System In Hallways Details: Control Corridor Linear Fluorescent Lighting with Motion Sensors	$4,196	0	3,006	0	10	$674	$0	$674	6.22	1.92	3854.55	15
Total For Capital Cost		**$7,821**	**0**	**5010**	**0**	**17**	**$1,124**	**$48**	**$1,172**	**6.67**			
	Interactive Savings Discount @ 10%		0	-1,050		-4	-$236	-$5	-$240				
	Total Contingency Expenses @ 15%	$1,331											
Total for Improvements		**$10,205**	**0**	**9,450**	**0**	**32**	**$2,120**	**$43**	**$2,163**	**4.72**			

If all of the above mentioned ECM's are implemented, High Rock Sixth Grade Center could potentially save approximately $2,163 per year with an investment of $10,205 yielding a net effective payback of 4.72 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 78 hours per week (during the school year, assumed to be 37 weeks long).
- The facility occupancy is assumed to be 490 people.
- Annual Heating Equipment Operating Hours are derived from actual consumption and equipment input rates to be 3,144 hours/year
- Annual Cooling Equipment Operating Hours are derived from actual consumption and equipment input rates to be 677 hours/year
- Typical lighting operating hours are assumed to be 15.5 per day or 2,868 hours per (school) year.

8.2. No/Low Cost ECM Descriptions

EMG has identified two 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. Install Automatic Lighting Controls

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.

The student dining room has a large window. Even though the window faces north, there will be times when artificial illumination is unnecessary, especially since the space does not require high illumination levels. The same goes for the corridor adjacent to the lower level main entrance, except that this window faces south.

In spaces exposed to natural light, EMG recommends installing a photo control sensor that shall control the ON/OFF function of the overhead lights. The photo controls can be pre-programmed to turn on the overhead lamps when the ambient lighting levels falls below a pre-determined level. This ensures that each space is sufficiently lit, even on cloudy days.

Projected annual savings of 1,810 kWh are possible with implementation of this ECM.

8.2.2. Install Energy Controllers On Electric Water Coolers and Vending Machine

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

In the teacher dining room, there is a "Coke" machine and there are 3 Electric Water Coolers located in the building corridors. EMG recommends installing cooler misers on these units, which will automatically reduce the running time of the units during weekends and unoccupied hours. There are two types of cooler misers; one has a timer in it, which is programmed to turn off or tune down the vending machines after the office hours and bring it back up an hour before the office opens. The other is a motion sensor based system that tunes down the machines upon detecting no-occupancy for a pre-programmed duration of time. In the case of vending machines storing chilled products, the vend miser does not turn off the machine entirely, but reduces the operating time of the compressor, such that the machine maintains the products at a minimum tolerable temperature.

Since the "Coke" machine is probably owned by a local distributor, they should be contacted to determine if they are willing to retrofit the unit with a cooler miser or substitute another unit equipped with a vending miser.

After implementation, EMG projects annual energy savings of up to 3,680 kWh.

8.3. CAPITAL COST ECM DESCRIPTIONS

EMG has identified two Capital Cost Energy Conservation Measures (ECMs) for this property. This list includes recommended measures which have an estimated implementation cost equal to or greater than $1,000. The following paragraphs describe each of these ECMs.

8.3.1. Replace High Intensity Discharge (HID) Lamp 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
- Optional Dimmable Ballast for Integrated Control: linearly dimmable to 30%

EMG estimates the replacement cost of 8 existing 150W HID gym lighting with 85W induction lighting will total $3,625. EMG projects annual energy savings of 2,004 kWh.

8.3.2. Replace Corridor Lighting with Motion Sensor Integrated Bilevel T5 Fixtures

Lighting systems consume large amounts of energy in most buildings. Energy is saved by reducing both lighting power consumption and the additional cooling load imposed by lighting. In winter, lights do help heat the building; however, in most cases, lighting is a less efficient heating source than the building HVAC system. Stairwell lighting typically operates continuously at full output even during low, intermittent use. A bi-level product in the market uses an ultrasonic motion sensor to detect motion in stairwells and corridors with solid state controls are used to dim fixtures to lower light levels when a space is unoccupied. The product is ideal for locations where safety and security codes require for minimal light levels during unoccupied periods and full light output during occupied periods.

Bi-level stairwell lighting fixture technology is designed to provide safe, reliable, and efficient lighting with high illumination during occupied periods and reduced illumination and energy usage when stairwells are vacant.

