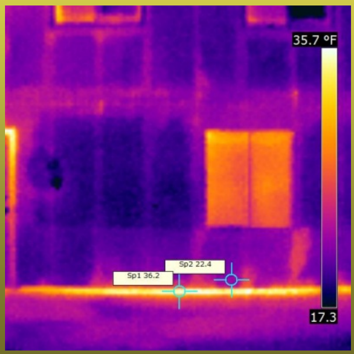

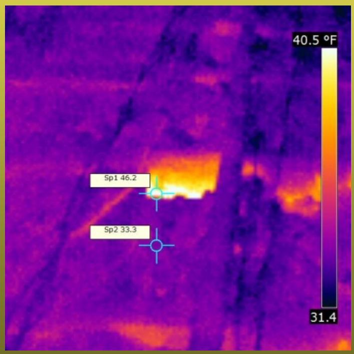

Facility Audit Report

Hollis Department of Public Works

FINAL

May 2012

Prepared for:
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A. EXECUTIVE SUMMARY

Program Introduction

Figure 1: Hollis Department of Public Works Facility

The Town of Hollis requested investment grade audits for seven (7) municipal buildings and five (5) school buildings located within the Town. Funding was provided by the United States Department of Energy (DOE) through the New Hampshire Office of Energy and Planning (NHOEP) Energy Efficiency Conservation Block Grant (EECBG) program.

Phase one of the evaluation process involves site assessment planning including evaluating utility bills, benchmarking, reviewing available building and mechanical plans and coordinating site reviews with facility managers. Phase two involves a comprehensive and holistic facility evaluation to gather relevant information and data. Analyzing the collected data and developing recommendations for energy efficiency measures is completed in Phase three. This information is presented to the Town within this report.

The objective of the building evaluation completed at the Hollis Department of Public Works (Figure 1) is to identify measures that reduce the net energy consumption thereby reducing operating costs and the consumption of non-renewable fossil fuel energies. In addition to energy conservation, the evaluations and recommendations presented herein consider occupant comfort and holistic building performance consistent with its intended use and function. The information obtained as part of this evaluation has been used to develop recommended Energy Efficiency Measures (EEMs). These EEMs provide the basis for future building improvements and modifying the manner in which the building systems are operated.

Procedure

Facility audits or evaluations identify all appropriate EEMs and a financial analysis that considers implementation costs, operating costs, and attainable savings. The objective is to identify the predicted energy savings, the amount the measure will cost, and the estimated payback period for each EEM. The evaluation also identifies any changes to operations and maintenance procedures that will reduce energy consumption. A comprehensive field survey of the facility is completed to evaluate the following:

- *Building Characteristics*
- *Building Use and Function*
- *Envelope Systems*
- *Heating and Cooling Systems*
- *Ventilation Systems*
- *Electrical and Lighting Systems*
- *Domestic Hot Water Systems*
- *Plug Loads*

Following completion of the field evaluation, the data and information are reviewed to develop proposed recommendations for the facility. All information, data, and recommendations are then compiled into a comprehensive report. The final report is then distributed to the municipality or school to assist with implementation and budgeting of the proposed EEMs. The information provided in the reports will assist the owner with determining the best value EEMs for their facilities. The reports also identify potential financial resources available to help fund the EEMs.

On January 3rd, 2012, AEC personnel completed site surveys at the Hollis Department of Public Works (HDPW) to obtain the information necessary to complete an assessment of overall building performance. All building systems that impact energy consumption were evaluated including the building envelope, heating and cooling, ventilation, electrical, plumbing, and mechanical. Secondary observations are also reported herein and include building code compliance, life safety, structural systems, and roofing systems. This evaluation also considers whole building performance that measures how well the integrated building systems in the HDPW function as a composite system.

AEC completed a desktop review of the data provided by the town including historical energy consumption data. The field review included an evaluation of all building systems and data collection including an infra-red thermal imaging survey, indoor air quality measurements, lighting density measurements, and metering of lighting fixtures and HVAC equipment. The HDPW building was modeled using a building energy modeling computer program (eQUEST®) and calibrated to historical energy data. A series of energy efficiency measures (EEMs) were then simulated in the 3-D building model to measure their effect on energy consumption. Capital investment costs for each EEM were developed, and based upon the predicted cost savings associated with the energy efficiency measure, the payback term is calculated. A savings to investment ratio (SIR) for each EEM is then calculated based on the cost of implementation, the predicted energy cost savings, and the predicted service life of the measure/equipment. Other noted recommendations relate to indoor air quality, occupant comfort, code compliance, accessibility, and life safety.

Summary of Findings

The following significant findings are presented for the HDPW building:

1. The economically constructed thirty-one year old timber structure has endured beyond its expected service life. Improving the facility to modern standards will require substantial cost investment.
2. Function of the facility is not consistent with modern public works repair and maintenance facilities.
3. Ventilation systems do not comply with current fire and mechanical code standards.

