EXECUTIVE SUMMARY
SECTION ONE

1.0 INTRODUCTION

Honeywell is pleased to present this Investment Grade Energy Audit to the Windham Southeast Supervisory Union Schools This report identifies an energy and operational cost savings from efficiency improvements in the school facilities. Overall, we have identified energy efficiency measures which will:

- Provide $759,050 in energy efficiency and facility improvements in the school facilities.
- Generate $70,785 in annual energy and operational savings.
- Provide a means for installing over $150,000 in needed capital upgrades such as replacing the boiler in the Oak Grove School.
- Significantly improve the comfort of the building environment and indoor air quality.
- Reduce operational costs and future capital outlay needs

BACKGROUND – WHY THIS PROGRAM IS NEEDED

The Brattleboro schools are in the difficult position of addressing the need to upgrade and modernize aging buildings and equipment, without placing a burden on your taxpayers. Our approach is to reduce operating costs significantly, thereby giving you the option to redirect those budgeted expenses into investments in your infrastructure. The proposed project maximizes the improvements that can be paid through savings.

In our discussions with Town and School representatives, we identified several primary needs that are addressed in Honeywell's proposed solution. The primary needs that we identified during preparation of this report are contained within the following pages.

Reduce Operating Costs - The first priority is to implement a project that makes economic sense by reducing operating costs and creating a savings stream that will pay for the project.

Address Deferred Maintenance Issues - Our discussions with Town and School staff, as well as our physical examination of the facilities, identified a number of areas of deferred maintenance. Deferred maintenance results in malfunctioning equipment. As a result, efficiencies drop and maintaining proper conditions becomes increasingly difficult. Deferred maintenance typically results in the early failure of equipment and

will cost more in the long run due to the need for expenditures on emergency repairs or on new equipment. Our solution provides you with an opportunity to get out from under the burden of deferred maintenance by repairing or replacing failing equipment through a bundled, economic solution.

Modernize Building Systems and Improve System Performance - The systems in many of the buildings are not operating properly. There are major issues with maintaining comfort conditions and indoor air quality and difficulties in managing costs of operations. Our solution addresses these issues by upgrading the systems and by repairing existing equipment that will remain in place. Our recommendations will also enable building staff and occupants to control their conditions more precisely, thereby improving both comfort and efficiency.

SCOPE OF WORK OVERVIEW

This proposal provides improvements to reduce energy consumption and operational costs in the Windham Southeast Supervisory Union facilities. The list below identifies the distinct energy conservation measures (ECMs) that have been identified and recommended for implementation to improve energy efficiency performance, improve comfort, and address facility deficiencies:

Building	ECM #	Energy Conservation Measure	Total Annual Fuel Oil Savings Gallons	Electric Savings (kWh)	Total Energy Savings	Total Operational Savings	Total Savings $	Guaranteed Installed Cost	Simple Payback Years	Return on Investment
Academy School	1-AC	DDC Control - Unit Ventilators	3,872	832	$ 9,827		$ 9,827	$ 111,600	11.36	9%
	2-AC ALT	Intellihood Controls	0	3,241	$ 202		$ 202	$ 5,625	27.85	4%
	3-AC	Infiltration Reductions	4,764		$ 11,123		$ 11,123	$ 30,825	2.77	36%
	4-AC	Lighting Upgrades	0	66,742	$ 8,810	$ 1,132	$ 9,942	$ 139,916	14.07	7%
	Academy	**Sub Total Academy School**	**8,636**	**67,574**	**$ 29,760**	**$ 1,132**	**$ 30,892**	**$ 282,341**	**9.14**	**11%**
Canal Street School	1-CS	Infiltration Reductions	166		$ 388		$ 388	$ 2,170	5.59	18%
	2-CS	Lighting Upgrades		13,526	$ 1,813	$ 356	$ 2,168	$ 25,523	11.77	8%
	Canal St	**Sub Total Canal Street School**	**166**	**13,526**	**$ 2,201**	**$ 356**	**$ 2,556**	**$ 27,693**	**10.83**	**9%**
Green Street School	1-GS	Boiler Control	1,632		$ 3,811		$ 3,811	$ 10,300	2.70	37%
	2-GS	Infiltration Reductions	412	0	$ 963		$ 963	$ 3,970	4.12	24%
	3-GS	Lighting Upgrades	0	46,088	$ 5,807	$ 840	$ 6,647	$ 81,440	12.25	8%
	Green St	**Sub Total Green Street School**	**2,044**	**46,088**	**$ 10,581**	**$ 840**	**$ 11,421**	**$ 95,710**	**8.38**	**12%**
Oak Grove School	1-OG	Boiler Control	845		$ 1,973		$ 1,973	$ 10,300	5.22	19%
	2-OG	Replace Steam Boiler	1,981		$ 4,626	$ 19,748	$ 24,374	$ 171,179	7.02	14%
	3-OG	Install dedicated DHW	764	0	$ 1,784		$ 1,784	$ 12,825	7.19	14%
	4-OG	Infiltration Reductions	2,164	0	$ 5,053		$ 5,053	$ 10,623	2.10	48%
	5-OG	Lighting Upgrades	0	47,108	$ 6,689	$ 983	$ 7,673	$ 100,187	13.06	8%
	Oak Grove	**Sub Total Oak Grove School**	**5,754**	**47,108**	**$ 20,125**	**$ 20,731**	**$ 40,857**	**$ 305,114**	**7.47**	**13%**
Powers House School	1-PH	Replace HW Boiler	510		$ 1,191		$ 1,191	$ 18,643	15.65	6%
	2-PH	Night Setback	343		$ 801		$ 801	$ 2,800	3.50	29%
	3-PH	Infiltration Reductions	148		$ 345		$ 345	$ 1,929	5.59	18%
	4-PH	Lighting Upgrades		6,077	$ 966	$ 131	$ 1,098	$ 12,194	11.11	9%
	Powers	**Sub Total Powers House School**	**1,001**	**6,077**	**$ 3,303**	**$ 131**	**$ 3,434**	**$ 35,565**	**10.36**	**10%**
Estyville School	1-ES	Night Setback	90		$ 210		$ 210	$ 2,800	13.32	8%
	2-ES	Infiltration Reductions	74		$ 172		$ 172	$ 964	5.59	18%
	3-ES	Lighting Upgrades		5,578	$ 892	$ 98	$ 991	$ 8,864	8.95	11%
	Estyville	**Sub Total Estyville School**	**164**	**5,578**	**$ 1,275**	**$ 98**	**$ 1,373**	**$ 12,628**	**9.20**	**11%**
Districtwide	**1-DW**	**Districtwide Measures Total**	**35,366**	**185,950**	**$67,245**	**$23,289**	**$ 90,533**	**$ 759,051**	**8.38**	**12%**
		Measures in Red Not Included in Project								

Maintenance and Support Services

Historically, the Schools have made minimal expenses in maintenance of their systems. Therefore, the opportunity to reduce those expenses is limited. However, the schools will need to revise their approach toward maintenance in order to protect their investmenr in the systems Honeywell is recommending dn to maintain the efficiencies that will prodiuce the savings. Our next step in addressing this issue will follow the School's preliminary selection of which measures to go forward with. Based on the equipment needs and financial impacts of the selected project we will work with the School officials to identify an appropriate plan for future preventative maintenance activities. That plan may include some combination of tasks performed with in-house staff, tasks performed by Honeywell personnel, and tasks performed by other third party vendors.