Existing building corridor lighting is more than adequate. Since the corridor light fixtures are "on" from early in the morning until the custodians leave the building (approximately 10pm), reductions in corridor lighting may produce significant savings. The existing corridors feature linear-fluorescent T5 (2-lamp) fixtures and CFL wall-sconce fixtures. Some sections have ceiling "can" fixtures as well. This ECM involves rewiring the ballasts of the linear fluorescent fixtures so that only one of the lamps is constantly lit. The other lamp will be activated by a motion sensor which will turn the lamp "on" when occupancy is sensed and allow the lamp to de-energize whenever no occupancy is sensed.

EMG estimates annual savings of 3006 kWh.

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

Proposed Improvements

1. Caulking and weather stripping functional and effective at all times
2. Walls observed weekly and holes patched in the building envelope as required
3. Windows inspected monthly for damaged panes and failed thermal seals
4. Ensure that windows remain closed when heating system is in use
5. Ensure that windows remain closed when cooling system is in use

Heating and Cooling

1. Observe operation of fan-powered units during heating system to ensure proper operation

Existing Maintenance

2. Boiler and tubes inspected and cleaned annually
3. Air filters inspected monthly (or quarterly in the case of 2-year filters) and replaced prior to excessive visual buildup (May increase filter costs, but will reduce fan energy costs)

Proposed Improvements

4. The burners cleaned and fuel/air ratios optimized during routine maintenance checks
5. Temperature settings reduced in unoccupied areas and set points seasonally adjusted.
6. Control valves and dampers checked for functionality monthly and repaired, when needed
7. Equipment inspected for worn or damaged parts as part of a monthly maintenance check
8. Ductwork visually inspected and checked for leaks or damaged insulation as part of a monthly maintenance check
9. Hot air registers and return air ductwork clean and unobstructed
10. Air dampers operating correctly
11. Test and balance completed annually to ensure heating uniform throughout the spaces
12. Evaporator coils and condenser coils regularly checked and cleaned

Domestic Hot Water

Existing Maintenance

1. Domestic hot water heater temperature set to the minimum temperature required

Proposed Improvements

2. Hot water piping checked routinely for damaged insulated and leaks
3. Tank-type water heaters flushed monthly

Lighting

Existing Maintenance

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 and/or photocells operating correctly on exterior lighting

Proposed Improvements

5. Over-lit areas managed by photocell controls

Existing Equipment and Replacements

Existing Maintenance

1. Refrigerator and freezer doors closed and sealed correctly
2. Kitchen exhaust fans only used when needed or timers installed to limit operation

Proposed Improvements

3. Install "smart" power strips which place Office/ computer equipment either in the "sleep" or "off" mode when the equipment is not in use
4. All other recommended equipment specific preventive maintenance actions conducted
5. Usage demands on the building/ equipment not changed significantly since the original building commissioning or the most recent retro-commissioning

In addition, equipment replacement performed assuring that:

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

10. APPENDICES

APPENDIX A: Photographic Record
APPENDIX B: Site Plan
APPENDIX C: Records of Communication
APPENDIX D: Glossary of Terms
APPENDIX E: Mechanical Equipment Inventory
APPENDIX F: Lighting Systems Schedules
APPENDIX G: ECM Calculations
APPENDIX H: Supporting Documents

APPENDIX A:
PHOTOGRAPHIC RECORD

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-005.268 **Project Name: High Rock Sixth Grade Center**

Photo #1:	South elevation of building

Photo #2:	South elevation of building showing parent pickup/drop-off

Photo #3:	View of rear of building (looking west)

Photo #4:	View of north side of building (looking south)

Photo #5:	View of roof showing solar PV panels

Photo #6:	Insulated window

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-005.268 **Project Name: High Rock Sixth Grade Center**

Photo #7:	Building water meter in boiler room

Photo #8:	Building gas meter

Photo #9:	Building main electric panel and meter

Photo #10:	Building natural gas-engine-driven emergency generator

Photo #11:	Emergency generator transfer switch

Photo #12:	Hot water boiler

EMG

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-005.268 **Project Name: High Rock Sixth Grade Center**

Photo #13:	Heating water pump

Photo #14:	Heating water pump - VFD Drive

Photo #15:	Typical fin-tube unit

Photo #16:	Typical cabinet unit heater

Photo #17:	Typical space temperature sensor

Photo #18:	Rooftop package unit

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-005.268 **Project Name: High Rock Sixth Grade Center**