Notable Observations

The following notable observations were made during the desktop data review and/or the building evaluation. Notable observations may be related to data that is outside the normal or expected range, irregularities in building use or function, or problematic systems.

- Considering the absence of mechanical ventilation systems, the HDPW building consumes a moderate amount of electricity. This is mostly attributable to the electric fintube heating and window A/C units in the office spaces.
- The high bay portion of the building is heated by a waste oil furnace unit and the offices are heated by electric baseboard units. Waste oil fuel for the heater is collected at the Town Transfer Station.
- The NH Department of Environmental Services (NHDES) regulates air emissions from waste oil heating units (Env-A 1400). Based on the operating characteristics of the waste oil furnace at HDPW, it appears to be exempt from the permit requirements pursuant to Env-A 1402.02(g) (this should be verified by the HDPW).
- The envelope is poorly insulated resulting in a significant amount of thermal transfer through the concrete footing walls, and roof. Improving the existing envelope would be a costly initiative.
- Gaps in entry doors and windows provide a significant amount of thermal energy transfer.

- There are no exchange air ventilation systems in the building. This is a code compliance issue.
- Exhaust ventilation in the service bays does not comply with current code requirements.
- The service bay overhead door height is lower than recommended and do not accommodate larger equipment. The bays are not pass-through requiring vehicles to back out of the single door service bays.

Summary of Recommendations

Following is a summary table identifying the proposed recommendations, EEM investment costs, predicted annual energy cost savings, simple payback period and savings to investment ratio. Part G provides a more detailed explanation of these recommendations.

The energy cost savings and resulting payback are based upon each independent measure implemented for the building in its current condition and function. There are interdependencies among measures that will affect the net composite energy savings. Interdependent measures are parametrically related therefore the net energy savings from two dependent measures do not equal the resulting savings determined by the addition of the two measures considered independent of each other. Investment costs are provided for budgetary planning only. They are estimated based on current industry pricing. A detailed cost estimate should be developed prior to appropriating capital funds for the more costly measures. Budgetary cost estimates for the Tier III and more costly Tier II measures are presented in Appendix J.

Table 1: Energy Efficiency Measures Summary

EEM No.	EEM Description	Capital Cost	Annual Cost Savings	Payback (yrs.)	SIR
T1-1	Reduce lighting density in DPW Directors office and second floor office by removing lamps and replacing with lower wattage units.	$0	$82	0	-
T1-2	Remove compact refrigerator in rear office.	$0	$102	0	-
T1-3	Complete intensive air-sealing/weather-stripping program including all overhead doors, entry door jambs, partings, headers, thresholds, moldings (interior and exterior), and wall and ceiling penetrations.	$2,000	$780	2.6	2.7
T1-4	Replace refrigerator in break room with an ENERGY STAR® model.	$500	$63	7.9	1.9
T1-5	Replace two (2) old CRT monitors with LCD ENERGY STAR® rated units.	$250	$31	8.1	1.5
T2-1	Insulate exposed interior sections of the concrete foundation wall with 2-inches of foil-faced polyisocyanurate rigid insulation and spray-foam entire top of wall/sill plate.	$1,518	$120	12.7	2.4
T2-2	Replace the existing electric domestic hot water heater with an electric demand tankless unit.	$2,622	$210	12.5	1.2
T2-3	Install 2-inches of foil-faced polyisocyanurate rigid insulation on interior of overhead garage doors (4).	$8,223	$287	28.6	1.0
T3-1	Add 6" of blown cellulose insulation on attic floor.	$15,939	$1,200	13.3	2.3
T3-2	Replace waste oil furnace in high-bay area with a self-contained pellet stove fan unit.	$28,118	$2,050	13.7	1.8
T3-3	Install a high-efficiency inverter driven electric heat-pump VRF system in office spaces for heating and cooling.	$42,723	$1,575	27.1	1.0

(1) Tier II and III EEM investment costs include fees for design & engineering, construction management, and a 15% cost contingency.

The following table summarizes the renewable energy technologies that were considered for the Hollis Police Department. Scores are determined based upon the feasibility of the technology for the facility. A more focused feasibility study should be completed prior to considering any renewable energy system(s).

Table 2: Renewable Energy Technology Feasibility Scoring Results

Renewable Energy Technology	Grade
Biomass Heating	87%
Geothermal Heating/Cooling	83%
Solar DHW	76%
Ground Photovoltaic	74%
Wind Turbine Generator	69%
Roof Photovoltaic	65%
Combined Heat & Power	64%
Solar Thermal	62%

Insulation resistance values (R-values) were determined based on given information, time of construction and visual observations. The industry standard *International Energy Conservation Code (IECC), 2009* for Commercial Buildings in Climate Zone 5 required values are provided along with the installed values in Table 3. The IECC values are for new construction only, however provide a guide as to how this facilities insulation compares with new construction.