Measurement and Verification – Guaranteed Performance
Honeywell proposes a cost-effective plan for Measurement and Verification (M&V), to ensure that the guaranteed savings are realized over the contract term. Our proposed approach strikes a balance between the cost of M&V, and the level of information required to substantiate our savings guarantee and performance.

Prior to construction, Honeywell will establish baseline efficiencies and operational parameters. Parameters that are beyond Honeywell's control, such as operating hours, energy rates, and others, will be agreed upon between Honeywell and theWindham Southeast Supervisor Union, and stipulated for the term of the contract. After construction is completed, Honeywell will conduct post-installation measurements in accordance with the M&V plan. Actual savings will then be determined from the baseline measurements, post-installation measurements, and agreed-upon stipulated parameters. In the event that actual savings are less than the guaranteed savings, Honeywell will take steps to identify and implement, at its cost, the necessary improvements to generate sufficient savings, or pay the Schools the difference between the actual and guaranteed savings. Finally, on an annual basis, Honeywell will conduct site surveys and measurements to confirm that the efficiency and operating conditions for each energy conservation measure are maintained. Final details of the M&V plan will be formulated after the Schools select the final project.

FINANCIAL SUMMARY

Honeywell's financial analysis focused on all of the recommended energy conservation measures.

The proposed project has been structured to be a self-funded project. In fact, this project exceeds those expectations and produces savings in excess of the project cost. Over the 10-year lease term, the project results in a positive cash flow in the amount of $99,583.

We have provided an analysis of the financial results. This analysis breaks out the financial impact on the School budget on an annual basis over a 10-year term. These

results are impressive to say the least. Several assumptions have been made in putting together this projection. These assumptions include:

- 10 year financing at 4.5% interest
- Energy and general inflation rate of 3.0%
- No significant changes in facilities, equipment, uses, or operations
- Efficiency Vermont subsidies in the amount of $5,000

The table below summarizes the financial impacts of implementing Honeywell's recommendations:

Project Cost	$759,050
State Education Department Aid	$151,810
Efficiency Vermont Incentives	$5,000
1st Year Savings & Avoided Costs	$90,533
Annual Lease Payments	$76,110
1st Year Ongoing Service Fees	$13,000
Cumulative Cash Flow over 15 Years	$99,583

The following page provides a Pro Forma that displays a detailed year by year breakout of the financial impacts of the project. This initial analysis assumes a straight line repayment schedule for the lease.

Honeywell

Windham Southeast Supervisory Union
10 YEAR FINANCIAL ANALYSIS

Project Cost	$759,050
StateConstruction Aid	$151,810
Eff VT	$5,000
Amount Financed	$602,240
Interest Rate	4.50%
Term	10 years
Inflation rate	3.0%
Discount Rate	3.0%

Fiscal Year	1	2	3	4	5	6	7	8	9	10	TOTAL
Energy Savings	$67,245	$69,262	$71,340	$73,480	$75,685	$77,955	$80,294	$82,703	$85,184	$87,739	$770,889
ACC	$19,748	$19,748	$19,748	$19,748	$19,748	$19,748	$19,748	$19,748	$19,748	$19,748	$197,484
Maintenance Savings	$3,540	$3,646	$3,756	$3,868	$3,984	$4,104	$4,227	$4,354	$4,484	$4,619	$40,582
TOTAL UTILITY & OPERATIONAL SAVINGS	**$90,533**	**$92,657**	**$94,844**	**$97,097**	**$99,418**	**$101,808**	**$104,269**	**$106,805**	**$109,417**	**$112,107**	**$1,008,955**
Project Costs											
Project Financing	$76,110	$76,110	$76,110	$76,110	$76,110	$76,110	$76,110	$76,110	$76,110	$76,110	$761,104
M&V	$5,000	$5,075	$5,227	$5,384	$5,546	$5,712	$5,883	$6,060	$6,242	$6,429	$56,557
Maintenance, Training	$8,000	$8,240	$8,487	$8,742	$9,004	$9,274	$9,552	$9,839	$10,134	$10,438	$91,711
TOTAL COSTS	$89,110	$89,425	$89,825	$90,236	$90,660	$91,097	$91,546	$92,009	$92,486	$92,977	$909,372
NET ANNUAL BUDGET IMPACT	$1,423	$3,232	$5,019	$6,861	$8,758	$10,711	$12,723	$14,796	$16,931	$19,129	$99,583
CUMMULATIVE CASH FLOW	$1,423	$4,655	$9,674	$16,535	$25,293	$36,004	$48,727	$63,523	$80,453	$99,583	

Honeywell

2.0 Introduction

Purpose

As part of an energy performance contract, Honeywell has performed an Investment Grade Audit for the Windham Southeast Supervisory Union School District in Brattleboro, Vermont.

Investment Grade Audit

An Investment Grade Energy Audit was conducted by Honeywell personnel from February 2006 through September 2006. Surveys were conducted in the following facilities:

Building	Square Footage
Academy School	50,000
Green Street School	32,000
Canal Street School	12,000
Oak Grove School	32,000
Esteyville School	3,000
Powers House	6,000
Total	**135,000**

Information for this study was primarily obtained during site visits to the facilities, onsite observations, interviews with facility personnel, equipment nameplate data, available utility data, and equipment measurements. Operating information was obtained from data collected during the survey and dialogues with facility staff.

Details on survey findings and recommendations, a summary of energy savings strategies and recommended upgrades as part of a Guaranteed Energy Savings Contract, are included in the following Section.

ECM Listing						
ECM / Location	Lighting Retrofit	DDC Controls	Building Envelope	Heating Plant Improvements	Replace Boiler	Night Setback
Academy School	X	X	X			
Green Street School	X	X	X			
Canal Street School	X		X			
Oak Grove School	X	X	X	X	X	
Estyville School	X		X			X
Powers House	X		X		X	X

Baseline Energy History

Honeywell studied and analyzed a two year history of the District's electrical and fuel energy consumption. The most recent 12 month period was selected as the base year.

Baseline Operating Parameters

Following are the facilities and systems operations measured and /or observed during the audit report period. The data summarized will be used in the calculations of the baseline energy consumption and/or demand and for calculating baseline adjustments for changes in facility operation that occur during the Guarantee Period. Honeywell and Windham Southeast Supervisory Union Public Schools agree that the operating parameters specified in this section are representative of equipment operating characteristics during the Base Year. The following data was collected with the assistance of the Windham Southeast Supervisory Union Schools personnel.

Schedule for All School Buildings (Baseline Heating Schedule)[1]

Time Period	HVAC On	HVAC Off
Week Days	Varies by Building	Varies by Building
Week Ends	Varies by Building	Varies by Building
Holidays	Varies by Building	Varies by Building

Space Temperatures

Time Period	Heating Temperature
Week Days	Varies by Building
Week Ends	Varies by Building
Holidays	Varies by Building

[1]Please refer to specific building descriptions for existing conditions.

Utility Rates

Utility information provided by Windham Southeast Supervisory Union Staff included consumption data for electric and oil. The use per school was taken directly from the utility billing information. The fuel oil (No. 2 Oil) price used in the analysis was $2.335 per gallon. This utility cost data averages were used directly in the analysis for project Energy Conservation Measure's (ECM's). This is the current rate that was provided by the District and is based upon a locked in winter 2006-07 rate.

Actual billing data summaries for each School are included in the Technical Appendix (Section Four) of this report. The following are summary data "Fact Sheets" for each School.