Photo #19:	Rooftop unit supply fan VFD

Photo #20:	Typical ceiling diffuser

Photo #21:	Rooftop exhaust fans

Photo #22:	Gas-fired water heaters

Photo #23:	Water-conserving faucet

Photo #24:	Interior lighting control box

EMG Photographic Record

Project No.: 98515.11R-005.268 **Project Name: High Rock Sixth Grade Center**

Photo #25: Exterior lighting control box

Photo #26: Solar panel control box

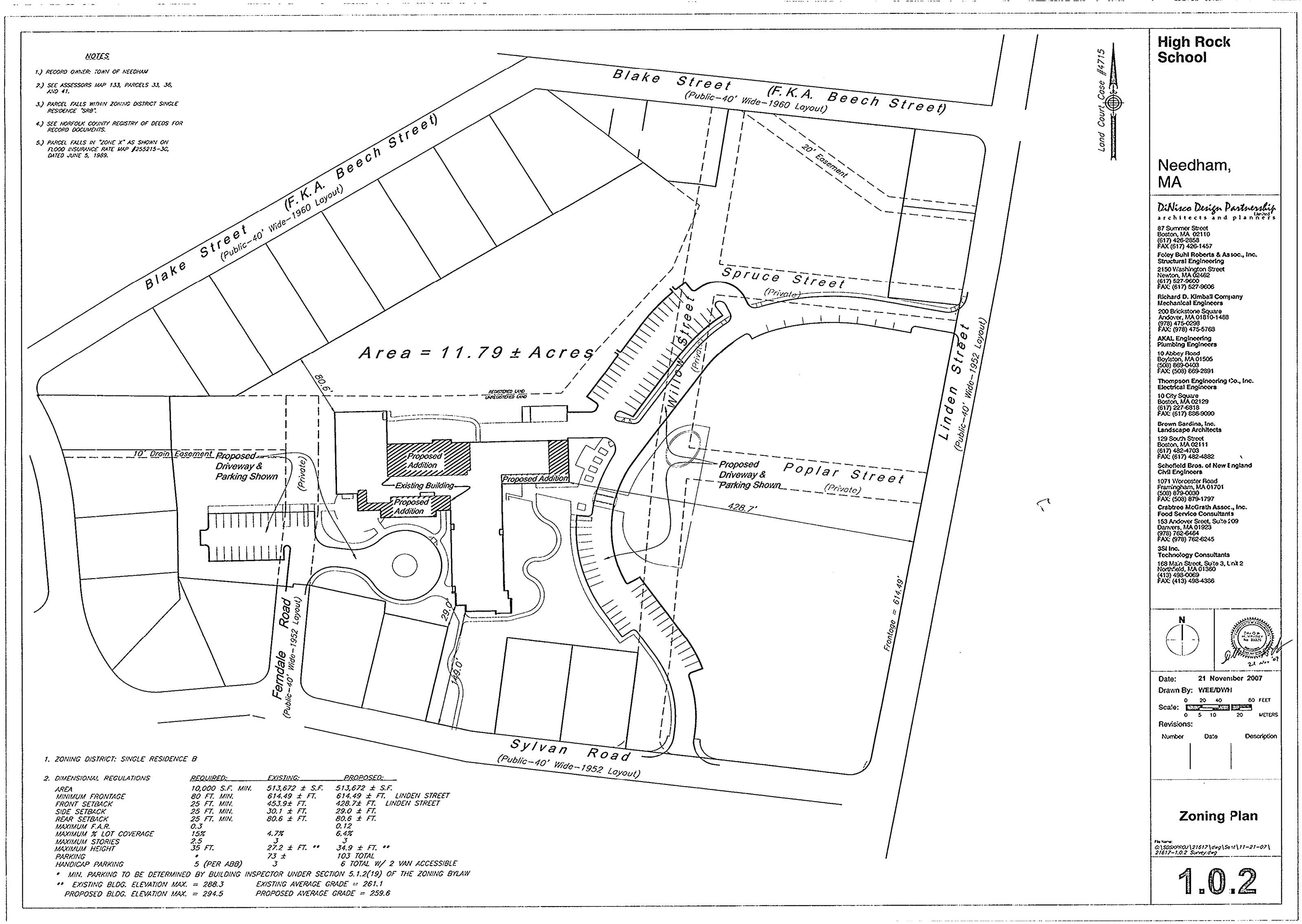
Photo #27: Typical motion sensor elevations