Table 3: Facility Insulation Summary

Insulation Values			
Space	Required (IECC, 2009)	Recommended	Installed
Floor 1 (High Bay, Workshop, Office)	NA	10	1.0
Floor 2 (Hallway)	NA	10	1.1
Floor 3 (Offices)	NA	10	2.2
Wall	13.0 +3.8 ci	13.0 +3.8 ci	18.7
Roof	38	38	11.1

Master Planning Considerations

The Hollis Department of Public Works was constructed in 1981 and consists of high-bay garages for Town Maintenance vehicles, a workshop area, offices, and an employee break area. A separate unconditioned high-bay open garage is located to the north of the facility which is used to store sand. The facility was economically constructed thirty-one (31) years ago and the building materials and systems are not durable. Building systems require substantial repairs and modifications to comply with current code requirements and to provide a facility that meets the needs of modern town DPW organizations.

The thermal integrity of the envelope is poor with substantial heat loss occurring through floors, walls, and the roof. The overhead garage doors are operated frequently resulting in high exchange of conditioned air with outdoor air. Thermal integrity of doors and windows is low and poor seals result in substantial air leakage. The building is not adequately ventilated or exhausted (code compliance issue) and air conditioning is provided to office spaces with inefficient window air-conditioning units. The building is spatially constrained and does not appear to provide adequate space for storage of tools, equipment, and parts. Overall function of the facility is not consistent with modern town DPW facilities.

Improving the existing building consistent with current building code and modern DPW facility standards will require a substantial cost investment. Prior to appropriating funding for improvements of the existing facility, it is recommended that the Town complete a feasibility study to evaluate if replacing the existing building with a new facility is a more cost practical approach.

B. PROCEDURES & METHODOLOGY

Standards and Protocol

The American Society for Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) has developed the most widely accepted process for completing energy audits at commercial facilities. ASHRAE document RP-669, SP-56, *Procedures for Commercial Building Energy Audits* defines several levels of audits. The appropriate level of audit for a particular facility depends on the availability of existing data and information, owner objectives, and owner budget. Levels range from simple benchmarking to a comprehensive review of all building systems. The most comprehensive audit is a Level III audit which was performed at the DPW. Level III audits are commonly referred to as "Investment Grade Audits".

Basic elements of a Level III Investment Grade Audit include the following:

- A review of existing facility data including energy usage.
- Benchmarking the facilities energy usage relative to similar use facilities.
- An on-site inspection and survey of all facility systems.
- On-site measurements and data collection.
- Informal interviews with owners, facility managers, and occupants.
- Energy use analysis and development of efficiency measures.
- Developing a simple payback cost estimate for each recommended measure.
- Development of a comprehensive report that clearly presents all findings and provides recommended energy conservation measures and the associated costs.

In addition to the ASHRAE standard for commercial audits, there are industry and code-based standards that must be considered when analyzing building systems and evaluating energy conservation measures. All recommendations must be consistent with the intent of these standards. For example, the US Environmental Protection Agency (EPA) has established a recommended carbon dioxide (CO_2) threshold concentration of 1,000 parts per million (ppm) to promote a healthy indoor air environment. ASHRAE defines recommended temperatures, relative humidity levels, minimum ventilation rates, and energy standards. The Illuminating Engineering Society of North America (IESNA) prescribes recommended lighting densities based on the designated space use. The International Code Council (ICC) is the adopted standard for all building and energy codes (2009) in the state of New Hampshire. New Hampshire has also adopted ASHRAE Standards 62.1 and 90.1.

Table 4: Relevant Industry Codes and Standards

Standard	Description
28 CFR Part 36	ADA Standards for Accessible Design
ANSI/ASHRAE Standard 55	Thermal Environmental Conditions for Occupancy
ANSI/ASHRAE Standard 62.1	Ventilation for Acceptable Indoor Air Quality
ANSI/ASHRAE/IESNA Standard 90.1	Energy Standards for Buildings Except Low-Rise Residential Buildings
ICC 2009	International Building Code (IBC)
ICC 2009	International Existing Building Code (IEBC)
ICC 2009	International Energy Conservation Code (IECC)
ICC 2009	International Mechanical Code (IMC)
ICC 2009	International Fuel Gas Code (IFGC)
IESNA Lighting Handbook	Reference and Application
NFPA 70	National Electrical Code (NEC)

While the primary objective of an energy audit is identify energy conservation measures, such measures cannot adversely affect occupant comfort and indoor air quality. For example, if a building ventilation system is inadequate then it would be recommended that additional ventilation capacity be added. The electrical power required to operate the added ventilation equipment would increase energy consumption. Typically, the net energy usage incorporating the sum of the recommended conservation measures would still be less than the current usage even with the added ventilation equipment.

