ENERGY ACTION PLAN

Energy Efficiency and Conservation Measures For the Town of Groton

FEBRUARY 2013

ACKNOWLEDGEMENTS

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Executive Summary

Peregrine Energy Group, Inc. ("Peregrine") has prepared this Energy Action Plan for the Town of Groton, Connecticut, with funding provided by U.S. DOE's Energy Efficiency and Conservation Block Grant program. This Plan provides a "snapshot" of the Town of Groton's current energy situation, our vision for what the Town could achieve with respect to future energy use, and a roadmap for getting there.

Groton has good reason to be thinking pro-actively about reducing energy use in operations and exploring alternatives to conventional fossil energy sources. First, in light of increasingly tight annual budgets, there are the budgetary benefits of reducing the energy expense resulting from the Town's own energy use. Second, there is the opportunity to positively affect energy use Town-wide as part of the stewardship role that Town government plays in guiding and encouraging the community to conserve resources and increase its economic strength. In addition, Groton's particular situation as a coastal community makes the Town particularly sensitive to the effects that maintaining or changing historical energy use patterns could have on carbon emissions associated with greenhouse gas induced climate impacts and resulting sea level rise. Coastal communities like Groton will likely all need to engage in adaptation planning as rising sea levels and storm-induced flooding affect land use, local economies, and public safety. This makes it particularly appropriate for Groton to have an Energy Action Plan that addresses climate preparedness issues.

The Town and Groton Public Schools (GPS) have already taken a number of steps that have resulted in significant energy reductions in facilities operations and set in motion a process for additional future savings. These efforts have also effectively helped reduce the Town's contribution to greenhouse gas emissions. Major initiatives to date include aggressive operations and maintenance policies for GPS buildings that have reduced energy use there significantly, incorporation of energy efficiency as a criteria used in evaluating proposed projects for inclusion in the Town's Capital Improvement Plan, participation in utility programs that provide incentives and rebates for investment in improvement energy efficiency, and a decision to purchase hybrid vehicles for use by Town employees.

That being said, there is more to do. This Plan presents strategies and specific actions for the Town to embrace. If adopted, they will result in further energy reductions and energy cost savings, as well as better decision making to help ensure that future energy impacts are considered in all Town and GPS purchasing and in new construction.

In addition to the Plan, this document includes, as attachments, a memorandum prepared by Peregrine that reviews existing Town policies for their impact on Town and community-wide energy use, and separate Building Assessment reports prepared by Peregrine for municipal buildings and schools.

Introduction to the Energy Action Plan

In March 2012, with funding secured from the US Department of Energy under the Energy Efficiency and Conservation Block Grant (EECBG) program, the Town of Groton engaged Peregrine Energy Group, Inc. to develop an Energy Action Plan for the Town.

Peregrine was asked to identify and recommend strategies and actions that Town government and employees could undertake to better manage Town and Public School energy use and to encourage and support community-wide energy use reductions and use of alternative energy sources.

More specifically, Peregrine was to review existing Town policies and practices, undertake site visits and prepare energy assessments for larger municipal and public school buildings, make recommendations for, and estimate costs and savings attributable to, building energy improvements, evaluate energy used for street lighting and Town vehicles, and develop a succinct energy efficiency and conservation action plan with clearly defined actions and a proposed priority sequence for their accomplishment. The Plan would:

- Be the implementation document for the Town's Energy Efficiency and Conservation Strategy developed under the Energy Efficiency and Conservation Block Grant
- Define over-arching mitigation and adaptive strategies to help reduce greenhouse gas emissions through the efficient use of energy and possible alternate energy sources
- Offer short and long term action recommendations
- Be a living document that could be updated and revised to reflect Town progress toward goals, changing priorities, and emerging opportunities and technologies that become available over time

This document, completed over a period of six months, is the culmination of this effort by Peregrine. In addition to the Action Plan itself, it includes as Appendices a number of other documents and analyses prepared by Peregrine as we worked to understand the current energy situation in the Town of Groton and to develop a vision for what could be.

These Appendices include: a Memorandum critiquing Town policies that have an impact on local energy use; a Report describing Building Assessments completed by Peregrine for select municipal buildings; a Report describing Building Assessments completed by Peregrine for Groton Public Schools buildings; Priorities for building improvements, from facility Planning Tools for municipal buildings and school buildings that Peregrine developed for use by the Town; and an analysis of fuel efficiency of Town vehicles.

Peregrine thanks the representatives of the Department of Public Works, the Groton Public Schools, and the Office of Planning and Development Services that provided direction, information, feedback, and support during the preparation of this Plan.

Town Energy Objectives and Goals

Peregrine has consulted with Town officials and Department heads to explore the existing policy drivers that could be harnessed to establish specific energy action goals and strategies. The policy drivers most often repeated to Peregrine are:

Balancing Budget and Service Needs: The Town of Groton, like communities throughout Connecticut, seeks opportunities to reduce municipal budgets without reducing the quantity of services it provides or compromising the quality of the services it provides. Better energy management and increases in the efficiency of energy use is a way to achieve this.

Addressing Climate Change and Potential Sea Level Rise: With an eye toward preparing for anticipated rising sea levels, the Town also wants to help reduce the greenhouse gas emissions associated with the energy it consumes to carry out its business responsibilities: educating its youth, maintaining its roadways, protecting public safety, enforcing laws and regulations, and supporting its senior citizens, as well as providing other public services. Reducing energy use and making use of alternative energy resources will help achieve this as well.

Providing Leadership on Sustainability: The Town wants to lead by example in adopting less impactful energy practices and encourage the community at large to adopt more "sustainable" energy behaviors as well. That means critically considering both the immediate and long-term energy and climate implications of everyday, periodic, and one-of-a-kind choices and decisions about when and how to use electricity and fossil fuels in buildings, for transportation, etc. Specifically, alternative practices could be pursued (e.g. in building design and construction, in purchasing equipment or vehicles, in building operations such as heating, cooling, and lighting, or in modes of transportation selected) that can reduce energy consumed and resulting greenhouse gas emissions and perhaps create other benefits as well.

Recommended Energy Goals

Peregrine recommends that the Town establish a specific goal for energy reductions to be achieved over the next five years by the end of fiscal year 2017. A number of communities in Connecticut are adopting energy reduction goals of 15% or even 20%.

A modest reduction goal for the Town would be a combined 10% against a fiscal year 2011 or 2012 baseline. This could include energy use reductions resulting from a variety of operations and physical improvements in municipal and school buildings, as well as improvements for street lighting and vehicles. The energy use reductions would also reduce greenhouse gas emissions associated with Town activities. Additional goals could be established for using renewable technologies that would meet energy needs for electricity and/or hot water (e.g. through solar electric and thermal technology) while further reducing greenhouse gas emissions.

Town of Groton's Energy Budget

The business of the Town of Groton is the provision of a variety of services required by the Town's residents and tax payers: education, public safety, elder care and other human services, economic development, street lighting and roadway maintenance, natural resource management, information services, wastewater treatment, and public administration. The infrastructure necessary to provide these services (including office buildings, schools, a senior center, library, wastewater treatment plant, police station, street lighting, heavy trucks, light trucks, and automobiles) is what consumes the energy that Groton uses.

Energy sources used by the Town of Groton include electricity, natural gas, fuel oil, propane, diesel fuel, and unleaded gasoline.

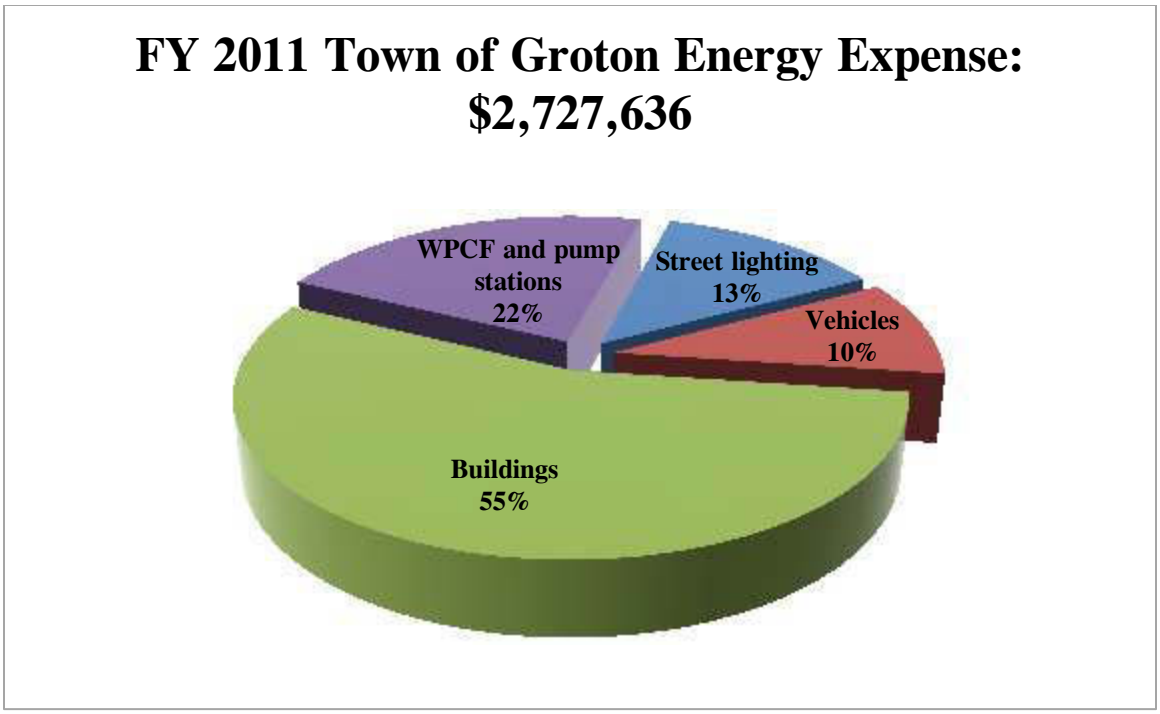
- Groton is unusual in that there are two electricity providers that supply Town buildings and facilities and streetlights. Connecticut Light and Power, a subsidiary of Northeast Utilities, serves much of the Town. The remainder of the Town is served by Groton Utilities, the local municipal utility with principal offices in the City of Groton, a political subdivision of the Town.
- There is very limited natural gas available for use in the Town, provided by Yankee Gas.
- Oil is the primary heating fuel used in Town buildings. The Senior Center is heated with natural gas. There is also some amount of propane used for heating.
- The Town's vehicles operated by the various departments use both unleaded gasoline and diesel fuel.

Annual Energy Expense

Peregrine found that in fiscal year 2011, from July 1, 2010 to June 30, 2011, the Town spent a combined $2,727,636 for energy used in municipal and public school buildings (for electricity, natural gas, oil, and propane), for street lighting and traffic signals (for electricity), for Town vehicles (for gasoline and diesel fuel), and in the Water Pollution Control Facility (electricity and heating oil) and related pumping stations (electricity).

Viewed as a pie chart on page 5, this total expenditure for buildings ($1,468,188), for vehicles ($262,844), for the Water Pollution Control Facility and pumping stations ($634,199), and finally for street lighting and traffic signals[1] ($362,405) is as follows:

[1] Note that the street lighting and traffic signal expense includes over $110,000 paid to Groton Utilities for street lighting in the City of Groton.



Of course, a primary motivation of energy management is budget control and cost reduction. To that end, the Town has already executed contracts with TransCanada, a competitive supplier of electricity, to secure best prices available for this commodity. Likewise, the Town has entered into bulk contracts wherever practical for liquid fuels for vehicles. But there are limits to the degree to which the Town can affect energy prices, which are set outside of Groton and often in national and even international markets, other than looking for the best deal that is out there.

However, there are a variety of other cost control strategies that the Town can pursue through reducing energy consumption. This is why the Town's energy goal is not tied to the price of energy, but to the amount of energy used to provide the services and support that residents expect from the Town.

Annual Energy Use

If the Town's goal is to reduce energy use, the Town's energy budget should be analyzed in terms of energy consumed: numbers of kilowatt hours (kWh) of electricity, hundreds of cubic feet (ccfs) of natural gas, gallons of fuel oil or propane, and gallons of gasoline or diesel fuel.

Where we are talking about lighting <u>or</u> vehicle energy requirements, using these standard units works well because a light is a light and a truck is a truck and they all use energy the same way. When we are talking about lighting <u>and</u> vehicle energy requirements, using these standard units works less well because it's hard to compare the energy attributes of electricity with unleaded gasoline. And when purchasing new efficient vehicles, how do we

compare the merits of vehicles that use unleaded gasoline with new vehicles that are powered by electricity?

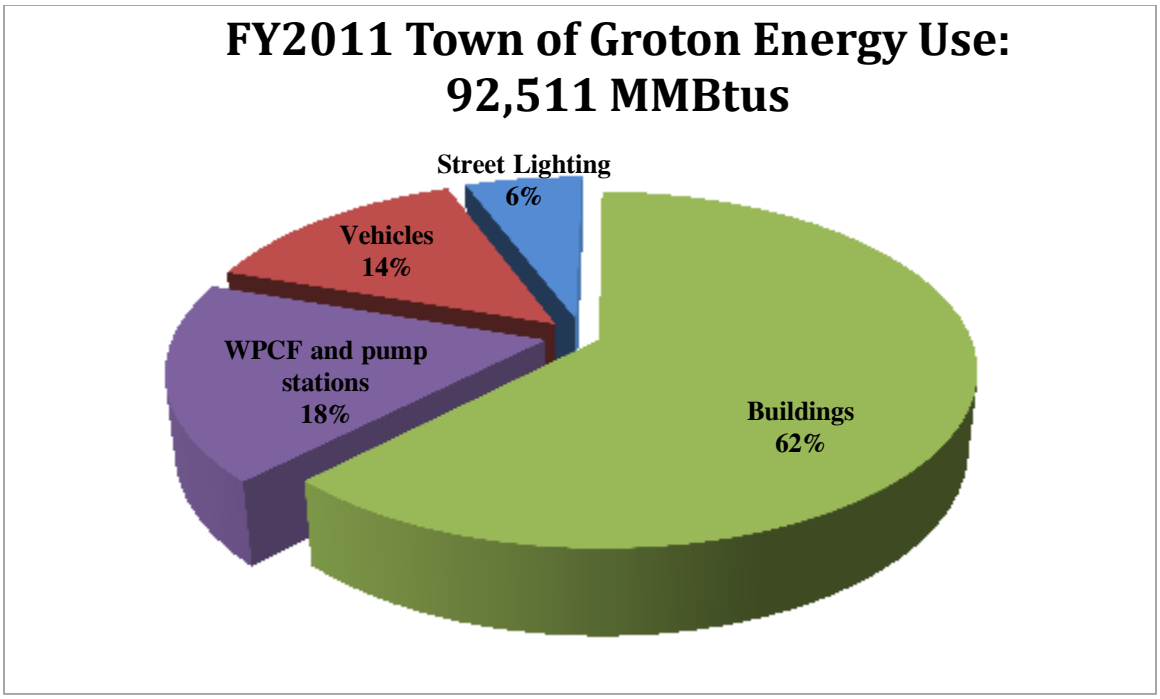
Similarly, comparing energy use of buildings based on units of energy purchased does not take into account the differences in size, purpose, and operating characteristics of different buildings. For example, a larger building will likely use more energy than a smaller one with a similar purpose and use pattern; and similarly, a building with a lot of mechanical and electrical equipment, like a high school or a wastewater treatment plant, will use more energy than another building of similar size that is used as offices.

To understand these differences and be able to compare energy use in buildings with similar purposes and differing purposes to target opportunities to improve efficiency, energy engineers look at energy use in British thermal units. A British thermal unit ("Btu") is a scientific term for the amount of heat energy needed to raise the temperature of one pound of water by one degree F. Any energy type can be converted from the units of energy we purchase (e.g., kilowatts or gallons, etc.) to their energy equivalent measured in Btus. Conversion of electricity, natural gas, heating oil, propane, and transportation fuels to a common basis that reflects the amount of useful energy they each provide is useful to compare the energy intensity of different buildings or to consider the economics of alternative fuels (e.g. oil vs. propane).[2]

The following pie chart on page 7 looks at Town energy use for the four major end users: buildings, street lighting, vehicles, and the Water Pollution Control Facility and pump stations.

[2] Conversion factors for different energy sources to Btus (1 million Btus is expressed as 1 MMBtu):

- 1 kilowatt hour of electricity = 0.003412 MMBtus
- 1 hundred cubic feet of natural gas (1 ccf) = 0.1028 MMBtus
- 1 gallon of propane = 0.091 MMBtus
- 1 gallon of heating oil = 0.139 MMBtus
- 1 cord of wood = 20 MMBtus



A comparison of the size of the "pie slices" and percentages of use and cost they represent in the two pie charts above shows the following:

- Buildings account for 55% of the cost of energy, but 62% of energy use in MMBtus
- The WPCF and pump stations account for 22% of energy cost, but 18% of energy use
- Street lighting accounts for 13% of energy cost, but only 6% of energy use
- Vehicles account for 10% of energy cost, but 14% of energy use

Comparing Energy Use in Buildings

Benchmarking the relative energy intensity of different buildings and how that use changes over time requires measuring the energy consumed against a standard index. Building energy performance is typically measured by energy engineers in thousands of Btus (kBtus) consumed per square feet of building area. This ratio is called the Energy Use Index or "EUI". The lower the EUI, the lower a building's energy intensity is, in terms of energy consumed per square foot of floor area. This allows comparison of buildings of different sizes and different uses and different energy efficiencies.

A higher EUI is not necessarily an indicator of worse performance, since some buildings such as Police Stations, which operate 24 hours a day year round, will naturally use more energy than a building that has more limited hours of operation, other things being equal. On the other hand, a Police Station with older inefficient energy systems (e.g. it's boilers and air conditioning equipment), with a poorly performing building envelope (e.g. with leaking doors and windows and little insulation), and little attention to energy equipment settings and scheduling (e.g. lighting shut off and temperature reset when areas are not being used for extended periods) will have a higher EUI that a Station with efficient equipment, a well designed and built building shell, and good building controls.

The following table on page 9, using information provided to Peregrine by the Town, summarizes all energy use by the Town of Groton in FY2011 for different purposes (again, for buildings, street lighting, vehicles, and the WPCF and pump stations) in native units (i.e. kilowatt hours of electricity, hundreds of cubic feet of natural gas, and gallons of fuel oil, propane, unleaded gasoline, and diesel fuel. This table also presents this energy use in equivalent British thermal units. Finally, for the buildings that Peregrine has evaluated where building square footage was provided, an Energy Use Index is calculated and shown. Similar EUIs can be calculated for the remaining buildings when square footage information is available.

	Building Area	Electricity		Natural Gas		#2 Distillate Fuel Oil		Propane		Unleaded Gasoline		Diesel		Total Energy Use	EUI
	(sq. feet)	kWh	MMBtu	Therms	MMBtu	Gallons	MMBtu	Gallons	MMBtu	Gallons	MMBtu	Gallons	MMBtu	(MMBtu)	kBtu/SF
BUILDIINGS															
Charles Barnum ES	43,500	210,000	717		0	7,800	1084		0		0		0	1,801	**41.40**
Claude Chester ES	43,600	221,000	754		0	13,900	1932		0		0		0	2,686	**61.61**
Cutler MS	73,700	318,000	1085		0	16,600	2307		0		0		0	3,392	**46.03**
Fitch HS	293,300	2,163,000	7380		0	67,500	9383		0		0		0	16,763	**57.15**
Mary Morrisson ES	42,200	239,000	815		0	7,800	1084		0		0		0	1,900	**45.02**
Pleasant Valley ES	33,700	266,000	908		0	9,800	1362		0		0		0	2,270	**67.35**
SB Butler ES	37,900	217,000	740		0	13,800	1918		0		0		0	2,659	**70.15**
West Side MS	76,000	409,000	1396		0	27,100	3767		0		0		0	5,162	**67.93**
SUBTOTAL PUBLIC SCHOOLS	643,900	4,043,000	13,795	-	-	164,300	22,838	-	-	-	-	-	-	36,632	**56.89**
Community Police Office		13,327	45		0		0	665.8	61		0		0	106	
Animal Shelter		54,151	185		0	4,781.5	665		0		0		0	849	
Highway Garage	21,300	131,760	450		0	6,186.9	860		0		0		0	1,310	**61.48**
Human Services Office (Comm Serv)	9,500	60,802	207		0	2,814.4	391		0		0		0	599	**63.02**
Human Services Office (security light)		504	2		0		0		0		0		0	2	
Library	37,400	675,840	2306		0	5,779.2	803		0		0		0	3,109	**83.14**
MRF - Former Matl Recycling Facility		15,360	52		0		0		0		0		0	52	
Mystic Restrooms/Community Policing		24,082	82		0		0	482.1	44		0		0	126	
Parks Maint Bldg		33,318	114		0		0		0		0		0	114	
Police Station	40,700	857,700	2926		0	14,821.4	2060		0		0		0	4,987	**122.52**
PW Barn/Bldg Maint Shop		22,441	77		0	624.7	87		0		0		0	163	
PW Vehicle Storage Garage		3,928	13		0		0		0		0		0	13	
Salt Shed		15,355	52		0		0	6449.4	587		0		0	639	
Senior Center	30,000	388,380	1325	18200	1820		0		0		0		0	3,145	**104.84**
Spicer House		16,072	55		0	1,788.3	249		0		0		0	303	
Town Hall	19,900	307,140	1048		0	6,089.9	846		0		0		0	1,894	**95.20**
Town Hall Annex	19,600	179,040	611		0	7,744.2	1076		0		0		0	1,687	**86.09**
Transfer Station - Offices		50,476	172		0	157.7	22		0		0		0	194	
Transfer Station - Flare		42,144	144		0		0		0		0		0	144	
Welles Rd Vehicle Storage		280	1		0		0	0	0		0		0	1	
SUBTOTAL MUNICIPAL BUILDINGS		2,892,100	9,868	18,200	1,820	50,788	7,060	7,597	691	-	-	-	-	19,439	
Burrows Field (Little League)		6,988	24				0		0		0		0	24	
Burrows Field Concession			0				0		0		0		0	-	
Esker Point Beach		12,401	42				0		0		0		0	42	
Farquhar Park (basketball court)		2,320	8				0		0		0		0	8	
Poq River Access (security light)		1,080	4				0		0		0		0	4	
Poquonnock Plains Pk (concession)		13,225	45				0		0		0		0	45	
Poquonnock Plains Pk (field)			0				0		0		0		0	-	
Sutton Park (front shelter/pavilions)		13,163	45				0		0		0		0	45	
Sutton Park (P.B. Little League)		115	0				0		0		0		0	0	
Sutton Park (security light)		1,584	5				0		0		0		0	5	
Sutton Park LL Pits & Concession			0				0		0		0		0	-	
SUBTOTAL PARK FACILITIES		50,876	174	-	-	-	-	-	-	-	-	-	-	174	
Colonel Ledyard		933	3			0.0	0		0		0		0	3	
Groton Heights		13,971	48			3493.6	486		0		0		0	533	
Noank Elementary		5,520	19		0	0.0	0		0		0		0	19	
William Seely School *		28,680	98		0	6,000.0	834		0		0		0	932	
SUBTOTAL VACATED SCHOOLS		49,104	168	-	-	9,494	1,320	-	-	-	-	-	-	1,487	
TOTAL FOR BUILDINGS		7,035,080	24,004	18,200	1,820	224,582	31,217	7,597	691	-	-	-	-	57,732	
Water Polution Control Facility		2,685,000	9161		0	18200	2530		0		0		0	11,691	
Pumping Stations		1,413,268	4822		0		0		0		0		0	4,822	
Vehicles in Aggregate			0		0		0		0	73,008	9053	27562	3831	12,884	
Street and Traffic Lights		1,577,419	5382		0		0		0		0		0	5,382	
TOTAL ENERGY USE		**12,710,767**	**43,369**	**18,200**	**1,820**	**242,782**	**33,747**	**7,597**	**691**	**73,008**	**9,053**	**27,562**	**3,831**	**92,511**	

Opportunities for Energy Action with Recommendations

Groton and its residents have shown leadership and commitment in addressing climate preparedness and anticipated sea level rise, and the potential role that greenhouses gas emissions could have in these changes. Further, Groton has taken many actions already that have helped reduce the Town's energy use and, as a result, the greenhouse gas emissions that result from this use.

However, these efforts are not occurring within the context of a formal Town energy action plan, with specific goals, identified strategies and actions to achieve them, designated roles and responsibilities, and a timeline for measuring progress toward achieving the Town's goals.

To that end, Peregrine recommends that the Town of Groton:

- Establish formal goals for energy reduction and use of alternative energy resources
- Consider endorsing this Plan as the Town's roadmap for Energy Action
- Create a staff-based organization to coordinate Town-wide energy management activities that includes, at minimum, core representatives from Planning and Development Services, Public Works, GPS Buildings and Grounds staff, and Purchasing.
- Track building energy use and cost over time, by month, in a dedicated energy database that supports measuring performance of each building
- Calculate the aggregate fuel efficiency of each vehicle (miles traveled per gallon consumed) annually
- Integrate energy goals appropriately into the Town's Plan of Conservation and Development (POCD)
- Ensure that the Project Manager's responsibilities include developing specs, securing vendors, overseeing construction, ensuring that the project is fully and successfully commissioned, preparing project documents and utility rebate forms as appropriate, and submitting forms for available incentives.

The sections below describe more specific opportunities and recommendations for action that the Town should consider for Town policies that will support Groton's energy and emissions reduction goals, as well as for improving the efficiency of Town operations, in municipal and school buildings, for street lighting, and for vehicle use.

Potential Funding Mechanisms for Projects

There are a variety of sources that the Town of Groton can draw on to fund projects that reduce energy use and the Town's greenhouse gas emissions.

Using Other People's Money

Other People's Money is the most popular and sought after source of funds for energy projects. There are potential utility incentives and rebates available from Connecticut Light and Power, as well as like financial support from Groton Utilities, for electricity saving projects identified by Peregrine. Further, there is the potential for State grant funding for specific projects through the Clean Energy Finance and Investment Authority (CEFIA), which supports both renewable energy and efficiency projects, and potentially through the State Department of Energy and Environmental Protection (DEEP). Finally, there may be future opportunities to secure Federal funds for projects or even foundation money. Naturally, there can be a lot of competition Other People's Money, and waiting for grants can be counterproductive when there are immediate cost reduction opportunities to be pursued.

Local Funding Sources for Energy Reduction and Renewable Energy

Purchasing Policies

The most obvious way to secure local funding for municipal and GPS energy reduction projects is to build energy reduction into all future purchasing and building renovations decisions so, as buildings and equipment need to be replaced, new systems and equipment will perform more efficiently. The incremental cost of adding efficiency to ongoing purchasing is very small and easy to sell as part of a larger capital expenditure. Life cycle analysis can be used to justify these decisions. Renewable technology can also be included in projects.

Capital Improvement Program

Groton's Capital Improvement Program is the most obvious source of funds for targeted energy projects. Where energy conversion equipment is at the end of its designed service life, replacement equipment with higher performance standards can be included in the CIP and funded through Town appropriation. As we observed in the Policy section of this Plan, setting minimum standards for energy performance for all CIP-funded projects is the best way to leverage these funds for this purpose.

Reinvesting Savings

When significant savings result from energy improvements, these savings can be banked and reapplied to additional investments in energy efficiency. One strategy for doing this is to level fund the year to year utility budget at an amount equal to some portion of these energy savings and put the funds into a separate investment account that can be drawn for approved energy reduction projects.

Performance Contracting

A more formalized approach to *Reinvesting Savings* occurs in performance contracting, an approach to funding energy improvements and capital upgrades where energy savings in level funded utility budgets are used to cover the debt service for a bundle of projects implemented by the Town through an energy services company. Given the relatively high level of investment in efficiency that Groton has been willing to make through its CIP, there may be limited opportunity for a larger scale paid from savings approach.

Power Purchase Agreements

While not a capital project funding mechanism per se, power purchase agreements ("PPAs") are being increasingly used by public and private entities to secure renewable energy, and most typically solar-generated electricity, though PPAs are also executed for wind and landfill gas projects. The Town would execute a PPA with a private company that would purchase and install and own, maintain, and operate a renewable energy project at a Town facility, either municipal or GPS. The Town agrees to purchase the power produced by the project at an agreed upon price over some number of years. The owner gets the tax benefits associated with the project. There are sometimes early buyout or term extension provisions in these contracts.

Priorities and Next Steps

Peregrine believes that the Town of Groton is well positioned to build on past energy initiatives and raise its energy-saving efforts to the next level, by

- Establishing specific goals for future reductions in energy use,
- Organizing these efforts under a designated energy management team,
- Implementing recommendations for energy reduction, and
- Identifying and pursuing opportunities to adopt proven and emerging energy efficient and alternative energy technologies.

To that end, Peregrine recommends that, as soon as possible, the Town of Groton

- Adopts resolutions by the Town Council and Board of Education making energy use reduction and use of alternative energy sources a formal Town objective
- Creates a Town-wide energy management core group with accountability and specific responsibilities
- Considers recommendations in the Peregrine Action Plan and confirms priorities
- Sets measurable goals for energy management and determines strategies
- Initiates specific projects and periodically reports on progress toward goals to the Town Council and Board of Education

APPENDIX A

Review of Town Policies and Practices With Respect to Energy Use

October 2012

Executive Summary

In February 2012, The Town of Groton engaged Peregrine Energy Group, Inc. to help develop an energy plan that will help guide future municipal and Board of Education operations, procurement, and construction, as well as support and encourage Town residents and businesses to reduce energy use and adopt clean energy technologies. This project was funded with EECBG funds received by the Town of Groton under ARRA.

As part of this effort, The Town asked Peregrine to critique a set of documents provided by Town staff that describes organizational practices and policies for operations and maintenance of buildings and other assets such as vehicle fleets. The document set included purchasing and construction guidelines and practices and policies that could affect energy use by the Town and Schools. Peregrine also reviewed local building codes and land use strategies in Groton to see if they encourage or discourage community-wide energy efficient construction and the use of renewable energy technologies. The document set did not include either purchasing or operations and maintenance policies to review.

The materials that Peregrine received and reviewed fall into the following five categories:

- **Long Term Plans** (e.g. Town capital improvement spending [2013-2018], economic development [2006], conservation and development [2002])
- **Land Use and Zoning Regulations; Building Code** (e.g. Road % Drainage Standards)
- **Policy Documents** (e.g. Town Council minutes regarding energy-related priorities and actions, Methodology for prioritizing qualified capital projects (including Sustainability Goals), Public and Affordable Housing guidelines, Personnel Policy manual)
- **Construction Standards** (e.g. Project Specifications for the Police Station addition, Town Hall Annex boiler replacement)
- **Position Papers** (e.g. Task Force on Climate Change and Sustainable Community report , Greenhouse Gas Inventory Final Report)

We find that, with a few exceptions, energy efficiency and use of clean energy alternative are not highlighted directly as a formal objective in the documents that Peregrine was provided. That said, the policies proposed by the Task Force on Climate Change and the Greenhouse Gas Inventory Final Reports, which do not have formal standing, do focus on matters related to energy use in the context of goals to reduce greenhouse gas emissions and perceived climate impacts. Many of these proposed policies are relevant to Peregrine's charge to create an energy plan for the Town of Groton and could be considered for endorsement.

With regards to local building codes and standards, Groton's current building code references the Connecticut State Building Code. The State Building Code references the 2009 International Energy Conservation Code (IECC). The 2009 IECC standards are very good and will be upgraded to higher performance standards in 2012. Groton can adopt the 2012 IECC standards now or wait for the State of Connecticut to adopt the new standards.

Land use strategies described in the 2002 Plan of Conservation and Development, 2006 Strategic Economic Development Plan, and the Subdivision regulations would have mixed results for community-wide efficiency and greenhouse gas reductions.

- Land use for economic and community development is proposed to occur in targeted nodes with mixed uses to encourage appropriate -scale residential focused services and small offices located near affordable and market rate housing.
- Land use regulations for larger residential development normally include minimum land allocations in subdivisions for public use for recreation and pathways through the properties.
- Land use regulations for industrial development focus on the development of green field sites located in undeveloped sections of town with limited access to water and sewer utilities.
- Current transportation patterns discourage community-wide efficiency and greenhouse gas reductions. As the 2002 Plan of Conservation and Development points out, "There is little doubt that the automobile is largely responsible for most of the development patterns that exist in Groton today."

Perhaps, the long-term plan's mixed use and "node" development and expansion of walking and biking trails will provide alternative transportation patterns and options for Groton residents.