Photo #28: Typical classroom sensor and gang switch

Photo #29: Typical corridor lighting

Photo #30: Student dining room lighting

APPENDIX B:
SITE PLAN


NOTES
1.) RECORD OWNER: TOWN OF NEEDHAM
2.) SEE ASSESSORS MAP 133, PARCELS 33, 36, AND 41.
3.) PARCEL FALLS WITHIN ZONING DISTRICT SINGLE RESIDENCE "SRB".
4.) SEE NORFOLK COUNTY REGISTRY OF DEEDS FOR RECORD DOCUMENTS.
5.) PARCEL FALLS IN "ZONE X" AS SHOWN ON FLOOD INSURANCE RATE MAP #255215-3C, DATED JUNE 5, 1989.
Blake Street (F.K.A. Beech Street)
(Public-40' Wide-1960 Layout)
20' Easement
Spruce Street
(Private)
Willow Street
(Private)
Linden Street
(Public-40' Wide-1952 Layout)
Area = 11.79 ± Acres
10' Drain Easement
Proposed Driveway & Parking Shown
Proposed Addition
Existing Building
Proposed Addition
Proposed Driveway & Parking Shown
Poplar Street
(Private)
428.7'
80.6'
29.0'
149.0'
Frontage = 614.49'
Ferndale Road
(Public-40' Wide-1952 Layout)
Sylvan Road
(Public-40' Wide-1952 Layout)
Land Court Case #4715
1. ZONING DISTRICT: SINGLE RESIDENCE B
2. DIMENSIONAL REGULATIONS REQUIRED: EXISTING: PROPOSED:
AREA 10,000 S.F. MIN. 513,672 ± S.F. 513,672 ± S.F.
MINIMUM FRONTAGE 80 FT. MIN. 614.49 ± FT. 614.49 ± FT. LINDEN STREET
FRONT SETBACK 25 FT. MIN. 453.9± FT. 428.7± FT. LINDEN STREET
SIDE SETBACK 25 FT. MIN. 30.1 ± FT. 29.0 ± FT.
REAR SETBACK 25 FT. MIN. 80.6 ± FT. 80.6 ± FT.
MAXIMUM F.A.R. 0.3 0.12
MAXIMUM % LOT COVERAGE 15% 4.7% 6.4%
MAXIMUM STORIES 2.5 3 3
MAXIMUM HEIGHT 35 FT. 27.2 ± FT. ** 34.9 ± FT. **
PARKING * 73 ± 103 TOTAL
HANDICAP PARKING 5 (PER ABB) 3 6 TOTAL W/ 2 VAN ACCESSIBLE
* MIN. PARKING TO BE DETERMINED BY BUILDING INSPECTOR UNDER SECTION 5.1.2(19) OF THE ZONING BYLAW
** EXISTING BLDG. ELEVATION MAX. = 288.3 EXISTING AVERAGE GRADE = 261.1
PROPOSED BLDG. ELEVATION MAX. = 294.5 PROPOSED AVERAGE GRADE = 259.6
High Rock School
Needham, MA
DiNisco Design Partnership
architects and planners
Date: 21 November 2007
Drawn By: WEE/DWH
Scale:
Revisions:
Number Date Description
Zoning Plan
1.0.2

APPENDIX C:
RECORDS OF COMMUNICATION

RECORD OF COMMUNICATION

Date:	**September 6, 2011**	**Time:**	**10:00 AM**
Project Number:	**98515.11R-005.268**	**Recorded by:**	**J. McLurg Field Observer/Project Manager**
Project Name:	**High Rock Sixth Grade Center**		

Communication with: **Chip Laffey**
of: **Town of Needham**
Phone: **781-389-7257**

Communication via:

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

RE: High Rock Sixth Grade Center Energy Audit

Summary of Communication:

Made arrangements for site visit on September 7.

RECORD OF COMMUNICATION

Date:	**September 6-9, 2011**	**Time:**	**1pm-5:00pm (Sept 7), 8am-12noon (Sept 7).**
Project Number:	**98515.11R-005.268**	**Recorded by:**	**J. McLurg Field Observer/Project Manager**
Project Name:	**High Rock Sixth Grade Center**		

Communication with: **Chip Laffey**
of: **Town of Needham**
Phone:

Communication via:
Telephone Conversation
X Discussions During Site Assessment
Office Visitation/Meeting at:
Other:

RE: High Rock Sixth Grade Center Energy Audit

Summary of Communication:

Mr. Laffey accompanied me during September 7 Site Visit.