2.1 Building Survey Data

2.1.1 Academy School

Academy School is a single story brick building that was originally constructed in 1954, underwent an expansion in 1977 and was most recently renovated and expanded in 1996. The building contains approximately 50,000 square feet of occupied space with 23 classrooms, an auditorium, gymnasium, library and administrative office area. Generally the classrooms, library and are occupied from 7AM to 4 PM Monday through Friday while the gymnasium is occupied from 7AM to 7PM Monday through Friday with some weekend use. The administrative areas are occupied during regular business hours from 8AM -5 PM Monday through Friday throughout the year.

Heating System:

The building is heated by a central hot water heating system with a single Cleaver Brooks Scotch Marine boiler. The boiler is rated at 4,184 MBH per hour and is fired with a No. 2 oil burner. The boilers are controlled to maintain a maximum hot water temperature of 180°F during the heating season which is then reset downwards based on the outside air temperature. Hot water is pumped to unit ventilators in each classroom and air handlers in the gymnasium, library and auditorium areas. The boiler is oversized for the load.

Lighting Systems:

Academy School

The Academy School current lighting mainly includes a mix of T12 and T8 fluorescents. As the T12 lamps and ballast fail, school personnel are phasing in the more efficient T8 technology. Because they were not aware that a T8 and T12 ballast were different and not interchangeable, many fixtures have lamps burned out or flickering, trying to ignite. The classrooms are a mix of the old classroom style fixtures and some newer classroom wraps in great condition. The offices that have recessed troffers or surface mount wraps.

The stage lighting is currently operated from the front side of the stage and is not currently dimmable.

The gymnasium uses metal halide lamps and it is reported that these lights remain on all day due to warm-up and re-strike times.

Cooling Systems:

There is no air conditioning in the building.

Ventilation Systems:

Each classroom has a unit ventilator that provides heating and ventilation. Each unit brings in between 150 and 300 cfm of outside air continuously while the unit operates. Outside air is mixed with return air that is re-circulated directly from the room. A hot water heating coil installed in each unit maintains the space temperature setpoint. Each unit ventilator has a fan that is operated by a fractional horsepower motor and is designed to supply a total airflow of 800 to 1000 cfm.

The majority of the unit ventilators are controlled pneumatically and operate continuously twenty-four hours a day. The newest unit ventilators installed during the 1996 renovation are controlled via digital controls and are shut-down during unoccupied periods.

The gymnasium, library and auditorium are served by larger air-handling units that operate similar to the classroom unit ventilators. The library air handler was installed during the 1996 renovation and is designed to provide 900 cfm of ventilation air and has a heating capacity of 162 MBH. The fan motor is 1.5 hp and the fan is designed to provide a total of 3,000 cfm. Unfortunately we were not able to find any design information about the gymnasium and auditorium air handlers. All three systems are controlled through the digital control system and are shut-down during unoccupied periods.

The kitchen has a make-up air system that was installed in 1996 to exhaust cooking fumes and odors. This system operates continuously during the day from 6AM to 4PM while staff prepare breakfast and lunch for the students. The system is designed to exhaust 8,000 cfm of air and has a 3 hp exhaust fan. A 2 hp make-up-air fan supplies 5,600 cfm of unconditioned air directly into the exhaust hood while the remainder of the air is supplied by a small kitchen heating and ventilation unit.

Identified Opportunities

The following opportunities were identified by Honeywell to improve the infrastructure, operations, and classroom environment at Academy School.

ECM # AES 1 Lighting Retrofit and Occupancy Sensors:

Honeywell recommends a comprehensive lighting retrofit to specifically include the following:

The Academy School current lighting mainly includes a mix of T12 and T8 fluorescents. As the T12 lamps and ballast fail, school personnel are phasing in the more efficient T8 technology. Because they were not aware that a T8 and T12 ballast were different and not interchangeable, many fixtures have lamps burned out or flickering, trying to ignite. To ease maintenance efforts and mitigate this problem completely, all of the systems will be taken to a super T8 system with a low power ballast. The old classroom style baffled fixtures found in the hallways will be replaced with new wraps. In addition to the maintenance reduction, these fixtures will provide better light and improve aesthetics. The classrooms are a mix of the old classroom style fixtures and some newer classroom wraps in great condition. The old style will be replaced with new fixtures while the newer luminaires will be retrofitted with a super T8 system. The offices that have recessed troffers or surface mount wraps will maintain the fixture bodies while being retrofitted with a super T8 and reflector combination. The reflector provides better optical performance from the fixture and allows for lamp quantity reduction.

The incandescent fixtures throughout the school will be retrofitted or replaced with compact fluorescent systems. Where the existing takes form as a recessed fixture, a hard-wire CFL retrofit will be the replacement. In some closets, storage areas, or in restrooms with light/fan combo units, the retrofit will be a screw-in CFL.

The stage lighting is currently operated from the front side of the stage and is not currently dimmable. It has been requested to add dimming capabilities to each of the four channels per row. The dimming controls will be added and located in the same location but will provide school officials drastic improvements to the flexibility and theatrical ability of the performances put on by the school.

The gymnasium uses metal halide lamps and it is reported that these lights remain on all day due to warm-up and re-strike times. It is proposed to replace these fixtures with T5 linear fluorescents to provide for the installation of occupancy sensors to turn lights off automatically when the space is not used while eliminating any warm-up and re-strike issues.

Additional sensors mounted either on the wall or on the ceiling will curtail the energy usage of many offices, restrooms and classrooms. In the hallways where skylights provide free natural daylight, photo sensors will be installed to dim the artificial lights based upon the amount of sun light entering the space. Both occupancy and photo sensors serve to reduce energy consumption and maintenance efforts. Vendmisers will also be installed on all vending machines located within the school to save additional energy.

ECM # AES 1 Lighting Upgrades

Electric kWh Saved	Electric Dollars Saved	Maintenance Savings	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
66,742	$8,810	$1,132	N/A	$9,942	$139,916	14.1

ECM # AES 2 Convert Unit Ventilators to Digital Control

Install digital controls on all the unit ventilators with pneumatic controls. These unit ventilators currently operate continuously even during unoccupied periods. Each unit ventilator should be programmed to open the outside air damper and enable the fan during occupied periods, during unoccupied periods the outside air damper should remain closed and the fan should only be cycled on to satisfy the unoccupied temperature setpoint. During occupied and unoccupied periods modulate the hot water valve to maintain the heating temperature setpoint. Setback the temperature of each classroom during unoccupied periods to a minimum of 63°F, currently there is no night-setback.

ECM # AES 2 Convert Unit Ventilators to Digital Control

Fuel Oil Saved Gallons	Fuel Oil Dollars Saved	Electric kWh Savings	Electric Saved $	Total Savings $	Installed Costs $	Simple Payback Years
3,872	$9,041	832	$786	$9,827	$111,600	11.4

ECM # AES 3 Building Envelope Upgrades:

Honeywell recommends repairs and upgrades to the building envelope to reduce infiltration/exfiltration and improve comfort levels within the space.

Our assessment of the potential energy savings through retrofit of the building shell at the Facility has focused on Air Leakage Control, since these are generally the most practical and cost effective measures to implement. Air leakage, is defined as "uncontrolled

migration of conditioned air through the building envelope". It is caused by pressure differences due to wind, chimney effect (stack) and mechanical systems. It has been shown to represent the single largest source of heat loss or gain through building envelopes of nearly all types of buildings. Recent tests carried out on high rise commercial, apartment buildings, schools and private residences have shown levels in the range of 30% to 50% of heat loss can be attributed to uncontrolled air leakage.