DISCUSSION OF DOCUMENTS, WITH PEREGRINE RECOMMENDATIONS

Long Term Plans

- **<u>Capital Improvement Program FYE 2013 to FYE 2018</u>**

  Summary

  Connecticut statutes require Towns to prepare six-year Capital Improvement Programs (CIP). Groton's CIP "is a long-term planning and policy document, development of which is coordinated by the Office of Planning and Development Services. .

  Discussion

  Groton's 6-year Capital Improvement Program includes significant energy-related investment proposed over the next six years. Proposed school capital investments are weighted heavily towards mechanical, ventilation, and air conditioning upgrades in addition to life safety and ADA compliance requirements. With the failure of the Phase II School referendum, GPS needs to work with the Town to pursue another referendum to update the aging school facilities or develop a plan to address the 40-60 year old school facility infrastructure.

  The Town already has Sustainability Goals to be considered for project development through the CIP (These are described further below). Having "Sustainability" as a prioritization criteria for projects is important, though this criterion is only one of the nine that are listed, with any five of the nine needed by a project to potentially be given "High Priority" during the prioritization process. An alternative and much stronger approach would be to require certain

sustainability goals (such as reducing overall energy use) to be met as a minimum threshold for including a project in the CIP.

A major challenge for GPS will be how to maintain or reduce energy consumption in schools that currently do not have air conditioning or adequate ventilation systems. The CIP includes recommendations to install air conditioning and ventilation upgrades in several schools. These measures are reasonable expectations for today's standards. However, GPS should understand that these measures could increase the energy use of the buildings significantly.

Peregrine commends DPW staff for including high efficient wastewater pumping stations in the proposed long term CIP.

Peregrine Recommendations

Sustainability: Focusing on sustainability draws attention to this goal and demonstrates that sustainability is a high priority for the Town. However, interpretation of this category varies. Groton can elect to continue to allow broad and creative interpretation of potential sustainability-related benefits from proposed capital investments; or alternatively, Groton can provide more specific sustainability-related criteria and guidance for capital investments. There are scoring systems that can be used to set performance targets. Groton can choose to create incentives for specific results from future capital investment projects and measure results to confirm that goals are being met.

Portable Classrooms: The CIP anticipates the need to add portable classrooms at several schools. Energy efficiency and indoor air quality standards for portable classrooms has historically been poor. As part of its due diligence, Groton should investigate the additional cost to procure or lease more efficient portable classrooms.

School Energy Efficiency: In response to the failure to pass the Phase II School Referendum, as part of its due diligence, Groton should investigate the opportunity to leverage energy-related capital upgrades with energy cost savings through an energy performance contract.

LED Traffic Lights: As part of proposed traffic management upgrades, Groton should make sure that all traffic signals are converted to LED technology as soon as practical. All recent replacements of State and Town owned traffic signals are LED lights, according to the Public Works Department..

Golf Course: The golf course maintenance shop is scheduled for facility upgrades and could have some interesting energy efficiency and renewable energy opportunities. Energy-related upgrades could be integrated with the proposed structural and chemical management upgrades proposed to be assessed in FYE2014.

- **Strategic Economic Development Plan (2006)**

Summary

Groton's Economic Development Plan describes and provides concrete recommendations for what appears to be a community at a significant crossroad. Sixty years of defense and pharmaceutical-related economic stability is at risk with the specter of lower-paying casino-related jobs replacing higher-paying manufacturing and research-related jobs. The report

contends that Groton will not have to, and should not compete on lowest cost alone, because of the Town is very close to major urban markets and has a high quality of life.

Discussion

Energy costs and related utility services come up frequently in the plan. From an economic development perspective, the plan points out that Groton can benefit in the long run from comprehensive energy efficiency and renewable energy investments. The two primary benefits from these investments will be reduced risk to future energy price shocks and energy shortages and support for local job creation.

The plan proposes reviving a trolley system for Mystic. Groton had electric trolley service (1904-1928) run by the Groton and Stonington Line with service every ½ hour.

Peregrine Recommendations

Natural Gas Service: Groton should add expanded natural gas service to the utility package under review for proposed business development and incubator centers. Natural gas service to the community is very limited and might offer significant greenhouse gas reduction opportunities, as well the opportunity to adopt more energy efficient technologies such as condensing boilers, which are not applicable to oil-fired systems.

Sustainability-related projects: Groton includes sustainability in the CIP scoring summary. Some departments are quite creative about sustainability links with proposed capital investments. Groton should develop clearer descriptions of what constitutes a sustainable measure.

Water Transit: The potential water transit project proposed as part of the Heritage project is interesting. Groton could investigate the opportunity to procure electric ferry boats if this project advances forward. Electric boats would be an interesting alternative and a nice connection to the Electric Boat shipyard.

Submarine Base: Retaining the submarine base in Groton is a high priority for Groton and the State. The State recently released its two top retention strategies – acquire more land around the base to increase the land buffer around the base, and Reduce energy costs at the Sub base. Groton has a good opportunity to help the State meet BRAC support goals with local utility contacts and generate some local business and expertise. Groton should investigate opportunities to leverage energy efficiency upgrades for the submarine base through Groton Utilities.

- **2002 Plan of Conservation and Development (POCD)**

Summary

The 2002 Plan of Conservation and Development was developed with a 10-year shelf life in mind. The Plan represents a three-year effort by the Town's Planning Commission to identify Groton's long-term conservation, development and infrastructure themes and priorities. The next version of this plan is in the update process with a tentative adoption timeline of spring 2014.

Discussion

Energy-related highlights from the plan include:

- Significant increase in 55 and over age group anticipated.
- Will be looking for smaller housing with maintenance included
- Less than 50% of tax base comes from residential property
- Each submarine that is based in Groton generates about $5 million payroll
- Reviewing possibility of allowing village district zoning
- Strong focus on strategic ,mixed use nodes
- Navy housing is 16% of Groton housing market
- Groton has slightly over 10% affordable housing
- 55% of Groton residents rent
- Population currently about 40,000 residents. Full build out carrying capacity is about 60,000 residents
- Energy considerations are limited to one small box on page 85
- Groton has twice as much retail space per capita than surrounding towns. Easier for retail to abandon old sites and build new on green sites. Consider reducing areas zoned commercial
- Airport – underutilized resource
- Automobile responsible for development patterns in Groton today
- Roads are fixed with limited east-west connections. Only minor road building in future, possible East-West connections. Need to promote walking, bicycles, and transit. Future focus should be on access management (connections to adjoining parcels) p. 111
- SEAT transportation service is infrequent and follows a fixed route.
- Consider multi-modal analysis for Mystic (completed with Stonington)
- Potential for excursion and commuter rail service on P&W line
- Water conservation and improved efficiency mentioned as public water option, but not recommended for some reason
- Gas pipeline to region has excess capacity that can be built out for residential, commercial, and retail use.
- City of Groton maintains its own electric transmission lines.
- Groton Utilities serves the three major companies. 2006 state law required all municipal power companies to charge $0.001 per kWh delivered for conservation and to run programs. It's unclear how robust or effective Groton Utility's efficiency program is.

Peregrine Recommendation

The next iteration of Groton's POCD will be a good opportunity for the Town to include more robust energy-related policy initiatives and long term plans.

Land Use and Zoning Regulations; Building Code

- **<u>Zoning Regulations</u>**

  Summary

  Groton has adopted zoning regulations in accordance with Chapter 124 of the General Statutes of the State of Connecticut statutes. The intent of the regulations is to promote "the health, safety, and general welfare of the community."

  Discussion

  The most recent zoning regulations appear to respond to several issues raised in the 2002 POCD and 2006 Economic Development Plan recommendations.

  Peregrine Recommendations

  Potential regulations for Groton to consider:

  - Dark sky regulations and alternative lighting options
  - Charging stations for electric powered vehicles at new development
  - New construction/ major rehab energy performance targets
  - Tree and tree canopy preservation ordinance and/or,standards
  - Pre-approved Municipal Renewable Energy (wind, solar, other?) overlay districts.
  - Consider standards for principal and accessory uses related to emerging alternative energy

- **<u>Subdivision Regulations</u>**

  Summary

  Groton's subdivision regulations were initially adopted in November 1956. The regulations provide guidance and enforceable oversight of multi-parcel subdivision development projects.

  Discussion

  The subdivision regulations include a section 4.1 (6) Energy Efficiency. This section requires that all subdivisions be designed with energy efficiency and solar orientation taken into consideration. This is consistent with the 2002 Plan of Conservation and Development that suggests Groton should pay attention to: energy efficient patterns of development; use of solar and other renewable energy, and energy conservation

  The 2002 Plan of Conservation and Development suggests that more specific energy conservation measures should be addressed at the building permit level. The big climate change and adaptation issue for these regulations is whether or not subdivisions should be allowed in floodplain zones.

  Peregrine Recommendations

  Continue to identify strategies that support more energy efficient subdivision development and land use, including street lighting standards, common area set asides for community gardening, designated bike paths, public transit friendly design, and conservation-oriented design for areas

where natural resource and open space preservation and natural hazard mitigation are needed, etc.

- **Building Code**

Summary

Groton's current building code references the Connecticut State Building Code. The State Building Code references the 2009 International Energy Conservation Code (IECC).

Discussion

The 2009 IECC standards are very good and will be upgraded to higher performance standards in 2012. Groton can adopt the 2012 IECC standards now or wait for the State of Connecticut to adopt the new standards.

Peregrine Recommendations

Potential standards for Groton to consider:

- Dark sky regulations
- Charging stations at new development
- New construction/ major rehab energy performance targets
- Stretch code for new construction at least equal to the 2012 IECC

- **Road and Drainage Standards (2002)**

Summary

The Planning Commission incorporated these standards into the Subdivision Regulations. They include excellent details for road, sidewalk, and culvert design.

Discussion

The 2013 – 2018 CIP includes an interesting note in the sustainability section that smooth roads increase vehicle efficiency by 5%. Several speakers on the Climate Change Task Force recordings reference the need to raise roads and increase culvert sizes in anticipation of higher sea water levels, greater chance of severe coastal flooding, and more frequent and severe rain events.

Peregrine Recommendations

Groton should consider the applicability and viability of "smoothness" standards for its asphalt and concrete road resurfacing projects. In addition, Groton should consider requiring new roads in coastal zones to address potential impacts of higher sea water levels, severe coastal flooding, and more frequent and severe rain events (e.g. culvert replacement, stormwater systems.

Policy Documents

- **Miscellaneous Policy Documents**

Summary

The policy documents binder that Peregrine received includes hard copy utility cost and consumption data collected by the Tremaine Foundation, a copy of ConServ energy retrofit recommendations, 12 months of Town and GPS electricity consumption data from TransCanada, copies of the Town Council reports, Public Works monthly report, Town Council meeting minutes, and energy-related OPDS email messages.

Discussion

Peregrine commends Town Council for making energy efficiency and related environmental activities one of the Town's highest priorities in FY 2012.

The four key actions proposed by Town Council for 2012 under the heading "Become a more environmentally conscious Town" include:

- Establish the Energy, Efficiency, and Conservation Committee
- Hire a full-time grant writer for energy efficiency projects
- Establish a 10% energy challenge for the Town
- Establish single stream recycling

Peregrine Recommendations

Energy Information Management: Collecting baseline energy information and assigning an energy management committee provides an effective starting point for Groton to start reducing Town facility energy consumption.

Operation and Maintenance Practices: Increasingly aggressive operation and maintenance of buildings will be the first and most cost effective action and can reduce portfolio-wide energy use in Town and School facilities up to 10%.

Energy Related Infrastructure Modernization: More capital-intensive energy-related investments can reduce portfolio-wide energy use in Town and School facilities up to 20%. The Town should consider setting higher performance standards for new construction or major renovation projects.

- **Procurement Policy (none provided)**

Summary

Peregrine did not receive a copy of Groton's procurement/purchasing policies.

Discussion

Groton's Purchasing Agent notes that the Town's procurement policies are old and should be updated.

Peregrine Recommendations

As part of any review of the Town's procurement policies, Peregrine recommends that Groton add energy-related procurement criteria. Potential energy-related procurement requirements include:

- Including life cycle cost analysis in comparisons between alternative products, systems, equipment, and construction specifications, rather than focusing on lowest first cost
- Require appliances and other small electronic equipment purchases meet EPA Energy Star standards
- Require all mechanical equipment and vehicle purchases to meet an established minimum energy performance standard
- Require all renovation and new construction building projects to meet an established minimum energy performance standard for the entire building

- **<u>Operations and Maintenance Standards and Procedures (GPS only)</u>**

Summary

Peregrine received a copy of operation and maintenance (O&M) standards from GPS. Peregrine did not receive copies of operation and maintenance standards for any other Town Departments.

Discussion

Most Town departments were unable to provide written practices and policies for (O&M) of buildings and other assets. GPS, on the other hand, has extensive formal requirements for school (O&M) practices by custodial staff. They include closing window shades when the building is unoccupied, regularly monitoring Energy Management System readings regarding equipment performance, shutting down or setting back systems during unoccupied periods, tracking oil consumption biweekly, tracking water use monthly, and conducting energy audits periodically. Perhaps most important, they include having trained specialists employed within the Buildings and Grounds Department who can resolve issues that arise quickly before they get out of hand and be held accountable for their work.

Peregrine Recommendations

Anticipated near-term changes in department leadership in Buildings and Grounds could compromise current energy efficiency operation and maintenance standards and practices. In order to avoid loss of the significant intellectual capital accumulated over the past 33 years, the Board of Education should extensively codify current best practices. Further, if this doesn't exist already in written form, both Town and GPS staff should document recommended seasonal equipment settings and target performance indicators, including temperature, relative humidity, light levels, and energy consumption. Finally, while high performance programs can often be the result of initiatives taken by individual champions, formally recognizing these contributions, establishing formal expectations for maintaining operating practices and for

continuous improvement, and continuously measuring results will help institutionalize such efforts and ensure persistence of results.

- **<u>Public and Affordable Housing Documents</u>**

Summary

Groton provided three public and affordable housing documents for Peregrine's review. Connecticut's 2011-2012 Action Plan for Housing and Community Development, Chapter 3 regarding National Objectives from US HUD's Community Development Block Grant (CDBG) Program, and Chapter 10 regarding Housing Quality Standards from US HUD's Housing Choice Voucher Program Guidebook.

Discussion

The public housing portfolio in Groton includes two housing developments Groton manages with a total of about 175 apartments for seniors. In addition, Groton has eight affordable housing developments listed on its subsidized housing list available online.

Connecticut's 2011- 2012 Action Plan – The Action Plan includes two energy-related initiatives. First, HOME funded projects must comply with model energy code. Second, the Connecticut Department of Economic and Community Development (DECD) has adopted Governor's Executive Order No. 15 on Responsible Growth and Sustainable Livable Communities.

US HUD CDBG Program Objectives – Chapter 3 summarizes US HUD's national objectives for the programs. In addition, this Chapter describes specific language that must be used in program reporting and how to coordinate applications for programs that propose to address multiple national community development objectives.

US HUD Housing Guidelines – Chapter 10 summarizes US HUD's housing standards and how to fill out and process the formwork associated with Housing Choice Voucher Program (formerly called Section 8 Housing Program) housing guidelines. HUD puts the onus on families to determine if the apartments are acceptable. For example, families are responsible to determine if the apartment will have adequate thermal comfort and low utility bills. The only energy-related task for local PHAs is to define "a healthy living environment" that is appropriate for the local climate.

Peregrine Recommendations

RE: Connecticut's 2011- 2012 Action Plan*:* State initiatives in the Action Plan for Housing and Community Development, that Groton could investigate further include:

- <u>Assistance through WAP</u>: Under Priority 1 - Preserve 2,850 state-financed elderly rental units, investigate opportunities to leverage assistance through WAP funds (p. 72).
- <u>Green Energy Business</u>: Compete for the one economic development per year with micro-enterprise funding of small green energy business in Groton (p. 86).
- <u>Groton Utilities</u>: Partner with Groton Utilities for renewable energy electricity infrastructure upgrades. (p. 89) to improved system reliability, increase renewable energy

consumption, and support local jobs. Municipal Utility Companies are uniquely positioned compared to investor-owned utility companies to support local renewable electricity generation investments.

- Transit oriented mixed use development: Investigate funding opportunity for mixed-use development/ transit oriented assistance for two communities (p. 96). Good fit for center of Town mixed-use node development.
- Healthy Homes Initiative: Investigate funding opportunities through the State's Healthy Homes Initiative (p. 99). Strong relationship between healthy homes and energy efficiency.

RE: US HUD CDBG Program Objectives: Groton should investigate potential links between CDBG funding and energy efficiency business development workforce training within Groton's enterprise zone. Energy efficiency investments are often labor intensive and a good engine for entry-level job creation.

RE: US HUD Housing Guidelines: Groton should consider providing energy labels for Housing Choice Voucher apartments. This would help residents compare energy use for apartments they are considering and provide an incentive for landlords to improve the energy efficiency of the apartments.

- **Housing Rehabilitation Program Documentation**

Summary

Groton provided a copy of its 2007 Guidelines and Procedures for its Housing Rehabilitation Program and associated 1980 Rental Housing Code. Groton provides financial assistance and technical support for qualifying one to four unit homes with low-to-moderate income residents. The program is an excellent resource for investor/ owners to upgrade substandard one to four family affordable housing properties.

Discussion

The Town of Groton Housing Rehabilitation Guidelines – Groton's housing rehabilitation guidelines reference the Rental Housing Code, Building Code, Property Maintenance Code and HUD Section 8 Housing Quality Standards for its rehabilitation standards. The primary Program objective, as approved by Town Council, is to bring qualifying one-to-four family structures up to code, make the properties lead and asbestos safe, and provide handicapped accessibility. A secondary objective is to "increase energy efficiency and prevent incipient code violations."

Most applicants request weatherization assistance through CL&P before they apply for housing assistance from the Town. The utility-managed weatherization programs and the Town routinely include insulation, air sealing, and new mechanical systems to help maintain long-term housing affordability. In addition, the Town hires a full-time rehabilitation contractor to manage the projects. Another important resource is the Town's building inspector who has 30 years of experience.

Recommendations

Groton's rehabilitation program provides solid resources for energy upgrades in the housing stock that it serves. As time permits and if additional resources are identified, the Town could investigate higher performance energy standards for rehabilitation projects.

It's probably best to leave Rental Housing Code document as is (relatively minimalist and open for interpretation by the health inspector). The DHW temperature requirement (220.12) could include a maximum temperature as well to improve energy efficiency and avoid potential scalding.

Construction Standards

- **<u>Project Specifications</u>**

Summary

Peregrine received some samples of project specifications for recent and proposed construction projects (the Police Station addition and the Town Hall Annex replacement boiler). We believe that the following policies should be put in place to ensure that any and all such specifications result in projects that are consistent with the Town's energy goals.

Discussion

Project specifications are the requirements documents that create the standards that the Town sets for purchasing decisions and for construction activities. These specifications are instructions to the equipment supplier or to prospective contractors. They should, where a proposed project will have an impact on energy consumption, include performance specifications that lay out the Town's expectations for energy use attributable to the thermal characteristics of an addition or new buildings, the efficiency and functionality of any HVAC equipment that services a Town building, and the interconnection of such equipment to a building's energy management system.

Further, Project Specifications should explicitly state the Town's expectations and the requirements on the Contractor for equipment and system commissioning as a condition for acceptance by the Town of the completed project and making final payment to the Contractor. Finally, the Specifications should dictate training to be provided to Town staff on proper operation and maintenance of equipment and what written documentation is to be provided to the Town.

Peregrine Recommendations

The Department of Public Works has told Peregrine that all of its projects adhere to the most current building codes or state statutes for energy efficiency. Nevertheless, we recommend the following approach be taken for all building construction projects and replacement of energy consuming or conversion equipment to help ensure that these investments are consistent with established Town goals to reduce energy use.

The Town should institutionalize the review of projects with an eye toward the energy implications of the designs proposed. Project documentation should establish expectations for

how the project as proposed will contribute to or hinder achievement of the Town's energy goals. Specifically, documentation should address the proposed energy efficiency features for mechanical systems, lighting, controls, and building envelope, subject to approvals by designated Town staff.

The Town should not rely on internal staff, building architects, or engineer generalists alone to develop energy specifications and review designs. Qualified energy specialists should be engaged to complete design reviews on proposed specifications and design submittals prior to authorizations to proceed with construction. These reviews should begin at conceptual project design and continue through the design process to ensure that design details remain consistent with these energy goals.

Formal commissioning of projects should always be required at the end of construction. The Town should engage an independent commissioning agent to observe the Contractor's formal commissioning and confirm that it has been completed consistent with performance requirements in the Project Specifications. Payments should be withheld until the Town is fully satisfied that equipment will function as designed during the full range of operating conditions that will be encountered.

As noted above, Town staff should be fully trained to operate and maintain equipment to protect warranties and ensure long-term performance and persistence of energy savings.

Position Papers

- **Groton Task Force on Climate Change and Sustainable Community (recording of 7.5 hours of hearings)**

Summary

Groton has many climate change experts and knowledgeable citizens living in or working in the community. The array of speakers that the Task Force assembled included professors and staff from several local colleges, Town officials, State officials, and long time residents. Most, though not all, of the speakers believe that climate change is real and that people are the primary cause for the change.

While there was general consensus by the speakers that some actions should be taken, at least one speaker acknowledged that the political process is slow and that change will only occur through economic disruption or weather-related catastrophe.

Discussion

Because Groton is located directly on the Atlantic coast, the focus of the presentations was on both mitigation to reduce future climate change impacts and adaptation to climate change impacts.

Several speakers confirmed that the coastline is changing and that sand and marshes will need room to migrate upward and inward as the water level continues to rise. In addition, the projected economic impact of major storm events like the 1938 "Long Island Express" is going

to be very expensive. Local and regional resources like UConn - Avery Point will be able to help Groton continue to monitor and assess trends on shoreline conditions.

Several speakers highlighted examples of "best practices" building construction for buildings located in Groton. The Eames House built in 1976 is one of the few remaining examples of 1970's era active solar house design. The Library, two new schools, and a recent Fire Station renovation were mentioned as examples of thoughtful, sustainable construction.

Michael Murphy, Director of Planning and Development, and Rick Norris, Program/Project Manager, from OPDS shared their thoughts on significant opportunities for effective long term planning initiatives tempered by the reality of the Department's recent funding cuts and staff layoffs. Wes Greenleaf described successful energy efficiency measures that were installed as part of the Fitch High School and two elementary school construction projects in 2008. That said, the schools have a major challenge ahead to deal with energy-related upgrades for the remaining schools that were constructed in the 1950's and 1960's.

Peregrine Recommendations

Town Council should continue to identify opportunities for the Town to act on the recommendations that further energy efficiency and conservation, and enhance climate preparedness.

- **<u>Greenhouse Gas Emissions Inventory final report (2010)</u>**

Summary

The Greenhouse Gas report represents a good first step effort to quantify the potential scale of greenhouse gas impacts from buildings, transportation, and other CO2-producing activities in Groton.

Discussion

As the authors acknowledge, accurate information for the report was difficult to collect.

Peregrine Recommendations

The Town should review and true up the greenhouse gas emission assumptions in the report as it collects more accurate energy information and continues to address climate preparedness priorities. For example, the residential,, commercial, and industrial sector calculations are based on New England and Connecticut averages that may not be accurate for Groton.

Another detail Groton should revisit is the energy use and total floor space assumptions used for calculating the building Energy Star ratings listed in Table 1. The scores for the school buildings are some of the highest Peregrine has ever seen, particularly given the level of energy-related investments proposed in the 5-year Capital Improvement Program. Peregrine concurs with the Board of Education's recommendation in the report to update the utility data before submitting a formal Energy Star certification request.

The report's "Five Milestones" process recommendations on page 5 are sound and can serve as a template for Groton's energy-related efforts. The Town has completed Milestone number one (collect baseline information) by finishing this report. The Town is working on Milestones

number two (set a target) and three (develop an action plan). The report recommends a 13% emissions reduction by 2020 target consistent with the goals set by the State of Connecticut. Town Council recently set a 10% energy reduction target for Groton's Town and School facilities.

APPENDIX B

Energy Efficiency Opportunities For Groton Municipal Buildings

September 2012

1.0 Introduction and Executive Summary

Peregrine Energy Group, Inc. ("Peregrine") has prepared this Energy Opportunities Assessment and Roadmap to Energy Efficiency for the Town of Groton's municipal buildings. Peregrine has completed this Energy Opportunity Assessment to guide the Town in developing and implementing an energy reduction strategy for their buildings and to inform a larger Town-wide energy planning initiative.

This assessment includes specific recommendations and next steps to reduce energy use and increase energy efficiency. We include summary information on the building with recommendations that can provide a starting point for securing bids from installation contractors for suggested projects. Buildings we were asked to include in this assessment are:

- Highway Garage, 108 Groton Long Point Road
- Police Station, 68 Groton Long Point Road
- Poquonnock Bridge Fire Substation, 373 Long Hill Road
- Groton Public Library, 52 Newton Road
- Town Hall, 45 Fort Hill Road
- Town Hall Annex, 134 Groton Long Point Road
- Waste Water Treatment Facility, 175 Gary Court
- Human Services Building, 2 Fort Hill Road
- Senior Center, 102 Newtown Road

As part of Peregrine Energy Group's engagement with the Town of Groton to develop an Energy Action Plan using EECBG funding, Peregrine staff toured municipal buildings in June 2012. Our objective during these site visits was to examine buildings and equipment and review operational procedures and issues with municipal facilities staff with the goal of identifying opportunities and strategies to improve energy efficiency in ongoing operations, reduce energy-related costs, and to identify and plan for needed energy infrastructure-related capital projects.

Our goal was to visit each of the buildings and collect information about their construction, their equipment and systems, how and when the buildings are used, and current energy-related practices. We also wanted to learn about operational issues and any comfort problems in each building. Finally, we hoped to clarify future plans for each of the buildings, including potential future changes in occupancy and use and planned or proposed building improvements or renovations. This report includes building-specific findings and recommendations for improvements to buildings and equipment, as well as their operation and maintenance that can reduce energy use and expense. Where appropriate and warranted, our recommendations include capital improvement projects.

Findings and Recommendations

Peregrine's Opportunity Assessment focused on:

- Historical energy use
- Operating practices
- Lighting technology and requirements
- HVAC equipment and controls

- Building envelope materials and condition
- Future building use and renovation plans

Our recommendations for efficiency improvements focus on lighting, controls, longer-term mechanical updates and tightening up doors and other building envelope features. The biggest and most immediate opportunities include updating older T12 lighting and addressing HID tunnel lighting at the wastewater treatment plant, instituting a more aggressive night setback policy, and recommissioning building controls to reduce the amount of reheat required in summer operations. We estimate that all energy reduction improvements and strategies we identify in this report will generate over $130,000 in utility cost savings annually. This represents about 19 percent of the Town's annual utility budget for this group of buildings (not including wastewater treatment plant).

Implementing all these recommendations will require an investment of approximately $2.2 million, less potential incentives from CL&P and Groton Utilities, which we hope will be significant. (While some CL&P incentives are prescriptive, others are "custom" and will require submission of design details before an incentive amount is calculated.) A selective approach, implementing priority projects or those with strong financial return is recommended which will result in a lower project budget.

We recommend prioritizing each identified opportunity based on financial return, available CIP budget, and short and long-term needs of the building. Peregrine has provided results of our analysis in a spreadsheet tool format, which provides immediate results for prioritization planning.

In addition to the measures we refer to in this report, Groton may want to consider installing renewable energy technologies such as rooftop photovoltaic solar panels. Such renewable energy projects are not included in this report.

Table 1 – Energy Reduction Program Potential Results

Building	Approximate Implementation Cost	Utility Incentive Available	Potential Utility Savings					Annual Cost Avoidance	Simple Payback Yr
			Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr	Propane Gal/yr		
Highway Garage	$207,750	$3,000	11	25,700	-	1,050	100	$6,630	30.9
Human Services	$434,300	$0	7	22,000	-	910	-	$5,550	78.3
Police Station	$102,500	$8,000	10	194,500	-	210	-	$30,060	3.1
Poquonock Bridge Fire House	$68,075	$3,000	4	22,000	-	-	150	$3,600	18.1
Public Library	$100,000	$6,000	18	98,000	(7,000)	5,779	-	$20,900	4.5
Senior Center	$66,000	$0	3	46,000	3,800	-	-	$11,330	5.8
Town Hall	$281,250	$9,000	8	28,500	-	1,680	-	$8,400	32.4
Town Hall Annex	$54,750	$3,000	3	37,600	-	590	-	$7,150	7.2
Wastewater Treatment	$933,000	$19,000	17	181,000	(10,200)	8,620	-	$36,730	24.9
Total	***$2,247,625***	***$51,000***	***81***	***655,300***	***(13,400)***	***18,839***	***250***	***$130,350***	***16.9***

General Observations

We commend the Town for efficiency work that has been accomplished in many of their municipal properties. There have been widespread investments in new lighting, variable speed drives, controls and other standard energy savings equipment. All buildings have some of this equipment, but there remain opportunities where projects can be implemented to save energy. The significant opportunities we found to make additional improvements generally fall into four categories:

(1) **Lighting.** Fluorescent lighting is predominantly older generation T8s. We suggest considering a Town-wide update to super T8s with strategically placed occupancy sensors. There are

additional lighting opportunities in some of the buildings to update incandescent, halogen and HID lights to LED or other technologies. Exterior metal halide lighting could be updated as well.

(2) **Controls.** Most municipal buildings can tighten up operations by recommissioning existing controls and/or adding additional control capability. For example, we recommend deeper unoccupied space temperature resets than is the current practice (55°F heating and 85°F summer reset is recommended). We also recommend review of space utilization and scheduling, perhaps adding zones for additional control or adding occupancy-based control for those areas that have intermittent use.

(3) **Boilers.** There are a number of older oil-fired boilers in use in Groton's municipal buildings, many of which are steam systems. Savings will result from replacing older boilers with new high efficiency units. It also makes sense to consider converting steam heating systems to hot water heating, which has better operating efficiency and requires less maintenance. Further, connecting to natural gas service where possible offers a significant cost advantage over oil and reduces emissions.

(4) **Exterior Doors.** With few exceptions, the outside doors at Groton's buildings need attention to weather stripping and alignment to ensure tight closure and protection from draft. This is an ongoing challenge at most buildings as door seals wear out quickly and require periodic replacement.

Table 2 on the next page provides an overview of possible measures at individual buildings.

Table 2 – Summary of Recommended Measures at Each Building

Building	LIGHTING							CONTROLS							HVAC					ENVELOPE				MISC		
	1 Update T12 lamps to T8	2 Replace Incandescent / Halogen Lighting	3 Update Fluorescent Lighting to Super T8s	4 Replace HID Fixtures with T5/T8	5 Update Exterior Lighting to LED	6 Install Occupancy Sensor Control	7 Daylighting Control	8 Lower Setpoint in Garage/Storage Areas	9 Schedule HVAC System / Setbacks	10 Add DHW Timer	11 Add Pump VFDs	12 Add Occupancy Based HVAC Control	13 Controls Recommissioning	14 Add Central Control System	15 Replace HVAC Units	16 Convert Electric Heating	17 Install Natural Gas Service	18 Replace Boiler Plant	19 Convert Steam to Hot Water Heating	20 Attention to Exterior Door Seals	21 Replace Overhead Door	22 Airseal Details / Attic Insulation	23 Replace Windows	24 Vending Machine Controller	25 Replace CRT Computer Monitors	26 Replace Refrigerator
Highway Garage			X	X	X			X		X						X		X	X	X		X				
Human Services	X					X			X											X		X	X			X
Police Station			X		X	X		X	X			X	X							X						
Poquonock Bridge Fire Dept	X	X	X		X	X			X						X					X		X				X
Public Library	X				X	X							X				X								X	
Senior Center			X		X								X													
Town Hall	X	X	X			X	X			X				X				X	X					X		X
Town Hall Annex			X			X				X		X	X							X				X		X
Wastewater Treatment	X		X	X	X	X					X				X	X		X	X	X	X					

Suggested Next Steps

We suggest that the Town move forward aggressively with specific projects that are of interest or provide value. All projects identified in this report require further development to obtain firm pricing.

Immediate next steps include:

- Commit to pursuing selected priority projects and establish an implementation schedule.
- Develop request for proposal documents and/or contact preferred lighting, mechanical and commissioning contractor(s). CL&P and CNG may require use of specific vendors for work supported by their incentive programs.
- Secure quotes for projects and select contractor(s).

2.0 Utility Use Summary

All Town facilities receive electricity from Connecticut Light and Power (CL&P) or Groton Utilities under various rates. Electricity is generally supplied to buildings in three phases at 208 volts (480 volts, three-phase at the wastewater treatment plant). Electricity cost an average $0.152 per kWh during fiscal year 2011 for the data set we have, which does not include all buildings in this study. This all-in delivered cost includes demand, taxes and other charges. Peregrine uses $0.152/kWh in this report's analysis to convert projected units of electrical savings to cost savings.