APPENDIX D:
GLOSSARY OF TERMS

Glossary of Terms and Acronyms

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

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

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

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

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

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

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

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

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

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

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

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

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

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

APPENDIX E:
MECHANICAL EQUIPMENT INVENTORY

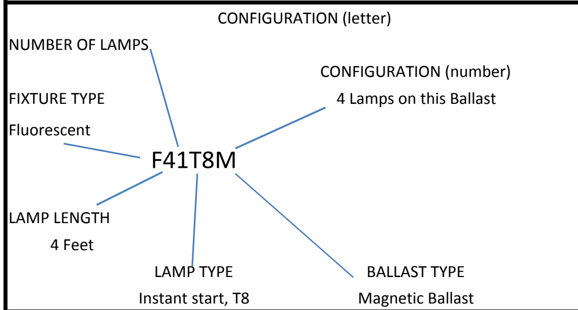
Mechanical Equipment Inventory								
Equipment	Manufacturer	Age	Location	Model/ Type	Capacity	Serves	Operating Hours/Year	Remarks
RTU-1	York/Fisen	2008	Roof	VAV	28,000 cfm	Building-West	3,000 (estimate)	Rooftop Air Handler
RTU-2	York/Fisen	2008	Roof	CV	2,500 cfm	Media Center	3,000 (estimate	Rooftop Air Handler
RTU-3	York/Fisen	2008	Roof	VAV	12,700 cfm	Building-East	3,000 (estimate)	Rooftop Air Handler
RTU-4	York/Fisen	2008	Roof	CV	2,500 cfm	Cafeteria	3,000 (estimate)	Rooftop Air Handler
RTU-5	York/Fisen	2008	Roof	CV	7,650 cfm	Gym	1,500 (estimate)	Rooftop Air Handler
RTU-6	York/Fisen	2008	Roof	CV	4,000 cfm	Cafeteria	1,500 (estimate)	Rooftop Air Handler
B1, 2, 3	Cleaver-Brooks	2008	Rm 133	CFC-700	900 MBH	Hydronic System	3,144	Boiler
F-1	Greenheck	2008	Roof		175 cfm	Toilets	1,758	Exhaust Fan
F-2	Greenheck	2008	Roof		200 cfm	Toilets	1,758	Exhaust Fan
F-3	Greenheck	2008	Roof		200 cfm	Toilets	1,758	Exhaust Fan
F-4	Greenheck	2008	Roof		300 cfm	Toilets	1,758	Exhaust Fan
F-5	Greenheck	2008	Roof		375 cfm	Toilets	1,758	Exhaust Fan
F-6	Greenheck	2008	Roof		460 cfm	Toilets	1,758	Exhaust Fan
F-7	Greenheck	2008	Roof		750 cfm	Toilets	1,758	Exhaust Fan
F-8	Greenheck	2008	Roof		1,100 cfm	Kiln	1,758	Exhaust Fan

Mechanical Equipment Inventory								
Equipment	**Manufacturer**	**Age**	**Location**	**Model/ Type**	**Capacity**	**Serves**	**Operating Hours/Year**	**Remarks**
F-9	Greenheck	2008	Roof		4,400 cfm	Kitchen Hood	1,758	Exhaust Fan
F-10	Greenheck	2008	Roof		5,000 cfm	Gym	1,758	Exhaust Fan
HP 1,2	Armstrong	2008	Rm133	4030	135 gpm	Hydronic System	3,144	HW Pump

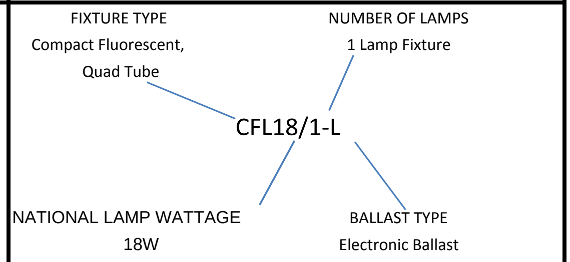
APPENDIX F:
LIGHTING SYSTEMS SCHEDULES

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.005.268
Facility Name:	High Rock Sixth Grade Center
Project Manager	J. McLurg
Date: 10/7/2011	Square Footage (ft2) 64504