Beyond the potential for energy savings, uncontrolled air leakage can severely affect the comfort in the building, also fire safety, moisture problems and on design days mechanical HVAC equipment may not be capable of maintaining comfort.

Honeywell's approach to controlling this leakage involves sealing gaps, cracks and holes using the most appropriate materials, labor and systems to effectively create, where possible, a continuous plane of air tightness to completely encompass the building envelope. This building will benefit greatly from this measure in both energy savings and occupant comfort. The following highlights our findings for this building:

Academy School

4 Double Commercial Doors to be weather-stripped
27 Single Commercial Doors to be weather-stripped
350' Roof Wall Joint to be sealed
8 Roof top ventilators to be opened, perimeter sealed, dampers lubricated, 68 linear feet
51 6 x 16 Wall Grills to be sealed
445' Ventilated Soffits to be sealed

ECM # AES 3 Building Envelope Upgrades

Fuel Oil Saved Gallons	Fuel Oil Dollars Saved	Maintenance Savings	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
4,764	$11,123	$N/A	$N/A	$11,123	$30,825	2.8

Summary

Illustrated below is a summary of the recommended ECMs for the Academy Elementary School.

ECM's Academy Elementary School Total

Fuel Oil Dollars Saved	Electric Dollars Saved	Maintenance Savings $	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
$20,164	$9,596	$1,132	$N/A	$30,892	$282,341	9.14

ECM # AES ALT Install an Intellihood system on the Kitchen Exhaust Not recommended due to long payback period

Install an Intellihood kitchen hood exhaust system. Intellihood utilizes an infrared beam to detect the presence of smoke in the exhaust hood and then increases the airflow in the hood to provide the necessary exhaust. When the system doesn't detect smoke the exhaust hood operates in a low airflow mode which saves electrical fan energy. A variable frequency drive on each fan motor allows the system to quickly switch between the low flow mode and the high airflow modes.

2.1.2 Green Street School

The Green Street is a 2 story brick faced building originally constructed in 1924 and most recently renovated in 1996 when a new gymnasium was added. The building currently has approximately 32,000 square feet of conditioned space with 18 classrooms, a media center, administrative offices and a gymnasium. The building is occupied from 7 am to 5 pm, Monday through Friday with some evening and weekend use.

Central Heating System:

The building has two steam boilers burning #2 fuel oil that are each large enough to heat the entire building. The older boiler, while still operational is poorly insulated and appears to have originally burned coal. It is not recommended to be replaced because the newer boiler is still in fair condition. The second boiler is a Weil Mclain cast iron sectional boiler with a rated input of 2,920 MBH and a net IBR of 2,539 MBH. The boiler is in fair shape and was re-furbished last winter. The Weil Mclain is used as the primary boiler. The boiler is controlled to maintain a steam pressure setpoint of 5 psi.

The heating system is a single pipe steam system which was renovated in 1996 when individual thermostatic control valves were installed on the radiators in each classroom. The control valves allow the occupants of each room some control over how quickly steam is allowed into the radiator in an effort to control the temperature in each room. There is currently no ability to setback the building temperature during unoccupied periods. The building is also prone to overheating during warmer shoulder months.

During the study we did not observe steam in the condensate return during the operation of the boiler which indicates that the main drip leg steam traps are operating properly.

Ventilation

A heating and ventilation air handler provides ventilation air to each classroom in the building. The unit operates continuously from 7AM to 11PM and is controlled by the digital control system installed in 1996. The air handler is designed to mix outside air and return air from the library/media center before being heated by the steam heating coil. During our study the outside air damper actuator was disconnected but was scheduled for repair. The air handler has a 3hp fan motor and a 2 hp exhaust fan motor. The system is being controlled to maintain a leaving air temperature of 75°F.

Domestic Hot Water

The domestic hot water heater burns #2 fuel oil and has a rated capacity of 185 gallons per hour with a rise of 100°F. The heater has a 70 gallon, insulated storage tank and a Carlin burner with a 1.25 gal/hr firing rate. Hot water is used in the bathrooms and for cleaning.

Lighting System The Green Street School lighting is overwhelmingly T8 technology.

Identified Opportunities

The following opportunities were identified by Honeywell to improve the infrastructure, operations, and classroom environment at Green Street School.

ECM # GSS 1 Lighting Retrofit and Occupancy Sensors:

Honeywell recommends a comprehensive lighting retrofit to specifically include the following:

Green Street School

The Green Street School lighting is overwhelmingly T8 technology. These systems will be retrofitted with a super T8 combination to reduce energy, improve the light output and replace the need to group relamp. The lamps installed are also mixed colors with some being 4100K and others being 3500K. Although this hardly effects the amount of light given off by the fixture, it does present an eyesore to students, faculty and visitors. Moving to super T8 systems will normalize the fluorescent lamp colors throughout as well. Many of these existing wraps have broken, or are missing lenses and these will be replaced through this project. In the hallways, the wraps will be replaced with new fixtures to present better optics and a more consistent look throughout. The recessed troffers throughout the school will be retrofitted with super T8 and reflector systems.

The few incandescent bulbs that exist are mainly in the form of simple porcelain fixtures. Since these exist in various closets or storage spaces they will be retrofitted with screw-in CFLs.

The library uses metal halide and CFL technology in the fancy pendants hung from the ceiling. Although the CFL lamps will remain, it is proposed to provide a custom retrofit to take the metal halide to CFL technology also. This measure reduces energy and mitigates warm-up and re-strike headaches. In the gymnasium, the metal halide fixtures will be replaced with T5 fluorescent fixtures to also eliminate the issues with HIDs.

Many of the exterior HID wallpack luminaires have broken and yellow lenses. These units will be replaced with new fixtures to reduce energy and improve the aesthetics of the exterior as well.

The occupancy sensors to be installed in this building will be both wall mounted and ceiling mounted. They will reduce the lighting usage of the classrooms, many offices and restrooms. Photocells will be installed near skylights to turn artificial lights off when enough sunlight enters the area. The second floor boys and girls restrooms are a great

application for this technology. Furthermore, all vending machines will be outfitted with vendmisers to curtail their energy use when they do not need to be running.

ECM # GSS 1 Lighting Upgrades

Electric kWh Saved	Electric Dollars Saved	Maintenance Savings	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
46,088	$5,807	$840	N/A	$6,647	$81,440	12.3

ECM # GSS 2 Boiler Reset Control

Currently the steam system is controlled via the thermostat in the gymnasium, the coldest area of the building. Install a Heat-Miser MSC-Q controller to cycle the boiler based on the outside air temperature. The cycle time can be adjusted to maintain the optimum space temperature within the building. The controller also has the capability to operate in an unoccupied mode allowing the building space temperature to be setback to a minimum of 62°F at night, currently there is no night-setback. This system will also greatly reduce the overheating during the shoulder months.

ECM # GSS 2 Convert Unit Ventilators to Digital Control

Fuel Oil Saved Gallons	Fuel Oil Dollars Saved	Electric kWh Savings	Electric Saved $	Total Savings $	Installed Costs $	Simple Payback Years
1,632	$3,811	0	$0	$3,811	$10,300	2.7

ECM # GSS 3 Building Envelope Upgrades:

Honeywell recommends repairs and upgrades to the building envelope to reduce infiltration/exfiltration and improve comfort levels within the space.