It is noted that although there is a prescriptive approach to commercial building audits, that every building is unique in many ways. Buildings should be evaluated consistent with the characteristics that define its need and appropriate function. This includes the following:

- *Use*: Current building use and occupant needs.
- *Systems*: Building systems characteristics and integration.
- *Control*: The effectiveness in which the existing building systems controls are utilized.

Desktop Data Review

Ideally, the building owner provides all available information to the engineering firm prior to initiating the facility site review. Information such as utility bills, building plans, repair records, planned improvements, and occupant concerns will help the building engineer identify potential issues before initiating the site review. The Building Engineer can then focus the site review toward problematic and energy intensive building systems.

Facility Site Review

Following the desktop data review, the Engineer initiates the facility site review. This review includes all major building systems including the envelope, electrical, mechanical, heating, cooling, and ventilation. The Engineer not only determines the performance and operating characteristics of all building systems, they also evaluate how the users operate the systems and how they perceive building performance. Photographs of representative systems, major equipment, and any identified issues are obtained to help document existing conditions. Field notes are maintained by the Engineer to further document building and user characteristics.

Data Measurements

In addition to collecting equipment information, several data measurements are obtained as part of the facility site review. This data is necessary to identify potential building issues and to collect the information needed to develop an accurate energy analysis. Measurements include:

- Infra-red thermal imaging survey of the building envelope.
- Indoor air quality (IAQ) measurements (temperature, relative humidity, and CO_2).
- Lighting metering to determine energy use and operating schedules.
- Lighting output density.
- Metering of energy intensive electrical equipment (e.g., motors, compressors, heaters) to determine energy use and operating schedules.
- Metering of energy intensive plug-loads to determine energy use and operating schedules.

Data Gap Review

Once the facility site review and data measurements are substantially complete, the Engineer begins reviewing and processing all of the collected data. Any data gaps discovered during this process are addressed prior to completing the audit report.

Energy Modeling and Conservation Measures

To identify the best value EEMs and ensure that the calculated energy and cost savings are relatively accurate, a DOE approved energy modeling software program is utilized. A three-dimensional model of the building is created using the simulation program. This includes all characteristic envelope systems, HVAC systems, domestic hot water systems, and mechanical systems. The geographic position and orientation of the building is input and regional climatic data is imported from the program database.

After the building is accurately modeled, the program simulates building performance and provides the estimated energy use for electric and heating fuel(s). The Engineer then compares the energy data to actual building data. The cause for any significant differences is determined and the building is re-simulated until the model closely matches the actual data. AEC utilizes eQUEST© for all building simulations and energy modeling.

With the base model complete, the Engineer then implements various energy reducing measures and simulates the performance of the building with the new measure. The resulting energy consumption is then compared to the baseline model and predicted energy savings are analyzed.

Cost Estimating and Payback

The cost for implementing each evaluated EEM is then estimated by the Engineer. This provides a net estimated energy savings per dollar invested. Simple payback calculations determine the number of years required for the capital investment cost to equal the present day cost savings realized from energy reductions. The savings to investment ratio (SIR) is the accumulated annual cost savings (as determined by the expected service life of the material or equipment associated with the EEM) divided by the cost of investment. A SIR equal to 1.0 indicates that the EEM has a “break-even” or net-zero cost. The higher the SIR, the more favorable the return on investment is.

C. FACILITY INFORMATION / EXISTING CONDITIONS

Setting

The Hollis Department of Public Works (HDPW) is located at 10 Muzzey Road in Hollis, NH. The HDPW facilities are set on a parcel of land owned by the Town of Hollis. They include the main HDPW building, a modern salt/sand storage shed, and laydown yard, and several small storage sheds (Figure 2).

Figure 2: Aerial Photo Hollis DPW Facilities 2011

The building is accessed from Silver Lake Road (State Route 122) and is approximately one mile north of the Town center. Abutting the facility to the west is a large parking area for school buses. Residential areas are located to the south of the facility. A large tract of wooded land abuts the facility to the northeast with agricultural use land located further east. The gross area of the DPW building is 7,522 square feet.

History

The building was constructed in 1981 to serve as the DPW office and garage. It does not appear any major improvements have been made to the building since its inception. Facility improvements include a modern sand/salt storage shed, paving, and passive stormwater treatment controls.

Use, Function & Occupancy Schedule

The DPW and the land it occupies are owned by the Town of Hollis. The building has four (4) overhead bays for maintenance work and a small office area and a break room on the second floor. The building is in a state of disrepair and does not properly serve the intended use. The building is not adequately designed for larger equipment and work areas are confined. The building is occupied 40 hours per week and for special events such as snow removal operations.