Seven municipal properties currently have exclusively oil-fired heating equipment (Highway Garage, Human Services, Police Station, Public Library, Town Hall and Town Hall Annex). Oil is delivered on an as-needed basis to local storage tanks at the individual buildings. The average cost of oil during fiscal year 2011 was $2.42/gallon, which is the same value used in this report to convert units of projected fuel savings to cost savings.

Two additional buildings use liquefied propane (Vehicle Storage Garage and Poquonnock Bridge Fire Substation). Propane is delivered on an as-needed basis to local pressure vessels at the individual buildings. The average cost of LP during fiscal year 2011 is was $1.78/gallon).

Only one of the Town's properties, the Senior Center, currently has natural gas-fired heating equipment. Gas is supplied and delivered by Yankee Gas. We are assuming gas costs on average $1.14/Therm based on billing data for another facility in the area. We are told that there is interest in expanding the availability of natural gas in Groton.

The table summarizes fiscal year 2011 utility use data and calculates the Energy Use Index (EUI). The EUI uses total energy input in Btu's divided by building occupied square footage for each facility as a comparative performance metric. Information on buildings that were not included in our tours has been included in the table for comparative purposes. Filling in the missing energy use data will allow Peregrine to calculate energy use per square foot for all buildings below.

Table 2 – Utility Use and EUI Summary

Bldg	Sq. Ft.	Elec. kWh	Gas Therm	Oil Gal	Propane Gal	Cost	EUI
Highway Garage (Including Vehicle Storage Garage)	21,300	158,100	-	6,800	6,400	$41,800	97.1
Human Services	9,500	61,300	-	2,800	-	$16,400	62.8
Police Station	40,700	857,700	-	14,800	-	$156,200	122.3
Poquonnock Bridge Fire House	NA	NA	-	-	NA	NA	NA
Public Library	37,400	675,800	-	5,800	-	$107,300	83.1
Senior Center	NA	388,400	18,200	-	-	$83,200	NA
Town Hall	19,900	307,100	-	6,100	-	$59,500	95.1
Town Hall Annex	19,600	179,000	-	7,700	-	$49,300	85.6
Wastewater Treatment	NA	NA	-	NA	-	NA	NA

3.0 Facility Details and Observations

3.1 Highway Department Garage

The Town of Groton operates a DPW highway garage at 108 Groton Long Point Road. The facility consists of main maintenance shop, plus separate truck garage building, sand/salt shed and carpenters shed.

The main 11,500 square foot main building was constructed in the 1960's (or 1950's). There are five heated vehicle maintenance bays minimum and seven maximum with a total of five overhead bay doors. The building was not designed to accommodate vehicles of today. For example, numerous times during the heating season the bay doors must be left open to service certain large vehicles, like fire engines that don't fit entirely into the complex. The main building has parts storage area, offices, break room, and sign shop. The separate 9,800 square foot truck garage was built in the late 1980's and houses all the snowplow vehicles.

This facility is generally in use from 7:00 a.m. to 3:30 p.m. weekdays. During snow events, the facility is often open and in use around the clock.

<u>Building Envelope</u>

The main building is constructed of masonry block on slab with steel framed flat roof. A "portable" office/sign shop was added behind the building that has become permanent. There is probably rigid insulation in the built up roof system, but no insulation in walls. The few windows are double pane casements that were replaced approximately 20 years ago. Garage doors are older, but are in good condition and have as effective weather seals as is possible. Exterior man-doors are generally lacking weather strips.

The truck garage is a typical steel framed and sided butler building with internal batt insulation. There are twenty-one overhead garage doors that appear to close tightly with perimeter weather seals. One of the metal side doors is heavily corroded on the bottom and has a large gap to the outside.

The sand and salt shed is built of wood. This building is not heated, and there is no insulation or other envelope features of importance.

<u>HVAC</u>

Overhead steam unit heaters heat the main building shops. The balance of the building has radiators (portable building employs electric baseboard). There are several ductless split units that provide air conditioning in the break room, and offices. The sign shop has its own HVAC system. Temperature control is via local thermostat. Since the system is essentially single zone, the level of control for individual office and other spaces is very poor. Propane fired unit heaters heat the separate snowplow garage, which is kept at about 65F.

<u>Boiler Plant</u>

A single Weil McLain sectional boiler rated at 1,084 MBH supplies low-pressure steam. The oil-fired unit has a Carlin burner. The boiler has only basic steam pressure based cycling control and is otherwise manually operated.

Domestic Water

Domestic water fixtures are not low-flow type. A small electric tank unit supplies domestic hot water.

Lighting

Fluorescent lighting fixtures in the main building and truck storage building were refurbished with new T8 lamps and ballast and have reflectors. This work was completed within the last two months. A lighting project was also completed for the Refueling Station canopy. The total project was to include converting shop metal halide lighting, but this scope has not yet been completed due to concern that lighting level would not be adequate. There are motion sensors in use in the break room, lockers, etc. Exterior lighting is metal halide and is controlled by photocell and timer.

Kitchen

The break room has a refrigerator, soda machine and ice machine.

Miscellaneous

There is a 7.5 hp reciprocating shop compressor that runs regularly during workdays.

Energy Efficiency Opportunities

Most DPW type garage facilities have higher than expected EUI's ranging from 75-100 kBtu/SF, and Groton's is no exception at 97 kBtu/SF. Ideas for efficiency improvement are summarized in the table on the next page. See Section 4 for descriptions of the ECMs.

Table 3.1-1 - Summary of Recommended ECMs for the Highway Garage

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings					Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr	Propane Gal/yr					
3 Update Fluorescent Lighting to Super T8s	LIGHTING	$7,000	$1,000	1	4,000	-	(50)	-	$500				12.0
4 Replace H D Fixtures with T5/T8	LIGHTING	$6,000	$2,000	2	5,000	-	(60)	-	$600			X	6.7
5 Update Exterior Lighting to LED	LIGHTING	$8,000	$0	-	10,000	-	-	-	$1,500	X			5.3
8 Lower Setpoint in Garage/Storage Areas	CONTROLS	$0	$0	-	-	-	-	400	$700				-
10 Add DHW Timer	CONTROLS	$250	$0	-	700	-	-	-	$110				2.3
16 Convert Electric Heating	HVAC	$5,000	$0	8	6,000	-	-	(300)	$380				13.2
18 Replace Boiler Plant	HVAC	$30,000	$0	-	-	-	120	-	$300	X	X		100.0
19 Convert Steam to Hot Water Heating	HVAC	$150,000	$0	-	-	-	900	-	$2,200	X	X	X	68.2
20 Attention to Exterior Door Seals	ENVELOPE	$500	$0	-	-	-	40	-	$100			X	5.0
22 Airseal Details / Attic Insulation	ENVELOPE	$1,000	$0	-	-	-	100	-	$200				5.0
TOTAL		***$207,750***	***$3,000***	***11***	***25,700***	***-***	***1,050***	***100***	***$6,590***				***31.1***

3.2 Human Services

The Town operates a human services office building a 2 Fort Hill Road. The former school and then library building dates to 1913 and is 9,500 square feet on a single level with basement and attic space. The building includes offices, committee room and public restrooms and is open during normal business hours. Donated food is kept in the basement.

Building Envelope

Construction is brick with wood framed pitched roof. Insulation material and thickness, and if there is any, is unknown for the building's walls. There is fiberglass insulation under attic floorboards, although there appears to be voids and a lack of vapor barrier between the occupied floor and attic. Windows are older single pane units, several of which were observed to not be closing tightly. Entrance doors do not have effective weather seals, and one of the doors latching mechanism wasn't working properly (but has since been repaired).

HVAC

The building is hydronically heated by perimeter radiation. A single Carrier rooftop unit provides air conditioning. The unit has 5 hp supply fan and is rated at approximately 12 tons.

Boiler Plant

An oil-fired Weil McLain unit rated at 400 MBH supplies hot water. There are two fractional horsepower hot water circulation pumps.

Controls

This facility's HVAC system is managed by an Alerton direct digital control (DDC) system. The controls are tied to a central front end at the highway garage building (since moved to the Town Hall Annex). The system provides operating control of the boiler and rooftop unit.

Energy management strategies in place include equipment scheduling and night setback to 64F and 85F heating/cooling respectively.

Domestic Water

Toilet fixtures are older standard flow units. Domestic hot water is supplied by a 20 gallon Hubbell unit with two 1 kW heating elements.

Lighting

This facility is predominantly lit with T12 fluorescent as well as CFL systems. There are no motion sensors. This building is a good candidate for a lighting retrofit.

Other

There are four refrigerators and freezers in the basement. One of the refrigerators was operating with nothing in it when we visited. Another freezer is dedicated to pet food.

Energy Efficiency Opportunities

The EUI for this facility is 63 kBtu/SF. This is quite moderate for this age and type of building. We identified several areas for efficiency improvement that are summarized in the table on the next page. See Section 4 for descriptions of the ECM.

Table 3.2-1 - Summary of Recommended ECMs for the Human Services Building

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings					Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr	Propane Gal/yr					
1 Update T12 lamps to T8	LIGHTING	$12,000	$0	5	14,000	-	(200)	-	$1,600	X			7 5
6 Install Occupancy Sensor Control	LIGHTING	$3,500	$0	1	3,000	-	(40)	-	$400				8 8
9 Schedule HVAC System / Setbacks	CONTROLS	$0	$0	-	-	-	400	-	$1,000				-
20 Attention to Exterior Door Seals	ENVELOPE	$1,500	$0	-	-	-	50	-	$120			X	12.5
22 Airseal Details / Attic Insulation	ENVELOPE	$15,000	$0	-	-	-	200	-	$500				30.0
23 Replace Windows	ENVELOPE	$400,000	$0	-	-	-	200	-	$500	X	X	X	800.0
26 Replace Refrigerator	MISC	$2,300	$0	1	5,000	-		-	$800	X	X		2 9
TOTAL		***$434,300***	***$0***	**7**	***22,000***	**-**	***610***	**-**	***$4,920***				***88.3***

3.3 Police Station

The Groton police station is located 68 Groton Long Point Road and totals 40,700 square feet. The two-level facility was built in 1977 and was expanded in roughly 2000. The Town would like to update the Station's booking area and detention handling areas, but funds for this project have not yet been approved. The building includes 24/7 dispatch, offices, patrol room, meeting rooms, lockers, records area, sallyport, etc. A small area of the building is rented to a cell phone company in conjunction with cell tower on the premises.

Building Envelope

The original facility is block construction with brick façade and flat built up roof sections construction with pitched roof section with rigid insulation. Insulation materials and effectiveness in the walls is unknown and expected to be minimal in the original structures. We expect that the newer part of the building is insulated. Windows throughout the facility have thermal panes and are in good condition. Exterior doors appear to close well and most, but not all, have effective weather seals.

HVAC

This facility is conditioned by seven air handlers, each with hot water and chilled water coil. Two of the units are variable air volume (VAV) serving terminal damper boxes with hydronic reheat. Other areas of the building use perimeter radiation and cabinet heaters. The sallyport and garage areas have hydronic ceiling unit heaters. There are also at least two split units conditioning the server and transmitter rooms. Known information on the AHUs is summarized in the table below.

Table 3.3-1 – Police Station Air Handler Units

Unit	Serves	Type	Motor hp	VFD?
AHU-1	Firing Range	Single zone	0.33	No
AHU-2	Men's Locker	Single zone	5	No
AHU-3	Administration	VAV/Reheat	25	Yes
AHU-5	Cells (heating only)	Single zone	5	No
AHU-6	Dispatch	Single zone	10	No
AHU-7	Admin (new wing)	VAV/Reheat	NA	Yes
AHU-8	Patrol Room	Single zone	2	No

Central Boiler Plant

There is a central hot water boiler plant serving perimeter radiation and reheat coils throughout the building. The plant consists of two oil-fired Burnham sectional units. Each has a 1½ hp Powerflame burner and 1½ hp inline primary pump. Heating hot water is circulated through the building by one of two 15 hp variable speed centrifugal pumps. The building's energy management system resets the hot water supply water temperature based on outside conditions.

Central Chiller Plant

The Station has a central chilled water plant consisting of a water-cooled Trane Centravac centrifugal unit. The R22 unit is rated at approximately 150 tons and is controlled by inlet guide vane. Chilled water is circulated by one of two 10 hp centrifugal variable speed pumps (320 gpm capacity each). Condenser water is circulated to an outdoor cooling tower by one of two additional 10 hp constant speed pumps (385 gpm capacity each).

Controls

All HVAC systems in the Police Station are controlled by an Alerton direct digital control (DDC) system. Functions include basic temperature and outside air (economizer) control, chiller plant management, and boiler control as mentioned above. The system can be accessed by PC in the building and also has dial-up to a front end in the highway garage (since moved to the Town Hall Annex). All systems run 24/7 at constant setpoint. The Alerton system controls all the VAV boxes and thermostats s in the building; there are no pneumatic devices in use. We noticed that some air handlers had their economizer function overridden and locked out, which should be investigated; having functional economizers is an effective way to reduce air conditioning energy use.

Lighting

The predominant lighting system at this facility is T8 fluorescent lamps with electronic ballasts. 2x2 biax fixtures are used in some hallways. There are also some compact fluorescent fixtures. There is opportunity to use motion sensors in meetings rooms, hallways and other intermittently used parts of the building. There are about 27 high-pressure sodium pole lights in the parking and perimeter areas of the building.

Domestic Water

This facility has mostly low flow type toilets and urinals. Domestic hot water is generated by a new Bock tank unit (91 gallon with 415 MBH oil burner).

Energy Efficiency Opportunities

This facility has a EUI of 122 kBtu/SF, which is somewhat high for this type of facility and operation. We identified several areas that could contribute to attractive savings. These are summarized in the table on the next page.

Table 3.3-2 - Summary of Recommended ECMs for the Police Station

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings					Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr	Propane Gal/yr					
3 Update Fluorescent Lighting to Super T8s	LIGHTING	$23,000	$3,000	3	27,000	-	(300)	-	$3,400				5 9
5 Update Exterior Lighting to LED	LIGHTING	$30,000	$0	-	30,000	-	-	-	$4,600	X			6 5
6 Install Occupancy Sensor Control	LIGHTING	$20,000	$4,000	4	37,000	-	(500)	-	$4,400				3 6
8 Lower Setpoint in Garage/Storage Areas	CONTROLS	$0	$0	-	-	-	150	-	$400				-
9 Schedule HVAC System / Setbacks	CONTROLS	$0	$0	-	70,000	-	500	-	$11,900				-
12 Add Occupancy Based HVAC Control	CONTROLS	$7,500	$1,000	1	10,000	-	100	-	$1,800				3 6
13 Controls Recommissioning	CONTROLS	$20,000	$0	2	20,000	-	200	-	$3,500	X		X	5.7
20 Attention to Exterior Door Seals	ENVELOPE	$2,000	$0	-	500	-	60	-	$200			X	10.0
TOTAL		***$102,500***	***$8,000***	***10***	***194,500***	***-***	***210***	***-***	***$30,200***				***3.1***

3.4 Poquonnock Bridge Fire Substation

The Poquonnock Bridge facility at 373 Long Hill Road is one of eight fire stations in seven separate districts in Groton. While not a "municipal" building per se, this facility was included in our study by the Town because it is one of many fire stations in the Town. This station dates to 1990 and is two stories with a three-door apparatus bay. Living quarters, including kitchen and dining room / lounge, are located on the second floor. There are five bunkrooms and a locker/shower room on the second floor as well, with a separate office area. The facility is on standby 24/7 with a crew of up to seven career fire fighters on duty per shift.

Building Envelope

The station is brick and includes a hose tower. Exhaust fan louvers in the tower are loose and may be a source of exfiltration. Insulation materials and effectiveness in the wall and roof are not known. Windows in the station are newer double pane casement type with thermal glazing in aluminum frames. The bay doors are weatherized and have effective seals. However, the entrance door does not have weather stripping.

HVAC

The bay has ceiling hung hydronic unit heaters and is kept at 58-62F during the winter. Upstairs areas have hydronic heating radiation zones. There are two older Carrier rooftop A/C units serving offices and living quarters as well as three smaller split units.

Boiler Plant

Heating hot water is generated by two propane-fired Peerless high efficiency boilers each rated at 199 MBH. There are approximately ½ hp hot water distribution pumps. Not all the hot water piping is insulated in the mechanical area.

Lighting

The bay of this station has eight foot T12 lighting. The rest of the facility is a mix of T8, T12, CFL and incandescent lighting. Exterior lights are HID. There are timers on bathrooms lights to automatically shut them down. This station is a good candidate for a comprehensive lighting update, including application of motion sensors in the lounge, offices, and any other intermittently used area of the building where lights tend to be left on for extended periods.

Domestic Water

Toilets and other domestic water fixtures are older standard (i.e. no water conservation) type. A 75-gallon tank unit supplies domestic hot water with 76 MBH propane burner.

Kitchen

This station's kitchen has a propane-fired range and two older refrigerators.

Miscellaneous

This station has commercial laundering equipment for fire gear as well as separate washer and drier for personal clothing. There is also a 3 hp general-purpose air compressor, which sees little use.

Energy Efficiency Opportunities

Utility use information for this station was not made available to us. We have identified many areas for efficiency improvement that are summarized in the table on the next page and described in Section 4.

Table 3.4-1 - Summary of Recommended ECMs for Poquonnock Bridge Fire Substation

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings					Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr	Propane Gal/yr					
1 Update T12 lamps to T8	LIGHTING	$3,000	$1,000	1	2,000	-	-	(20)	$300	X	X		6.7
2 Replace ncandescent / Halogen Lighting	LIGHTING	$75	$0	1	5,000	-	-	(60)	$700	X			0.1
3 Update Fluorescent Lighting to Super T8s	LIGHTING	$1,000	$0	-	1,000	-	-	(10)	$100				10.0
5 Update Exterior Lighting to LED	LIGHTING	$6,000	$0	-	6,000	-	-	-	$900				6.7
6 Install Occupancy Sensor Control	LIGHTING	$5,000	$1,000	1	5,000	-	-	(60)	$700				5.7
9 Schedule HVAC System / Setbacks	CONTROLS	$0	$0	-	-	-	-	100	$200				-
15 Replace HVAC Units	HVAC	$50,000	$1,000	1	1,000	-	-	-	$150	X	X		326.7
20 Attention to Exterior Door Seals	ENVELOPE	$1,000	$0	-	-	-	-	100	$200			X	5.0
22 Airseal Details / Attic Insulation	ENVELOPE	$500	$0	-	-	-	-	100	$200				2.5
26 Replace Refrigerator	MISC	$1,500	$0	-	2,000	-	-		$300				5.0
TOTAL		***$68,075***	***$3,000***	***4***	***22,000***	***-***	***-***	***150***	***$3,750***				***17.4***

3.5 Public Library

The Town's library is located at 52 Newtown Road and totals 37,400 square feet. The library was first opened in 1977 and was expanded and renovated in the mid 1990's. The single level facility includes stacks, reading areas, children and young adult section, meeting rooms, circulation desk, public bathrooms, and extensive offices.

The library's operating schedule is Monday through Thursday from 9 a.m. to 9 p.m., Fridays 9 a.m. to 5:30 p.m., Saturday 9 a.m. to 5 p.m., and Sunday's 1 p.m. to 5 p.m. The library is not open on Sundays during the summer. It also is very occasionally used as a polling place.

Building Envelope

Construction is brick over block on slab with steel framed flat roof. In all likelihood, there is rigid insulation in the built up roof system. Status of wall and slab insulation is unknown, but we would not be surprised to learn there is no insulation there as this, unfortunately, was common practice in 1970's building construction.

Windows are newer double pane casement type that appear to have been replaced during the latest renovation. Main entrance doors are automatic slider type with inner vestibule. As is often a problem with such pairs of sliding doors, both the inner and outer doors remain open at the same time, reducing the effectiveness of the intended airlock. All other exterior doors are newer and appear to close tightly.

HVAC

The building is conditioned by water-source heat pumps, including twenty-one above ceiling units and four rooftop units. The rooftop units serve the main entrance and circulation desk area (10 hp), open stack area (7.5 hp), quiet study area (5 hp) and AV Studio (2 hp). Condenser water is circulated throughout the building by one of two 7.5 hp Taco centrifugal pumps (one pump is standby). Heat is rejected from the loop via Evapco evaporative cooler located on a pad outside the mechanical room. The evaporative cooler has an approximately 7.5 hp fan and 1 hp spray pump.

Boiler Plant

A Burnham oil-fired sectional boiler is used to heat the condenser water loop in winter operations. The boiler is rated at 1,064 MBH and has a ½ hp Carlin burner. The condenser loop is maintained at 72F during the winter.

Controls

This facility's HVAC system is managed by an older Alerton direct digital control (DDC) system. The DDC system dates to the 1990's renovation and includes dial-up to a front end located in the highway garage (since relocated to the Town Hall Annex). The system provides operating control of the boiler, rooftop units, condenser water system and heat pumps. Energy management strategies in place include equipment scheduling and maintaining unoccupied setpoints (60F winter and 85F summer). The system has an optimum start program that automatically starts equipment at the right time so that occupied space temperature setpoints are achieved at the scheduled occupied time. Currently, these systems are set to achieve occupied set points at 6 a.m., but the building doesn't open to the public until 9 a.m.

Domestic Water

Toilet fixtures are newer low-flow models.

Lighting

This facility is predominantly lighted with T12 fluorescent and CFL systems. There are no motion controls in use at this building. Exterior pole lights are metal halide. Though there has already been lighting upgrades installed in the stacks, this library is a prime candidate for a lighting update.

Energy Efficiency Opportunities

The EUI at the library is 83 kBtu/SF. This is a typical value for a library, but a combination of relatively efficient heat pumps and the older generation lighting is not typical. We identified several potential improvements, summarized in the table on the next page and described in Section 4.

Table 3.5-1 - Summary of Recommended ECMs for the Public Library

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings					Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr	Propane Gal/yr					
1 Update T12 lamps to T8	LIGHTING	$30,000	$0	12	35,000	-	(200)	-	$4,800	X			6 3
5 Update Exterior Lighting to LED	LIGHTING	$20,000	$0	-	20,000	-	-	-	$3,000	X			6.7
6 Install Occupancy Sensor Control	LIGHTING	$15,000	$6,000	6	18,000	-	(100)	-	$2,500				3 6
13 Controls Recommissioning	CONTROLS	$20,000	$0		20,000	-	-	-	$3,000				6.7
17 Install Natural Gas Service	HVAC	$10,000	$0	-	-	(7,000)	6,079	-	$7,500				1 3
25 Replace CRT Computer Monitors	MISC	$5,000	$0	-	5,000	-	-	-	$800				6 3
TOTAL		***$100,000***	***$6,000***	***18***	***98,000***	***(7,000)***	***5,779***	***-***	***$21,600***				***4.4***

3.6 Senior Center

The Town's Senior Center is located adjacent to the Public Library at 102 Newtown Road. We do not have building square footage information on this building, which was opened within the last three years. The single level facility includes a reception area, multi-function rooms, large dining/event room in the core of the building with kitchen, computer lab, fitness rooms, store, salon and offices.

The Senior Center's general hours are weekday 8 a.m. to 4:30 p.m., and it remains open for frequent events in the evening and on weekends.

Building Envelope

Construction is brick over block on slab with steel framed flat roof. We expect this building has code-complying levels of wall and roof insulation, or better. Windows are inoperable thermal panes and exterior door were observed to close tightly with effective weather seals. This building is believed to a well performing thermal envelope.

HVAC

Four four-pipe VAV air handlers condition the building. Each air handler has supply and return fan VFDs (2 to 10 hp) and freeze protection coil circulation pumps. Air distribution is to terminal VAV boxes, most with hydronic reheat coils. A large percentage of the reheats were active when observed during the tour (warm weather conditions). There is also a kitchen make-up air unit and split unit serving electrical room. The air handlers appear to be in excellent condition.

Boiler Plant

Hot water is supplied by two gas-fired Lochnivar "Copper Fin II" models. Each boiler is rated at 1,210 MBH output. Heating hot water is circulated by one of two 10 hp Armstrong in-line pumps (235 gpm rating). One of the pumps is for standby service. Both have VFD control. The boiler plant is kept on-line for the summer to help manage humidity in the building.

Chiller Plant

The senior center has a central chilled water system. The chiller is an outdoor pad mounted R22 Trane unit rated at approximately 100 tons. One of two 10 hp centrifugal pumps circulates chilled water. The pumps are integral with the chiller package and probably have VFD control (unconfirmed).

Controls

This facility's HVAC system is managed by usual Alerton direct digital control (DDC) system. The system provides operating control of the air handlers, exhaust fans, chiller and boiler plants.

Energy management strategies in place include equipment scheduling, economizer free-cooling and demand control ventilation. The system has an optimum start program that automatically starts equipment at the right time so that occupied space temperature setpoints are achieved at the scheduled occupied time. We were unable to confirm setback space temperature setpoints. The chiller is not scheduled and remains operational full-time throughout the cooling season.

Domestic Water

Toilet fixtures surprisingly do not appear to be low flow type, or at least aren't labeled as such. A 150-gallon A.O. Smith unit supplies domestic hot water with 199 MBH burner (193 gph recovery).

Lighting

This facility is predominantly lit with T8 and T5 fluorescent as well as CFL systems. The reception area has high light levels, which could be adjusted down to save electricity. There are motion controls in use at this building. There are approximately 29 metal halide exterior pole lights in the parking lot and grounds.

Energy Efficiency Opportunities

We were not provided with building square footage or gas use necessary to calculate EUI at this facility. Electric use appears to be typical for this type of operation. We expect gas use to be high given the use of the heating boiler year-round. Identified areas for efficiency improvement are summarized on the next page and described in section 4.

Table 3.6-1 - Summary of Recommended ECMs for the Senior Center

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings					Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr	Propane Gal/yr					
3 Update Fluorescent Lighting to Super T8s	LIGHTING	$16,000	$0	3	10,000	(200)	-	-	$1,300				12 3
5 Update Exterior Lighting to LED	LIGHTING	$30,000	$0	-	28,000	-	-	-	$4,300	X			7.0
13 Controls Recommissioning	CONTROLS	$20,000	$0	-	8,000	4,000	-	-	$5,400				3.7
TOTAL		***$66,000***	***$0***	***3***	***46,000***	***3,800***	**-**	**-**	***$11,000***				***6.0***

3.7 Town Hall

Groton's Town Hall is located at 45 Fort Hill Road. The 19,900 square foot three-level building dates to 1908 with updates and renovations in 1938 and 1980. The facility includes Town department offices (Clerk, Finance, Mayor, Records, etc.) as well as Groton's IT servers, vault areas, meeting rooms, break room, bathrooms, mechanical and electrical areas. Approximately 50 people work in this facility during weekdays from 7 a.m. to 4:30 p.m. There generally are no evening or weekend activities.

Building Envelope

Construction details on this older building are not available. We suspect there is minimal, if any, insulation in walls. Windows are newer double hung models with thermal panes. The exterior doors we looked at closed tightly and had good seals.

HVAC

The Town Hall is heated by steam radiation. Most radiators have thermostatic control via steam valve to wall thermostats. Stairwells and other areas employ thermostatic radiator valves, which are mechanical self-regulating temperature control devices that sit on the radiator. An oil-fired Weil McLain sectional boiler rated at 3,388 MBH supplies low-pressure steam. Air conditioning is provided by multiple splits of various age and condition. The server room is cooled by small DX Liebert unit.

Controls

The building has a pneumatic control system that is partially disabled. Dual 1½ hp air compressors provide instrument air. Some DDC has been added and new equipment runs off local thermostats. We understand much of the building is maintained at constant heating and cooling temperature without a reset for unoccupied periods.

Lighting

This building is predominately lit with fluorescent four foot T8 and 2x2 biax fixtures. There are some T12 lamps and ballasts remaining in service, as well as incandescent exit signs. There aren't any lighting controls in the building.

Domestic Water

Toilets and other domestic water fixtures are older (no water conservation) type. A 30-gallon electric heater with 4.5 kW element supplies domestic hot water.

Miscellaneous

There is a lunchroom in the lower level with older refrigerator and vending machines.

Energy Efficiency Opportunities

The EUI for this facility is 95 kBtu/SF. This represents fairly poor performance, but is consistent with the lack of effective HVAC controls in this building. We identified several areas for efficiency improvement that are summarized on the following page and described in Section 4.

Table 3.7-1 - Summary of Recommended ECMs for the Town Hall

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings					Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr	Propane Gal/yr					
1 Update T12 lamps to T8	LIGHTING	$2,000	$1,000	1	2,000	-	(10)	-	$300				3.3
2 Replace Incandescent / Halogen Lighting	LIGHTING	$1,500	$500	-	1,300	-	(10)	-	$200	X			5.0
3 Update Fluorescent Lighting to Super T8s	LIGHTING	$18,000	$4,000	4	11,000	-	(70)	-	$1,500				9.3
6 Install Occupancy Sensor Control	LIGHTING	$6,000	$1,500	1	4,000	-	(20)	-	$600				7.5
7 Daylighting Control	LIGHTING	$1,500	$0	-	1,000	-	(10)	-	$100				15.0
10 Add DHW Timer	CONTROLS	$250	$0	-	700	-	-	-	$100				2.5
14 Add Central Control System	CONTROLS	$60,000	$2,000	2	6,000	-	900	-	$3,100	X		X	18.7
18 Replace Boiler Plant	HVAC	$40,000	$0	-	-	-	300	-	$700	X	X		57.1
19 Convert Steam to Hot Water Heating	HVAC	$150,000	$0	-	-	-	600	-	$1,500	X	X	X	100.0
24 Vending Machine Controller	MISC	$1,000	$0	-	1,500	-	-	-	$200				5.0
26 Replace Refrigerator	MISC	$1,000	$0	-	1,000	-	-	-	$150				6.7
TOTAL		***$281,250***	***$9,000***	***8***	***28,500***	***-***	***1,680***	***-***	***$8,450***				***32.2***

3.8 Town Hall Annex

The Town of Groton operates a Town Hall Annex building at 134 Groton Long Point Road. The building was opened in the 1970's with a significant addition and comprehensive renovation around 2000. The facility includes ground and partial basement levels totaling about 19,600 square feet. Town offices include Public Works Administration and Planning and Development Services. Approximately 20 to 30 people work in this facility on weekdays from 8 a.m. to 5 p.m. In addition, there are evening meetings 3 -4 nights a week. The building also serves as a polling station.

Building Envelope

The original building is constructed of prefabricated steel sections with metal siding. As part of the renovation, about 2 inches of foam was added to the exterior with a stucco finish. The addition is built with stud walls with a similar foam and stucco exterior treatment. Roof sections have rigid insulation. Windows are newer double hung units with thermal glazing, all in good condition. Exterior doors appear to be in good condition, but are mostly lacking effective weather seals. The garage door in the lower level storage area is insulated and has good seals.

HVAC

Eight DX air handlers condition the building with independent condensing units on pads outside the building. Units range in size from roughly 3 to 8 tons and total about 45 tons. Most of the units have outside air ducting, but only to meet minimum ventilation requirements (no economizer cooling capability). This equipment was installed in the renovation and appears to be in good working condition.

The systems seem to perform satisfactorily, but there is tendency for humidity levels to rise in the building during the summer months. Building occupants complain about uneven humidity control and cooling throughout the building. Some offices are very humid to the point where occupants remarked that desktops feel wet. Other spaces are much too cold for comfort. Occupants report that some of the meeting rooms will have large temperature fluctuations in the course of a two-hour meeting.

Outside air dampers are closed in the summer to limit moisture intake. Perimeter heat is supplied by fin tube ration. In addition, there is an approximately 2-ton ductless split system serving the server room and a smaller ductless split serving the copy room.

Boiler

Two oil-fired Burnham cast iron sectional hot water boilers heat the Annex. Each has a 1/3 hp Becket burner and is rated at 351 MBH. The 1/3 hp oil pump runs continuously. Four 1½ hp in-line pumps circulate hot water.

Controls

HVAC is controlled by an Alerton DDC system. The system manages boiler operation including turning off the plant when outside conditions warrant and reset of hot water circulating temperature. The system also includes air handler scheduling and space temperature control with occupied and unoccupied setpoints and demand ventilation control. The unoccupied heating

setpoint is believed to average about 60°F. Humidistats have been added to zones and are used to manage mechanical ventilation in the building.

Lighting

This building is predominately lit with fluorescent four foot T8 and 2x2 biax fixtures. The new addition area has eighteen 250-watt metal halide pennant fixtures with remote ballasts. There are no lighting controls in the building. Exterior lighting is high-pressure sodium.