Our assessment of the potential energy savings through retrofit of the building shell at the Facility has focused on Air Leakage Control, since these are generally the most practical and cost effective measures to implement. Air leakage, is defined as "uncontrolled migration of conditioned air through the building envelope". It is caused by pressure differences due to wind, chimney effect (stack) and mechanical systems. It has been shown to represent the single largest source of heat loss or gain through building envelopes of nearly all types of buildings. Recent tests carried out on high rise commercial, apartment buildings, schools and private residences have shown levels in the range of 30% to 50% of heat loss can be attributed to uncontrolled air leakage.

Beyond the potential for energy savings, uncontrolled air leakage can severely affect the comfort in the building, also fire safety, moisture problems and on design days mechanical HVAC equipment may not be capable of maintaining comfort.

Honeywell's approach to controlling this leakage involves sealing gaps, cracks and holes using the most appropriate materials, labor and systems to effectively create, where possible, a continuous plane of air tightness to completely encompass the building envelope. This building will benefit greatly from this measure in both energy savings and occupant comfort. The following highlights our findings for this building:

Green Street School

3 Double Commercial Doors to be weather-stripped
7 Single Commercial Doors to be weather-stripped
2 Roof top ventilators to be opened, perimeter sealed, dampers lubricated, 16 linear feet
2 Skylight Vents to be sealed (2,(8"), 1 (6" x 4')

ECM # GSS 3 Building Envelope Upgrades

Fuel Oil Saved Gallons	Fuel Oil Dollars Saved	Maintenance Savings	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
412	$963	$N/A	$N/A	$963	$3,970	4.1

Summary

Illustrated below is a summary of the recommended ECMs for the Green Street School.

ECM's Green Street School Total

Fuel Oil Dollars Saved	Electric Dollars Saved	Maintenance Savings $	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
$4,774	$5,807	$840	$N/A	$11,421	$95,710	8.38

2.1.3 Canal Street

Canal Street School is a three story stone building originally constructed in 1922. The building is currently used for daycare, after school programs and, a late night child care facility for single parents working second shift jobs. The building has 12,000 square feet of conditioned space including eight classrooms and several offices. Head Start uses the building from 8AM-4PM Monday through Friday and the evening / nighttime CABA program uses the building from and is used from 5:30 PM through midnight Monday through Friday.

Central Heating System:

The building is heated by a Weil McLain cast iron sectional hot water boiler with a rated efficiency of 81.7%. The boiler has a rated capacity of 886 MBH and a net IBR of 770 MBH and is fired with a No. 2 oil burner sized for a 7.5 gallon per hour burn rate. The boiler was installed in 1998 and is in good condition. Hot water is circulated throughout the building by an inline centrifugal pump sized for 50 gpm and 40' head.

Each classroom on the first and second floor has a hot water cabinet heater for heating. The units are all sized for 43 MBH of heating and have a fractional hp fan motor. Each unit is controlled by a wall mounted thermostat located in the classroom. One basement classroom has a unit ventilator that was retrofit from steam to hot water while the other has baseboard radiation heating. All offices, restrooms and small storage areas utilize fin tube radiation or a recessed convector for heating. The ventilation unit in the attic also has a hot water coil for tempering ventilation air.

Domestic Hot Water

The domestic hot water heater burns #2 fuel oil and has a rated capacity of 138 gallons per hour with a rise of 100°F. The heater has a 50 gallon, insulated storage tank and the burner has a 1.1 gal/hr firing rate. Hot water is used in the bathrooms and for cleaning.

Lighting Systems:

The Canal Street School lighting is a mixture of both T12 and T8 systems.

Ventilation Systems:

A ventilation system was installed in 1996 that provides fresh air to each of the classrooms in the building. The air-handler is designed to supply 6,000 cfm of airflow with a minimum outside airflow rate of 1,800 cfm. The unit is a constant volume system with a 1 hp fan motor and a heating coil sized for 324 MBH. The unit runs during all occupied periods.

Identified Opportunities

The following opportunities were identified by Honeywell to improve the infrastructure, operations, and classroom environment at the Canal Street School.

ECM # CSS 1 Lighting Retrofit and Occupancy Sensors:

Canal Street School

The Canal Street School lighting is a mixture of both T12 and T8 systems. The classrooms consist of T8 wraps that will be retrofitted with super T8 technology. The surface mount and recessed troffers will also be retrofitted with super T8 and low power ballast systems. The stairwell fixtures that are currently T12 will be replaced with new T8 wraps.

The fancy incandescent fixtures with globes will be retrofitted with screw-in CFLs to maintain the traditional look. The elevator lights will be replaced with similar LED fixtures to reduce heat, energy and, with a 100,000 hour life, will serve to decrease maintenance efforts. The compact fluorescent domes will remain since they are efficient and in good condition.

Occupancy sensors will be installed in some restrooms, classrooms and the cafeteria area in the basement. These will be a mix of wall mount and ceiling mount with a couple using dual technology sensing techniques.

ECM # CSS 1 Lighting Upgrades

Electric kWh Saved	Electric Dollars Saved	Maintenance Savings	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
13,526	$1,813	$356	N/A	$2,168	$25,523	11.8

ECM # CSS 2 Building Envelope Upgrades:

Honeywell recommends repairs and upgrades to the building envelope to reduce infiltration/exfiltration and improve comfort levels within the space.

Our assessment of the potential energy savings through retrofit of the building shell at the Facility has focused on Air Leakage Control, since these are generally the most practical and cost effective measures to implement. Air leakage, is defined as “uncontrolled migration of conditioned air through the building envelope”. It is caused by pressure differences due to wind, chimney effect (stack) and mechanical systems. It has been shown to represent the single largest source of heat loss or gain through building envelopes of nearly all types of buildings. Recent tests carried out on high rise

commercial, apartment buildings, schools and private residences have shown levels in the range of 30% to 50% of heat loss can be attributed to uncontrolled air leakage.

Beyond the potential for energy savings, uncontrolled air leakage can severely affect the comfort in the building, also fire safety, moisture problems and on design days mechanical HVAC equipment may not be capable of maintaining comfort.

Honeywell's approach to controlling this leakage involves sealing gaps, cracks and holes using the most appropriate materials, labor and systems to effectively create, where possible, a continuous plane of air tightness to completely encompass the building envelope. The following highlights our findings for this building:

Canal Street School

1 Double Commercial Door to be weather-stripped
6 Single Commercial Doors to be weather-stripped
1 Single Commercial interior attic access to be sealed

ECM # CSS 2 Building Envelope Upgrades

Fuel Oil Saved Gallons	Fuel Oil Dollars Saved	Maintenance Savings	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
166	$388	$N/A	$N/A	$388	$2,170	5.6

Summary

Illustrated below is a summary of the recommended ECMs for the Canal Street School.

ECM's Canal Street School Total

Fuel Oil Dollars Saved	Electric Dollars Saved	Maintenance Savings $	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
$388	$1,813	$356	$N/A	$2,556	$27,693	10.83

2.1.4 Oak Grove School

The Oak Grove School is a brick building originally constructed in 1924. Several Additions have been added over the years with the most recent in 1996. The building now has approximately 32,000 square feet of conditioned space with 14 classrooms a gymnasium / cafeteria, library and administrative offices. The building is occupied form 7AM -5PM Monday through Friday with some weekend and evening use.