Anecdotal Information

Anecdotal information includes all relevant information collected during the desktop review, as part of occupant interviews, or general observations noted during the site evaluation. Generally, anecdotal information corresponds to issues or concerns that may not be apparent during the building evaluation. It includes complaints about seasonal occupant comfort, maintenance issues, systems or equipment performance issues, recent improvements or changes in use, and previous reports prepared by others. Anecdotal information obtained during the DPW evaluation includes the following:

- One (1) window A/C unit is used for cooling the first floor offices in the summertime.
- The building operates as a typical work building for 40 hours a week but is often open for extended hours for emergency Town maintenance details (snow removal, downed tree removal, flooding, etc.).

Utility Data

Utility data for the Hollis Department of Public Works was provided by the Town. Table 5 summarizes the total energy consumption for the year including electric and oil usage as well as propane usage for the dog kennel.

Energy consumption and cost for electricity per pay period is shown in Table 6 and Figure 3. The regional electric utility supplier is Public Service Company of New Hampshire (PSNH), waste fuel oil is provided by the Town's transfer station and propane is supplied by a local supplier.

Table 5 : Annual Energy Consumption (2011)

Energy	Period	Consumption	Units	Cost
Electric	January 2010 – December 2010	36,160	Kilowatt hours	$5,556
Propane (Kennel)	January 2010 – December 2010	680	Gallons	$1,470
Waste Fuel Oil	January 2010 – December 2010	999(1)	Gallons	$0
			Total Annual Energy Cost (2010):	$7,026
Electric	January 2011 – December 2011	38,420	Kilowatt hours	$6,147
Propane (Kennel)	January 2011 – December 2011	572	Gallons	$967
Waste Fuel Oil	January 2011 – December 2011	999(1)	Gallons	$0
			Total Annual Energy Cost (2011):	$7,114

(1) No consumption data available. Value is predicted by the energy model (eQUEST).

Over the twelve (12) month period (2010) January was the peak demand month, consuming 5,410 kWh of electricity. Over the second twelve month period (2011), February was the peak demand month, consuming 6,200 kWh of electricity. The electrical consumption peaks during the winter months because a section if the building is heated with electrical baseboards. August is lowest month indicating little electricity is used for cooling.

Table 6 : Monthly Electric Consumption (2010 – 2011)

Month	Year	Electric Consumption (kWh)	Electric Cost
Jan	2010	5,410	$784
Feb	2010	5,000	$737
Mar	2010	4,480	$650
Apr	2010	2,880	$451
May	2010	2,410	$370
June	2010	1,870	$271
July	2010	1,630	$268
Aug	2010	1,490	$245
Sep	2010	1,740	$298
Oct	2010	2,270	$381
Nov	2010	2,890	$472
Dec	2010	4,090	$629
Totals:	*2010*	*36,160*	*$5,556*
Jan	2011	5,510	$830
Feb	2011	6,200	$963
Mar	2011	6,090	$944
Apr	2011	4,130	$667
May	2011	2,740	$454
June	2011	1,960	$354
July	2011	1,590	$245
Aug	2011	1,560	$266
Sep	2011	1,590	$257
Oct	2011	1,910	$322
Nov	2011	2,360	$400
Dec	2011	2,780	$443
Totals:	*2011*	*38,420*	*$6,147*
Totals:	*'10 - '11*	*74,580*	*$11,703*

Based on the Town provided data the average annual electric usage (January 2010 through December 2011) for the HDPW is 37,290 kWh at an average cost of $5,852. Based on the building size and function, this usage is at the lower end of the expected range. The absence of exchange air ventilation systems in the building attributes to the low electrical usage.