Domestic Water

Domestic hot water is generated by a Bradford tank heater (4.5 kW, 80 gallons).

Miscellaneous

There is a lunchroom in the lower level with two older refrigerators and electric range.

Energy Efficiency Opportunities

The EUI for the Town Hall Annex is 86 kBtu/SF. This represents somewhat on the higher side of typical performance for an office building. Having the boiler active in the summer is certainly increasing energy use and keeping the EUI higher. There are opportunities for improvement that are summarized in the table on the next page and described in Section 4.

Table 3.8-1 - Summary of Recommended ECMs for Town Hall Annex

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings					Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr	Propane Gal/yr					
3 Update Fluorescent Lighting to Super T8s	LIGHTING	$20,000	$2,000	2	7,000	-	(90)	-	$800				22.5
6 Install Occupancy Sensor Control	LIGHTING	$6,000	$1,000	1	5,700	-	(70)	-	$700				7.1
10 Add DHW Timer	CONTROLS	$250	$0	-	900	-	-	-	$100				2.5
12 Add Occupancy Based HVAC Control	CONTROLS	$10,000	$0	-	8,000	-	200	-	$1,700				5.9
13 Controls Recommissioning	CONTROLS	$15,000	$0	-	12,000	-	500	-	$3,000	X		X	5.0
20 Attention to Exterior Door Seals	ENVELOPE	$1,000	$0	-	500	-	50	-	$200			X	5.0
24 Vending Machine Controller	MISC	$1,000	$0	-	1,500	-	-	-	$200				5.0
26 Replace Refrigerator	MISC	$1,500	$0	-	2,000	-	-	-	$300		X		5.0
TOTAL		***$54,750***	***$3,000***	***3***	***37,600***	***-***	***590***	***-***	***$7,000***				***7.4***

3.9 Wastewater Treatment Facility

The Town's wastewater plant was first opened in approximately 1972. There have been numerous expansions and processing updates, including new aeration blowers in the late 1990's. The facility consists of a main processing building with control room, lockers, offices, sludge processing areas, sludge shipping bay, and maintenance shop. There is a separate administrative building with laboratory, office trailers (2), and effluent building that is currently being renovated.

This plant uses a conventional activated sludge process with fine bubble aeration. Wastewater processing is continuous. The facility is manned weekdays from about 7:30 a.m. to 4:00 p.m. On weekends, samples are analyzed in the lab for a few hours. Sludge is processed 4-5 days/week and trucked off site. There is an incinerator on-site, but it is not used.

Process Summary

The plant was designed to process up to 7.5 million gallon per day (MGD). Loads average 3.5 MGD. There is very high loading during storms, but the plant has always been able to keep up.

Wastewater from the Town enters the premises and is pumped up the hill to the step screen building for initial debris removal (four 75 hp centrifugal pumps). Wastewater flows through three clarifiers, and then three ½ million gallon aeration basins. Four 150 hp variable speed blowers maintain dissolved oxygen in the secondary treatment basins. For most of the year, only one blower is required; in the summer, two blowers are usually on-line. Return activated sludge is pumped by three 30 hp centrifugal pumps with VFD control (only one pump is normally required). Sludge is dewatered by rotary sludge thicker and shipped off-sit. Typically there are 2-3 truck hauls per week. Effluent is pumped to the Thames River (about 7 miles away) via six turbine pumps (three 50 hp and three 125 hp). Typically only one or two effluent pumps are needed.

Treated water is pumped through the plant for processing such as pump seal cooling, grit removal rinse, filter press, chemical dosing carry water, etc. There are two 40 hp centrifugal pumps that circulate plant water. These pumps have VFD control.

There are dozens of additional processing pumps. All pumps with significant run hours are equipped with VFDs.

The plant has a SCADA control system that monitors process functions. The system provides minimal control.

Building Envelope

The buildings are masonry block, some with a brick exterior. There is no insulation in wall structures. A steel framed and sided extension added to the main processing building has blanket insulation. Flat built up roofing probably had rigid insulation added when last replaced. The main processing building has two overhead steel garage doors that are not insulated, nor have weather seals. Exterior man doors generally do not have weather stripping. The control room has double pane casement windows with interior film treatment.

HVAC

The main process and effluent buildings are heated by a single Cleaver Brooks 70 bhp oil-fired low-pressure steam boiler (2,929 MBH). Steam is converted to hot water and circulated by 2 hp pump

to several H&V units and radiation, some of which does not work. The control room is air conditioned by two splits. The administration building has a DX rooftop unit and is electrically heated. The smaller processing buildings have electric unit heaters. Processing areas are generally kept in the 50's. The Town has commissioned an HVAC engineering study to explore options to modernize systems.

Lighting

This facility is a prime candidate for lighting updates. There is an abundance of fluorescent T12 lamps and older ballasts, as well as T8 technology. Processing areas and tunnels have many HID lights that operate 24/7. Adding occupancy based bi-level lighting should be considered in most areas.

Energy Efficiency Opportunities

Wastewater facilities by nature consume large amounts of electricity due to continuous use of large pump and aeration motors. Groton is no exception, although there have been many energy improvements made already, including installation of variable speed pumping controls and updating to fine bubble aeration. The plant is believed to be operating at the higher end of the efficiency scale. Utility data for the WWTP was not provided for this study. Options for efficiency improvements are listed in the table on the next page and described in Section 4.

Table 3.9-1 - Summary of Recommended ECMs for the Wastewater Treatment Plant

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings					Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr	Propane Gal/yr					
1 Update T12 lamps to T8	LIGHTING	$10,000	$2,000	2	20,000	-	-	-	$3,000				2.7
3 Update Fluorescent Lighting to Super T8s	LIGHTING	$20,000	$2,000	2	10,000	-	-	-	$1,500				12.0
4 Replace H D Fixtures with T5/T8	LIGHTING	$60,000	$8,000	8	70,000	-	-	-	$10,600	X			4.9
5 Update Exterior Lighting to LED	LIGHTING	$10,000	$0	-	10,000	-	-	-	$1,500	X			6.7
6 Install Occupancy Sensor Control	LIGHTING	$20,000	$3,000	3	20,000	-	-	-	$3,000				5.7
11 Add Pump VFDs	CONTROLS	$80,000	$4,000	2	20,000	-		-	$3,000				25.3
15 Replace HVAC Units	HVAC	$100,000	$0	-	1,000	-	-	-	$150	X	X	X	666.7
16 Convert Electric Heating	HVAC	$125,000	$0	-	30,000	(1,200)	-	-	$3,300				37.9
17 Install Natural Gas Service	HVAC	$40,000	$0	-		(11,000)	8,000	-	$8,000				5.0
18 Replace Boiler Plant	HVAC	$150,000	$0	-	-	-	200	-	$500	X	X		300.0
19 Convert Steam to Hot Water Heating	HVAC	$300,000	$0	-	-	2,000	-	-	$2,100		X	X	142.9
20 Attention to Exterior Door Seals	ENVELOPE	$3,000	$0	-	-	-	200	-	$500			X	6.0
21 Replace Overhead Door	ENVELOPE	$15,000	$0	-	-	-	220	-	$500			X	30.0
TOTAL		***$933,000***	***$19,000***	***17***	***181,000***	***(10,200)***	***8,620***	***-***	***$37,650***				***24.3***

4.0 Recommended Energy Conservation Measures (ECMs)

This section provides a brief description of each recommended ECM for Groton's municipal buildings.

LIGHTING

4.1 Update T12 lamps to T8 (Human Services, Poquonnock Bridge Fire Substation, Public Library, Town Hall, Wastewater Treatment)

The listed buildings contain older T12 florescent lighting lamps and ballasts. Many of the buildings are served by Groton Utilities, which had historically not offered an incentive program for installing high efficiency lighting. We understand the utility is now open to providing incentives on a custom basis, which should be pursued. Under changes to federal law, this T12 product is to be discontinued and soon will not be available for purchase.

Significantly more efficient T8 lamp and ballast technology is available to replace the older T12 setups. Making the conversion is typically a simple swap of lights and ballasts, including cleaning or replacement of lenses as appropriate. In some cases, where there is an eight-foot fixture involved, new four-foot fixtures are generally recommended to standardize on four-foot lamps and to avoid the need to modify existing fixtures to accommodate different clip types for HO lamps.

Next Steps: Confirm quantity and wattage of existing lamps. We recommend using a qualified lighting contractor who will look at the existing lights and propose a fixed price T8 solution. The lighting contractor's proposal normally includes energy savings and other information, which will be of interest to Groton Utilities. We recommend pursuing all lighting updates as one contracted project to assure completeness and consistency of work and to generate economies of scale.

4.2 Replace Incandescent / Halogen Lighting (Poquonnock Bridge Fire Substation, Town Hall)

Almost all prior energy intensive incandescent and halogen lighting systems in Groton's properties have been replaced with more energy efficient compact fluorescent or other technologies. In our visits to the buildings, we did notice a few lingering light fixtures that should be updated as follows:

- Poquonnock Bridge Fire Substation: There are a dozen or so ceiling "can" fixtures with incandescent flood lamps. We recommend replacing these and any other incandescent lamps in the building with comparable CFL lamps.
- Town Hall: Exit signs use incandescent lamps. We recommend replacing the sign in its entirety with an LED model.

Next Steps: Confirm quantity and wattage of existing lamps. This is a project that the town could pursue using its own staff since selecting replacement equipment does not require engineering, nor is the installation difficult. Otherwise, we recommend combining all lighting work for sole-source contracted services to simplify the process.

4.3 Update Fluorescent Lighting to Super T8s (Highway Garage, Police Station, Poquonnock Bridge Fire Substation, Senior Center, Town Hall, Town Hall Annex, Wastewater Treatment)

The Town has made excellent progress updating fluorescent lighting to T8 systems in almost all municipal buildings. Standard 32-watt T8 lamps are in use. More recent advances to "super T8" technology have made available 28-watt and even 25-watt lamps. This latest technology, which capitalizes on optimizing light color, combined with low-power ballasts and aggressive use of reflectors, can yield significant reductions from the standard T8s currently in place (up to 20 percent reduction has been documented). We recommend updating to super T8s, if not now then within five years when lamp and ballasts are nearer the end of their expected service lives and group replacement of all components has a significant maintenance advantage.

<u>Next Steps:</u> Confirm quantity and wattage of existing lamps. As above, we recommend using a qualified lighting contractor who will look at the existing lights and propose a fixed price super T8 solution. The lighting contractor's proposal normally includes energy savings and projected value of available incentives. The Town will have to work with Groton Utilities to negotiate an incentive for some of the buildings. We recommend combining this work with all other lighting recommendations.

4.4 Replace HID Fixtures with T5/T8 (Highway Garage, Wastewater Treatment)

The listed buildings have metal halide and high-pressure sodium lighting. This lighting technology requires about five minutes to "warm-up" before full light output is achieved and is not particularly efficient. The "warm up" period also creates a disincentive for building users to shut off lights when rooms are not being used. For high bay applications (such as the highway garage shops) T5 fluorescent lighting is preferred because it is more efficient, again does not require a warm-up period, and has very bright high quality lighting characteristics. At the wastewater plant, we recommend considering T8 pennant or wall fixtures in the tunnels in lieu of the HID systems.

<u>Next Steps:</u> Confirm quantity and wattage of existing lamps. As above, we recommend using a qualified lighting contractor who will look at the existing lights and propose a fixed price lighting solution. The lighting contractor's proposal normally includes energy savings and projected value of available incentives.

4.5 Update Exterior Lighting to LED (Highway Garage, Police Station, Poquonnock Bridge Fire Substation, Public Library, Senior Center, Town Hall, Town Hall Annex, Wastewater Treatment)

Exterior lighting systems at Groton's town properties include standard HID pole and sidelight applications. All exterior lights are on some form of control – photocell, timer or both. Most lights stay on all night. We recommend updating exterior fixtures with LED lamps. The project may require the installation of new pole fixtures and could be expensive. However, LED manufacturers are getting very aggressive in developing new product to replace many old technology installations, and prices for LEDs are dropping fast. There aren't any prescriptive utility incentives at this time, although there could be in the near future; or it may be possible to get a customized incentive based on actual savings. LEDs can result in 70% reductions in kWh use.

<u>Next Steps:</u> Confirm quantity and wattage of existing outside lamps. As above, we recommend using a qualified lighting contractor who will look at the existing lights and

propose a fixed price exterior lighting options. This work should be combined with other lighting recommendations.

4.6 Install Occupancy Sensor Control for Lighting (Human Services, Police Station, Poquonnock Bridge Fire Substation, Public Library, Town Hall, Town Hall Annex, Wastewater Treatment)

There is already widespread use of lighting motion control sensors in several of Groton's town and school buildings. Results have been very positive with noticeable electric bill reductions reported. There are additional opportunities to install motion sensors in other areas subject to intermittent use during the building's occupied period, but where lights are likely to be left on. Candidate areas include break rooms, conference rooms, bathrooms, hallways and storage areas. Offices should be considered as well, although they tend to have fewer lamps than common areas and therefore occupancy sensors are not as cost effective. It is important to set up motion sensors with 15 minute or more of delay time for light shutoff. This prevents excessive light starts, which ultimately can degrade lamp life.

<u>Next Step</u>: Conduct more detailed review of the above buildings and potentially others to decide which areas are suitable for occupancy sensors and develop a bill of materials for installations. As above, we recommend using a qualified lighting contractor who will provide this service at no cost and will subsequently generate a fixed price proposal for an engineered solution that may include other enhancements such as minor lighting updates, rewiring, etc. We recommend combining all lighting and lighting control work.

4.7 Daylighting Control (Town Hall)

The Town Hall has skylights in some areas. Lighting in the immediate areas of the skylights is unnecessary during bright daylight hours. We recommend investigating the installation of "daylighting" controls, which are used to determine if there is sufficient ambient light and will cut electricity to lights when appropriate. Depending on the existing wiring configuration, this could be a very simple project, or it could involve some degree of rewiring.

<u>Next Step</u>: Conduct more detailed review of the lighting systems and wiring at the Town Hall to determine how to add daylighting controls. As above, we recommend using a qualified lighting contractor who will provide this service at no cost and will subsequently generate a fixed price proposal for adding controls.

CONTROLS

4.8 Lower Temperature Settings in Garage / Storage Areas (Highway Garage Police Station)

These facilities both have garage space that is maintained at 65F-plus during the winter. At the highway garage, we recommend turning down the heat to about 50F in the snow plow storage building. If necessary during a storm event, raise temperature to assist with melting of snow and ice from vehicles. Similarly at the police station, we recommend turning down the heat in the garage space.

<u>Next Steps:</u> We recommend further discussion with staff regarding implications of lowered heating setpoints in the garage spaces. For example, it may be necessary to install engine block heaters to assure reliable diesel engine startup in cold weather.

4.9 Schedule HVAC System / Setback (Human Services, Police Station, Poquonnock Bridge Fire Substation)

There is opportunity at these facilities to reduce space heating and cooling during unoccupied or low occupancy periods.

- <u>Human Services:</u> We recommend programming a 55F night setback for winter operations via cutting off the boiler plant. The control system is reported to have an "optimum start" feature so will automatically adjust startup times earlier in cold weather to compensate for the deeper setback.
- <u>Police Station:</u> Administrative zone VAV boxes can be scheduled to close down the air damper during unoccupied periods. This will save fan and thermal energy, as the zones will be effectively shut off. The control system should include programming to reopen the boxes as necessary to maintain an unoccupied setpoint. We recommend 55F / 80F for winter and summer setpoints respectively.
- <u>Poquonnock Bridge Fire Substation:</u> The Station has programmable thermostats that aren't being used. It should be acceptable to drop space temperature to about 65F during the night when the resident crew is either sleeping or on a call.

<u>Next Steps:</u> We recommend further discussion with staff regarding implications of more aggressive night setbacks policies. It may be necessary to hire a controls technician to make the scheduling and setpoint updates on the Alerton system and to assure that the optimum start program is working effectively.

4.10 Add Domestic Hot Water Timer (Highway Garage, Town Hall, Town Hall Annex)

These three facilities have full-time tank-type domestic hot water systems. We recommend adding scheduling controls to disable the hot water system circulation pump and/or burner during unoccupied periods. There are a number of inexpensive stand-alone controllers that can be installed locally. If not already so configured, the Town Hall Annex domestic hot water system should be integrated with the Alerton control system. Scheduling for all buildings should allow an hour or so for the hot water system to recover in the morning. It should be possible to schedule each system off 30 minute or more before the building closes for the day.

At the Highway Garage, the selected system should include an override so that the hot water system can easily be kept on-line when there is a snow event in the winter and 24/7 availability of hot water is required.

<u>Next Step</u>: Research and select stand-alone domestic hot water timers. If necessary, consult with preferred controls vendor, which may be required to reprogram the Alerton system.

4.11 Add Pump VFDs (Wastewater Treatment)

Variable frequency drives (VFDs) are the most efficient way to unload pumping systems to match load requirements in the piping system served by the unit. VFDs work by reducing the frequency of alternating current feeding the motor. Since induction motor speed follows line frequency, the

motor slows down. Power use goes down exponentially. For example, if a motor is slowed down by 15 percent, the power savings is roughly 32 percent. There is also the advantage of "soft start", which is much gentler on the systems hydraulically, mechanically and electrically.

At the Wastewater Treatment facility, almost all full-time processing pumps have already been converted to VFD control. There are a few remaining application to consider for VFDs, but they do not have strong economic return. Rather adding VFDs will improve control, reliability and provide the benefit of the soft start:

- Replace "flow matcher" DC sewer pump controllers with VFDs (2 x 75 hp)
- Add VFD to one large and one small effluent pump (50 hp and 125 hp)

Next Step: We are told that VFDs are part of the design for the $1.1 million pump replacement and upgrade, for which funding will be requested in the FY2014 budget. This project can be pursued as design-build from qualified electrical or controls contractors. There are likely to be utility incentives available, which should be pursued before work is awarded.

4.12 Add Occupancy Based HVAC Control (Police Station, Town Hall Annex)

We recommend considering occupancy based HVAC control for intermittently used meeting rooms. Use of a motion sensor such as is used for lighting control would provide a signal to the HVAC system to maintain a standby setpoint when the space is not being used. The HVAC system would shut down until the space temperature drifts to the standby setpoint and restarts briefly. We are differentiating "standby" from an unoccupied setpoint because it is important that the space recover to an acceptable setpoint quickly and therefore a more moderate setback is called for than we normally recommend for unoccupied periods. We recommend 65F heating and 76 cooling standby setpoints.

- Police Station: AHU-8 serves the patrol room. This area sees heavy use during shift change periods and is otherwise unoccupied.
- Town Hall Annex: There are two meeting rooms, each served by dedicated air handler. These rooms see intermittent use during business hours as well as evening hours and air handlers see long hours to accommodate potential room use.

Next Step: Consult with preferred control vendors for pricing to install new control features. CL&P may offer an incentive for this installation and should be consulted before work begins.

4.13 Controls Recommissioning (Police Station, Public Library, Senior Center, Town Hall Annex)

Recommissioning (RCxing) is a systematic review of an existing building control and mechanical systems. The purpose is to ensure that the design intent is being met and/or that operations are consistent with current use. The goal is to achieve the best performance possible from the existing system.

Many common RCxing-related operating deficiencies can be traced to original design and construction issues and how thoroughly systems were set up during commissioning. The second

most common building efficiency problem is related to changed conditions in the building. For example, an air handler is set up to operate at a certain time of day with a prescribed rate of ventilation, but those requirements don't apply anymore. Lastly, there could be maintenance and age-related problems that may not be noticed because they don't affect occupant comfort. For example, a valve may be leaking hot water through to a coil and the unit's DX system is activating to compensate so that supply air temperature to the zone is exactly at the required setpoint. RCxing opportunities at each Town building is discussed below:

- Police Station: Attention to control setpoints and settings. It should be possible to significantly reduce need for reheat in the summer. VAV box minimum setting should be reviewed as well as opportunity to adjust discharge air temperature from the air handlers.
- Public Library: Revisit equipment programmed start times, which appear to be excessively early. If necessary, troubleshoot optimum start sequence. Also, night setbacks can be setup with more aggressive setpoints.
- Senior Center: Attention to control setpoints and settings. It should be possible to significantly reduce need for reheat in the summer. VAV box minimum setting should be reviewed as well as opportunity to adjust discharge air temperature from the air handlers.
- Town Hall Annex: We are told that the Town has recently completed the recommissioning of this entire building, but the building's performance still seems to have problems. We suggest further work as described above for the Senior Center.

A third party commissioning specialist normally provides recommissioning in two or more phases. The first phase is "discovery" where the building is reviewed fairly quickly, but in enough detail to develop a comprehensive RCxing plan, including target systems to be addressed and establishing testing and data collection procedures. The next phase involves detailed testing, data collection and diagnostic services which results in a list of specific recommendations to make improvements. Many changes can be implemented on the fly with the owner's approval. Other recommendations may require the paid services of a controls programmer or contractor to replace defective components.

Next Step: Develop appropriate requirements for RCxing effort to meet the needs of the Town's larger buildings with central HVAC controls. CL&P offers at RCxing program that can partially pay for RCxing services. We recommend contacting CL&P to initiate the process. It may be necessary to use CL&P's pre-qualified consultants to conduct the work.

4.14 Add Central Control System (Town Hall)

The Town Hall has pneumatic thermostat control. The pneumatic systems there are in poor condition and many components may not be operational. There is no effective night setback practice in place with much energy being wasted. While there are lower cost solutions, we recommend installing a central control system tied to the main front end at the DPW, similar to what has been done with other municipal buildings. Central control offers flexible and centrally managed equipment scheduling as well as remote monitoring and troubleshooting for complaint calls. Converting from pneumatic to all-DDC is an expensive prospect and return on investment when looking at energy savings alone is hard to justify. However, the project offers strong O&M benefits and should be considered as necessary infrastructure renewal.

<u>Next Step</u>: Review long term plans for the Town Hall and capital investment plans for HVAC replacement. Converting to DDC at the same time as a major renovation will be the most cost effective. Once plans have been established, develop project requirement documentation for a bid solicitation.

MECHANICAL

4.15 Replace HVAC Units (Poquonnock Bridge Fire Substation, Wastewater Treatment)
These facilities both have HVAC units that are well beyond their expected service life and are already or are near failing. Immediate or near-term replacement is strongly recommended. At the fire substation, the two older A/C rooftops need to be replaced. At the wastewater facility, the two steam H&V units in the main processing building are not are operational. Replacing HVAC equipment offers better A/C compressor efficiency, higher efficiency motors, and potential application of VFDs. (We understand that Public Works has undertaken a design study for the HVAC replacement in the Operations Buildings at WCPF.) The resulting savings alone will not be enough to justify these needed replacements, but will help defray the cost of these projects, which should be considered necessary infrastructure renewal.

<u>Next Steps:</u> Consider long terms plans for buildings and establish CIP budgeting for replacement. At the wastewater plant, we understand there has been a comprehensive HVAC study completed, and there may very well be a larger renewal project, including replacement of boiler and electric heating and bringing in natural gas service to the facility. Once a plan has been agreed on for proceeding with these projects, the Town should develop bid documentation for design-build services to replace these units. Confer with electric and potentially gas utility to secure potential incentives before beginning work.

4.16 Convert Electric Heating (Highway Garage, Wastewater Treatment)
Both of these facilities have electric heating. We recommend considering conversion to natural gas and propane as alternates to electric heating. Although electric heat is 100 percent efficient, it is very expensive compared to heating with fossil fuel energy sources.

- <u>Highway Garage</u>: The "portable" addition that has electric baseboard. For this area we recommend installing a through-the-wall propane heater and removing the existing baseboard.
- <u>Wastewater Treatment</u>: The Administrative and Laboratory Building is 100 percent electrically heated. For this building, we recommend replacement of the rooftop unit with a new natural gas or propane-fired unit. There are also two trailers with electric heating, but we understand the renovations in the effluent building will be providing office space and that the trailers may not be needed in the future.

<u>Next Steps:</u> Consider long terms plans for buildings and move to alternatives to electric heat, establishing CIP budgets for projects. Once a plan is confirmed, develop bid documentation for design-build services to convert to fossil fuel fired heating. Confer with natural gas utility and/or propane suppliers to secure potential incentives before beginning work.

4.17 Install Natural Gas Service (Public Library, Wastewater Treatment)
There is a significant financial advantage to using natural gas instead of heating oil in the current and foreseeable energy market. The local utility has offered to install natural gas piping to the

wastewater plant for $17,000, a very low cost considering the remote location of the plant. There is also opportunity to extend gas service to the Public Library, either from the road or indirectly from the adjacent Senior Center (if the existing natural gas line is large enough). We understand that Public Works is in discussions with Yankee Gas about this expansion of natural gas service.

Converting to natural gas at other municipal properties should be considered in the future as natural gas service in the Town is expanded and similar offers for no-cost or very low cost access arise.

<u>Next Steps:</u> Develop bid documentation for design-build services to install a gas train from the planned utility meter location as well as new dual fuel burners and potential mechanical updates to satisfy current fire code requirements.

4.18 Replace Boiler Plant (Highway Garage, Town Hall, Wastewater Treatment)

These properties are relaying on older steam boiler systems, near or beyond their normal expected service lives. While the boilers continue to operate reliably and are in serviceable condition, it is prudent to plan for their replacement. Parts availability is limited, and a component failure could result in lost heating service and result in a building closure and/or premium cost for temporary services.

New steam boilers will result in some efficiency improvement, but converting to hot water based heating systems employing condensing boiler technology offer a 15 percent or more combustion efficiency advantage (see Section 4.19).

<u>Next Steps:</u> Develop bid documentation for design-build services to replace equipment. This work could be combined with other mechanical update recommendations to simplify the project and potentially obtain better bids. Consider converting to hot water.

4.19 Convert Steam to Hot Water Heating (Highway Garage, Town Hall, Wastewater Treatment)

Given the age and condition of the steam systems at the above properties, boiler replacement will be required in the near to mid future (See Section 4.18). When evaluating boiler replacement, Peregrine recommends considering this as an opportunity to convert the buildings' steam-based heating systems to hot water based systems. Hot water systems have better space temperature control, less maintenance requirements, and operate more efficiently than steam boilers.

The project will require installation of additional piping throughout the buildings, replacement of air handler coils (or outright AHU replacements), and new radiation sections. This project would result in an entirely new high efficiency heating system. Since the project payback is exceedingly long based on the cost to energy savings ratio, as is always the case with new heating system installations, the project should be treated as a long-term infrastructure renewal improvement, rather than as an efficiency improvement investment.

<u>Next Steps:</u> Confirm the long term plans for the buildings and the optimal timing for an HVAC replacement project. Once plans have been confirmed, including any future renovations that may affect space utilization and/or heating load requirements, conduct a feasibility study to evaluate life cycle cost of the steam versus hot water options. A full design would be required eventually to develop plans and specifications for the boiler replacement and possible hot water conversion.

ENVELOPE

4.20 Attention to Exterior Door Seals (Highway Garage, Human Services, Police Station, Poquonnock Bridge Fire Substation, Town Hall Annex, Wastewater Treatment)

At most of Groton's buildings, some or most of the exterior doors are not closing properly and/or do not have weather stripping or sweeps to seal the doorsill. There are significant exposed gaps to the outside. During the winter heating season, these gaps create uncomfortable drafts and stress adjacent heating devices. We suggest developing a program that gives attention to all exterior doors to make sure they provide a reasonable seal to the elements. We suggest realignment and adjustments to salvageable doors, plus the addition (or in some case replacement) of weather stripping and bottom sweeps. All doors beyond repair should be replaced. There is one such door we noted at the snowplow building at the Highway Garage facility, which has extensive corrosion on the lower part of the door.

<u>Next Step</u>: Conduct more detailed review of exterior doors to establish a detailed scope of work. Develop a request for proposal for door services.

4.21 Replace Overhead Door (Wastewater Treatment)

The main processing building has an extension for sludge truck loading. This bay is maintained in the high 50's low 60's during the winter. The overhead door and the door in the adjacent bay are not weatherized and are a source of significant heat losses. Assuming heat is required in these areas, we recommend replacing the doors with insulated models that include perimeter weather stripping. In all likelihood the existing door opener system can be retained.

<u>Next Step</u>: Conduct more detailed review and measurement of the overhead doors to obtain pricing. We recommend combining overhead door and standard door weather stripping work into one request for proposal for door services.

4.22 Airseal Details / Attic Insulation (Highway Garage, Human Services, Poquonnock Bridge Fire Substation)

Air sealing refers to carefully sealing building envelope penetrations to prevent unwanted air movement through a building to the detriment of heating and air conditioning performance. Typical areas requiring attention beyond doors and windows include heating appliance flues, exhaust fan connection to the building and/or dampers, electrical conduit and piping. Also, the perimeter of attic space is often not very well sealed, which is a critical area, given potential air movement up walls. Typically the above problem areas are caulked or filled with expanding foam in voids to seal areas. In some cases, plastic sheeting or other vapor barrier material needs to be added under insulation materials, which is the case at the Human Services building.

<u>Next Step</u>: Peregrine recommends consulting with an air sealing / building insulation specialist, particularly for the Human Services building, which may require considerable work. Many of these vendors are willing to inspect a building and develop a schedule of treatment at no upfront cost.

4.23 Replace Windows (Human Services)

Many of the Town's buildings have had successful window replacements. Human Services requires similar treatment, as its windows are older single pane units in generally poor condition. Modern thermal pane casement windows offer much better "U" values, but more importantly will reduce

draft compared to the existing windows many of which don't have effective seals. Window replacement projects are very expensive and do not have attractive economic returns. However, window replacements are a necessary infrastructure renewal project that also improves the appearance and comfort of the buildings.

<u>Next Step</u>: Determine long term plans for the building and appropriate CIP budget timing. Consult with architect and/or window vendor to develop design details and obtain pricing via bid solicitation.

4.24 Vending Machine Controller (Town Hall, Town Hall Annex)

There are vending machine occupancy-based controller products that cycle the machines on/off depending on presents of people in the vicinity of the vending machine. Vendmiser is the most well know supplier of vending machine controllers. Their product installs on top of the vending machine with the unit plugging directly into the controller. The Vendmiser turns off the soda or snack machine when the area is determined to be vacant. The shutdown cycle includes timed delay to filter out false readings from passing foot traffic. Once every two or so hours the unit restarts itself to maintain refrigeration in drink machines. The manufacture claims 35-50 percent savings for typical office applications. Our own verification indicates that savings is more on the range of 25-35 percent and highly dependent on occupancy patterns in the building.

The Town Hall and Town Hall Annex both have vending machines and intermittent occupancy, which makes them good candidates for vending machine controller. There could be additional machines in town buildings that were not seen during our tours that could be included in the scope.

<u>Next Step</u>: Obtain and review list of all vending machines in service at Groton's municipal buildings. Determine which ones to control and contact Vendmiser or other manufacture to obtain purchasing guidance and pricing.

4.25 Replace CRT Computer Monitors (Public Library)

The majority of computers at the public library have older CRT monitors. We recommend upgrading to flat screen monitors, which use much less energy. The CRTs must be properly disposed since they contain hazardous materials.

<u>Next Step</u>: Obtain inventory of CRT monitors to determine quantity of new monitors to purchase. Obtain pricing for suitable flat screen monitors.

4.26 Replace Refrigerator (Human Services, Poquonnock Bridge Fire Substation, Town Hall, Town Hall Annex)

The above facilities have older refrigerators and freezer appliances. New Energy-Star rated units offer considerable efficiency advantages. At Human Services, we question if all the many operating refrigerators/freezers are necessary. Any unnecessary units should be turned off and disposed of, with space allocated in new units for all potential users.

<u>Next Step</u>: Select refrigerator model(s). There may be incentives available for particular models, and a refrigerator supplier should be able to provide all necessary paperwork.

APPENDIX C

Energy Efficiency Opportunities For Groton Public School Buildings

September 2012

1.0 Introduction and Executive Summary

Peregrine Energy Group, Inc. ("Peregrine") has prepared this Energy Opportunities Assessment and Roadmap to Energy Efficiency for the Town of Groton's public school buildings. Peregrine has completed this Energy Opportunity Assessment to guide the Town in developing and implementing an energy reduction strategy for their BOE buildings and to inform a larger Town-wide energy planning initiative.