Central Heating System:

The original building was heated with a central two-pipe steam heating system although many areas originally heated by steam were converted to hot water in 1996. The existing boiler is a Weil McLain cast iron sectional boiler installed in 1984 and is in poor condition. The rated capacity of the boiler is 2,040 MBH. In addition to heating the boiler is also used for domestic hot water. During non-heating periods the boiler is operated manually, generally just in the morning, for several hours to bring the domestic hot water tank up to 120°F. This is a very inefficient means of generating hot water because the entire boiler has to be heated to over 212°F just to create 100 gallons of 120°F hot water. Any heat not used by the domestic hot water system gets wasted as the boiler cools down and heats the mechanical room air instead. During our visits it was observed that the boiler room was always hot another indication of a system not operating very efficiently.

There are two, steam to hot water shell and tube heat exchangers one for the 1996 addition and one for the special education room and domestic hot water. The heat exchanger serving the 1996 addition has a rated capacity of 1,040 MBH and the size of the second heat exchanger is unknown given its age. Each heat exchanger has a dedicated fractional horsepower hot water circulator that runs continuously during the heating season.

Lighting Systems:

The Oak Grove School lighting is primarily T8 technology. The existing recessed troffers, surface mount wraps and stem mount indirect/direct luminaires are in great condition. There are also a few existing T-12 Fixtures.

Ventilation Systems:
Ventilation is provided by unit ventilators and air-handling units throughout the building.

Perimeter Classroom Unit Ventilators. Each classroom along the exterior (perimeter) of the building has a unit ventilator that provides 300-400 cfm of outside air for ventilation. During the renovation of 1996 new unit ventilators, using hot water for heating, were installed in both the new classrooms and most of the existing classrooms and offices. Only three classrooms, on the West/Northwest side of the second floor, still have older style unit ventilators that use steam for heat.

Interior Classrooms. Two interior classrooms used for music and chorus activities have an air-handling system that was installed in 1996 to provide heating and ventilation. This system is designed to provide a minimum of 720 cfm of outside air and 129 MBH of heating.

Gymnasium & Health Offices. The gymnasium and health offices are also served by air handling systems. These two systems are located in a mezzanine above the health offices. Both system use steam heat and provide ventilation air. It was observed during our study that while the units are operational they are in poor condition. Unfortunately due to their age we were unable to determine the original design conditions of the units

Domestic Hot Water:

Domestic hot water is generated using the main steam boiler for the building. A small circulator continuously pumps water through a flat plate heat exchanger to maintain the domestic water temperature setpoint of 120°F in the 100 gallon storage tank. During the heating season the domestic water tank is continuously charged but during non-heating periods the steam boiler is enabled for several hours in the morning to heat up the water in the tank. Using the steam boiler is a very inefficient way of heating domestic hot water unless the steam is also needed for heating.

Identified Opportunities

The following opportunities were identified by Honeywell to improve the infrastructure, operations, and classroom environment at the Oak Grove School:

ECM # OGS 1 Lighting Retrofit and Occupancy Sensors:

Honeywell recommends a comprehensive lighting retrofit to specifically include the following:

Oak Grove School

The Oak Grove School lighting is primarily T8 technology. The existing recessed troffers, surface mount wraps and stem mount indirect/direct luminaires are in great condition and will be retrofitted with super T8 systems. In some instances, lamp quantities will be reduced and a reflector will be installed. Where the handful of T12 fixtures exist, the lights will be replaced with new super T8 fixtures.

The domes that are installed throughout the school are a mix of compact fluorescents and incandescents. This project will bring the remaining incandescent dome fixtures to compact fluorescents to minimize maintenance stock and to conserve energy. The incandescent sconces will be retrofitted with screw-in CFLs and the flood lighting on the stage will also be retrofitted with special high-lumen flood CFL screw-ins. By converting the stage fixtures, the school will dramatically reduce their demand load without an effect on performance or light levels. Also, by giving off much less heat, the CFLs will make the stage a more comfortable and conditioned area.

The gymnasium will be taken from metal halide to T5 linear fluorescents. This change eliminates warm-up and re-strike concerns while improving the quality of lighting and reducing energy.

Wall mount and ceiling mount occupancy sensors will be installed in offices, bathrooms, conference rooms, classrooms and in the faculty lounge. These will conserve energy by providing automatic control of the lights when the rooms are vacant. Photocells and photo sensors will also provide automatic control of the lighting directly near the skylights that exist, and vendmisers will be installed on all vending machines.

ECM # OGS 1 Lighting Upgrades

Electric kWh Saved	Electric Dollars Saved	Maintenance Savings	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
47,108	$6,689	$983	N/A	$7,673	$100,187	13.1

ECM # OGS 2 Replace the Steam Boiler:

Replace the existing steam boiler with a new high efficiency cast iron sectional boiler with a #2 fuel oil burner. The existing boiler is nearing the end of its useful life and should be replaced.

Install a new cast-iron sectional boiler with a NET IBR of 1,543 MBH steam. As a package the boiler/burner should have a nominal efficiency of 86% or higher. Install a Buderus G515/12 series or equivalent product.

Install a #2 fuel oil burner with low-high-low step modulation.

Install combustion air ductwork as required by VT code. Include an automatic damper that is opened prior to the boiler being enabled. The damper actuator should have an end-switch to indicate it is fully open prior to the burner being enabled.

Install steam boiler accessories as required by VT code.

Remove the existing boiler and dispose of properly.

Install new steam piping as necessary to connect the new boiler to the existing steam piping. Insulate all new piping with minimum 1.5" fiberglass pipe insulation and protective jacket. All piping shall be Sch. 40 black iron pipe suitable for use with low pressure steam.

All work shall be done in a workman-like manner.

Boiler start-up shall be by a manufacturer's representative.

Install a new steam to HW heat exchanger sized for 400 lbs/hr steam to replace the existing heat exchanger (mounted on side of boiler) serving the kindergarten area and the Domestic Hot Water heater. HX size based on 40°F water delta T with 2' pressure drop and 2 psi steam inlet. HX design based on Bell & Gossett SU type.

All new piping (including fittings and accessories) shall be insulated with minimum 1.5" fiberglass insulation with protective jacket. Insulate existing un-insulated piping in the boiler room with new 1.5" fiberglass insulation with protective jacket.

ECM # OGS 2 Replace Steam Boiler

Fuel Oil Saved Gallons	Fuel Oil Dollars Saved	Operational Savings $	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
1,981	$4,626		$19,748	$24,374	$171,179	7.0

ECM # OGS 3 Install a Dedicated DHW heater:

Install a dedicated domestic hot water heater with a #2 fuel oil burner rather than relying on using the main heating boilers. Leave the existing flat plate hot water heat exchanger and circulating pump so that heat from the main boiler can be used to heat domestic hot water during the heating season. The burner on the new hot water heater should be enabled any time the main heating boiler is turned off. This control should be done using a line voltage aquastat that would enable the new burner anytime the water temperature on the hot-side (steam boiler side) of the flat plate heat exchanger was below 130°F (adjustable).

Replace the existing domestic hot water storage tank and plate heat exchanger with a new tankless, #2 oil fired, hot water heater

Install a new tankless hot water heater with a hot water output rating of 148,000 btuh. As a package the boiler/burner should have a nominal efficiency of 87% or higher. Install a Toyotomi Model OM-148 equivalent product.

Install per manufacturers recommendations.