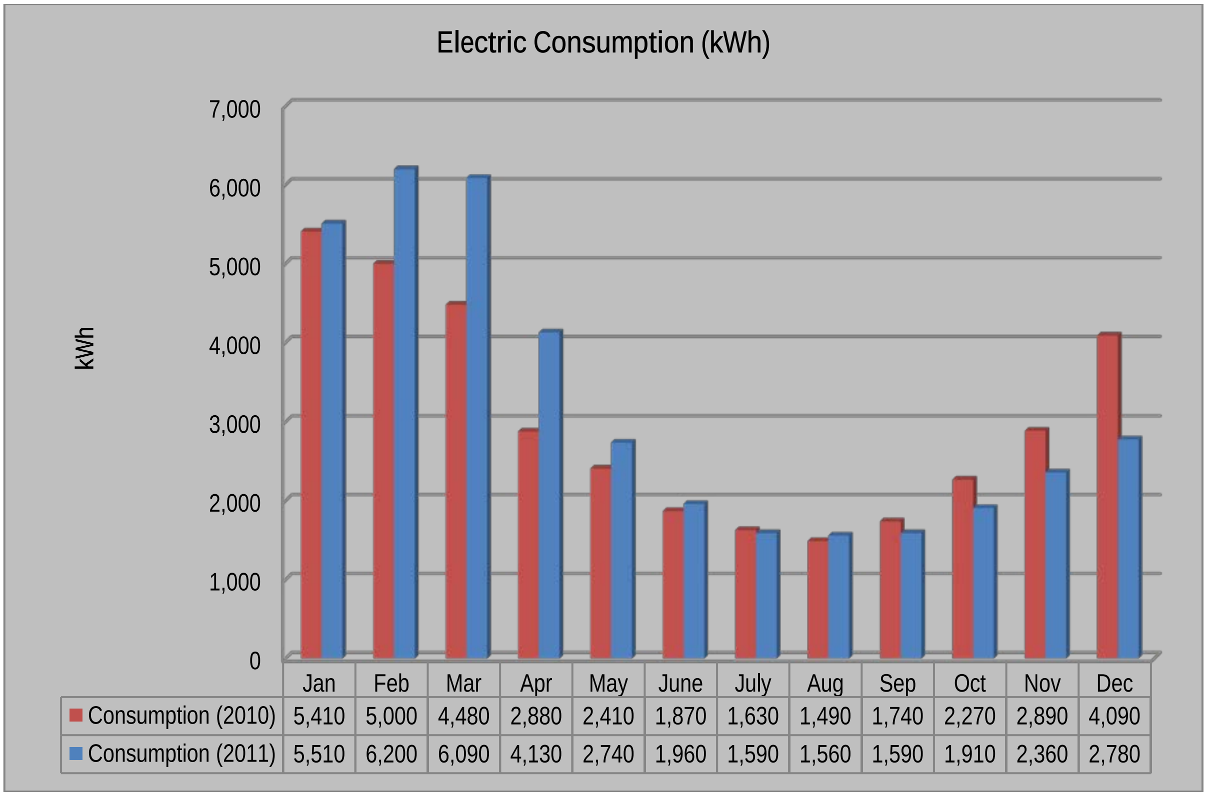


Figure 3 : Electric Consumption (2010 – 2011)

To provide the most accurate recommendations for energy conservation, the energy consumption based on end use was determined. Table 7 presents the estimated electrical usage for categories including lighting, plug loads, and mechanical equipment. Mechanical equipment includes all hard-wired, permanently installed equipment including ventilation, exhaust, heating, cooling, pumps, etc. These values were determined using observations from the field audit and typical energy consumption data for appliances observed throughout the building. A more detailed accounting of all electrical equipment by end-use is presented in Part C of this Report.

Table 7 : Categorized Electrical Consumption (2011)

Equipment Type	Annual Consumption (kWh/yr)	% of Total Consumption	Annual Cost
Mechanical Equipment	23,050	59%	$3,573
Lighting Fixtures	10,979	28%	$1,702
Plug Loads	4,974	13%	$771
Totals:	39,003	100%	$6,045

Electrical consumption is largely consumed by mechanical equipment, at a predicted annual consumption of 23,050 kWh/yr. The mechanical systems are limited in the building mostly space heating. Lighting fixtures consume a moderate amount of electricity at an estimated 10,907 kWh/yr. A Town wide lighting upgrade project was completed at the HDPW facility in 2011 which should reduce interior lighting energy consumption. Additional control measures will further reduce energy consumption of the lighting fixtures. Plug loads are predicted to consume the least amount of electricity at an estimated 4,974 kWh/yr.