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				1,2,3	Classrooms	420	46	MS	259	F42T8	59	15.28	2,392	36,552
2				1,2,3	Classrooms	420	46	MS	18	F42T5	63	1.13	2,392	2,713
3				1,2,3	Classrooms	420	46	MS	36	CFL32	39	1.40	2,392	3,358
4				1,2,3	Restrooms	129	46	MS	17	F42T8	59	1.00	2,392	2,399
5				2	Media Center		28	LS	30	CFL32	39	1.17	1,456	1,704
6				2	Media Center		28	LS	2	CFL26	33	0.07	1,456	96
7				2	Media Center		28	LS	3	CFL42	48	0.14	1,456	210
8				2	Media Center		28	LS	20	F42T5	63	1.26	1,456	1,835
9				2	Media Center		28	LS	5	F41T5	32	0.16	1,456	233
10				1,2,3	Conference Rooms	284	7	MS	4	F22T5	55	0.22	364	80
11				1,2,3	Conference Rooms	284	7	MS	1	F22T8	33	0.03	364	12
12				1,2,3	Conference Rooms	284	7	MS	3	F42T8	59	0.18	364	64
13				1	121-Kitchen		46	LS	17	F22T5	55	0.94	2,392	2,237
14				2	202-Lobby		46	LS	3	F42T5	63	0.19	2,392	452
15				2	202-Lobby		46	LS	4	CFL40	46	0.18	2,392	440
16				2	202-Lobby		46	LS	8	CFL32	39	0.31	2,392	746
17				1,2,3	Stairways	130	56	LS	24	CFL26	33	0.79	2,912	2,306
18				1,2,3	Stairways	130	56	LS	6	F42T8	59	0.35	2,912	1,031
19				1,2,3	Stairways	130	56	LS	6	CFL40	46	0.28	2,912	804
20	ECM	PS		1	120-Dining Room	585	56	LS	12	F42T8	59	0.71	2,912	2,062
21	ECM	PS		1	120-Dining Room	585	56	LS	36	CFL26	33	1.19	2,912	3,459
22	ECM	PS		2	Gym		56	LS	16	F43T8	89	1.42	2,912	4,147
23	ECM	RB	PS	2	Gym		56	LS	8	H150	150	1.20	2,912	3,494
24	ECM	PS		1	130-Corridor	288	56	LS	4	CFL32	39	0.16	2,912	454
25	ECM	PS		1	130-Corridor	288	56	LS	2	CFL40	46	0.09	2,912	268
26	ECM	BL		1	Lower Level Corridors	196	56	LS	34	F22T5	55	1.87	2,912	5,445
27	ECM	BL		2	Main level Corridors	207	56	LS	14	F22T5	55	0.77	2,912	2,242
28	ECM	BL		3	Upper level Corridors	217	56	LS	11	F22T5	55	0.61	2,912	1,762
29				1	Lower Level Corridors	196	56	LS	58	CFL26	33	1.91	2,912	5,574
30				1	Lower Level Corridors	196	56	LS	9	CFL32	39	0.35	2,912	1,022
31				1	Lower Level Corridors	196	56	LS	5	CFL40	46	0.23	2,912	670
32				2	Main Level Corridors	207	56	LS	52	CFL26	33	1.72	2,912	4,997

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				2	Main level Corridors	207	56	LS	18	CFL32	39	0.70	2,912	2,044
34				3	Upper Level Corridors	217	56	LS	7	CFL32	39	0.27	2,912	795
35				3	Upper level Corridors	217	56	LS	3	CFL40	46	0.14	2,912	402
36				G	Pole Lights		84	TM	4	MH100	128	0.51	4,368	2,236
37				G	Pole Lights		84	TM	8	MH70	95	0.76	4,368	3,320
38				G	Pole Lights		84	TM	11	MH150	190	2.09	4,368	9,129
39				G	Security Lights		84	TM	28	CFL42	48	1.34	4,368	5,871
40				G	Security Lights		84	TM	1	CFL32	39	0.04	4,368	170
41				G	Flag Pole Lights		84	TM	2	MH100	128	0.26	4,368	1,118
								Total Pre Fixt.	**809**		**Total Pre kW**	**43**	**kWh Consumed**	**117,953**

Light Intensity	0.673 Watt/ ft2	**Annual Light Usage Intensity**	1.83 KWh / ft2

Existing Facilities Program Lighting Form:

Performance Based

Project Name: 98515.11R.005.268

Facility Name: High Rock Sixth Grade Center

Date: 10/7/2011 Project Manager J. McLurg

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*
20	ECM	PS - Install Photo Sensor		1	120-Dining Room	585	56	2,912	LS	12	F42T8	12	F42T8	59	50.00	PS	0.00	221
21	ECM	PS - Install Photo Sensor		1	120-Dining Room	585	56	2,912	LS	36	CFL26	36	CFL26	33	50.00	PS	0.00	371
22	ECM	PS - Install Photo Sensor		2	Gym	-	56	2,912	LS	16	F43T8	16	F43T8	89	42.00	PS	0.00	1,037
23	ECM	RB - Replace Bulb	PS - Install Photo Sensor	2	Gym	-	56	2,912	LS	8	H150	8	QL85	85	42.00	PS	0.52	2,009
24	ECM	PS - Install Photo Sensor		1	130-Corridor	288	56	2,912	LS	4	CFL32	4	CFL32	39	42.00	PS	0.00	114
25	ECM	PS - Install Photo Sensor		1	130-Corridor	288	56	2,912	LS	2	CFL40	2	CFL40	46	42.00	PS	0.00	67
									Total Pre Fixt.	**78**		**78**	**Total Post kW**	**351.00**		**Total kW Saved**	**0.52**	**3,818.05**

APPENDIX G:
ECM CALCULATIONS

UIC	Install Energy Savers on Vending, Snack Machines
EAC8	Details: Install Cooler Misers on 3 Electric Water Coolers & 1 Soft Drink Vending Machine

No. of Vending Machines:	1.00	Qty	No. of Beverage Cooling Machines:	3.00	Qty
No. of Snack Machines	0.00	Qty			

Vending Machines (Cold Beverage Vending Machines)

Estimated Annual kWh Consumption of Vending Machine:	3500.00	kWh
Estimated Annual kWh of Vending Machine With VendMiser:	1890.00	kWh
Total annual kWh savings:	1610.00	kWh
Total Annual kWh Savings for All Vending Machines:	1610.00	kWh

Beverage Cooling Machines

Estimated Annual kWh Consumption of Beverage Cooling Machine:	2300.00	kWh
Estimated Annual kWh of Cooling Machine With CoolerMiser:	1610.00	kWh
Total Annual kWh savings:	690.00	kWh
Total Annual kWh Savings For All Cooling Machines:	2070.00	kWh

Snack Vending Machines

Estimated Annual kWh Consumption of Individual Snack Machine:	873.60	kWh
Estimated Annual kWh of Individual Snack Machines With VendMiser:	366.91	kWh
Total Annual kWh savings:	506.69	kWh
Total Annual kWh Savings For All Water Fountain Coolers:	0.00	kWh

Cost Analysis

Total estimated annual kWh savings withEnergy Misers:	**3680.00**	kWh
Cost/kWh:	**$0.22**	
Estimated Cost of Vendmiser/ Vending Machine:	$200	
Estimated Cost of Coolermiser/ Water cooler:	$190	
Estimated Cost of Vendmiser/ Snack Machine:	$70	
Estimated total installed cost of all VendMisers:	**$770**	
Estimated Total Annual Electricity Savings Using VendingMisers and CoolerMisers:	**$826**	
Simple Payback:	0.93	years

Type of Recommendation No/Low Cost ECM Recommendation

UIC	**Install Automatic Lighting Controls**		
EAL5	**Details: Install Photosensors in Gym, Cafeteria**		
	Type of Sensor	Internal Photosensors	
Step: 1	Total Number of Sensors	3	
Step: 2	Purchase Cost/Lighting Control Sensors	$15	
Step: 3	Installation Cost /Sensor	$65	
Step:4	Total Installation Costs	$282.48	
Step:5	Total Energy Savings	1810.00	kWh
Step:6	Electric Tariff Rate	**$0.22**	$
Step:7	Total Cost Savings	$406.05	
Step:8	Simple Pay Back Period	0.70	Years
Type of Recommendation		No/Low Cost ECM Recommendation	

UIC	**Install Bi-Level Lighting System In Hallways**
EAL6A	**Details: Control Corridor Linear Fluorescent Lighting with Motion Sensors**

Total Number of Light Fixtures in Hallways	59	
No. of Fixtures To Be Controlled By Occupancy Sensors	30	
Total Number of Fixtures To Be Left On All Times	29	
Total Number of Linear Florescent Lamps To be Replaced *$5/28W-T8 Lamp*	0	
Total Number of Fixtures To Be Retrofitted with Rapid Start Ballast *$35/Rapid Start Ballast*	0	
Are the Ballast being replaced? (Y/N)	No	
Total Number of Lighting Control Sensors To be Installed *Ceiling Mounted Occupancy Sensors $135/ Sensor*	17	
Estimated Total Material Cost For The Proposed Retrofit:	$2,295	
Estimated Labor Cost For The Retrofit:	$1,900.86	
TOTAL ESTIMATED COST FOR RETROFIT	$4,196	
Total Energy Saved	3006	kWh
Existing Electric Tariff per kWH	**$0.22**	$
Estimated Annual Cost Savings	$674	
Estimated Return on Investment	6.22	Yrs
Type of Recommendation	Capital Cost ECM Recommendation	