This assessment includes specific recommendations and next steps to reduce energy use and increase energy efficiency. We include summary information on the building with recommendations that can provide a starting point for securing bids from installation contractors for suggested projects. Buildings included in this assessment are:

- Charles Barnum Elementary School, 68 Briar Hill Road
- Claude Chester Elementary School, 1 Harry Day Drive
- Cutler Middle School, 160 Fishtown Road (Mystic)
- Fitch High School, 101 Groton Long Point Road
- Mary Morrisson Elementary School, 154 Toll Gate Road
- Pleasant Valley Elementary School, 380 Pleasant Valley Road
- SB Butler Elementary School, 155 Ocean View Avenue (Mystic)
- West Side Middle School, 250 Brandegee Avenue

As part of Peregrine Energy Group's engagement with the Town of Groton to develop an Energy Action Plan using EECBG funding, Peregrine staff toured Board of Education properties on June 6thand 7th, 2012. Our objective during these site visits was to examine buildings and equipment and review operational procedures and issues with BOE facilities personnel with the goal of identifying opportunities and strategies to improve energy efficiency in ongoing operations, reduce energy-related costs, and to identify and plan for needed energy infrastructure-related capital projects.

During these site visits, we collected information about building construction, equipment and systems, how and when the buildings are used, and current energy-related practices. We also wanted to clarify future plans for each of the buildings, including potential future changes in occupancy and use and planned or proposed building improvements, renovations and/or replacements.

Our goal was to visit each of the buildings and collect information about their construction, their equipment and systems, how and when the buildings are used, and current energy-related practices. We also wanted to learn about operational issues and any comfort problems in each building. Finally, we hoped to clarify future plans for each of the buildings, including potential future changes in occupancy and use and planned or proposed building improvements or renovations. This report includes building-specific findings and recommendations for improvements to buildings and equipment, as well as their operation and maintenance that can reduce energy use and expense. Where appropriate and warranted, our recommendations include capital improvement projects.

Findings and Recommendations

Peregrine's Opportunity Assessment focused on:

- Historical energy use
- Operating practices
- Lighting technology and requirements
- HVAC equipment and controls
- Building envelope materials and condition
- Future building use and renovation plans

Our recommendations for efficiency improvements focus on lighting, controls, longer-term mechanical updates and tightening up doors and other building envelop features. The biggest and most immediate opportunities include updating older T12 lighting and converting the High School to natural gas heating. We estimate that all energy reduction improvements and strategies we identify in this report will generate over $170,000 in utility cost savings annually. This represents about 6.5 percent of the Town's annual utility budget for this group of buildings. Note that 65% of these projected savings will be generated at the High School, with a simple payback of three years.

Implementing all these recommendations will require an investment of approximately $4 Million, less potential incentives from CL&P, CNG and Groton Municipal which are expected to be significant. A selective approach, implementing priority projects or those with strong financial return is recommended which will result in a lower project budget.

We recommend prioritizing each identified opportunity based on financial return, available CIP budget, and short and long-term needs of the building. Peregrine has provided results of our analysis in a spreadsheet tool format, which provides immediate results for prioritization planning.

In addition to the measures we refer to in this report, Groton may want to consider installing renewable energy technologies such as rooftop photovoltaic solar panels. Such renewable energy projects are not included in this report.

General Observations

Peregrine commends the Board of Education, its Buildings and Grounds Department, and BOE Buildings and Grounds Director Wes Greenleaf for the standards they have established for school properties, both in terms of modernization and operations and maintenance. Groton has invested heavily in improving and maintaining school buildings, including integration of energy efficient systems whenever possible.

With few exceptions, Town schools perform well ahead of the norm for schools, based on its lower than average energy use index (EUI), which is performance metric of total input energy (Btu's) divided by building square footage (see table on page 8).

Strategically, the BOE's commitment to building a strong internal maintenance and operations staff with the broad capability to manage, maintain, and repair buildings and equipment has resulted in this energy performance that far exceeds what we would expect to find in a portfolio with the mix of older and newer buildings that Groton currently has. We are particularly impressed with the district's centralized control system, with staff dedicated to monitoring and managing energy use, which is unusual for a community the size of Groton.

Looking at the Strategic Profiles report for Groton Public Schools for 2010 – 2011, released May 14, 2012, we see that Plant Operation and Maintenance expenditure is only slightly more on a per Pupil basis ($1,636 for Groton vs. the statewide average of $1,421 for PK-12 Districts), while Land, Buildings, and Debt Service is only $624 per Pupil, compared to $1,622 statewide. We interpret this as a vivid demonstration of how pro-active management and commitment to quality in operations and maintenance can help address the limitations of older buildings and systems. While future re-investing in infrastructure renewal is inevitable as buildings and equipment wear out and new technology becomes available, BOE's focus on good stewardship of what it has clearly is paying off in superior performance.

Looking forward, we expect that only moderate additional energy reductions will be possible in schools, given the current high level of operating sophistication. Most of the opportunity we found falls into four categories outlined below. Table 1 below provides an overview of possible measures at individual buildings.

Table 1 – Energy Reduction Program Potential Results

Building	Approximate Implementation Cost	Utility Incentive Available	Potential Utility Savings				Annual Cost Avoidance	Baseline EUI kBtu/sf	Projected EUI kBtu/sf	Overall Savings	Simple Payback Yr
			Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr					
Charles Barnum ES	$810,550	$0	5	27,600	-	750	$6,410	42	37	10.9%	126.5
Claude Chester ES	$13,000	$4,000	4	13,000	-	(110)	$1,920	62	61	1.1%	4.7
Cutler MS	$854,000	$7,000	7	32,500	-	800	$7,430	46	43	6.4%	114.0
Fitch HS	$412,500	$72,500	71	279,400	(95,800)	67,500	$113,420	57	55	4.9%	3.0
Mary Morrisson ES	$826,400	$0	15	71,000	-	710	$13,630	45	37	17.5%	60.6
Pleasant Valley ES	$32,100	$0	10	46,700	-	(290)	$7,060	68	64	5.0%	4.5
SB Butler ES	$9,500	$3,000	3	13,500	-	(40)	$2,220	70	69	1.4%	2.9
West Side MS	$994,100	$0	13	102,300	-	1,920	$21,870	68	60	11.8%	45.5
Total	***$3,952,150***	***$86,500***	***128***	***586,000***	***(95,800)***	***71,240***	***$173,960***	***57***	53	***6.5%***	***22.2***

(1) Lighting. Lighting updates are probably the biggest opportunity to save energy at Groton's schools. Fluorescent lighting is predominantly older generation T8s, with T12 lamps and associated ballasts remaining in many of the buildings served by Groton Utilities. We suggest that the BOE implement a system-wide conversion to super T8 lighting technology and also install strategically placed occupancy and daylight sensors. There are additional lighting update opportunities in some buildings to replace incandescent and metal halide lights with LEDs and T5s, respectively. Exterior HID lighting could be replaced with more efficient lighting as well.

(2) Variable Speed Drives. There is opportunity to install variable speed drives on heating hot water pumps in many of the older elementary schools and several older air handlers at the high school.

(3) Boilers and Heating Systems. CNG is offering to install natural gas to the high school. Converting from oil to natural gas-fired boilers will yield significant cost savings due to current pricing structure of gas versus oil. Gas also offers reduced emissions and burns cleaner than oil thereby reducing maintenance.

Also, the town has many antiquated steam and hot water boilers, several of which must remain on-line beyond the heating season to make domestic hot water. Modernizing boiler plants will provide some energy reduction, but more importantly will address infrastructure renewal needs. While requiring major investment, converting steam buildings to all hot water heating systems has many advantages, including higher operating efficiency and reduced maintenance requirements.

(4) Envelope – Doors and Windows. Outside doors need attention to weather stripping and alignment to ensure tight closure and eliminate drafts. This is an ongoing challenge as door seals wear out quickly and require periodic replacement. Several of the buildings have very poor windows, which should be replaced with thermal pane units. Unfortunately window replacement projects have very poor economic return.

Additional Opportunities:

- **Re-Commissioning.** We recommend third party review of control system settings, sequences and functionality – i.e. building recommissioning. We were very impressed with what we've seen of the Alerton control systems and do not expect there is opportunity to make significant improvements. However, having a qualified commissioning agent thoroughly review the system could result in some fine-tuning enhancements and will provide an educational experience on "continuous commissioning" practices.
- **Power Monitoring.** Consider adding equipment power monitoring and diagnostic software tool with "energy dashboard" to closely monitor key energy using systems and help quickly find operational problems. Savings results from these types of approaches tend to vary considerably.

Table 2 on the next page provides an overview of possible measures at individual buildings.

Table 2 – Summary of Recommended Measures at Each Building

Building	LIGHTING								CONTROLS						HVAC							ENVELOPE		
	1 Reduce Hallway Light Level	2 Update T12 lamps to T8	3 Replace Incandescent / Halogen Lighting	4 Update Fluorescent Lighting to Super T8s	5 Replace High Bay Metal Halide with T5	6 Update Exterior Lighting to LED	7 Install Occupancy Sensor Control	8 Daylighting Control	9 Add Window A/C Wall Timers	10 Add VFD Controls to Pumps	11 Add VFD Controls to Fans	12 Add Demand Control Ventilation	13 Add DDC Thermostatic Control	14 Walk-in Evaporator Control & ECM Motors	15 Update Pipe Insulation	16 Install Premium Efficiency Motors	17 Steam Trap Replacement	18 Convert to Natural Gas	19 Replace Domestic Hot Water System	20 Replace Boiler Plant	21 Convert from Steam to Hot Water Heating	22 Attention to Exterior Door Seals	23 Add Entrance Vestibule	24 Replace Windows
Charles Barnum ES	X		X	X		X	X		X	X			X			X				X		X		X
Claude Chester ES				X		X	X			X			X		X	X	X			X	X	X		
Cutler MS				X		X		X	X					X								X		X
Fitch HS	X		X	X	X	X		X			X	X		X		X		X				X		
Mary Morrisson ES	X	X		X		X	X		X	X			X			X			X	X		X	X	X
Pleasant Valley ES		X	X	X		X	X		X				X			X	X		X	X	X	X		
SB Butler ES		X		X		X		X	X	X			X		X	X	X					X		X
West Side MS			X	X	X	X	X	X	X	X			X	X			X			X	X	X		

Suggested Next Steps

We suggest that the Town move forward aggressively with specific projects that are of interest or provide value. All projects identified in this report require further development to obtain firm pricing.

Immediate next steps include:

- Commit to pursuing selected priority projects and establish an implementation schedule.
- Develop request for proposal documents and/or contact preferred lighting, mechanical and commissioning contractor(s). CL&P and CNG may require use of specific vendors for work supported by their incentive programs.
- Secure quotes for projects and select contractor(s).

2.0 Utility Use Summary

All school facilities receive electricity from Connecticut Light and Power (CL&P) or Groton Utilities under various rates. Electricity is generally supplied to buildings in three phases at 208 volts. Electricity cost an average $0.167 per kWh during fiscal year 2011. This all-in delivered cost includes demand, taxes and other charges. Peregrine uses $0.167/kWh in this report's analysis to convert projected units of electrical savings to cost savings.

All of the Town's school properties currently have exclusively oil-fired heating equipment. Oil is delivered on an as-needed basis to local storage tanks at the individual buildings. The average cost of oil during fiscal year 2011 was $2.45/gallon, which is the same value used in this report to convert units of projected fuel savings to cost savings.

The table summarizes fiscal year 2011 utility use data and calculates the Energy Use Index (EUI). The EUI uses total energy input in Btu's divided by building occupied square footage for each facility as a comparative performance metric. Information on buildings that were not included in our tours has been included in the table for comparative purposes.

Table 2 – Utility Use and EUI Summary

Bldg	Sq. Ft.	Elec. kWh	Oil Gal	Annual Cost	EUI[1]
Admin	29,700	316,000	9,200	$42,500	79.6
Catherine Kolnaski	61,600	583,000	13,300	$128,700	62.4
Charles Barnum ES	43,500	210,000	7,800	$56,000	41.5
Claude Chester ES	43,600	221,000	13,900	$71,100	62.0
Cutler MS	73,700	318,000	16,600	$62,800	46.2
Fitch HS	293,300	2,163,000	67,500	$335,900	57.4
Fitch MS	90,800	566,000	21,000	$149,900	53.6
Mary Morrisson ES	42,200	239,000	7,800	$60,800	45.0
Northeast Academy	55,300	480,000	11,400	$69,600	58.6
Pleasant Valley	33,700	266,000	9,800	$68,400	67.5
SB Butler	37,900	217,000	13,800	$51,100	70.5
West Side MS	76,000	409,000	27,100	$127,600	68.2

3.0 Facility Details and Observations

3.1 Barnum Elementary School

The Charles Barnum elementary school is located at 68 Briar Hill Road and totals 43,500 square feet. The split-level building was first opened in 1965 and was expanded in 1970. Otherwise, it remains architecturally original. Two portable classrooms were setup in 1990. There are currently 393 pre-kindergarten through fifth grade students enrolled at this school. The facility has approximately twenty-three classrooms, a multipurpose room (gymnasium/auditorium/cafeteria), and administrative offices.

Normal school hours are weekdays approximately 8:30 a.m. to 3:30 p.m. There are no afterschool programs or weekend activity. Custodial services are completed in evening. The school is shut down for the summer break.

<u>Building Envelope</u>

This facility is constructed of masonry block wall with brick veneer and flat built up and one pitched roof section. There is likely to be two or more inches of rigid foam insulation in the roofing. The nature of the insulation materials and its effectiveness in the walls are unknown. Singe pane windows are older casement type in aluminum frames. The windows appear to close properly, although thermally they are less than optimal. Exterior doors have miscellaneous gaps to the outside due to misalignment and/or lack of effective weather stripping. We do not have any construction information on the two "portable" classrooms, which are typically similar to mobile home construction and offer very poor insulation, windows, etc.

<u>HVAC</u>

The building is heated by hydronic Univents in classrooms and a roughly 3 hp H&V unit in the multipurpose room. The multipurpose room also has four ductless split A/C units. The small media center room has a single window A/C unit. There are several additional window A/C's and the Town may be installing additional units for classrooms. Portables (2) are served by rooftop DX unit with electric heating.

<u>Central Boiler Plant</u>

This school has a central hot water plant consisting of two original oil-fired HB Smith sectional boilers. Each boiler has nine sections. There aren't any nameplates on the boilers to determine size, which is estimated at roughly 1,500 MBH each. Heating hot water is distributed by one of two 3 hp Taco pumps (one standby) and a single 1 hp B&G pump. The electric motors on the pumps are very old.

The Alerton control systems turn off the boiler plant when it gets above 50F outside. The control system also applies a heating hot water temperature reset to lower distribution temperature when it is warmer outside.

Controls

As with all other school properties in Groton, Barnum is equipped with a centralized direct digital control (DDC) system by Alerton. The DDC system package communicates externally via the Internet and includes control of all major HVAC systems in the school including boiler plants, H&V unit, exhaust fans and occupied/unoccupied scheduling of existing pneumatic zones. Pneumatic thermostats and other components are regularly serviced and are reported to provide reasonably good temperature control.

The Alerton system effectively includes energy management strategies including equipment scheduling, night setback, and management of the boiler plant, including heating hot water reset. HVAC equipment is scheduled to run from 6:00 a.m. to 3 p.m. weekdays (7:30 a.m. to 2 p.m. for multipurpose H&V unit). The scheduling program includes an optimum start feature that calculates latest equipment start time to precondition the building so that it is comfortable when staff start to arrive at roughly 6:00 a.m. The unoccupied heating setback on the H&V unit is 55F.

The pneumatic system includes input from the Alerton for occupied/unoccupied scheduling. The unoccupied heating setpoint is intended to be 55F, which will vary given the inaccuracy of pneumatic controls. The system also includes mechanical occupied override timers in the mechanical room. There are two 1 hp instrument air compressors.

Domestic Water

This school has standard flow toilet and urinal fixtures. Domestic hot water is generated via newer Bock tank unit (50 gallons with 152 MBH oil-fired burner rated at 161 gph recovery).

Lighting

Lighting at this school was replaced within the last year, including T8 lamps and ballasts and motion sensors in classrooms and hallways. We believe that hallways generally have unnecessarily high light levels that can be reduced for savings. Also, a few incandescent lamps were noted in the hallway. There are no motion sensors in the bathrooms adjoining pre-kindergarten through 1st grade classrooms. The few exterior lights are on a dual photocell and timer control that turns on lights at dusk and turns them off again at around 11:30 p.m. and on again from about 5 a.m. to dawn.

Energy Efficiency Opportunities

This facility has a EUI of 42 kBtu/SF, which is exceptionally low, especially considering the age of the facility, poor windows and inefficient boilers. The EUI performance of this school

is a testament to Groton's excellent O&M practices. We also suspect that this building's Univents outside air dampers are sealed shut, which reduces energy use at the expense of indoor air quality. Ideas for efficiency improvement are summarized in the table on the next page. See Section 4 for descriptions of the ECMs.

Table 3.1-1 - Summary of Recommended ECMs for Barnum Elementary School

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings				Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr					
1 Reduce Hallway Light Level	LIGHTING	$0	$0	2	6,000		(70)	$800				-
3 Replace Incandescent / Halogen Lighting	LIGHTING	$50	$0	-	600		-	$100	X			0.5
4 Update Fluorescent Lighting to Super T8s	LIGHTING	$20,000	$0	3	10,000		(120)	$1,400				14.3
6 Update Exterior Lighting to LED	LIGHTING	$3,000	$0	-	2,900		-	$480	X			6.3
7 Install Occupancy Sensor Control	LIGHTING	$500	$0	-	200		-	$30				16.7
9 Add Window A/C Wall Timers	CONTROLS	$1,000	$0	-	3,100		-	$500				2.0
10 Add VFD Controls to Pumps	CONTROLS	$4,000	$0	-	2,000		-	$330				12.1
13 Add DDC Thermostatic Control	CONTROLS	$80,000	$0	-	2,500		160	$800	X	X	X	100.0
16 Install Premium Efficiency Motors	HVAC	$1,000	$0	-	300		-	$50		X		20.0
20 Replace Boiler Plant	HVAC	$200,000	$0	-	-		230	$600	X	X		333.3
22 Attention to Exterior Door Seals	ENVELOPE	$1,000	$0	-	-		50	$120			X	8.3
24 Replace Windows	ENVELOPE	$500,000	$0	-	-		500	$1,200		X	X	416.7
TOTAL		***$810,550***	***$0***	***5***	***27,600***	***-***	***750***	***$6,410***				***126.5***

3.2 Chester Elementary School

The Claude Chester elementary school is located at 1 Harry Day Drive and totals 43,600 square feet. The single-level building was first opened in 1952 and was expanded in 1956 and 1965. There are 335 kindergarten through fifth grade students enrolled at this school this year. The facility has approximately twenty-seven classrooms, a multipurpose room with adjacent kitchen, and administrative offices.

Normal school hours are weekdays approximately 8:30 a.m. to 3:30 p.m. However, there are some afterschool programs, and it is common for a small portion of students and staff to remain in the building until approximately 6 p.m. The custodial staff complete their work by around 11 p.m. The recreation department operates programs in the school during the summer, although use of the facility is generally light.

Peregrine was asked to assume that Chester School would remain in service for at least 10 years. Groton's current long-term facility plans call for replacement of the Chester school as a more cost effective option than making needed building renovations.

Building Envelope

This facility is constructed of masonry block wall with brick veneer and flat built up and one pitched roof section. There is believed to be two inches or more of rigid foam insulation in the roofing. We suspect there is no wall insulation in this older building. All windows were replaced in 2008 and are casement type in metal frames with thermal glazing. Exterior doors have some gaps to the outside due to misalignment and/or lack of effective weather stripping.

HVAC

The original building uses steam-fired unit ventilators. The 1965 wing has a hydronic system with hot water units. There are a few split units providing air conditioning to administrative offices. The Town is in the process of installing additional ductless splits.

Central Boiler Plant

This school has a central steam plant consisting of two 20-year-old Weil McLain sectional oil-fired low-pressure boilers. Each has 1 hp Carlin burner. There are no nameplates on boiler equipment to determine size. The boilers are opened annually and are reported to be in good serviceable condition. Heating hot water for the 1965 wing is supplied by steam to hot water exchanger and pumped by one of two 3 hp constant speed centrifugal pumps. The pumps are old with inefficient motors and there isn't any pipe insulation in the vicinity of the pumps.

Domestic hot water is generated indirectly via integral heat exchangers in the boilers. Since there is also an independent source of domestic hot water, the steam plant is not run except when needed to heat the building.

The Alerton control system turns off the boiler plant when it gets above 52F outside. The control system also applies a heating hot water temperature reset to lower distribution temperature when it is warmer outside.

Controls

As with all other school properties in Groton, Chester is equipped with a centralized direct digital control (DDC) system by Alerton. The DDC system package communicates externally via the Internet and includes control of all major HVAC systems in the school including boiler plant, exhaust fans and occupied/unoccupied scheduling of existing pneumatic zones. Pneumatic thermostats and other components are regularly serviced and are reported to provide reasonably good temperature control.

The Alerton system effectively includes energy management strategies including equipment scheduling, night setback, and management of the boiler plant, including heating loop temperature reset. The pneumatic system includes input from the Alerton for occupied/unoccupied scheduling. The system also includes mechanical override timers in the mechanical room. The unoccupied heating setpoint standard is reported to be 55F.

Domestic Water

This school has standard flow toilet and urinal fixtures. Domestic hot water is generated indirectly off the main boilers, which is backup by a Bock tank unit (67 gallon with 242 MBH oil-fired burner rated at 258 gph recovery).

Lighting

Lighting in the school was replaced in 2004-2007 as part of a ceiling update project. Fixtures employ T8 lights, and all T12 systems were reported to have been replaced. There are T5s in the multipurpose room that have integral motion sensors. Otherwise, there are no motion sensors in use at this school. Parking lots are lit with about six cobra head style pole lights that are scheduled to run in the evening and dawn period.

Kitchen

This school has a small kitchen. The propane range has six burners, each with standing pilot. Gas service was reported to be turned off for the summer. The kitchen hood exhaust fan is controlled by wall switch and is active from roughly 6 a.m. to 1 p.m. or later. There are no walk-in coolers.

Energy Efficiency Opportunities

This facility has a EUI of 62 kBtu/SF, which is decent performance for an elementary school in this region. However, this EUI is on the high side compared to the other elementary schools in Groton. We identified several areas for efficiency improvement that are summarized in the table on the next page. See Section 4 for descriptions of the ECM.

Table 3.2-1 - Summary of Recommended ECMs for Chester Elementary School

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings				Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr					
4 Update Fluorescent Lighting to Super T8s	LIGHTING	$20,000	$3,000	3	10,000		(120)	$1,400				12.1
6 Update Exterior Lighting to LED	LIGHTING	$3,000	$0	-	2,900		-	$480	X			6.3
7 Install Occupancy Sensor Control	LIGHTING	$12,000	$4,000	4	13,000		(160)	$1,800				4.4
10 Add VFD Controls to Pumps	CONTROLS	$4,000	$0	-	1,900		-	$320				12.5
13 Add DDC Thermostatic Control	CONTROLS	$90,000	$0	-	3,000		300	$1,200	X	X	X	75.0
15 Update Pipe Insulation	HVAC	$1,000	$0	-	-		50	$100				10.0
16 Install Premium Efficiency Motors	HVAC	$1,000	$0	-	300		-	$50		X		20.0
17 Steam Trap Replacement	HVAC	$10,000	$0	-	-		200	$500				20.0
20 Replace Boiler Plant	HVAC	$200,000	$0	-	-		500	$1,200	X	X		166.7
21 Convert from Steam to Hot Water Heating	HVAC	$500,000	$0	-	-		300	$700	X	X	X	714.3
22 Attention to Exterior Door Seals	ENVELOPE	$1,000	$0	-	-		50	$120			X	8.3
TOTAL		***$842,000***	***$7,000***	***7***	***31,100***	***-***	***1,120***	***$7,870***				***106.1***

3.3 Cutler Middle School

The Carl C. Cutler middle school is located at 160 Fishtown Road in Mystic. The single level building totals 73,700 square feet and was originally built in 1960. There were additions in 1962 and 1968. Boilers and other systems in the building were recently modernized.

There are currently 355 sixth through eighth grade students enrolled in this school. The number of students will increase considerably next year due to the middle school consolidation resulting from Town's decision to close Fitch Middle School. The facility has approximately thirty-three classrooms, a multifunction room (gymnasium/auditorium/cafeteria), and administrative offices.

Normal school hours are weekdays approximately 8:00 a.m. to 2:30 p.m. However, staff begin to arrive as early as 6 a.m. and recreational programs wind down as late at 9 p.m. Custodial services are typically completed by 11 p.m. In the winter, the gym and locker areas are often in use from 8 a.m. to 8 p.m. There are also several summer programs that include use of the gym and several classrooms. Unused parts of the building are shut down for the summer, except as needed for summer maintenance projects.

<u>Building Envelope</u>

This facility is constructed of masonry block wall with brick veneer and flat built up roof sections. When roofing membrane on older sections of the building were last replaced, rigid insulation board was added. The nature of insulation materials and its effectiveness in the walls of older parts of the building are unknown. Casement windows are single pane in old metal frames and thermally are very poor. Shades are drawn by custodial staff at the end of each school day to help reduce heat loss. There are skylights in most major hallways. Those exterior doors checked during our tour closed tightly and had effective weather seals. We recommend checking all doors, as wear is inevitable and continuous diligence is required to keep doors tight.

<u>HVAC</u>

This school has simple mechanical systems consisting of hydronic unit ventilators in classrooms and H&V units serving the multipurpose room and media center. The media center is air conditioned by six ductless split units. Administrative areas are also equipped with ductless splits and several window A/C units. Classroom Univents are original Trane units. These older pneumatic units have received maintenance attention over the years and are thought to be in reasonable condition. We were told that that the majority of the Univents outside air dampers have been sealed closed. This is not a recommended practice and could result in indoor air quality issues. This lack of ventilation air may partially explain the very low fuel use at this school.

Central Boiler Plant

Two oil-fired Buderus sectional boilers that were installed in 2010 generate heating hot water. Each boiler is rated at 2,202 MBH. There is a 10,000-gallon above ground oil tank on the premises. Heating hot water is circulated by one of two 15 hp variable speed Taco centrifugal pumps that were installed in 2008. Only one pump runs at a time. The Alerton control system manages boiler operations, including start/stop and hot water reset based on outside conditions. This plant is in excellent condition and is very well operated.

Controls

Cutler Middle School is equipped with a centralized direct digital control (DDC) system by Alerton. The DDC system package communicates externally via the Internet and includes control of all major HVAC systems in the school including boiler plants, and occupied/unoccupied scheduling of existing pneumatic zones (6). Pneumatic thermostats and other components on the Univents and H&Vs are regularly serviced and are reported to provide reasonably good temperature control.

The Alerton system effectively includes energy management strategies including equipment scheduling, night setback, and management of the boiler plant, including heating hot water reset. HVAC equipment is scheduled to run from 6 a.m. to 4 p.m. weekdays. The scheduling program includes an optimum start feature that calculates latest equipment start time to precondition the building so that it is comfortable when staff start to arrive at 6 a.m.

The pneumatic system includes input from the Alerton for occupied/unoccupied scheduling. The system also includes mechanical override timers in the mechanical room. When additional HVAC service is required, for example in the gym area on a Saturday, custodial staff activate the timers which provide HVAC service for up to eight hours after which time the systems revert to unoccupied status.

Domestic Water

This school has standard flow toilet and urinal fixtures. Domestic hot water is generated by a Bock tank unit (91 gallon, 415 MBH oil burner rated at 443 gph recovery).

Lighting

Most of the lighting in this school is newer or has recently been updated with new T8 lamps and ballasts. The multipurpose room has new T5 lights with integral motion sensors. Hallways are excessively lit on bright days and are excellent candidates for daylighting controls. All classrooms, hallways and other areas are equipped with motion sensors. All exterior lights are on a dual photocell and timer control that turns on lights at dusk and turns them off again at around 11:30 p.m. and on again from about 5 a.m. to dawn.

Kitchen

The kitchen uses propane-fired appliances. The range has 10 burners, each with its own pilot. The kitchen is shut down and pilot lights are extinguished during the summer break. The kitchen hood exhaust fan is controlled by wall switch. The dishwasher does not have a dedicated exhaust. There is a walk-in freezer with new refrigeration components. There are plans to install a new walk-in freezer and convert the current freezer to a cooler.

Energy Efficiency Opportunities

This facility has a EUI of 46 kBtu/SF, which is exceptional performance for this older building and is one of the lowest energy use densities we've seen for a middle school. New boilers and other systems are certainly contributing to efficient operations. We identified several areas that could contribute to additional moderate savings that are summarized in the table on the next page.

Table 3.3-1 - Summary of Recommended ECMs for Cutler Middle School

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings				Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr					
4 Update Fluorescent Lighting to Super T8s	LIGHTING	$40,000	$6,000	6	20,000		(240)	$2,800				12.1
6 Update Exterior Lighting to LED	LIGHTING	$3,000	$0	-	2,900		-	$480				6.3
8 Daylighting Control	LIGHTING	$3,500	$0	-	3,700		(50)	$500				7.0
9 Add Window A/C Wall Timers	CONTROLS	$500	$0	-	2,000		-	$330				1.5
14 Walk-in Evaporator Control & ECM Motors	CONTROLS	$5,000	$1,000	1	3,900		-	$700				5.7
22 Attention to Exterior Door Seals	ENVELOPE	$2,000	$0	-	-		90	$220			X	9.1
24 Replace Windows	ENVELOPE	$800,000	$0	-	-		1,000	$2,400	X	X	X	333.3
TOTAL		***$854,000***	***$7,000***	***7***	***32,500***	***-***	***800***	***$7,430***				***114.0***

3.4 Fitch High School

The Robert E. Fitch High School is located at 101 Groton Long Point Road and totals 293,300 square feet. The building was first opened in 1955 and has had multiple additions and renovations (1958, 1971, 1982, 1989). Most recently (2007), an 119,000 square foot three-level academic wing was added, along with a new central heating plant and additional enhancements throughout the school.

There are 1,240 students enrolled in this school. The facility has approximately eighty classrooms, two gymnasiums, cafeteria, auditorium, and administrative offices.

Normal school hours are weekdays approximately 7:15 a.m. to 2:15 p.m. However, staff begin to arrive as early as 6 a.m. and there are extensive afterschool programs and activities with students and staff remaining in the building into the late afternoon evening. There are occasional special events (dances, performances, etc.), which may take place until midnight or even later. Custodial services are typically completed by 11 p.m. On weekends, particularly during the winter, there are athletic and community events which require parts of the building to be open. There are also several summer programs and roughly 30 percent of the building is air conditioned for the summer. Building staff joke that this is almost a 24/7 facility.

<u>Building Envelope</u>

This facility is constructed of masonry block wall with brick veneer and flat built up roof sections. When roofing membranes on older sections of the building were last replaced, rigid insulation board was added. In some areas thickness is substantial to create pitch. The nature of insulation materials and its effectiveness in the walls of older parts of the building are unknown. Due to recent construction, it is assumed that the Academic wing has effective insulation and vapor barrier materials in place that are in compliance with current energy code requirements. Windows are newer casement type in metal frames with thermal glazing and appear to be in good condition. Exterior doors are a mix of newer and older metal units. Many of the public doors and especially service doors have significant gaps to the outside due to misalignment and/or lack of effective weather stripping.

<u>HVAC</u>

Groton's high school has a variety of space heating and air conditioning systems. Central air conditioning via two rooftop units and two energy recovery ventilation units is provided to the entire new academic wing. Classrooms in the north section of the older building are conditioned via multizone with split DX coil. There are a number of additional units (see table below). Classrooms also have radiant ceiling heat above windows.

Table 3.4-1 – Air Handler Design Details

Unit	Serves	Type	HP	VFD?	CFM	Clg ton	Htg MBH
AHU-1	New Bldg CRs	VAV	25	Yes	24,000	59	911
AHU-2	New Bldg CRs	VAV	25	Yes	24,000	59	911
DOA-1	Science Wing	HRV	30/7.5	Yes	17,000	68	930
DOA-2	Science Wing	HRV	30/7.5	Yes	17,000	68	930
AHU-3	Café	CV	5	No	6,000	28	500
AHU-4	Kitchen	CV	5	No	6,400	30	500
AHU-5	Auditorium	CV	15	No	15,600	56	750
AHU-6	Auditorium	CV	15	No	15,600	56	750
AHU-11	Media Center?	Unconfirmed	7.5	No	12,000	27	480
AHU-13	New Gym	H&V	10/5	No	20,000	-	500
AHU-14	Locker Room	MUA	1.5	No	3,000	-	100
AHU-15	Old Gym	H&V	~1.5	No	10,000	-	300
AHU-16	Old Gym	H&V	~1.5	No	10,000	-	300
N/A	Old section CRs	Multizone	5	No	N/A	DX	N/A

Central Boiler Plant

Two oil-fired Smith sectional boilers in the new central mechanical room generate heating hot water for the entire building. Each boiler is rated at 5,394 MBH and has a 5 hp burner. There is a 12,000-gallon oil tank on the premises. The heating hot water loop is primary/secondary with three 5 hp primary pumps and three 30 hp secondary pumps. All hot water pumps are controlled by variable speed drive. The Alerton control system manages the boiler plant, including shutting it down when ambient temperature exceeds 60F, and adjusting distribution temperature setpoint depending on outside conditions and if the building is in unoccupied mode.