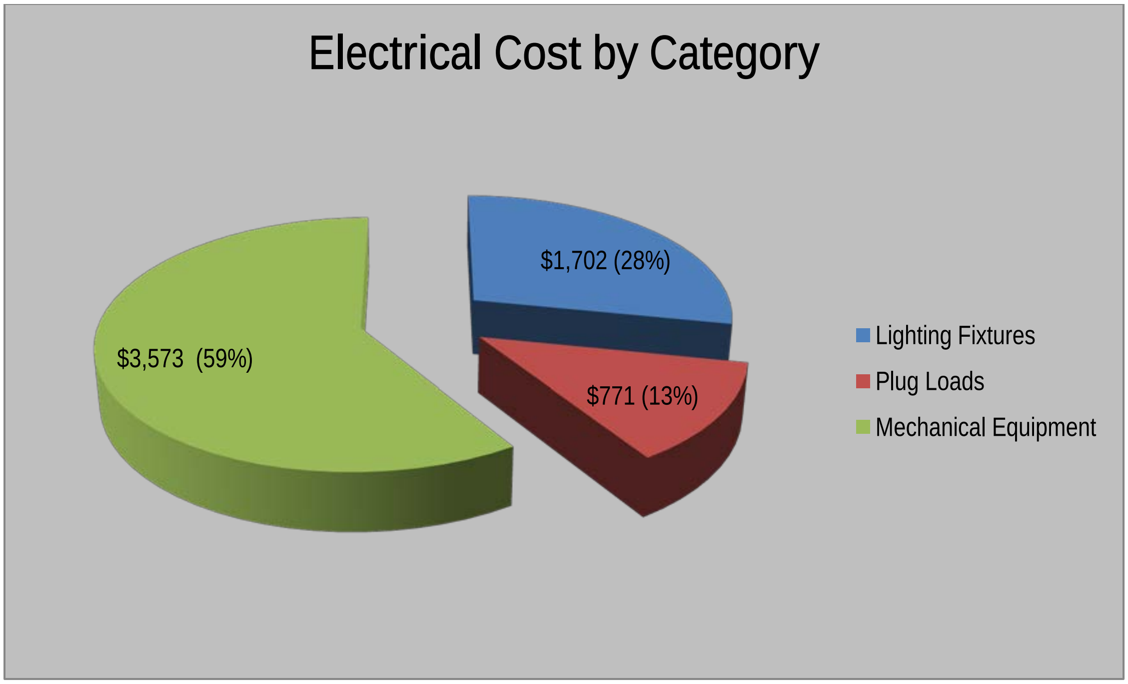


Figure 4 : Hollis DPW Cost by Category (2011)

Consumption for mechanical systems is within the expected range (59%) at a cost of $3,573. Lighting fixtures consume a moderate amount of electricity but are still within a reasonable electrical consumption at 28% and a cost of $1,702. Plug loads account for the lowest annual cost of $771 and 13% of consumption (2011-2012).

Table 8 : Monthly Heating Fuel Consumption (Waste Oil) (2011)

Month	Oil Consumption (Gallons) (1)
January	249
February	220
March	183
April	67
May	10
June	0
July	0
August	0
September	0
October	7
November	93
December	171
Totals:	999

(1) No consumption data available. Values are predicted by the energy model (eQUEST).

Heating fuel for Hollis DPW high-bay is provided by recycled waste oil from the Town Transfer Station. (Table 8, Figure 5). Because the volume of waste oil is not metered, the values in Table 8 were derived from the eQUEST® energy simulation. The model predicted annual heating fuel consumption for the HDPW facility is 999 gallons of oil. Because all of the heating fuel for the garage is provided at no cost, the building is economically viable to operate.

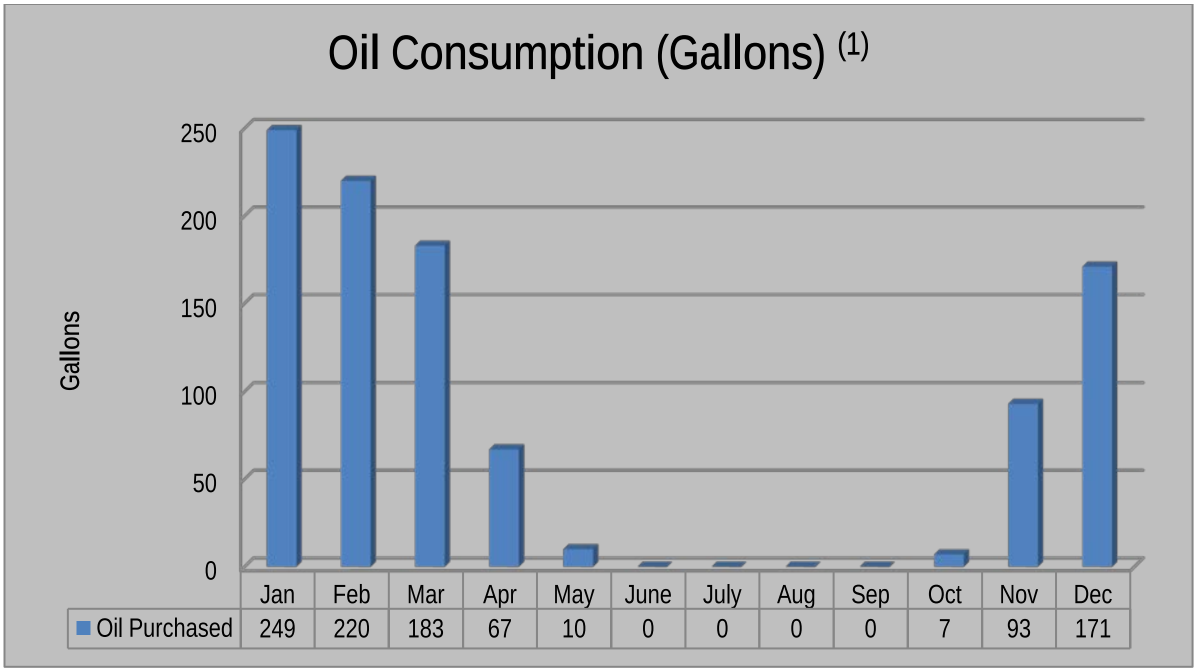


Figure 5: Fuel Oil Consumption (2011)

(1) No consumption data available. Values are predicted by the energy model (eQUEST).

Considering the building systems including the envelope integrity (insulation and air leakage), mechanical equipment, and use of the facility, the heating fuel usage is within the expected range. Heating for the high-bay is provided by a single waste oil furnace. The estimated combustion efficiency of this unit is 75%.