ECM # OGS 3 Install Dedicated Domestic Water Heater

Fuel Oil Saved Gallons	Fuel Oil Dollars Saved	Operational Savings $	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
764	$1,784	$0	$N/A	$1,784	$12,825	7.2

ECM # OGS 4 Building Envelope Upgrades:

Honeywell recommends repairs and upgrades to the building envelope to reduce infiltration/exfiltration and improve comfort levels within the space.

Our assessment of the potential energy savings through retrofit of the building shell at the Facility has focused on Air Leakage Control, since these are generally the most practical and cost effective measures to implement. Air leakage, is defined as "uncontrolled migration of conditioned air through the building envelope". It is caused by pressure differences due to wind, chimney effect (stack) and mechanical systems. It has been shown to represent the single largest source of heat loss or gain through building envelopes of nearly all types of buildings. Recent tests carried out on high rise commercial, apartment buildings, schools and private residences have shown levels in the range of 30% to 50% of heat loss can be attributed to uncontrolled air leakage.

Beyond the potential for energy savings, uncontrolled air leakage can severely affect the comfort in the building, also fire safety, moisture problems and on design days mechanical HVAC equipment may not be capable of maintaining comfort.

Honeywell's approach to controlling this leakage involves sealing gaps, cracks and holes using the most appropriate materials, labor and systems to effectively create, where possible, a continuous plane of air tightness to completely encompass the building envelope. This building will benefit greatly from this measure in both energy savings and occupant comfort. The following highlights our findings for this building:

Oak Grove School

2 Double Commercial Doors to be weather-stripped
6 Single Commercial Doors to be weather-stripped
39 6 x 16 Wall Grills to be sealed
11 Roof top ventilators to be opened, perimeter sealed, dampers lubricated, 84 linear feet

ECM # OGS 4 Building Envelope Upgrades

Fuel Oil Saved Gallons	Fuel Oil Dollars Saved	Maintenance Savings	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
2,164	$5,053	$N/A	$N/A	$5,053	$10,623	2.1

Summary

Illustrated below is a summary of the recommended ECMs for the Oak Grove School.

ECM's Oak Grove School Total

Fuel Oil Dollars Saved	Electric Dollars Saved	Maintenance Savings $	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
$13,436	$6,689	$983	$19,748	$40,857	$305,114	7.5

Not recommended due to long payback period:

As an alternate to replacing the steam boiler, we considered converting the entire heating system to hot water. Although there would be little additional energy savings associated with this alternate it would significantly reduce the maintenance associated with the heating system. In 1996 most of the building heating system was converted to hot water with the exception of two air handlers and three unit ventilators. Converting to hot water would allow the installation of a smaller boiler and would allow the removal of the various heat exchanger systems that are currently used to convert steam to hot water. Could not economically justify the conversion to hot water.

2.1.5 Estyville School

The Estyville School is an old 2 story wood frame building originally constructed during the early years of the 20th century (~1900-1905). The building presently consists of 3,000 square feet of occupied space and is occupied Monday through Friday from 7AM-4PM. The School has one large classroom on each floor.

Central Heating System:

The building is heated by a central hot water heating system with a single Peerless Model boiler rated at 117 MBH per hour and is fired with a No. 2 fuel oil burner. The boiler is currently controlled to maintain a hot water temperature of 180°F. This past winter a new burner was installed after a failure that resulted in a smoke filling up the basement of the school.

There are two heating zones each with a circulating pump and wall mounted thermostat. One zone serves the upstairs and the second serves the downstairs. It was observed that there is no time of day control strategy being utilized during unoccupied periods.

Lighting Systems:

The Estyville School lighting is a mix of T8 and T12 linear fluorescent.

Ventilation Systems: Operable windows allow building occupants to individually respond to the indoor environment in their immediate area.

Identified Opportunities

The following opportunities were identified by Honeywell to improve the infrastructure, operations, and classroom environment at the Estyville School:

ECM # ES 1 Lighting Retrofit and Occupancy Sensors:

Honeywell recommends a comprehensive lighting retrofit to specifically include the following:

Estyville School

The Estyville School lighting is a mix of T8 and T12 linear fluorescent. The classroom stem mount wraps will be retrofitted with super T8 lamps and ballast. The recessed T12 troffers in the kitchen area in the basement will also be retrofitted with super T8 systems, but will also use a reflector to reduce the lamp quantity. This area is also ideal to sensor via a ceiling mounted occupancy sensor which is included in this project. The stairwell porcelain incandescent will be retrofitted with a screw-in CFL and the exit signs will be replaced with more efficient LED exits.

ECM # ES 1 Lighting Upgrades

Electric kWh Saved	Electric Dollars Saved	Maintenance Savings	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
5,578	$892	$98	N/A	$991	$8,864	8.9

ECM # ES 2 Night Setback Controls

Install new thermostats to replace each existing thermostat. The new thermostats shall be programmable with a total of 28 unique programmable periods (4 per day / 7 days a week). The thermostats should be programmed to match the occupied schedule of the school with an occupied temperature setpoint of 72°F and an unoccupied setpoint of 62°F.

ECM # ES 2 Night Setback Controls

Fuel Oil Saved Gallons	Fuel Oil Dollars Saved	Maintenance Savings	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
90	$210	$N/A	$N/A	$210	$2,800	13.3

ECM # ES 3 Building Envelope Upgrades:

Honeywell recommends repairs and upgrades to the building envelope to reduce infiltration/exfiltration and improve comfort levels within the space.

Our assessment of the potential energy savings through retrofit of the building shell at the Facility has focused on Air Leakage Control, since these are generally the most practical and cost effective measures to implement. Air leakage, is defined as "uncontrolled migration of conditioned air through the building envelope". It is caused by pressure differences due to wind, chimney effect (stack) and mechanical systems. It has been shown to represent the single largest source of heat loss or gain through building envelopes of nearly all types of buildings. Recent tests carried out on high rise commercial, apartment buildings, schools and private residences have shown levels in the range of 30% to 50% of heat loss can be attributed to uncontrolled air leakage.

Beyond the potential for energy savings, uncontrolled air leakage can severely affect the comfort in the building, also fire safety, moisture problems and on design days mechanical HVAC equipment may not be capable of maintaining comfort.

Honeywell's approach to controlling this leakage involves sealing gaps, cracks and holes using the most appropriate materials, labor and systems to effectively create, where possible, a continuous plane of air tightness to completely encompass the building envelope. The following highlights our findings for this building:

Estyville St. School

4 Single Commercial Doors to be weather-stripped

ECM # ES 3 Building Envelope Upgrades

Fuel Oil Saved Gallons	Fuel Oil Dollars Saved	Maintenance Savings	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
74	$172	$N/A	$N/A	$172	$964	5.6

Summary

Illustrated below is a summary of the recommended ECMs for the Estyville School.

ECM's Estyville School Total

Fuel Oil Dollars Saved	Electric Dollars Saved	Maintenance Savings $	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
$383	$892	$98	$N/A	$1,373	$12,628	9.20

2.1.7 Powers House

Powers House is a single story 6,000 square foot wood-frame building originally constructed during the early years of the 20th century (~1900-1905). An addition was added onto the back of the building that serves as a large open classroom. The building is used as a daycare for younger children. The school is regularly occupied 7AM – 5 PM Monday through Friday.

Central Heating System:

The original building is heated by a central hot water heating system with a single Peerless Model boiler is rated at 233 MBH per hour and is fired with a No. 2 fuel oil burner. The boiler is currently controlled to maintain a hot water temperature of 180°F and is in poor condition. The boiler is installed in the basement crawlspace and frequently experiences freezing problems when the boiler is off. The existing pipe insulation is also in poor condition which further explains the problems with freezing. Heating is controlled via wall mounted thermostats that control the temperature on each floor.