Central Chiller Plant

An air-cooled 185 ton packaged rooftop chiller supplies chilled water to the new academic wing. Chilled water is distributed by two 30 hp and two 40 hp pump centrifugal pump sets (second pump is for standby service). Distribution temperature is generally around 44F.

The system is equipped with eight-ice storage tanks rated at 320 ton-hours each. The ice system is short of capacity and reportedly cannot carry the building for the day in hot weather. The utility rate structure has also been changed since the project was designed and is reported to be much less favorable for load shifting to off-peak periods (Peregrine did not review electric rate details). Under these circumstances, it may no longer make sense to use the ice system as designed since the operating efficiency of the plant in ice-making mode is less than when it generates 44F-chilled water.

Controls

As with all other school properties in Groton, the high school is equipped with a centralized direct digital control (DDC) system by Alerton. This is an excellent control system that is very well managed.

The DDC system package communicates externally via the Internet and includes control of all major HVAC systems in the school including boiler and chiller plants, air handlers, A/C units, exhaust fans, etc. For the most part, this building is reported to be comfortable with adequate HVAC control. The only problem reported is difficulty with solar gain in areas of the building with southern exposure; these areas get hot, particularly in the summer.

The Alerton system effectively includes energy management strategies including equipment scheduling, night setback, air handler supply air temperature reset, free-cooling economizer activation, demand control ventilation and heating hot water reset, including a more aggressive setback for unoccupied periods. The heating/cooling setback temperature in zones was confirmed to typically be 55/78°F respectively. HVAC is generally scheduled to run from 5:30 a.m. to 8 p.m. weekdays and as required for night or weekend activity. The Alerton system is setup with an optimum start feature to minimize equipment run time, but also to ensure that the building is comfortable when scheduled to open.

Domestic Water

This school has standard flow toilet and urinal fixtures, even in the new part of the building. Domestic hot water is generated by two A.O. Smith tank units (300 gallons each with 1,250 MBH oil-fired burners).

Lighting

Most of the lighting in this school is newer or has recently been updated with new T8 lamps and ballasts. The gyms (2) each have twenty-four 400-watt metal halide ceiling fixtures. The main atrium also has metal halide fixtures, including wall wash applications. The auditorium has roughly ninety par 38 and a hundred and twenty five 500-watt dimmable incandescent recessed fixtures. A number of lighting specialists have reviewed the 500-watt application and cannot come up with a solution using LED or CLF technology. Hallways light levels are somewhat higher than necessary, and there are several areas on the southern side of the building and in stairwells where daylighting controls could be employed. There are motion sensors in use in appropriate areas in the building.

Parking lots are lit with roughly 50 metal halide pole fixtures. There are also at least four 400-watt metal halide exterior lights on the building. All exterior lights are on a dual photocell and timer control that turns on lights at dusk and turns them off again at around 11:30 p.m. and on again from about 5 a.m. to dawn.

Kitchen

The kitchen uses propane-fired appliances. The kitchen make-up air and hood exhaust fan run together off a wall switch. The dishwasher does not have a dedicated exhaust. There is a walk-in cooler and freezer. All equipment in the kitchen is newer and appears to be in good condition. We did note a problem with the walk-in freezer door seal, which had an abundance of condensate forming on the outside of the corner of the door.

Energy Efficiency Opportunities

The high school has a EUI of 57 kBtu/SF. This value indicates excellent performance for a busy school with extensive air conditioning and afterschool and summer programs. We identified many areas for efficiency improvement that are summarized in the table on the next page and described in Section 4.

Table 3.4-2 - Summary of Recommended ECMs for Fitch High School

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings				Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr					
1 Reduce Hallway Light Level	LIGHTING	$0	$0	4	12,000		(150)	$1,600				-
3 Replace Incandescent / Halogen Lighting	LIGHTING	$150,000	$50,000	50	70,000		(500)	$10,500	X			9.5
4 Update Fluorescent Lighting to Super T8s	LIGHTING	$200,000	$30,000	30	110,000		(1,000)	$15,900				10.7
5 Replace High Bay Metal Halide with T5	LIGHTING	$20,000	$6,000	6	26,000		(320)	$3,600				3.9
6 Update Exterior Lighting to LED	LIGHTING	$40,000	$0	-	40,000		-	$6,700				6.0
8 Daylighting Control	LIGHTING	$2,000	$0	-	2,700		(30)	$380				5.3
11 Add VFD Controls to Fans	CONTROLS	$25,000	$5,000	-	20,000		-	$3,340				6.0
12 Add Demand Control Ventilation	CONTROLS	$8,000	$500	-	10,000		500	$2,900				2.6
14 Walk-in Evaporator Control & ECM Motors	CONTROLS	$5,000	$1,000	-	5,000		-	$800				5.0
16 Install Premium Efficiency Motors	HVAC	$5,000	$0	1	3,700		-	$600		X		8.3
18 Convert to Natural Gas	HVAC	$30,000	$0	-	-	(97,000)	69,000	$70,000		X		0.4
22 Attention to Exterior Door Seals	ENVELOPE	$2,500	$0	-	-	200	-	$200			X	12.5
TOTAL		***$487,500***	***$92,500***	***91***	***299,400***	***(96,800)***	***67,500***	***$116,520***				***3.4***

3.5 Morrisson Elementary School

The Mary Morrisson Elementary School is located at 154 Toll Gate Road and totals 42,200 square feet. The single level building was first opened in 1963 and remains largely original. Two portable classrooms were setup in 1990. There are currently 372 pre-kindergarten through fifth grade students enrolled at this school. The facility has approximately twenty-six classrooms, a multipurpose room (gymnasium/auditorium/cafeteria), and administrative offices.

Normal school hours are weekdays approximately 8:00 a.m. to 3:10 p.m. There are no afterschool programs or weekend activity. Custodial services are completed in evening. The school is shut down for the summer break.

Building Envelope

This facility is constructed of masonry block wall with brick veneer and flat built up and one pitched roof section. There is likely to be two or more inches of rigid foam insulation in the roofing. The nature of insulation materials and its effectiveness in the walls are unknown. Singe pane windows are older casement type in fairly rough condition, without effective seals. The windows appear to close properly, although they are thermally less than optimal. Unlike many of the other schools in Groton, Morrisson does not have hallway skylights. Exterior doors have miscellaneous gaps to the outside due to misalignment and/or lack of effective weather stripping. At the main entrance, there is space for an inner vestibule. We do not have any construction information on the two "portable" classrooms, which typically are built using mobile home construction methods and have very poor thermal performance.

HVAC

The building is heated by hydronic Univents in classrooms and a roughly 3 hp H&V unit in the multipurpose room. The multipurpose room also has four ductless split A/C units. There are two additional splits, one serving a data closet near the kitchen. The media center has a window A/C unit. There are several additional window A/C's and the Town may be installing additional units for classrooms. Portable classrooms (2) each have a rooftop DX unit with electric heating.

Central Boiler Plant

This school has a central hot water plant consisting of two original oil-fired HB Smith sectional boilers. Each boiler is rated at 1,885 MBH each. Heating hot water is distributed by one of two 3 hp Taco pumps. The electric motors on the pumps are very old. The second pump is for standby service. The boilers are in use or standby year-round to supply domestic hot water via an indirect tank. The Alerton control system applies a heating hot water temperature reset to lower distribution temperature when it is warmer outside.

Controls

As with all other school properties in Groton, Morrisson is equipped with a centralized direct digital control (DDC) system by Alerton. The DDC system package communicates externally via the Internet and includes control of all major HVAC systems in the school including boiler plants, H&V unit, exhaust fans and occupied/unoccupied scheduling of existing pneumatic zones. Pneumatic thermostats and other components are regularly serviced and are reported to provide reasonably good temperature control.

The Alerton system effectively includes energy management strategies including equipment scheduling, night setback, and management of the boiler plant, including heating hot water reset. The controls setup for this building is exactly the same as Barnum so we elected to not review it.

The pneumatic system includes input from the Alerton for occupied/unoccupied scheduling. The unoccupied heating setpoint is intended to be 55F, which will vary given the inaccuracy of pneumatic controls. The system also includes mechanical occupied override timers in the mechanical room. There are two 1 hp instrument air compressors with Hankison refrigerated compressed air drier.

Domestic Water

This school has standard flow toilet and urinal fixtures. Domestic hot water is generated indirectly off the main heating boiler, which are required to run beyond the heating season period to provide hot water to the kitchen and bathroom sinks.

Lighting

About half the lighting in this school is older T12, including "U" lamps and eight-foot fixtures. Hallways are generally excessively bright. There are no motion sensors in use at this school. The few exterior lights are on a dual photocell and timer control that turns on lights at dusk and turns them off again at around 11:30 p.m. and on again from about 5 a.m. to dawn.

Kitchen

The kitchen at Morrisson is limited to serving only; there is no cooking at this facility. There is limited kitchen equipment and no walk-in refrigeration.

Energy Efficiency Opportunities

Morrisson has a EUI of 45 kBtu/SF, which is excellent performance. We identified many areas for moderate efficiency improvement that are summarized in the table on the next page.

Table 3.5-1 - Summary of Recommended ECMs for Morrisson Elementary School

	ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings				Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
					Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr					
1	Reduce Hallway Light Level	LIGHTING	$0	$0	1	4,200		(50)	$580				-
2	Update T12 lamps to T8	LIGHTING	$19,000	$0	10	27,000		(250)	$3,900				4.9
4	Update Fluorescent Lighting to Super T8s	LIGHTING	$17,000	$0	3	9,000		(80)	$1,300				13.1
6	Update Exterior Lighting to LED	LIGHTING	$3,000	$0	1	2,900		-	$480	X			6.3
7	Install Occupancy Sensor Control	LIGHTING	$15,000	$0	-	20,000		(180)	$2,900				5.2
9	Add Window A/C Wall Timers	CONTROLS	$500	$0	-	1,600		-	$270				1.9
10	Add VFD Controls to Pumps	CONTROLS	$4,000	$0	-	1,600		-	$270				14.8
13	Add DDC Thermostatic Control	CONTROLS	$90,000	$0	-	4,000		120	$1,000	X	X	X	90.0
16	Install Premium Efficiency Motors	HVAC	$1,400	$0	-	700		-	$120		X		11.7
19	Replace Domestic Hot Water System	HVAC	$10,000	$0	-	-		160	$400	X			25.0
20	Replace Boiler Plant	HVAC	$150,000	$0	-	-		320	$800		X		187.5
22	Attention to Exterior Door Seals	ENVELOPE	$1,500	$0	-	-		70	$170			X	8.8
23	Add Entrance Vestibule	ENVELOPE	$15,000	$0	-	-		100	$240			X	62.5
24	Replace Windows	ENVELOPE	$500,000	$0	-	-		500	$1,200	X	X	X	416.7
	TOTAL		***$826,400***	***$0***	***15***	***71,000***	***-***	***710***	***$13,630***				***60.6***

3.6 Pleasant Valley Elementary School

The Pleasant Valley elementary school is located at 380 Pleasant Valley Road. The single level building was built in 1955 totals 33,700 square feet. There was a wing addition in 1960; otherwise the building's architecture remains mostly original. Two portable classrooms were setup in 1992 and another two added in 1994. There are currently 358 pre-kindergarten through fifth grade students enrolled at this school. The facility has approximately twenty-three classrooms, a multipurpose room (gymnasium/auditorium/cafeteria), and administrative offices.

Normal school hours are weekdays approximately 8:30 a.m. to 3:30 p.m. There is a kids club afterschool program that runs until 6 p.m. Custodial services are completed by 11 p.m. There is very little weekend activity and the school is shut down for the summer break.

Groton's long-term facility plans call for replacement of Pleasant Valley School rather than making major building renovations. Per direction from Groton, we have assumed that this school will remain in service for approximately 10 years.

<u>Building Envelope</u>

This facility is constructed of masonry block wall with brick veneer and flat built up sections. There is likely to be two or more inches of rigid foam insulation in the roofing. The nature of insulation materials and its effectiveness in the walls of this old building are unknown, if they're even is any. The "portable" classrooms likely don't have much wall or roof insulation. Casement windows were replaced in 2000 and include thermal panes in aluminum frames. Exterior doors have extensive gaps to the outside due to misalignment and/or lack of effective weather stripping.

<u>HVAC</u>

The building is heated by a mix of steam and hydronic Univents in classrooms and in the multipurpose room. Administration and several classrooms have window A/C units. The Town plans to install window A/C units in all classrooms this year. Classroom A/C is not expected to be active outside of the normal school year and thus use is expected to be fairly low. The portable classrooms have rooftop DX units with electric heating.

<u>Central Boiler Plant</u>

This school has a central steam plant consisting of two original oil-fired HB Smith sectional boilers. Each boiler is rated at 2,669 MBH and has a Carlin burner. There is a heat exchanger that generates heating hot water for a portion of the building. Hot water is distributed by one of two constant speed 2 hp centrifugal pumps (one pump is standby). Domestic hot water is generated indirectly off the steam boilers, which are required to run beyond the normal heating season to generate hot water for the kitchen and bathroom sinks.

The Alerton control system applies a heating hot water temperature reset to lower distribution temperature when it is warmer outside.

Controls

Pleasant Valley is equipped with a centralized direct digital control (DDC) system by Alerton. The DDC system package communicates externally via the Internet and includes control of all major HVAC systems in the school including boiler plants, exhaust fans and occupied/unoccupied scheduling of existing pneumatic zones. Pneumatic thermostats and other components are regularly serviced and are reported to provide reasonably good temperature control.

The Alerton system effectively includes energy management strategies including equipment scheduling, night setback, and management of the boiler plant, including heating hot water reset. HVAC equipment is scheduled to run from 6:00 a.m. to 3 p.m. weekdays. The scheduling program includes an optimum start feature that calculates latest equipment start time to precondition the building so that it is comfortable when staff start to arrive in the morning.

The pneumatic system includes input from the Alerton for occupied/unoccupied scheduling. The unoccupied heating setpoint is intended to be 55F, which will vary given the inaccuracy of pneumatic controls. The system also includes mechanical occupied override timers in the mechanical room. There are two 1½ hp instrument air compressors.

Domestic Water

This school has standard flow toilet and urinal fixtures. Domestic hot water is generated indirectly via heat exchanger in steam boilers. There is no insulation on domestic hot water piping in the boiler room.

Lighting

This school is a prime candidate for lighting work. Lighting in the original part of the building was updated to T8s in 1998 when ceilings were replaced. Other areas of the building have not been updated for some time and include T12 fluorescent lighting and a few incandescent lights. There are no motion sensors in use.

Kitchen

The kitchen uses propane-fired appliances. The range has eight burners, each with pilot light. Gas service to the kitchen is reported to be shut down for the summer recess. The kitchen hood exhaust fan is controlled by wall switch. The dishwasher does not have a dedicated exhaust. There are no walk-in refrigeration units at this school.

Energy Efficiency Opportunities

This facility has a EUI of 68 kBtu/SF, which is good performance for a school in the region. However, Pleasant Valley ranks 9th out of the 11 Groton schools for energy intensiveness. Identified areas for efficiency improvement are summarized on the next page and described in section 4.

Table 3.6-1 - Summary of Recommended ECMs for Pleasant Valley Elementary School

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings				Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr					
2 Update T12 lamps to T8	LIGHTING	$15,000	$0	10	23,000		(210)	$3,300	X	X		4.5
3 Replace Incandescent / Halogen Lighting	LIGHTING	$100	$0	-	1,100		(10)	$160	X			0.6
4 Update Fluorescent Lighting to Super T8s	LIGHTING	$15,000	$0	-	10,000		(90)	$1,500				10.0
6 Update Exterior Lighting to LED	LIGHTING	$3,000	$0	1	2,900		-	$480	X			6.3
7 Install Occupancy Sensor Control	LIGHTING	$15,000	$0	-	20,000		(180)	$2,900				5.2
9 Add Window A/C Wall Timers	CONTROLS	$1,000	$0	-	2,600		-	$430				2.3
13 Add DDC Thermostatic Control	CONTROLS	$80,000	$0	-	3,500		250	$1,200	X	X	X	66.7
16 Install Premium Efficiency Motors	HVAC	$600	$0	-	300		-	$50		X		12.0
17 Steam Trap Replacement	HVAC	$10,000	$0	-	-		200	$500		X		20.0
19 Replace Domestic Hot Water System	HVAC	$10,000	$0	-	-		200	$500	X			20.0
20 Replace Boiler Plant	HVAC	$150,000	$0	-	-		400	$1,000	X	X	X	150.0
21 Convert from Steam to Hot Water Heating	HVAC	$250,000	$0	-	-		500	$1,200	X	X	X	208.3
22 Attention to Exterior Door Seals	ENVELOPE	$1,000	$0	-	-		110	$270			X	3.7
TOTAL		***$550,700***	***$0***	***11***	***63,400***	***-***	***1,170***	***$13,490***				***40.8***

3.7 S. B. Butler Elementary School

The S. B. Butler Elementary School is located at 155 Ocean view Avenue and totals 37,900 square feet. The split-level building was first opened in 1952 and was expanded in 1962. Three portable classrooms were added in 1993; otherwise the school remains in its original configuration. There are currently 321 kindergarten through fifth grade students enrolled at this school. The facility has approximately twenty-seven classrooms, a gym/auditorium, administrative offices, and a basement level cafeteria and kitchen.

Normal school hours are weekdays approximately 8:30 a.m. to 3:30 p.m. However, there are some afterschool programs, and it is common for a small portion of students and staff to remain in the building until approximately 6 p.m. The custodial staff complete their work by around 11 p.m. Use of the facility is very light in the summer and most areas are shutdown.

Groton's long-term facility plans call for replacement of this school as a less costly option than making repairs and major renovations. We are assuming that Butler will be in service for 10 years.

Building Envelope

The original facility is constructed of brick. Roof sections are flat with integral built up rigid insulation. There is unlikely to be any wall insulation. Most of the windows at this school are older single pane casement type in aluminum frames. These windows don't have seals and are thermally very poor. There are some newer windows including wooden double hung units with thermal panes. There are skylights over most hallways. Exterior doors appear to be in good condition, but many lack working weather seals.

HVAC

The original building uses steam-fired unit ventilators. The 1962 wing has a hydronic system with hot water units. The entire school is setup with window A/C units. Most of the building's air conditioning is shut down for the summer.

Central Boiler Plant

This school has a central steam plant consisting of two original HB Smith section boilers. Each low-pressure boiler is rated at 1,950 MBH and has a Carlin oil burner. The boilers are being replaced this summer (2012). Steam traps in the distribution system are generally serviced upon failure.

Heating hot water for the 1962 wing is supplied by a steam to hot water exchanger and pumped by one of two 3 hp constant speed centrifugal pumps. The pumps are old with inefficient motors and there is no pipe insulation in the vicinity of the pumps.

Domestic hot water is generated indirectly via integral heat exchangers in the boilers. As part of the boiler replacement project, a new independent domestic hot water heater will be installed.

The Alerton control system applies a heating hot water temperature reset to lower distribution temperature when it is warmer outside.

Controls

As with all other school properties in Groton, S. B. Butler is equipped with a centralized direct digital control (DDC) system by Alerton. The DDC system package communicates externally via the Internet and includes control of all major HVAC systems in the school including boiler plant, exhaust fans and occupied/unoccupied scheduling of existing pneumatic zones. Pneumatic thermostats and other components are regularly serviced and are reported to provide reasonably good temperature control.

The Alerton system effectively includes energy management strategies including equipment scheduling, night setback, and management of the boiler plant, including heating loop temperature reset. The pneumatic system includes input from the Alerton for occupied/unoccupied scheduling. The system also includes mechanical override timers in the mechanical room. The unoccupied heating setpoint standard is reported to be 55F.

Domestic Water

This school has standard flow toilet and urinal fixtures. Domestic hot water is generated indirectly off the main boilers. As mentioned, a new domestic hot water heater will be installed this summer.

Lighting

Lighting in the 1962 section of the building was replaced in 1998 as part of a ceiling replacement project. The gym has eight foot T12s. Additional T12s are expected in the building. All appropriate areas (classrooms, halls, etc.) have motion sensors installed. Parking lots are lit with about ten metal halide pole lights that are scheduled to run in the evening and pre-dawn periods.

Kitchen

This school has a small kitchen with all-electric cooking equipment. There is a new kitchen hood with wall exhaust fan switch. The fan is on whenever staff are working in the kitchen. There are no walk-in refrigeration units and no dishwasher.

Energy Efficiency Opportunities

S. B Butler has a EUI of 71 kBtu/SF, which is the highest of all the schools in Groton. Fuel use is abnormally high at 51 kBtu/SF. The new boilers and independent domestic hot water heaters being installed this summer should help to improve performance next year.

However, it should be noted that a EUI of 71 kBtu/SF is still better than average for the region. We identified several areas for efficiency improvement that are summarized on the following page and described in Section 4.

Table 3.7-1 - Summary of Recommended ECMs for S.B. Butler Elementary School

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings				Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr					
2 Update T12 lamps to T8	LIGHTING	$7,000	$3,000	3	10,000		(90)	$1,500		X		2.7
4 Update Fluorescent Lighting to Super T8s	LIGHTING	$21,000	$3,000	3	12,000		(110)	$1,700				10.6
6 Update Exterior Lighting to LED	LIGHTING	$8,000	$2,000	2	6,000		-	$1,000	X			6.0
8 Daylighting Control	LIGHTING	$3,500	$0	-	3,700		(50)	$500				7.0
9 Add Window A/C Wall Timers	CONTROLS	$1,500	$0	-	3,500		-	$600				2.5
10 Add VFD Controls to Pumps	CONTROLS	$4,000	$0	-	1,600		-	$270				14.8
13 Add DDC Thermostatic Control	CONTROLS	$90,000	$0	-	4,000		410	$1,700	X	X	X	52.9
15 Update Pipe Insulation	HVAC	$1,000	$0	-	-		50	$120			X	8.3
16 Install Premium Efficiency Motors	HVAC	$500	$0	-	300		-	$50		X		12.0
17 Steam Trap Replacement	HVAC	$10,000	$0	-	-		200	$500	X	X		20.0
22 Attention to Exterior Door Seals	ENVELOPE	$1,000	$0	-	-		50	$120			X	8.3
24 Replace Windows	ENVELOPE	$500,000	$0	-	-		500	$1,200	X	X	X	416.7
TOTAL		***$647,600***	***$8,000***	***8***	***41,100***	***-***	***960***	***$9,260***				***69.1***

3.8 West Side Middle School

The West Side Middle School is located at 250 Brandegee Avenue and totals 76,000 square feet. The split-level building was first opened in 1956 and was expanded in 1994. There are 267 students enrolled at this school this year. The facility has approximately thirty-four classrooms, a gymnasium/auditorium, cafeteria, and administrative offices.

Normal school hours are weekdays approximately 7:30 a.m. to 2:15 p.m. However, staff begins to arrive as early as 6 a.m. and there is a breakfast program that begins at 6:30 a.m. Roughly 50 to 70 students remain in the building during afternoons for recreational and other programs. Custodial services are typically completed by 11 p.m. Parks and Recreation use the facility on weekends and in the summer. After school programs usually retain use of the gym, cafeteria, health service offices, and up to six classrooms.

Building Envelope

This facility is constructed of masonry block wall with brick veneer and flat built up and pitched roof section. There is believed to be two inches or more of rigid foam insulation in the roofing. Some sections have considerably more insulation to create drainage pitch. The nature of insulation materials and its effectiveness in the walls of older parts of the building are unknown. Windows are newer (2001) casement type in metal frames with thermal glazing and appear to be in good condition. There are extensive skylights over hallways. Exterior doors have significant gaps to the outside due to misalignment and/or lack of effective weather stripping. At the main entrance, inner vestibule doors lack seals.

HVAC

The original building uses steam-fired unit ventilators. The 1994 wing has a hydronic system with hot water radiators. There are small three small DX rooftop units, plus a kitchen make-up air unit with steam coil and energy recovery ventilator for the newer classroom wing. The gym/auditorium has an older steam-fired H&V unit with roughly 3 hp fan motor. There is also a similar, but much smaller H&V for the stage area (approximately 1 hp). Air conditioning is limited to the administration area and media center. The Town may be installing window A/C for classrooms, but these units shouldn't see much use, as they will be shut down for the summer break.

Central Boiler Plant

This school has a central steam plant consisting of two HB Smith sectional oil-fired low-pressure boilers. Each has 1 hp Carlin burner and is rated at approximately 1,904 MBH. Heating hot water to the 1994 addition is circulated by one of two 7.5 hp centrifugal pumps (second pump is standby). The Alerton control system turns off the boiler plant when it gets above 50F outside. The control system also applies a heating hot water temperature reset to lower distribution temperature when it is warmer outside.

Controls

As with all other school properties in Groton, the West Side Middle School is equipped with a centralized direct digital control (DDC) system by Alerton. The DDC system package communicates externally via the Internet and includes control of all major HVAC systems in the school including boiler plants, rooftop units and occupied/unoccupied scheduling of existing pneumatic zones. Pneumatic thermostats and other components are regularly serviced and are reported to provide reasonably good temperature control.

The Alerton system effectively includes energy management strategies including equipment scheduling, night setback, and management of the boiler plant, including heating hot water reset. HVAC equipment is scheduled to run from 6 a.m. to 4 p.m. weekdays. The scheduling program includes an optimum start feature that calculates latest equipment start time to precondition the building so that it is comfortable when staff start to arrive at 6 a.m. Unoccupied setpoints were noted at 60F.

The pneumatic system includes input from the Alerton for occupied/unoccupied scheduling. The system also includes mechanical override timers in the mechanical room. When additional HVAC service is required, for example in the gym area on a Saturday, custodial staff activate timers, which provide HVAC service for up to eight hours; after that period, systems revert to unoccupied status.

Domestic Water

This school has standard flow toilet and urinal fixtures. Incoming water pressure is boosted via one of two 7.5 hp centrifugal pumps with discharge throttling control valve. Domestic hot water is generated by oil-fired tank unit. The domestic hot water system is scheduled to shut down when the school is unoccupied.

Lighting

Most of the lighting in this school is newer or has recently been updated with new T8 lamps and ballasts. The only T12 fluorescent lights observed were in the boiler room. Except for downlighting in the entrance canopy, we saw very few incandescent lights (kitchen hood and walk-in cooler). The gym/auditorium has twelve 400-watt metal halide ceiling fixtures. There are no motion sensors in use at this building.

Parking lots are lit with twelve fixtures that what appear to be high-pressure sodium. All exterior lights are on a dual photocell and timer control that turns on lights at dusk and turns them off again at around 11:30 p.m. and on again from about 5 a.m. to dawn. At the time of our visit, all exterior lights, including pole lamps and recessed fixtures, were on at 4 p.m. in bright daylight. We were told that the lights could have been in “test” mode to check for burned out lamps.

Kitchen

The kitchen at West Side is used to distribute to other schools in the region and thus sees fairly heavy use. The kitchen uses propane-fired appliances. The range has six standing pilots, which are extinguished for the summer. The kitchen hood exhaust fan is wall switch controlled. The dishwasher is in its own section across the hall from the kitchen and has its own exhaust. There is a walk-in cooler and freezer.

Energy Efficiency Opportunities

West Side has a EUI of 68 kBtu/SF. Fuel use is the dominant factor at 50 kBtu/SF. We have identified a number of opportunities to consider which are in the table on the next page and described in Section 4.

Table 3.8-1 - Summary of Recommended ECMs for West Side Elementary School

ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings				Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Provides Visual and/or Comfort Improvement	Simple Payback Yr
				Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr					
3 Replace Incandescent / Halogen Lighting	LIGHTING	$100	$0	-	1,400		(10)	$210	X			0.5
4 Update Fluorescent Lighting to Super T8s	LIGHTING	$50,000	$0	10	30,000		(300)	$4,300	X			11.6
5 Replace High Bay Metal Halide with T5	LIGHTING	$6,000	$0	-	6,000		(50)	$900	X		X	6.7
6 Update Exterior Lighting to LED	LIGHTING	$9,000	$0	2	7,000		-	$1,200	X			7.5
7 Install Occupancy Sensor Control	LIGHTING	$27,000	$0	-	40,000		(370)	$5,800				4.7
8 Daylighting Control	LIGHTING	$5,000	$0	-	5,000		(60)	$690				7.2
9 Add Window A/C Wall Timers	CONTROLS	$500	$0	-	2,100		-	$350				1.4
10 Add VFD Controls to Pumps	CONTROLS	$6,000	$0	-	3,300		-	$550				10.9
13 Add DDC Thermostatic Control	CONTROLS	$120,000	$0	-	3,600		700	$2,300				52.2
14 Walk-in Evaporator Control & ECM Motors	CONTROLS	$3,000	$0	1	3,900		-	$700				4.3
17 Steam Trap Replacement	HVAC	$15,000	$0	-	-		400	$1,000	X	X		15.0
20 Replace Boiler Plant	HVAC	$250,000	$0	-	-		1,000	$2,400	X	X		104.2
21 Convert from Steam to Hot Water Heating	HVAC	$500,000	$0	-	-		500	$1,200	X	X	X	416.7
22 Attention to Exterior Door Seals	ENVELOPE	$2,500	$0	-	-		110	$270				9.3
TOTAL		***$994,100***	***$0***	***13***	***102,300***	***-***	***1,920***	***$21,870***				***45.5***

4.0 Recommended Energy Conservation Measures (ECMs)

This section provides a brief description of each recommended ECM for Groton's school buildings.

LIGHTING

4.1 Reduce Hallway Light Level (Burnham, Fitch HS, Morrisson)

Many of the school facilities have brightly lit hallways, which is fairly common in schools. Current lighting standards set forth by Illuminating Engineering Society (IES) suggest 15 foot-candles in hallways. A number of our clients have successfully de-lamped hallway lighting to save energy. The reduced light output has not been a problem. We do not recommend lowering light level in areas with student lockers.

<u>Next Steps:</u> Confirm light level in hallways and areas where delamping could be implemented. Lamps can be pulled from individual fixtures (for example removing one lamp from one or two lamp fixtures), or every other fixture can be de-energized. It is not necessary to install "phantom" tubes where lamps have been removed with current electronic ballasts.

4.2 Update T12 lamps to T8 (Morrisson, Pleasant Valley, SB Butler)

The listed buildings contain older T12 florescent lighting lamps and ballasts. These buildings are served by Groton Utilities, which has historically not offered an incentive program for installing high efficiency lighting. We understand, the utility is now open to providing incentives on a custom basis, which should pursued. Under changes to federal law, this T12 product is to be discontinued and will not be available for purchase.

Significantly more efficient T8 lamp and ballast technology is available. Making the conversion is typically a simple swap of lights and ballasts, including cleaning or replacement of lenses as appropriate. In some cases, where there is an eight-foot fixture involved, new fixtures are generally recommended to standardize on four-foot lamps and to avoid the need to modify existing fixtures to accommodate different clip types for HO lamps.

<u>Next Steps:</u> Confirm quantity and wattage of existing lamps. We recommend using a qualified lighting contractor who will look at the existing lights and propose a fixed price T8 solution. The lighting contractor's proposal normally includes energy savings and other information, which will be of interest to Groton Utilities. We recommend pursuing all lighting updates as one contracted project to assure completeness and consistency of work and to generate economies of scale.

4.3 Replace Incandescent / Halogen Lighting (Burnham, Fitch HS, Pleasant Valley, West Side)

Almost all prior energy intensive incandescent and halogen lighting systems in Groton's properties have been replaced with more energy efficient compact fluorescent or other technologies. In our visits to the buildings, we did notice a few lingering light fixtures that should be updated as follows:

- Barnum: Several incandescent lights were noted in the main hallway. We recommend replacing these with comparable CFL lamps.
- Fitch High School: The auditorium has roughly ninety par 38 and a hundred and twenty five 500-watt dimmable incandescent recessed fixtures that are tremendously inefficient. Replacement of the lamps with LEDs is highly desirable since energy use and subsequent heat production will be much lower, but also for the extended lamp life in this particularly challenging to access ceiling area.

  A number of lighting specialists have reviewed the 500-watt application and cannot come up with an easy solution. The problem is that the deep fixtures will not accept LED replacement lamps and the fixtures are not readily accessible from above for replacement. To replace the fixture will require ceiling modifications and/or assembly of temporary scaffolding or other means to gain access to the top of the fixtures. We recommend reviewing the project with CL&P and their lighting specialists.
- Pleasant Valley: About half a dozen incandescent lights were noted in the building. We suspect they were installed replacing CFLs for which there may not have been a ready replacement available. We recommend replacing these with comparable CFL lamps (and keeping a stock of CFLs on site).
- West Side: Incandescent lamps were noted in the kitchen hood and walk-in cooler and freezer. We recommend replacing these with comparable CFL lamps (refrigerated space requires special cold temperature lamps).