UIC	Replace High Intensity Discharge Lamp (HID) with Induction Lighting
EAL9	Details: Replace Gym HID Lamps with Induction Lamps

Step:1	Number of 60-100W HID Lamps Replaced by 40W Induction	0	
	Number of 100-150W HID Lamps Replaced by 70W Induction	0	
	Number of 150-200W HID Lamps Replaced by 85W Induction	8	
	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	$0	
Step:4	Subtotal Cost of 85 Watt Induction Retrofit	$3,080	
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**	$3,625	
	Energy & Cost Saving Analysis		
Step:10	Estimated Annual Energy Savings	2004.00	kwh
Step:11	Current Electric Price Per kWh	$0.22	$
Step:12	Estimated Annual Cost Savings	$450	
Step:13	Existing Annual Usage *(For O&M Savings)*	2886	hrs
	Proposed Annual Usage Post Retrofit *(For O&M Savings)*	2146	hrs
	Estimated Annual O&M Savings	$48	$$
Step:14	Total Estimated Annual Cost Savings *(Energy & O&M Savings)*	$498	$$
Step:15	Simple Pay back Period	7.29	Yrs

Type of Recommendation — Capital Cost ECM Recommendation

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

APPENDIX H:
SUPPORTING DOCUMENTS

OMB No. 2060-0347

STATEMENT OF ENERGY PERFORMANCE
Needham: High Rock Sixth Grade Center

Building ID: 2849766
For 12-month Period Ending: May 31, 2011[1]
Date SEP becomes ineligible: N/A

Date SEP Generated: January 06, 2012

Facility
Needham: High Rock Sixth Grade Center
77 Sylvan Road
Needham, MA 02492

Facility Owner
N/A

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

Year Built: 1940
Gross Floor Area (ft²): 56,599

Energy Performance Rating[2] (1-100) 58

Site Energy Use Summary[3]	
Electricity - Grid Purchase(kBtu)	1,711,787
Natural Gas (kBtu)[4]	1,957,100
Total Energy (kBtu)	3,668,887

Energy Intensity[4]	
Site (kBtu/ft²/yr)	65
Source (kBtu/ft²/yr)	137

Emissions (based on site energy use)	
Greenhouse Gas Emissions (MtCO$_2$e/year)	294

Electric Distribution Utility
NSTAR Electric Co

National Median Comparison	
National Median Site EUI	70
National Median Source EUI	148
% Difference from National Median Source EUI	-7%
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.

Meets Industry Standards[5] for Indoor Environmental Conditions:

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

Certifying Professional
Matt Munter
222 Schilling Circle Suite 275
Hunt Valley, MD 21031

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.

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: High Rock Sixth Grade Center
77 Sylvan 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: High Rock Sixth Grade Center	
Gross Floor Area Excluding Parking: (ft²)	56,599
Year Built	1940
For 12-month Evaluation Period Ending Date:	May 31, 2011

Facility Space Use Summary

School	
Space Type	K-12 School
Gross Floor Area(ft²)	56,599
Open Weekends?d	No
Number of PCsd	99
Number of walk-in refrigeration/freezer unitsd	1
Presence of cooking facilitiesd	Yes
Percent Cooled	80
Percent Heatedd	100
Monthso	9
High School?d	No
School Districto	N/A

Energy Performance Comparison

	Evaluation Periods		Comparisons		
Performance Metrics	**Current** (Ending Date 05/31/2011)	**Baseline** (Ending Date 01/31/2011)	**Rating of 75**	**Target**	**National Median**
Energy Performance Rating	58	46	75	N/A	50
Energy Intensity					
Site (kBtu/ft²)	65	70	55	N/A	70
Source (kBtu/ft²)	137	153	116	N/A	148
Energy Cost					
$/year	$ 132,005.29	$ 143,780.29	$ 111,538.56	N/A	$ 142,635.77
$/ft²/year	$ 2.33	$ 2.54	$ 1.97	N/A	$ 2.52
Greenhouse Gas Emissions					
$MtCO_2e$/year	294	324	248	N/A	318
$kgCO_2e$/ft²/year	5	6	4	N/A	5

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 Median column presents energy performance data your building would have if your building had a median rating of 50.

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