It was observed that there is no time of day control strategy being utilized during unoccupied periods in either the original building or the addition.

Lighting Systems:

The Powers House School lighting includes some fluorescents and some incandescent fixtures that provide a residential look.

Ventilation Systems:

Operable windows allow building occupants to individually respond to the indoor environment in their immediate area.

Identified Opportunities

The following opportunities were identified by Honeywell to improve the infrastructure, operations, and classroom environment at the Powers House School:

ESM # PH 1 Lighting Retrofit and Occupancy Sensors:

Honeywell recommends a comprehensive lighting retrofit to specifically include the following:

Powers House School

The Powers House School lighting includes some fluorescents and some incandescent fixtures that provide a residential look. The fancy incandescent pendants will be maintained and retrofitted with screw-in CFLs. The less fancy fixtures, or ones with missing hardware, will be replaced with new CFL dome fixtures. These not only provide energy savings but the lamp life is also extended 5-10 times. The recessed T12 troffers in the classroom and downstairs office, either 1x4 or 2x4, will be retrofitted with super T8 lamps, ballast and reflectors. The remaining T12 wraps in the upstairs offices will be replaced with new T8 luminaires.

It was also communicated by school staff that the copy machine interferes with the lighting and causes flickering all day due to its high electrical load and it being on the same circuit as the fixtures. Included in the project is a new circuit for the copier to eliminate this issue.

To further energy savings, occupancy sensors are viable and will be installed in the classroom, garage and in a single office upstairs.

ECM # PH 1 Lighting Upgrades

Electric kWh Saved	Electric Dollars Saved	Maintenance Savings	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
6,077	$966	$131	N/A	$1,098	$12,194	11.1

ECM # PH 2 Night Setback Controls

Install new thermostats to replace each existing thermostat. The new thermostats shall be programmable with a total of 28 unique programmable periods (4 per day / 7 days a week). The thermostats should be programmed to match the occupied schedule of the school with an occupied temperature setpoint of 72°F and an unoccupied setpoint of 62°F.

ECM # PH 2 Night Setback Controls

Fuel Oil Saved Gallons	Fuel Oil Dollars Saved	Maintenance Savings	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
343	$801	$N/A	$N/A	$801	$2,800	3.5

ECM # PH 3 Replace the Hot Water Boiler

The existing boiler is in poor condition and nearing the end of its useful life. During replacement the existing hot water pipes should be insulated with a minimum of 1.5" of fiberglass insulation with a protective jacket. The insulation should be installed to cover both piping and fittings.

Replace the existing boiler with a new high efficiency steam boiler with a #2 fuel oil burner.

Install a new cast-iron sectional boiler with a hot water NET IBR of 219 MBH. As a package the boiler/burner should have a nominal efficiency of 85% or higher. Install Weil McLain WGO-8, Burnham V87 or Buderus G215/6 or equivalent product.

Install combustion air ductwork as required by VT code. Include an automatic damper that is opened prior to the boiler being enabled. The damper actuator should have an end-switch to indicate it is fully open prior to the burner being enabled.

Remove the existing boiler and dispose of properly.

Install new hot water piping as necessary to connect the new boiler to the existing piping. Insulate all new piping with minimum 1.5" fiberglass pipe insulation and protective jacket. All piping shall be Sch. 40 black iron pipe suitable for use with 200°F hot water. All work shall be done in a workman-like manner.

Boiler start-up shall be by an authorized manufacturer's representative.

ECM # PH 3 Replace Hot Water Boiler

Fuel Oil Saved Gallons	Fuel Oil Dollars Saved	Maintenance Savings	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
510	$1,191	$N/A	$N/A	$1,191	$18,643	15.7

ECM # PH 4 Building Envelope Upgrades:

Honeywell recommends repairs and upgrades to the building envelope to reduce infiltration/exfiltration and improve comfort levels within the space.

Our assessment of the potential energy savings through retrofit of the building shell at the Facility has focused on Air Leakage Control, since these are generally the most practical and cost effective measures to implement. Air leakage, is defined as "uncontrolled migration of conditioned air through the building envelope". It is caused by pressure differences due to wind, chimney effect (stack) and mechanical systems. It has been shown to represent the single largest source of heat loss or gain through building envelopes of nearly all types of buildings. Recent tests carried out on high rise commercial, apartment buildings, schools and private residences have shown levels in the range of 30% to 50% of heat loss can be attributed to uncontrolled air leakage.

Beyond the potential for energy savings, uncontrolled air leakage can severely affect the comfort in the building, also fire safety, moisture problems and on design days mechanical HVAC equipment may not be capable of maintaining comfort.

Honeywell's approach to controlling this leakage involves sealing gaps, cracks and holes using the most appropriate materials, labor and systems to effectively create, where possible, a continuous plane of air tightness to completely encompass the building envelope. The following highlights our findings for this building:

Powers House

1 Double Residential Door to be weather-stripped
4 Single Residential Doors to be weather-stripped
2 Interior Single Residential Doors to be weather-stripped

ECM # PH 4 Building Envelope Upgrades

Fuel Oil Saved Gallons	Fuel Oil Dollars Saved	Maintenance Savings	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
148	$345	$N/A	$N/A	$345	$1,929	5.6

Summary
Illustrated below is a summary of the recommended ECMs for the Powers House School.

ECM's Powers House School Total

Fuel Oil Dollars Saved	Electric Dollars Saved	Maintenance Savings $	Capital Cost Avoidance $	Total Savings $	Installed Costs $	Simple Payback Years
$2,337	$966	$131	$N/A	$3,434	$35,565	10.36

2.1.8 District wide Measures Not Recommended

Other Technologies to Consider (*not included due to long payback period*):

1.Solar Energy

Conservation—this is a great first step. This will save Brattleboro significant energy and, therefore, money. At American Energy Care, we offer cutting edge technologies and services that include the next step, after energy conservation measures are implemented. Generating renewable power for the city of Brattleboro is one such significant opportunity.

Through this efficiency project, Brattleboro is reducing energy consumption. Now is the best time to introduce a solar electric (photovoltaic [PV]) system. The electricity produced by a PV system is used on-site resulting in reduced electricity demand from the utility. This provides valuable cost savings, especially during peak daytime periods, which is when solar systems produce the most electricity. Many of Brattleboro's accounts are currently on time of day (peak/off-peak) pricing. The more expensive peak hours will see the reduction, adding to the overall savings. Additionally, energy prices are volatile and will rise over the long-term. As rates rise, a PV system provides increased savings. Furthermore, Federal government incentives are available through rebates and incentives and can cover much of the cost of a solar electric system.

If implementing a PV system, Brattleboro would also be able to utilize monitoring equipment, both on-site and through a website, to illustrate and promote the clean renewable power being generated. Also, when Brattleboro is using less electricity than is being created at that moment, the system could charge batteries and provide backup power, or potentially sell power back to the grid through net-metering.

A feasibility study of adding a PV system to one or more school or municipal building roofs, or as a car shading structure, can be performed by American Energy Care with interest from Honeywell and Brattleboro.

2.Window Quilts and Interior Storm Windows

Honeywell investigated a few additional technologies with regard to the building envelope. The paybacks on both of these technologies were in excess of 15 years.