Next Steps: Confirm quantity and wattage of existing lamps. We recommend using a qualified lighting contractor who will look at the existing lights and propose a fixed price CFL/LED solution. The lighting contractor's proposal normally includes energy savings and projected value of CL&P rebates. It is also customary for the lighting contractor to handle the paperwork associated with obtaining CL&P rebates. For all but the high school project, it will be possible for the Town to purchase replacement CLF and/or LED lamps and install with its own staff at a lower cost.

4.4 Update Fluorescent Lighting to Super T8s (All Properties)

The Town has made excellent progress updating fluorescent lighting to T8 systems in almost all its buildings. Standard 32-watt T8 lamps are in use. Current advances in "super T8" technology have made available 28 and even 25-watt lamps. This latest technology, which capitalizes on optimizing light color, combined with low-power ballasts and aggressive use of reflectors, can yield significant reductions from the current T8 standard (up to 20 percent reduction has been documented). We recommend considering updating to super T8s, if not now then within five years when lamp and ballasts are nearer the end of their expected service lives and group replacement of all components has a significant maintenance advantage.

Next Steps: Confirm quantity and wattage of existing lamps. As above, we recommend using a qualified lighting contractor who will look at the existing lights

and propose a fixed price super T8 solution. The lighting contractor's proposal normally includes energy savings and projected value of CL&P rebates. The Town will have to work with Groton Utilities to negotiate an incentive for some of the buildings. We recommend combining this work with all other lighting recommendations.

4.5 Replace High Bay Metal Halide with T5 (Fitch HS, West Side)

The listed schools have metal halide gymnasium lighting. This lighting technology requires about 5 minutes to "warm-up" before full light output is achieved and is not particularly efficient. T5 fluorescent lighting is preferred for this application because it is more efficient, doesn't require a warm-up period, and has very bright high quality lighting characteristics. Groton has already successfully updated Chester and Cutler's multi-purpose rooms with T5 fluorescent lighting, including integral motion controls. We recommend continuing with this standard at the larger gyms.

Next Steps: Confirm quantity and wattage of existing lamps. As above, we recommend using a qualified lighting contractor who will look at the existing lights and propose a fixed price T5 solution. The lighting contractor's proposal normally includes energy savings and projected value of CL&P incentives.

4.6 Update Exterior Lighting to LED (All Properties)

Exterior lighting systems at Groton's school properties include standard HID pole and side-light applications. All exterior lights are on a dual photocell and timer control that turns on lights at dusk and turns them off again at around 11:30 p.m. and on again from about 5 a.m. to dawn. We recommend considering updating to LED exterior lamps. The project may require the installation of new pole fixtures and could be expensive. However, LED manufacturers are getting very aggressive in developing new product to replace many old technology installations, and prices for LEDs are dropping very fast. There aren't any prescriptive utility incentives at this time, although there could be in the near future; or it may be possible to get a customized incentive based on actual savings. LEDs can result in 70% reductions in kWh use.

Next Steps: Confirm quantity and wattage of existing outside lamps. As above, we recommend using a qualified lighting contractor who will look at the existing lights and propose a fixed price exterior lighting options. This work should be combined with other lighting recommendations.

4.7 Install Occupancy Sensor Control for Lighting (Barnum, Chester, Morrisson, Pleasant Valley, West Side)

There is already widespread use of lighting motion control sensors in several of Groton's school buildings. Results have been very positive with noticeable electric bill impacts reported. There are additional opportunities to install more motion sensors as follows:

- Barnum: Add motion sensors in the kindergarten and 1st grade classroom bathrooms. If possible, tie the lighting control with toilet exhaust fan.

- Chester: Add lighting motion controls to classrooms, hallways and bathrooms.
- Morrisson: Add lighting motion controls to classrooms, hallways and bathrooms.
- Pleasant Valley: Add lighting motion controls to classrooms, hallways and bathrooms.
- West Side: Add lighting motion controls to classrooms, hallways and bathrooms.

Next Step: Conduct more detailed review of the above buildings and potentially others to decide which areas are suitable for occupancy sensors and develop a bill of materials for installations. As above, we recommend using a qualified lighting contractor who will provide this service at no cost and will subsequently generate a fixed price proposal for an engineered solution that may include other enhancements such as minor lighting updates, rewiring, etc. We recommend combining all lighting and lighting control work.

4.8 Daylighting Control (Cutler, Fitch HS, SB Butler, West Side)

The above schools are equipped with skylights over portions of hallways. Lighting in the immediate areas of the skylights is unnecessary during bright daylight hours. We recommend investigating the installation of "daylighting" controls, which are used to determine if there is sufficient ambient light and will cut electricity to lights when appropriate. Depending on the existing wiring configuration, this could be a very simple project, or it could involve some degree of rewiring.

Next Step: Conduct more detailed review of the lighting systems and wiring at above buildings to determine how to add daylighting controls. As above, we recommend using a qualified lighting contractor who will provide this service at no cost and will subsequently generate a fixed price proposal for adding controls.

CONTROLS

4.9 Add Window A/C Wall Timers (Barnum, Cutler, Morrisson, Pleasant Valley, SB Butler, West Side)

These properties have window air conditioning units that operate with integral thermostatic control. The window units are not necessarily being shut down at the end of school days in hot weather, or in some cases during the summer break. We recommend installing timer controllers, which plug into the wall socket and then the window unit is plugged into the timer. These devices are programmed to cut power to the A/C units during unoccupied periods and to restart air conditioning with enough time to precondition the space so it's comfortable when students and staff arrive in the morning,

Next Step: Consult with HVAC or controls specialist to price controllers. There a number of inexpensive models available. Once controllers are installed, confer with staff to learn how HVAC systems perform during the morning cool-down so that an appropriate start time can be programmed to ensure comfort when building occupants arrive in the morning.

4.10 Add VFD Controls to Pumps (Barnum, Chester, Morrisson, Butler, West Side)

Variable frequency drives (VFDs) are the most efficient way to unload pumping systems to match load requirements in the piping system served by the unit. VFDs work by reducing the frequency of alternating current feeding the motor. Since induction motor speed follows line frequency, the motor slows down. Power use goes down exponentially. For example, if a motor is slowed down by 15 percent, the power savings is roughly 32 percent. We recommend considering VFDs for hot water pumping systems at the above schools. Further review of the hot water systems is required, since many unit ventilators, radiators and air handler units are setup with constant flow coils with no valves or three-way valves. In these cases, new two-way valves will need to be installed, which can become cost prohibitive.

Next Step: Review hot water piping systems and end-use devices to see if they are compatible with a variable volume pumping system, i.e. use two-way control valves. Develop project requirement documentation for bid solicitation. This project can be pursued as design-build from qualified electrical, or controls contractors. CL&P offers incentives for pump VFDs and should be consulted before work is awarded.

4.11 Add VFD Controls to Fans (Fitch High School)

Continuing from above (4.10), VFDs are also the most efficient way to unload fan systems to match load requirements in the duct system served by the unit. At Fitch high school, we recommend adding VFDs to the auditorium units (AHU-5, -6) and the new gym unit (AHU-1). The VFDs should be controlled by schedule and temperature. In other words, the system slow down during periods when there are no activities scheduled and/or the space temperature is satisfied. Employing a demand control ventilation strategy tied to the VFDs can also be pursued (See Section 4.12 below). We recommend selection of VFD with line bypass so that the air--handling device can remain operational should the VFD fail. This is not necessary for pump sets or fan systems with redundancy.

Next Step: Develop project requirement documentation for bid solicitation. This project can be pursued as design-build from qualified electrical, or controls contractors. CL&P offers incentives for pump VFDs and should be consulted before work is awarded.

4.12 Demand Control Ventilation (Fitch High School)

Groton's school district's energy management system includes a demand control ventilation strategy on most of the significant air-handling units. Demand control ventilation employs carbon dioxide sensors in return air ducts, which provide input to the control system to make ventilation adjustments. When there is light occupancy in a space, CO2 levels drop and the system reduces the amount of outside air being brought into the building. This is the equivalent of closing open windows and can have a big impact of boiler and cooling loads and energy use in hot/cold weather. At the high school, we recommend adding demand control ventilation for the auditorium units (AHU-5, -6) and the new gym H&V unit.

Next Step: Consult with preferred control vendors for pricing to install demand control ventilation. We suggest coordinating this project with the VFD installation.

CL&P may offer an incentive for this installation and should be consulted before work begins.

4.13 Add DDC Thermostatic Control (Barnum, Chester, Morrisson, Pleasant Valley, S.B. Butler, West Side)

The schools listed above employ pneumatic thermostatic control in classrooms and other areas. Pneumatic systems are notoriously high maintenance and require considerable attention to keep running with any degree of accuracy. The pneumatic systems at Groton's schools include day/night settings and are diligently monitored and maintained. Also, boiler operations are curtailed during unoccupied periods. Therefore, there is limited potential to save energy by converting to direct digital control (DDC) throughout the buildings and eliminating the pneumatic systems. For buildings that will be kept long term, investing in DDC equipment is well worthwhile to reduce O&M liability and to ensure the schools are comfortable as parts availability and skilled resources to maintain the older systems diminish with time.

Next Step: Review long term plans for school buildings and capital investment plans for HVAC replacement. Converting to DDC at the same time unit ventilators and other unitary HVAC systems are replaced will be the most cost effective. Once plans have been established, develop project requirement documentation for a bid solicitation.

4.14 Walk-in Evaporator Control & ECM Motors (Cutler, Fitch HS, West Side)

The above schools have significant walk-in cooler/freezer boxes. Each has multiple fan evaporator unit. Almost all older evaporator fan motors are standard shaded pole technology, most of which run continuously. Several refrigeration vendors are offering evaporator upgrades that include replacing motors with much more efficient electrically commuted (EC) DC motors that are better suited for refrigeration service. More importantly, the update includes new refrigeration controls that cycle fan motors on/off when appropriate while monitoring space temperature. Potential vendors to consider include National Resource Management, Frigitek, and Heatcraft Refrigeration Products, among many others.

Next Step: Contact refrigeration vendor(s) to identify EC motor and control updates available and to obtain price quote(s). The bidders should visit the site to review refrigeration systems. We expect them to provide a savings analysis for the update and include an ROI or simple payback in their proposal.

MECHANICAL

4.15 Update Pipe Insulation (Chester, S.B. Butler)

Peregrine recommends installing new hot water / steam pipe insulation where inadequate. At the above properties, there is a lack of insulation on heating hot water piping in the vicinity of the pumps in the boiler rooms. Both mechanical rooms are vented and therefore pipe losses are not "gainful". All hot water piping and components should be tightly insulated.

Next Steps: **Obtain pricing from local mechanical or insulating contractor.**

4.16 Install Premium Efficiency Motors (Barnum, Chester, Fitch HS, Morrisson, Pleasant Valley, SB Butler)

The above schools have original electric induction motors on some of the HVAC fan and pump systems. While continuing to operate reliably, older motors are much less efficient than premium efficiency (PE) models currently available. PE motors are designed with larger winding coils and low friction bearings and fans to optimize performance. Peregrine recommends replacement of older motors with PE motors with priority on any motors that have been rewound, a process that has been documented to degrade motor efficiency. See specific applications below:

- Barnum: Hot water pumps (2 x 3 hp)
- Chester: Hot water pumps (2 x 3 hp)
- Fitch HS: Air Handlers (2x 15 hp, 5 hp)
- Morrisson: Hot water pumps (2 x 3 hp)
- Pleasant Valley: Hot water pumps (2 x 2 hp)

Next Steps: **Field confirm existing motor horsepower, frame size, speed and amp rating, etc. Use data to create bid documentation for motor replacement.**

4.17 Steam Trap Replacement (Chester, Pleasant Valley, SB Butler, West Side)

The above steam facilities are generally very well maintained, but there is no formal steam-trap testing program. Steam traps are serviced upon failure of HVAC equipment to provide heat (i.e. clogged trap). Other trap failures, which include leaking or 'stuck open' are unlikely to be detected and can waste a considerable amount of energy. Peregrine recommends group testing and servicing of all traps. One approach is to replace/rebuild all traps and then to conduct testing each fall before the heating season commences.

Next Steps: **Contact trap service specialist (For example Armstrong Services) for comprehensive trap services and pricing. Alternatively a plumber or mechanical contractor can be asked to price trap replacement.**

4.18 Convert to Natural Gas (Fitch High School)

There is a significant financial advantage to use gas over oil in the current and foreseeable energy market. The local utility has offered to install natural gas piping to the high school at no cost. To convert to gas, the existing oil boilers will need new burners and gas piping will need to be installed from the utility meter to the plant. Converting to gas at other schools should be considered in the future as gas service in the Town is expanded and similar offers for no-cost or very low cost piping to properties arise.

Next Steps: **Develop bid documentation for design-build services to install a gas train from the planned utility meter location as well as new dual fuel burners and potential mechanical updates to satisfy current fire code requirements.**

4.19 Replace Domestic Hot Water System (Morrisson and Pleasant Valley)

We recommend considering replacement of domestic hot water systems at the two properties, which have indirect heating. Indirect water heating requires the main heating plant to remain on-line year-round. While these indirect systems are in reasonable

condition and have almost nothing to wear out, replacement with independent high-efficiency gas-fired condensing plants offers energy savings. The installations require new vent piping from the mechanical room.

<u>Next Steps:</u> Develop bid documentation for design-build services to replace equipment. This work could be combined with other mechanical update recommendations to simplify the project and potentially obtain better bid prices.

4.20 Replace Boiler Plant (Barnum, Chester, Morrisson, Pleasant Valley, West Side)
These properties are relaying on antiquated boiler systems, well beyond their normal expected service lives. While the hot water and steam boilers continue to operate reliably and are in serviceable condition, it is prudent to plan for replacement when parts availability is limited and a component failure could result in significant lost school days and/or premium cost for temporary services. New boilers also offer considerable efficiency improvements.

<u>Next Steps:</u> Develop bid documentation for design-build services to replace equipment. This work could be combined with other mechanical update recommendations to simplify the project and potentially obtain better bids.

4.21 Convert from Steam to Hot Water Heating (Chester, Pleasant Valley, West Side)
Given the age and condition of the steam systems at the above properties, boiler replacement will be required in the near future (See Section 4.20). When evaluating boiler replacement, Peregrine recommends considering the opportunity to convert the building's steam-based heating system to a hot water based system. Hot water systems offer better space temperature control, less maintenance requirements, and hot water boilers and distribution systems are more efficient than steam boilers.

The project will require installation of additional piping throughout the buildings, replacement of the unit ventilators and H&V coils, and likely the replacement of some, if not all, radiators. This project provides an entirely new high efficiency heating system. Since the project payback is exceedingly high, based on the cost to energy savings ratio, the project should be treated as a long-term infrastructure renewal improvement, rather than as an efficiency improvement investment.

<u>Next Steps:</u> Consider long term plans for the schools and appropriate timing for an HVAC replacement project. Once plans have been confirmed, including any future renovations that may affect space utilization and/or heating load requirements, conduct a feasibility study to evaluate life cycle cost of steam versus hot water option. A full design would be required eventually to develop plans and specifications for the boiler replacement and possible hot water conversion.

ENVELOPE

4.22 Attention to Exterior Door Seals (All Schools)
At all Groton's schools, many of the exterior doors are not closing properly and/or do not have weather stripping or sweeps to seal the doorsill. There are significant exposed gaps to the outside. During the winter heating season, these gaps will create uncomfortable drafts and stress adjacent heating devices. We suggest developing a program that gives attention

to all exterior doors to make sure they provide a reasonable seal to the elements. We suggest realignment and adjustments to salvageable doors, plus the addition (or in some case replacement) of weather stripping and bottom sweeps. All doors beyond repair should be replaced.

<u>Next Step</u>: Conduct more detailed review of exterior doors to establish a detailed scope of work. Develop a request for proposal for door services.

4.23 Add Entrance Vestibule (Morrisson)

The main entrance to Morrisson has single door sets. There is an excellent space in this area to install a second door set creating an entrance air lock or vestibule to minimize air exchange when staff and students enter and leave the building.

<u>Next Step</u>: Consult with architect and/or door vendor to develop design details and obtain pricing via bid solicitation.

4.26 Replace Windows (Barnum, Cutler, Morrisson, SB Butler)

Many of the Town's schools have had successful window replacements. The schools listed above retain older, very leaky windows that should be replaced. Modern thermal pane casement windows offer much better "U" values, but more importantly will reduce draft compared to the existing windows many of which don't have effective seals. Window replacement projects are very expensive and do not have attractive economic returns. However, window replacements are a necessary infrastructure update and improve the appearance and comfort of the buildings.

<u>Next Step</u>: Determine long term plans for the building and appropriate CIP budget timing. Consult with architect and/or window vendor to develop design details and obtain pricing via bid solicitation.

APPENDIX D

Tool for Municipal Buildings

ECM Selection Provided

Other spreadsheets are available for review on the Town/OPDS website.

Tool for School Buildings

ECM Selection Provided

Other spreadsheets are available for review on the Town/OPDS website.

Analysis of Fuel Efficiency for Town Vehicles

Fuel Use Evaluation Sheet

Municipal Buildings Planning Tool
ECM Selection

Priority (1, 2, 3)	Bldg	ECM No.	ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available [1]	Potential Utility Savings					Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Visual and/or Comfort Improvement	Simple Payback Yr
							Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr	Propane Gal/yr					
2	Highway Garage	3	Update Fluorescent Lighting to Super T8s	LIGHTING	$7,000	$1,000	1	4,000	-	(50)	-	$490	-	-	-	12.2
1	Highway Garage	4	Replace HID Fixtures with T5/T8	LIGHTING	$6,000	$2,000	2	5,000	-	(60)	-	$610	-	-	X	6.6
2	Highway Garage	5	Update Exterior Lighting to LED	LIGHTING	$8,000	$0	-	10,000	-	-	-	$1,520	X	-	-	5.3
1	Highway Garage	8	Lower Setpoint in Garage/Storage Areas	CONTROLS	$0	$0	-	-	-	-	400	$710	-	-	-	-
1	Highway Garage	10	Add DHW Timer	CONTROLS	$250	$0	-	700	-	-	-	$110	-	-	-	2.3
3	Highway Garage	16	Convert Electric Heating	HVAC	$5,000	$0	8	6,000	-	-	(300)	$380	-	-	-	13.2
2	Highway Garage	18	Replace Boiler Plant	HVAC	$30,000	$0	-	-	-	120	-	$290	X	X	-	103.4
3	Highway Garage	19	Convert Steam to Hot Water Heating	HVAC	$150,000	$0	-	-	-	900	-	$2,180	X	X	X	68.8
1	Highway Garage	20	Attention to Exterior Door Seals	ENVELOPE	$500	$0	-	-	-	40	-	$100	-	-	X	5.0
1	Highway Garage	22	Airseal Details / Attic Insulation	ENVELOPE	$1,000	$0	-	-	-	100	-	$240	-	-	-	4.2
1	Human Services	1	Update T12 lamps to T8	LIGHTING	$12,000	$0	5	14,000	-	(200)	-	$1,640	X	-	-	7.3
2	Human Services	6	Install Occupancy Sensor Control	LIGHTING	$3,500	$0	1	3,000	-	(40)	-	$360	-	-	-	9.7
1	Human Services	9	Schedule HVAC System / Setbacks	CONTROLS	$0	$0	-	-	-	400	-	$970	-	-	-	-
1	Human Services	20	Attention to Exterior Door Seals	ENVELOPE	$1,500	$0	-	-	-	50	-	$120	-	-	X	12.5
2	Human Services	22	Airseal Details / Attic Insulation	ENVELOPE	$15,000	$0	-	-	-	300	-	$730	-	-	-	20.5
3	Human Services	23	Replace Windows	ENVELOPE	$400,000	$0	-	-	-	400	-	$970	X	X	X	412.4
1	Human Services	26	Replace Refrigerator	MISC	$2,300	$0	1	5,000	-	-	-	$760	X	X	-	3.0
2	Police Station	3	Update Fluorescent Lighting to Super T8s	LIGHTING	$23,000	$3,000	3	27,000	-	(300)	-	$3,380	-	-	-	5.9
2	Police Station	5	Update Exterior Lighting to LED	LIGHTING	$30,000	$0	-	30,000	-	-	-	$4,560	X	-	-	6.6
2	Police Station	6	Install Occupancy Sensor Control	LIGHTING	$20,000	$4,000	4	37,000	-	(500)	-	$4,410	-	-	-	3.6
1	Police Station	8	Lower Setpoint in Garage/Storage Areas	CONTROLS	$0	$0	-	-	-	150	-	$360	-	-	-	-
1	Police Station	9	Schedule HVAC System / Setbacks	CONTROLS	$0	$0	-	70,000	-	500	-	$11,850	-	-	-	-
2	Police Station	12	Add Occupancy Based HVAC Control	CONTROLS	$7,500	$1,000	1	10,000	-	100	-	$1,760	-	-	-	3.7
1	Police Station	13	Controls Recommissioning	CONTROLS	$20,000	$0	2	20,000	-	200	-	$3,520	X	-	X	5.7
1	Police Station	20	Attention to Exterior Door Seals	ENVELOPE	$2,000	$0	-	500	-	60	-	$220	-	-	X	9.1
1	Poquonnock Bridge Fire House	1	Update T12 lamps to T8	LIGHTING	$3,000	$1,000	1	2,000	-	-	(20)	$270	X	X	-	7.4
1	Poquonnock Bridge Fire House	2	Replace Incandescent / Halogen Lighting	LIGHTING	$75	$0	1	5,000	-	-	(60)	$650	X	-	-	0.1
2	Poquonnock Bridge Fire House	3	Update Fluorescent Lighting to Super T8s	LIGHTING	$1,000	$0	-	1,000	-	-	(10)	$130	-	-	-	7.7

2	Poquonnock Bridge Fire House	5	Update Exterior Lighting to LED	LIGHTING	$6,000	$0	-	6,000	-	-	-	$910	-	-	-	6.6
2	Poquonnock Bridge Fire House	6	Install Occupancy Sensor Control	LIGHTING	$5,000	$1,000	1	5,000	-	-	(60)	$650	-	-	-	6.2
1	Poquonnock Bridge Fire House	9	Schedule HVAC System / Setbacks	CONTROLS	$0	$0	-	-	-	-	100	$180	-	-	-	-
2	Poquonnock Bridge Fire House	15	Replace HVAC Units	HVAC	$50,000	$1,000	1	1,000	-	-	-	$150	X	X	-	326.7
1	Poquonnock Bridge Fire House	20	Attention to Exterior Door Seals	ENVELOPE	$1,000	$0	-	-	-	-	100	$180	-	-	X	5.6
1	Poquonnock Bridge Fire House	22	Airseal Details / Attic Insulation	ENVELOPE	$500	$0	-	-	-	-	100	$180	-	-	-	2.8
1	Poquonnock Bridge Fire House	26	Replace Refrigerator	MISC	$1,500	$0	-	2,000	-	-	-	$300	-	-	-	5.0
1	Public Library	1	Update T12 lamps to T8	LIGHTING	$30,000	$0	12	35,000	-	(200)	-	$4,840	X	-	-	6.2
2	Public Library	5	Update Exterior Lighting to LED	LIGHTING	$20,000	$0	-	20,000	-	-	-	$3,040	X	-	-	6.6
2	Public Library	6	Install Occupancy Sensor Control	LIGHTING	$15,000	$6,000	6	18,000	-	(100)	-	$2,490	-	-	-	3.6
1	Public Library	13	Controls Recommissioning	CONTROLS	$20,000	$0	-	20,000	-	-	-	$3,040	-	-	-	6.6
1	Public Library	17	Install Natural Gas Service	HVAC	$10,000	$0	-	-	(7,000)	6,079	-	$6,730	-	-	-	1.5
1	Public Library	25	Replace CRT Computer Monitors	MISC	$5,000	$0	-	5,000	-	-	-	$760	-	-	-	6.6
2	Senior Center	3	Update Fluorescent Lighting to Super T8s	LIGHTING	$16,000	$0	3	10,000	(200)	-	-	$1,290	-	-	-	12.4
2	Senior Center	5	Update Exterior Lighting to LED	LIGHTING	$30,000	$0	-	28,000	-	-	-	$4,260	X	-	-	7.0
1	Senior Center	13	Controls Recommissioning	CONTROLS	$20,000	$0	-	8,000	4,000	-	-	$5,780	-	-	-	3.5
1	Town Hall	1	Update T12 lamps to T8	LIGHTING	$2,000	$1,000	1	2,000	-	(10)	-	$280	-	-	-	3.6
1	Town Hall	2	Replace Incandescent / Halogen Lighting	LIGHTING	$1,500	$500	-	1,300	-	(10)	-	$170	X	-	-	5.9
2	Town Hall	3	Update Fluorescent Lighting to Super T8s	LIGHTING	$18,000	$4,000	4	11,000	-	(70)	-	$1,500	-	-	-	9.3
2	Town Hall	6	Install Occupancy Sensor Control	LIGHTING	$6,000	$1,500	1	4,000	-	(20)	-	$560	-	-	-	8.0
2	Town Hall	7	Daylighting Control	LIGHTING	$1,500	$0	-	1,000	-	(10)	-	$130	-	-	-	11.5
1	Town Hall	10	Add DHW Timer	CONTROLS	$250	$0	-	700	-	-	-	$110	-	-	-	2.3
2	Town Hall	14	Add Central Control System	CONTROLS	$60,000	$2,000	2	6,000	-	900	-	$3,090	X	-	X	18.8
3	Town Hall	18	Replace Boiler Plant	HVAC	$40,000	$0	-	-	-	300	-	$730	X	X	-	54.8
3	Town Hall	19	Convert Steam to Hot Water Heating	HVAC	$150,000	$0	-	-	-	600	-	$1,450	X	X	X	103.4
1	Town Hall	24	Vending Machine Controller	MISC	$1,000	$0	-	1,500	-	-	-	$230	-	-	-	4.3
1	Town Hall	26	Replace Refrigerator	MISC	$1,000	$0	-	1,000	-	-	-	$150	-	-	-	6.7
2	Town Hall Annex	3	Update Fluorescent Lighting to Super T8s	LIGHTING	$20,000	$2,000	2	7,000	-	(90)	-	$850	-	-	-	21.2
2	Town Hall Annex	6	Install Occupancy Sensor Control	LIGHTING	$6,000	$1,000	1	5,700	-	(70)	-	$700	-	-	-	7.1
1	Town Hall Annex	10	Add DHW Timer	CONTROLS	$250	$0	-	900	-	-	-	$140	-	-	-	1.8
2	Town Hall Annex	12	Add Occupancy Based HVAC Control	CONTROLS	$10,000	$0	-	8,000	-	200	-	$1,700	-	-	-	5.9
1	Town Hall Annex	13	Controls Recommissioning	CONTROLS	$15,000	$0	-	12,000	-	500	-	$3,030	X	-	X	5.0
1	Town Hall Annex	20	Attention to Exterior Door Seals	ENVELOPE	$1,000	$0	-	500	-	50	-	$200	-	-	X	5.0
1	Town Hall Annex	24	Vending Machine Controller	MISC	$1,000	$0	-	1,500	-	-	-	$230	-	-	-	4.3
1	Town Hall Annex	26	Replace Refrigerator	MISC	$1,500	$0	-	2,000	-	-	-	$300	-	X	-	5.0
1	Wastewater Treatment	1	Update T12 lamps to T8	LIGHTING	$10,000	$2,000	2	20,000	-	-	-	$3,040	-	-	-	2.6
2	Wastewater Treatment	3	Update Fluorescent Lighting to Super T8s	LIGHTING	$20,000	$2,000	2	10,000	-	-	-	$1,520	-	-	-	11.8

1	Wastewater Treatment	4	Replace HID Fixtures with T5/T8	LIGHTING	$60,000	$8,000	8	70,000	-	-	-	$10,640	X	-	-	4.9
2	Wastewater Treatment	5	Update Exterior Lighting to LED	LIGHTING	$10,000	$0	-	10,000	-	-	-	$1,520	X	-	-	6.6
2	Wastewater Treatment	6	Install Occupancy Sensor Control	LIGHTING	$20,000	$3,000	3	20,000	-	-	-	$3,040	-	-	-	5.6
2	Wastewater Treatment	11	Add Pump VFDs	CONTROLS	$80,000	$4,000	2	20,000	-	-	-	$3,040	-	-	-	25.0
2	Wastewater Treatment	15	Replace HVAC Units	HVAC	$100,000	$0	-	1,000	-	-	-	$150	X	X	X	666.7
2	Wastewater Treatment	16	Convert Electric Heating	HVAC	$125,000	$0	-	30,000	(1,200)	-	-	$3,190	-	-	-	39.2
1	Wastewater Treatment	17	Install Natural Gas Service	HVAC	$40,000	$0	-	-	(11,000)	8,000	-	$6,820	-	-	-	5.9
2	Wastewater Treatment	18	Replace Boiler Plant	HVAC	$150,000	$0	-	-	-	200	-	$480	X	X	-	312.5
3	Wastewater Treatment	19	Convert Steam to Hot Water Heating	HVAC	$300,000	$0	-	-	2,000	-	-	$2,280	-	X	X	131.6
1	Wastewater Treatment	20	Attention to Exterior Door Seals	ENVELOPE	$3,000	$0	-	-	-	200	-	$480	-	-	X	6.3
2	Wastewater Treatment	21	Replace Overhead Door	ENVELOPE	$15,000	$0	-	-	-	220	-	$530	-	-	X	28.3

School Buildings Planning Tool
ECM Selection

Priority (1, 2, 3)	Bldg	ECM No.	ECM No. and Description	Technology Group	Approximate Implementation Cost	Utility Incentive Available[1]	Potential Utility Savings					Annual Cost Avoidance	Reduces O&M Liability	Addresses End Of Life Equipment	Visual and/or Comfort Improvement	Simple Payback Yr
							Demand kW	Electric kWh/yr	Gas Therm/yr	Oil Gal/yr	Propane Gal/yr					
1	Charles Barnum ES	1	Reduce Hallway Light Level	LIGHTING	$0	$0	2	6,000	-	(70)	-	$800	-	-	-	-
1	Charles Barnum ES	3	Replace Incandescent / Halogen Lighting	LIGHTING	$50	$0	-	600	-	-	-	$100	X	-	-	0.5
2	Charles Barnum ES	4	Update Fluorescent Lighting to Super T8s	LIGHTING	$20,000	$0	3	10,000	-	(120)	-	$1,400	-	-	-	14.3
2	Charles Barnum ES	6	Update Exterior Lighting to LED	LIGHTING	$3,000	$0	-	2,900	-	-	-	$480	X	-	-	6.3
2	Charles Barnum ES	7	Install Occupancy Sensor Control	LIGHTING	$500	$0	-	200	-	-	-	$30	-	-	-	16.7
1	Charles Barnum ES	9	Add Window A/C Wall Timers	CONTROLS	$1,000	$0	-	3,100	-	-	-	$500	-	-	-	2.0
2	Charles Barnum ES	10	Add VFD Controls to Pumps	CONTROLS	$4,000	$0	-	2,000	-	-	-	$330	-	-	-	12.1
3	Charles Barnum ES	13	Add DDC Thermostatic Control	CONTROLS	$80,000	$0	-	2,500	-	160	-	$800	X	X	X	100.0
2	Charles Barnum ES	16	Install Premium Efficiency Motors	HVAC	$1,000	$0	-	300	-	-	-	$50	-	X	-	20.0
3	Charles Barnum ES	20	Replace Boiler Plant	HVAC	$200,000	$0	-	-	-	230	-	$600	X	X	-	333.3
1	Charles Barnum ES	22	Attention to Exterior Door Seals	ENVELOPE	$1,000	$0	-	-	-	50	-	$120	-	-	X	8.3
3	Charles Barnum ES	24	Replace Windows	ENVELOPE	$500,000	$0	-	-	-	500	-	$1,200	-	X	X	416.7
-	Claude Chester ES	4	Update Fluorescent Lighting to Super T8s	LIGHTING	$20,000	$3,000	3	10,000	-	(120)	-	$1,400	-	-	-	12.1
-	Claude Chester ES	6	Update Exterior Lighting to LED	LIGHTING	$3,000	$0	-	2,900	-	-	-	$480	X	-	-	6.3
1	Claude Chester ES	7	Install Occupancy Sensor Control	LIGHTING	$12,000	$4,000	4	13,000	-	(160)	-	$1,800	-	-	-	4.4
-	Claude Chester ES	10	Add VFD Controls to Pumps	CONTROLS	$4,000	$0	-	1,900	-	-	-	$320	-	-	-	12.5
-	Claude Chester ES	13	Add DDC Thermostatic Control	CONTROLS	$90,000	$0	-	3,000	-	300	-	$1,200	X	X	X	75.0
-	Claude Chester ES	15	Update Pipe Insulation	HVAC	$1,000	$0	-	-	-	50	-	$100	-	-	-	10.0
-	Claude Chester ES	16	Install Premium Efficiency Motors	HVAC	$1,000	$0	-	300	-	-	-	$50	-	X	-	20.0
-	Claude Chester ES	17	Steam Trap Replacement	HVAC	$10,000	$0	-	-	-	200	-	$500	-	-	-	20.0
-	Claude Chester ES	20	Replace Boiler Plant	HVAC	$200,000	$0	-	-	-	500	-	$1,200	X	X	-	166.7
-	Claude Chester ES	21	Convert from Steam to Hot Water Heating	HVAC	$500,000	$0	-	-	-	300	-	$700	X	X	X	714.3
1	Claude Chester ES	22	Attention to Exterior Door Seals	ENVELOPE	$1,000	$0	-	-	-	50	-	$120	-	-	X	8.3
2	Cutler MS	4	Update Fluorescent Lighting to Super T8s	LIGHTING	$40,000	$6,000	6	20,000	-	(240)	-	$2,800	-	-	-	12.1
2	Cutler MS	6	Update Exterior Lighting to LED	LIGHTING	$3,000	$0	-	2,900	-	-	-	$480	-	-	-	6.3
2	Cutler MS	8	Daylighting Control	LIGHTING	$3,500	$0	-	3,700	-	(50)	-	$500	-	-	-	7.0
1	Cutler MS	9	Add Window A/C Wall Timers	CONTROLS	$500	$0	-	2,000	-	-	-	$330	-	-	-	1.5
2	Cutler MS	14	Walk-in Evaporator Control & ECM Motors	CONTROLS	$5,000	$1,000	1	3,900	-	-	-	$700	-	-	-	5.7
1	Cutler MS	22	Attention to Exterior Door Seals	ENVELOPE	$2,000	$0	-	-	-	90	-	$220	-	-	X	9.1

3	Cutler MS	24	Replace Windows	ENVELOPE	$800,000	$0	-	-	-	1,000	-	$2,400	X	X	X	333.3
1	Fitch HS	1	Reduce Hallway Light Level	LIGHTING	$0	$0	4	12,000	-	(150)	-	$1,600	-	-	-	-
1	Fitch HS	3	Replace Incandescent / Halogen Lighting	LIGHTING	$75,000	$30,000	30	50,000	-	(380)	-	$7,400	X	-	-	6.1
2	Fitch HS	4	Update Fluorescent Lighting to Super T8s	LIGHTING	$200,000	$30,000	30	110,000	-	(1,000)	-	$15,900	-	-	-	10.7
1	Fitch HS	5	Replace High Bay Metal Halide with T5	LIGHTING	$20,000	$6,000	6	26,000	-	(320)	-	$3,600	-	-	-	3.9
2	Fitch HS	6	Update Exterior Lighting to LED	LIGHTING	$40,000	$0	-	40,000	-	-	-	$6,700	-	-	-	6.0
2	Fitch HS	8	Daylighting Control	LIGHTING	$2,000	$0	-	2,700	-	(30)	-	$380	-	-	-	5.3
1	Fitch HS	11	Add VFD Controls to Fans	CONTROLS	$25,000	$5,000	-	20,000	-	-	-	$3,340	-	-	-	6.0
1	Fitch HS	12	Add Demand Control Ventilation	CONTROLS	$8,000	$500	-	10,000	-	500	-	$2,900	-	-	-	2.6
2	Fitch HS	14	Walk-in Evaporator Control & ECM Motors	CONTROLS	$5,000	$1,000	-	5,000	-	-	-	$800	-	-	-	5.0
2	Fitch HS	16	Install Premium Efficiency Motors	HVAC	$5,000	$0	1	3,700	-	-	-	$600	-	X	-	8.3
1	Fitch HS	18	Convert to Natural Gas	HVAC	$30,000	$0	-	-	(96,000)	68,880	-	$70,000	-	X	-	0.4
1	Fitch HS	22	Attention to Exterior Door Seals	ENVELOPE	$2,500	$0	-	-	200	-	-	$200	-	-	X	12.5
1	Mary Morrisson ES	1	Reduce Hallway Light Level	LIGHTING	$0	$0	1	4,200	-	(50)	-	$580	-	-	-	-
1	Mary Morrisson ES	2	Update T12 lamps to T8	LIGHTING	$19,000	$0	10	27,000	-	(250)	-	$3,900	-	-	-	4.9
3	Mary Morrisson ES	4	Update Fluorescent Lighting to Super T8s	LIGHTING	$17,000	$0	3	9,000	-	(80)	-	$1,300	-	-	-	13.1
3	Mary Morrisson ES	6	Update Exterior Lighting to LED	LIGHTING	$3,000	$0	1	2,900	-	-	-	$480	X	-	-	6.3
2	Mary Morrisson ES	7	Install Occupancy Sensor Control	LIGHTING	$15,000	$0	-	20,000	-	(180)	-	$2,900	-	-	-	5.2
1	Mary Morrisson ES	9	Add Window A/C Wall Timers	CONTROLS	$500	$0	-	1,600	-	-	-	$270	-	-	-	1.9
2	Mary Morrisson ES	10	Add VFD Controls to Pumps	CONTROLS	$4,000	$0	-	1,600	-	-	-	$270	-	-	-	14.8
3	Mary Morrisson ES	13	Add DDC Thermostatic Control	CONTROLS	$90,000	$0	-	4,000	-	120	-	$1,000	X	X	X	90.0
2	Mary Morrisson ES	16	Install Premium Efficiency Motors	HVAC	$1,400	$0	-	700	-	-	-	$120	-	X	-	11.7
2	Mary Morrisson ES	19	Replace Domestic Hot Water System	HVAC	$10,000	$0	-	-	-	160	-	$400	X	-	-	25.0
3	Mary Morrisson ES	20	Replace Boiler Plant	HVAC	$150,000	$0	-	-	-	320	-	$800	-	X	-	187.5
1	Mary Morrisson ES	22	Attention to Exterior Door Seals	ENVELOPE	$1,500	$0	-	-	-	70	-	$170	-	-	X	8.8
3	Mary Morrisson ES	23	Add Entrance Vestibule	ENVELOPE	$15,000	$0	-	-	-	100	-	$240	-	-	X	62.5
3	Mary Morrisson ES	24	Replace Windows	ENVELOPE	$500,000	$0	-	-	-	500	-	$1,200	X	X	X	416.7
1	Pleasant Valley ES	2	Update T12 lamps to T8	LIGHTING	$15,000	$0	10	23,000	-	(210)	-	$3,300	X	X	-	4.5
1	Pleasant Valley ES	3	Replace Incandescent / Halogen Lighting	LIGHTING	$100	$0	-	1,100	-	(10)	-	$160	X	-	-	0.6
-	Pleasant Valley ES	4	Update Fluorescent Lighting to Super T8s	LIGHTING	$15,000	$0	-	10,000	-	(90)	-	$1,500	-	-	-	10.0
-	Pleasant Valley ES	6	Update Exterior Lighting to LED	LIGHTING	$3,000	$0	1	2,900	-	-	-	$480	X	-	-	6.3
1	Pleasant Valley ES	7	Install Occupancy Sensor Control	LIGHTING	$15,000	$0	-	20,000	-	(180)	-	$2,900	-	-	-	5.2
1	Pleasant Valley ES	9	Add Window A/C Wall Timers	CONTROLS	$1,000	$0	-	2,600	-	-	-	$430	-	-	-	2.3
-	Pleasant Valley ES	13	Add DDC Thermostatic Control	CONTROLS	$80,000	$0	-	3,500	-	250	-	$1,200	X	X	X	66.7
-	Pleasant Valley ES	16	Install Premium Efficiency Motors	HVAC	$600	$0	-	300	-	-	-	$50	-	X	-	12.0
-	Pleasant Valley ES	17	Steam Trap Replacement	HVAC	$10,000	$0	-	-	-	200	-	$500	-	X	-	20.0
-	Pleasant Valley ES	19	Replace Domestic Hot Water System	HVAC	$10,000	$0	-	-	-	200	-	$500	X	-	-	20.0

-	Pleasant Valley ES	20	Replace Boiler Plant	HVAC	$150,000	$0	-	-	-	400	-	$1,000	X	X	X	150.0
-	Pleasant Valley ES	21	Convert from Steam to Hot Water Heating	HVAC	$250,000	$0	-	-	-	500	-	$1,200	X	X	X	208.3
1	Pleasant Valley ES	22	Attention to Exterior Door Seals	ENVELOPE	$1,000	$0	-	-	-	110	-	$270	-	-	X	3.7
1	SB Butler ES	2	Update T12 lamps to T8	LIGHTING	$7,000	$3,000	3	10,000	-	(90)	-	$1,500	-	X	-	2.7
-	SB Butler ES	4	Update Fluorescent Lighting to Super T8s	LIGHTING	$21,000	$3,000	3	12,000	-	(110)	-	$1,700	-	-	-	10.6
-	SB Butler ES	6	Update Exterior Lighting to LED	LIGHTING	$8,000	$2,000	2	6,000	-	-	-	$1,000	X	-	-	6.0
-	SB Butler ES	8	Daylighting Control	LIGHTING	$3,500	$0	-	3,700	-	(50)	-	$500	-	-	-	7.0
1	SB Butler ES	9	Add Window A/C Wall Timers	CONTROLS	$1,500	$0	-	3,500	-	-	-	$600	-	-	-	2.5
-	SB Butler ES	10	Add VFD Controls to Pumps	CONTROLS	$4,000	$0	-	1,600	-	-	-	$270	-	-	-	14.8
-	SB Butler ES	13	Add DDC Thermostatic Control	CONTROLS	$90,000	$0	-	4,000	-	410	-	$1,700	X	X	X	52.9
-	SB Butler ES	15	Update Pipe Insulation	HVAC	$1,000	$0	-	-	-	50	-	$120	-	-	X	8.3
-	SB Butler ES	16	Install Premium Efficiency Motors	HVAC	$600	$0	-	300	-	-	-	$50	-	X	-	12.0
-	SB Butler ES	17	Steam Trap Replacement	HVAC	$10,000	$0	-	-	-	200	-	$500	X	X	-	20.0
1	SB Butler ES	22	Attention to Exterior Door Seals	ENVELOPE	$1,000	$0	-	-	-	50	-	$120	-	-	X	8.3
-	SB Butler ES	24	Replace Windows	ENVELOPE	$500,000	$0	-	-	-	500	-	$1,200	X	X	X	416.7
1	West Side MS	3	Replace Incandescent / Halogen Lighting	LIGHTING	$100	$0	-	1,400	-	(10)	-	$210	X	-	-	0.5
2	West Side MS	4	Update Fluorescent Lighting to Super T8s	LIGHTING	$50,000	$0	10	30,000	-	(300)	-	$4,300	X	-	-	11.6
1	West Side MS	5	Replace High Bay Metal Halide with T5	LIGHTING	$6,000	$0	-	6,000	-	(50)	-	$900	X	-	X	6.7
2	West Side MS	6	Update Exterior Lighting to LED	LIGHTING	$9,000	$0	2	7,000	-	-	-	$1,200	X	-	-	7.5
2	West Side MS	7	Install Occupancy Sensor Control	LIGHTING	$27,000	$0	-	40,000	-	(370)	-	$5,800	-	-	-	4.7
2	West Side MS	8	Daylighting Control	LIGHTING	$5,000	$0	-	5,000	-	(60)	-	$690	-	-	-	7.2
1	West Side MS	9	Add Window A/C Wall Timers	CONTROLS	$500	$0	-	2,100	-	-	-	$350	-	-	-	1.4
2	West Side MS	10	Add VFD Controls to Pumps	CONTROLS	$6,000	$0	-	3,300	-	-	-	$550	-	-	-	10.9
3	West Side MS	13	Add DDC Thermostatic Control	CONTROLS	$120,000	$0	-	3,600	-	700	-	$2,300	-	-	-	52.2
2	West Side MS	14	Walk-in Evaporator Control & ECM Motors	CONTROLS	$3,000	$0	1	3,900	-	-	-	$700	-	-	-	4.3
2	West Side MS	17	Steam Trap Replacement	HVAC	$15,000	$0	-	-	-	400	-	$1,000	X	X	-	15.0
3	West Side MS	20	Replace Boiler Plant	HVAC	$250,000	$0	-	-	-	1,000	-	$2,400	X	X	-	104.2
3	West Side MS	21	Convert from Steam to Hot Water Heating	HVAC	$500,000	$0	-	-	-	500	-	$1,200	X	X	X	416.7
1	West Side MS	22	Attention to Exterior Door Seals	ENVELOPE	$2,500	$0	-	-	-	110	-	$270	-	-	-	9.3

Fuel Use Evaluation

DEPT

LICENSE	YEAR	MAKE	MODEL	FUELTYPE	GALLONS	ANNUAL MILES	M.P.G	PRICE			UNLEADED GALS	DIESEL GALS
ADMIN SERV - IT USER SUPPORT							**18.35**					
079GRO	2008	FORD	ESCAPE	UNLEADED	180.96	3646	20.15	2.63	$	475.92	180.96	
144GRO	2008	FORD	ESCAPE	UNLEADED	130.77	2073	15.85	2.63	$	343.93	130.77	
FINANCIAL ADMIN - LEADERSHIP							**42.39**					
413GRO	2008	TOYOTA	PRIUS	UNLEADED	58.05	2461	42.39	2.63	$	152.67	58.05	
POLICE - LEADERSHIP							**15.54**					
191UUY	2007	FORD	CROWN VIC	UNLEADED	316.69	4790	15.13	2.63	$	832.89	316.69	
226URZ	2005	FORD	CROWN VIC	UNLEADED								
296XKO	2009	DODGE	CHARGER SXT	UNLEADED	276.17	4726	17.11	2.63	$	726.33	276.17	
317SFV	2003	FORD	CROWN VIC	UNLEADED	327.87	4673	14.25	2.63	$	862.30	327.87	
353XLW	2009	FORD	CROWN VIC	UNLEADED	794.25	12240	15.41	2.63	$	2,088.88	794.25	
561YXV	2012	FORD	TAURUS	UNLEADED	709.19	12050	16.99	2.63	$	1,865.17	709.19	
875SVS	2003	FORD	CROWN VIC	UNLEADED	256.19	4288	16.74	2.63	$	673.78	256.19	
944SEM	2003	FORD	CROWN VIC	UNLEADED	172.49	1966	11.40	2.63	$	453.65	172.49	
967WRO	2008	DODGE	CHARGER	UNLEADED	217.89	3840	17.62	2.63	$	573.05	217.89	
969WRO	2008	DODGE	CHARGER	UNLEADED	770.24	11107	14.42	2.63	$	2,025.73	770.24	
POLICE - PATROL							**8.52**					
001GRO	2011	CHEVROLET	TAHOE	UNLEADED	2220.14	22672	10.21	2.63	$	5,838.97	2220.14	
002GRO	2008	FORD	EXPEDITION	UNLEADED	1565.88	10675	6.82	2.63	$	4,118.26	1565.88	
003GRO	2009	FORD	CR VICTORIA	UNLEADED	2584.54	21518	8.33	2.63	$	6,797.34	2584.54	
004GRO	2011	FORD	CROWN VIC	UNLEADED	3203.42	27487	8.58	2.63	$	8,424.99	3203.42	
005GRO	2008	FORD	CROWN VIC	UNLEADED	1698.78	12078	7.11	2.63	$	4,467.79	1698.78	
006GRO	2007	FORD	CROWN VIC	UNLEADED	1746.59	12001	6.87	2.63	$	4,593.53	1746.59	

007GRO	2011	FORD	CROWN VIC	UNLEADED	2793.7	25714	9.20	2.63	$	7,347.43	2793.7	
008GRO	2009	FORD	CROWN VIC	UNLEADED	1614.86	10397	6.44	2.63	$	4,247.08	1614.86	
009GRO	2011	FORD	CROWN VIC	UNLEADED	2077.18	18276	8.80	2.63	$	5,462.98	2077.18	
010GRO	2009	FORD	CROWN VIC	UNLEADED	3725.36	33595	9.02	2.63	$	9,797.70	3725.36	
011GRO	2011	FORD	CROWN VIC	UNLEADED	1015.32	9478	9.33	2.63	$	2,670.29	1015.32	
012GRO	2008	FORD	CROWN VIC	UNLEADED	3418.36	31162	9.12	2.63	$	8,990.29	3418.36	
014GRO	2005	FORD	CROWN VIC	UNLEADED	2172.98	18225	8.39	2.63	$	5,714.94	2172.98	
015GRO	2009	FORD	CROWN VIC	UNLEADED	3220.61	28766	8.93	2.63	$	8,470.20	3220.61	
016GRO	2005	FORD	CROWN VIC	UNLEADED	1657.9	12175	7.34	2.63	$	4,360.28	1657.9	
017GRO	2007	FORD	CROWN VIC	UNLEADED	2104.53	17881	8.50	2.63	$	5,534.91	2104.53	
018GRO	2008	FORD	CROWN VIC	UNLEADED	2210.25	19027	8.61	2.63	$	5,812.96	2210.25	
020GRO	2006	FORD	CROWN VIC	UNLEADED	1565.88	12265	7.83	2.63	$	4,118.26	1565.88	
021GRO	2008	FORD	F250 CREW CAB	UNLEADED	319.34	2132	6.68	2.63	$	839.86	319.34	
074GRO	2011	FORD	CROWN VIC	UNLEADED	3481.04	30813	8.85	2.63	$	9,155.14	3481.04	
093GRO	1995	CHEVROLET	P30	UNLEADED								
761PSL	2001	FORD	CROWN VIC	UNLEADED	239.79	3964	16.53	2.63	$	630.65	239.79	
POLICE -CRIMINAL INVESTIGATION							**18.68**					
227URZ	2006	FORD	CROWN VIC	UNLEADED								
328SFV	2003	FORD	CROWN VIC	UNLEADED	477.67	7431	15.56	2.63	$	1,256.27	477.67	
378NRM	2000	FORD	CROWN VIC	UNLEADED	241.9	5080	21.00	2.63	$	636.20	241.9	
637SWX	1998	FORD	EXPLORER	UNLEADED	36.63	716	19.55	2.63	$	96.34	36.63	
689XTC	2010	FORD	ESCAPE	UNLEADED	191.65	5603	29.24	2.63	$	504.04	191.65	
837PSL	2001	FORD	CROWN VIC	UNLEADED	303.41	4364	14.38	2.63	$	797.97	303.41	
968WRO	2008	DODGE	CHARGER	UNLEADED	758.58	14340	18.90	2.63	$	1,995.07	758.58	
POLICE - ANIMAL CONTROL							**11.54**					
019GRO	2005	GMC	SAVANNA	UNLEADED	973.88	11236	11.54	2.63	$	2,561.30	973.88	
ADMIN SERV - EC FIRE/EMS							**15.56**					
029GRO	2001	FORD	F350	DIESEL	107.4	1153	10.74	2.57	$	276.02		107.4
098GRO	2003	CHEVROLET	BLAZER	UNLEADED	278.39	4848	17.41	2.63	$	732.17	278.39	
PUBLIC WORKS LEADERSHIP/GENSUP							**26.18**					

063GRO	2008	FORD	FOCUS	UNLEADED	33.46	918	27.44	2.63	$	88.00	33.46	
182GRO	2006	FORD	ESCAPE HYBRID	UNLEADED	341.42	8897	26.06	2.63	$	897.93	341.42	
PUBLIC WORKS ENGINEERING							**21.55**					
084GRO	2008	FORD	FOCUS 4 DR SEDAN	UNLEADED	321.49	9220	28.68	2.63	$	845.52	321.49	
132GRO	1999	GMC	JIMMY	UNLEADED	67.82	1001	14.76	2.63	$	178.37	67.82	
139GRO	2000	FORD	E150	UNLEADED	246.32	3068	12.46	2.63	$	647.82	246.32	
202GRO	2011	TOYOTA	PRIUS	UNLEADED	62.74	1761	28.07	2.63	$	165.01	62.74	
PUBLIC WORKS PUBLIC BUILDINGS							**11.91**					
062GRO	2007	FORD	FOCUS WAGON	UNLEADED	198.06	4061	20.50	2.63	$	520.90	198.06	
076GRO	1993	FORD	F350	DIESEL	104.3	802	7.69	2.57	$	268.05		104.3
104GRO	2001	FORD	E150	UNLEADED	400.01	4821	12.05	2.63	$	1,052.03	400.01	
107GRO	2001	FORD	E150	UNLEADED	359.37	4133	11.50	2.63	$	945.14	359.37	
138GRO	2009	FORD	E150	UNLEADED	516.44	5482	10.61	2.63	$	1,358.24	516.44	
140GRO	2011	FORD	E350	UNLEADED	427.29	4579	10.72	2.63	$	1,123.77	427.29	
PUBLIC WORKS ROADS & STREETS							**6.24**					
057GRO	2000	INTERNATIONAL	4900	DIESEL	69.58	593	8.52	2.57	$	178.82		69.58
058GRO	2008	FORD	F350	DIESEL	1009.64	9228	9.14	2.57	$	2,594.77		1009.64
059GRO	1998	INTERNATIONAL	4900 4X2	DIESEL	65.62	449	6.84	2.57	$	168.64		65.62
075GRO	1993	INTERNATIONAL	4900	DIESEL	439.11	1640	3.73	2.57	$	1,128.51		439.11
091GRO	2006	FORD	E350 VAN CUTAWAY	DIESEL	921.49	9519	10.33	2.57	$	2,368.23		921.49
097GRO	2001	FORD	F150	UNLEADED	1051.78	9973	9.48	2.63	$	2,766.18	1051.78	
103GRO	2009	INTERNATIONAL	7600	DIESEL	1414.68	6321	4.47	2.57	$	3,635.73		1414.68
117GRO	1997	INTERNATIONAL	4900	DIESEL	107.24	330	3.08	2.57	$	275.61		107.24
148GRO	2009	FORD	F350	DIESEL	754	8310	11.02	2.57	$	1,937.78		754
149GRO	1997	INTERNATIONAL	4900	DIESEL	217.39	1312	6.04	2.57	$	558.69		217.39
151GRO	2004	FORD	F350	DIESEL	453.97	5471	12.05	2.57	$	1,166.70		453.97
152GRO	2010	FORD	F550	DIESEL	1134.24	9279	8.18	2.57	$	2,915.00		1134.24
153GRO	2008	INTERNATIONAL	7600	DIESEL	544.47	2057	3.78	2.57	$	1,399.29		544.47
156GRO	2006	FORD	ESCAPE HYBRID	UNLEADED	622.19	1679	2.70	2.63	$	1,636.36	622.19	
163GRO	2002	FREIGHTLINER	SWEEPER	DIESEL	1095.79	1860	1.70	2.57	$	2,816.18		1095.79

165GRO	1995	FORD	F800	DIESEL	58.07	619	10.66	2.57	$	149.24		58.07
166GRO	2006	SCHWARZE	A8000	DIESEL	1295.62	604	0.47	2.57	$	3,329.74		1295.62
167GRO	1990	INTERNATIONAL	4900	DIESEL	75.09	516	6.87	2.57	$	192.98		75.09
199GRO	1987	INTERNATIONAL	S-2674	DIESEL	454.87	2232	4.91	2.57	$	1,169.02		454.87
200GRO	1997	INTERNATIONAL	4900 4X2	DIESEL	163.73	553	3.38	2.57	$	420.79		163.73
201GRO	1999	CHEVROLET	K20	DIESEL	649.58	8585	13.22	2.57	$	1,669.42		649.58
204GRO	2001	FORD	F150	UNLEADED	21.41	215	10.04	2.63	$	56.31	21.41	
217GRO	2010	FORD	F550	DIESEL	1189.88	9766	8.21	2.57	$	3,057.99		1189.88
220GRO	2003	STERLING	LT9500	DIESEL	647.93	179	0.28	2.57	$	1,665.18		647.93
224GRO	2011	INTERNATIONAL	7400 SFA 4X2	DIESEL	893.79	4231	4.73	2.57	$	2,297.04		893.79
226GRO	2002	FORD	F350	DIESEL	729.25	7147	9.80	2.57	$	1,874.17		729.25
231GRO	2002	STERLING	LT9500	DIESEL	1420.41	5948	4.19	2.57	$	3,650.45		1420.41
349GRO	1999	INTERNATIONAL	4900	DIESEL	177.28	577	3.25	2.57	$	455.61		177.28
350GRO	2009	INTERNATIONAL	7400	DIESEL	699.78	3305	4.72	2.57	$	1,798.43		699.78
351GRO	2008	INTERNATIONAL	7400 SFA 4X2	DIESEL	239.27	995	4.16	2.57	$	614.92		239.27
356GRO	2012	FORD	F350	UNLEADED	686.73	6875	10.01	2.63	$	1,806.10	686.73	
358GRO	2003	STERLING	LT9501	DIESEL	971.49	4157	4.28	2.57	$	2,496.73		971.49
360GRO	1991	FORD	L8000	DIESEL	80.96	295	3.64	2.57	$	208.07		80.96
412GRO	2006	FORD	ESCAPE HYBRID	UNLEADED	136.23	3584	26.31	2.63	$	358.28	136.23	
418GRO	2003	STERLING	L7500	DIESEL	482.23	2483	5.15	2.57	$	1,239.33		482.23
PUBLIC WORKS FLEET -LEADERSHIP							**11.60**					
100GRO	2007	FORD	F150	UNLEADED	598.92	6835	11.41	2.63	$	1,575.16	598.92	
194GRO	2002	FORD	F350	DIESEL	261.53	2542	9.72	2.57	$	672.13		261.53
313GRO	2006	CHEVROLET	SILVERADO 1500	UNLEADED	669.28	8364	12.50	2.63	$	1,760.21	669.28	
419GRO	2003	FORD	F150	UNLEADED	425.48	4936	11.60	2.63	$	1,119.01	425.48	
OPDS - INSPECTIN SERVICES							**19.97**					
130GRO	2003	CHEVROLET	BLAZER	UNLEADED	804.15	10602	13.18	2.63	$	2,114.91	804.15	
162GRO	2011	FORD	ESCAPE	UNLEADED	231.58	6934	29.94	2.63	$	609.06	231.58	
193GRO	2010	FORD	ESCAPE HYBRID	UNLEADED	251.52	8168	32.47	2.63	$	661.50	251.52	
OPDS - PLANNING							**23.08**					

173GRO	2009	FORD	ESCAPE	UNLEADED	120.78	2784	23.05	2.63	$	317.65	120.78	
183GRO	2008	FORD	ESCAPE	UNLEADED	57.97	1342	23.15	2.63	$	152.46	57.97	
HUMAN SERVICES - LEADERSHIP							**14.43**					
116GRO	2003	CHEVROLET	BLAZER	UNLEADED	130.46	1883	14.43	2.63	$	343.11	130.46	
PARKS & REC - LEADERSHIP							**15.03**					
078GRO	2003	CHEVROLET	VENTURE	UNLEADED	51.79	928	17.92	2.63	$	136.21	51.79	
119GRO	1994	CHEVROLET	S-10	UNLEADED	31.24	417	13.35	2.63	$	82.16	31.24	
187GRO	1999	FORD	WINDSTAR	UNLEADED	61.44	1060	17.25	2.63	$	161.59	61.44	
207GRO	2009	FORD	ESCAPE HYBRID	UNLEADED	128.45	3294	25.64	2.63	$	337.82	128.45	
233GRO	2009	FORD	ESCAPE HYBRID	UNLEADED	191.18	4863	25.44	2.63	$	502.80	191.18	
41478	2008	CHEVROLET	KODIAK - CUTAWAY	DIESEL	556.37	4771	8.58	2.57	$	1,429.87		556.37
PARKS & REC -SR TRANSPORTATION							**7.85**					
37066	2001	FORD	E350	DIESEL	151.56	1707	11.26	2.57	$	389.51		151.56
38573	2002	FORD	E450	DIESEL	700.01	6313	9.02	2.57	$	1,799.03		700.01
39700	2006	FORD	E350	DIESEL	828.48	8205	9.90	2.57	$	2,129.19		828.48
40732	2008	FORD	SUPER E350 CUTAWAY	UNLEADED	2404.26	17680	7.35	2.63	$	6,323.20	2404.26	
41074	2010	FORD		UNLEADED	2441.04	17287	7.08	2.63	$	6,419.94	2441.04	
PARKS & REC - PARKS/REC AREAS							**9.88**					
048GRO	1997	GMC	C30	DIESEL	248.32	2526	10.17	2.57	$	638.18		248.32
112GRO	2001	FORD	F550	DIESEL	361.92	3404	9.41	2.57	$	930.13		361.92
114GRO	2009	FORD	F250	UNLEADED	515.03	4168	8.09	2.63	$	1,354.53	515.03	
115GRO	2003	FORD	F550	DIESEL	406.99	3538	8.69	2.57	$	1,045.96		406.99
118GRO	2002	FORD	F250	DIESEL	494.99	4817	9.73	2.57	$	1,272.12		494.99
147GRO	1997	GMC	C30	DIESEL	305.71	2740	8.96	2.57	$	785.67		305.71
150GRO	1999	CHEVROLET	K20	DIESEL	388.03	4954	12.77	2.57	$	997.24		388.03
221GRO	2010	FORD	F350 REG CAB 4X4	UNLEADED	1130.22	11892	10.52	2.63	$	2,972.48	1130.22	
LIBRARY - AV/VIDEO SERVICES							**25.91**					
154GRO	2009	FORD	ESCAPE HYBRID	UNLEADED	149.07	3863	25.91	2.63	$	392.05	149.07	
PUBLIC WORKS SEWER FUND							**13.28**					

040GRO	2002	FORD	F250	DIESEL	436.29	4005	9.18	2.57	$	1,121.27		436.29
041GRO	2002	FORD	F250	DIESEL	407.72	4270	10.47	2.57	$	1,047.84		407.72
070GRO	2006	FORD	F250	UNLEADED	883.96	7390	8.36	2.63	$	2,324.81	883.96	
090GRO	2007	FORD	RANGER	UNLEADED	602.94	8465	14.04	2.63	$	1,585.73	602.94	
133GRO	2008	FORD	FOCUS	UNLEADED	96.3	3090	32.09	2.63	$	253.27	96.3	
136GRO	2000	CHEVROLET	S10	UNLEADED	224.19	2866	12.78	2.63	$	589.62	224.19	
141GRO	2010	TOYOTA	PRIUS	UNLEADED	122.42	5644	46.10	2.63	$	321.96	122.42	
142GRO	1999	CHEVROLET	S10	UNLEADED	414.3	4190	10.11	2.63	$	1,089.61	414.3	
146GRO	2012	FORD	F150	UNLEADED	18.88	227	12.02	2.63	$	49.65	18.88	
186GRO	2010	FORD	ESCAPE HYBRID	UNLEADED	122.12	3707	30.36	2.63	$	321.18	122.12	
188GRO	2008	FORD	RANGER 4X4	UNLEADED	570.62	7074	12.40	2.63	$	1,500.73	570.62	
205GRO	2002	STERLING	L7500	DIESEL	128.63	485	3.77	2.57	$	330.58		128.63
208GRO	1987	INTERNATIONAL	1954	DIESEL								
227GRO	2008	FORD	CUTAWAY W/UTIL BODY	UNLEADED	198.72	1376	6.92	2.63	$	522.63	198.72	
353GRO	2010	FORD	ESCAPE HYBRID	UNLEADED	207.23	6105	29.46	2.63	$	545.01	207.23	
PUBLIC WORKS TRANSFER STATION							**5.80**					
072GRO	2003	INTERNATIONAL	9100 I	DIESEL	527.73	2946	5.58	2.57	$	1,356.27		527.73
229GRO	2005	FORD	F250	UNLEADED	531.9	4678	8.79	2.63	$	1,398.90	531.9	
357GRO	2007	FORD	RANGER	UNLEADED	348.91	4953	14.20	2.63	$	917.63	348.91	
359GRO	2004	STERLING	LT9500	DIESEL	2689.35	11189	4.16	2.57	$	6,911.63		2689.35
OPDS - COMMUNITY DEVELOPMENT							**14.81**					
228GRO	2003	CHEVROLET	BLAZER	UNLEADED	669.41	9917	14.81	2.63	$	1,760.55	669.41	
TOTALS					**100,570**	**937,956**	**9.33**		**$**	**262,844.39**	**73,008**	**27,562**