The DPW is responsible for supplying electric and heat to the adjoining dog kennel. Electricity is expected to be minimal. Table 9 below outlines the last two (2) years of the heating fuel cost. This information is only used for the ENERGY STAR® Statement of Energy Performance (SEP) and is not referred to elsewhere in the audit report.

Table 9: Heating Fuel for Dog Kennel (2010 – 2011)

Month	Year	LP Consumption (Gallons)	Cost of Consumption	Est. LP Consumption (Gallons)	Est. Cost of Consumption
Jan	2010	180	$405	169	$366
Feb	2010	0	$0	150	$324
Mar	2010	166	$375	125	$269
Apr	2010	0	$0	46	$98
May	2010	0	$0	7	$15
June	2010	0	$0	0	$0
July	2010	0	$0	0	$0
Aug	2010	0	$0	0	$0
Sep	2010	0	$0	0	$0
Oct	2010	0	$0	5	$10
Nov	2010	0	$0	63	$137
Dec	2010	335	$690	116	$251
Totals:	*2010*	*680*	*$1,470*	*680*	*$1,470*
Jan	2011	0	$0	142	$241
Feb	2011	0	$0	126	$213
Mar	2011	263	$423	105	$177
Apr	2011	0	$0	38	$65
May	2011	116	$166	6	$10
June	2011	0	$0	0	$0
July	2011	0	$0	0	$0
Aug	2011	0	$0	0	$0
Sep	2011	0	$0	0	$0
Oct	2011	0	$0	4	$6
Nov	2011	70	$143	53	$90
Dec	2011	123	$236	98	$165
Totals:	*2011*	*572*	*$967*	*572*	*$967*
Totals:	*10 - '11*	*1144*	*$1,935*	*1001*	*$1,694*

D. FACILITY SYSTEMS

Building Envelope

The following sections present the building envelope systems and insulation values for each assembly. Assembly values are compared to the *International Energy Conservation Code (IECC), 2009* for commercial buildings located in Climate Zone 5. The IECC code is used as a standard of comparison only and existing buildings are not required to comply with the code unless it undergoes a substantial renovation. New construction and major renovations are required to comply with current energy codes. No plans for the building were available during the audit.

Floor Systems

The building is constructed on a slab-on-grade concrete floor. Flooring in the high bay and back offices are unfinished while the hallway is covered with linoleum tiles and the offices are covered with carpeting. Respective R-values for the three flooring systems are 1.0, 1.1, and 2.2. Although the IECC does not specify an insulation requirement for unheated slab-on-grade floors in Climate Zone 5, a minimum value of R-10 is generally recommended.

Table 10 : Floor Insulation Values

Floor Area 1 (High Bay, Back Workshop and office)				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Concrete slab	4.0	0.3	1.0	0.3
Interior air film	NA	0.7	NA	0.7
			Installed Assembly	1.0
			2009 IECC Requirement:	NR
			Best Practice Recommendation	10.0
Floor Area 2 (Hallway)				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Concrete slab	4.0	0.3	1.0	0.3
Tile	NA	0.1	1.0	0.1
Interior air film	NA	0.7	NA	0.7
			Installed Assembly	1.1
			2009 IECC Requirement:	NR
			Best Practice Recommendation	10.0
Floor Area 3 (Offices)				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Concrete slab	4.0	0.3	1.0	0.3
Carpet	NA	1.2	1.0	1.2
Interior air film	NA	0.7	NA	0.7
			Installed Assembly	2.2
			2009 IECC Requirement:	NR
			Best Practice Recommendation	10.0

Wall Systems

The building is timber framed with an engineered trussed roof system. Exterior walls are clad in T-111 sheathing and wall cavities are insulated with six (6) inches of fiberglass batt insulation (Figure 6). The interior of the building is clad in gypsum board. The wall systems do not comply with current energy code standards (IECC 2009) as presented in Table 11.

Figure 6: Exterior Wall (typ.)

Table 11: Wall Assembly Insulation Values

Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
T-111 Sheathing	¾	0.8	0.9	0.6
Fiberglass Batt Insulation	6.0	19.0	0.8	16.8
Gypsum board	5/8	0.5	0.9	0.4
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	18.7
			2009 IECC Requirement:	13+3.8ci
			Code Compliant?	NO

Ceiling Systems

Ceilings throughout the building are gypsum board. The ceiling is insulated with six (6) inches of blow in cellulous that is in poor condition (Figure 7). Through ceiling penetrations are not entirely sealed allowing addition air leakages.

Table 12: Ceiling Insulation Values

Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Loose Cellulous Insulation	6.0	13.8	0.7	9.7
Gypsum board	5/8	0.5	0.9	0.5
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	11.1
			2009 IECC Requirement:	38.0
			Code Compliant?	NO

Roofing Systems

The roof of the building is supported with 2-inch by 6-inch timber trusses. The roof is clad in galvanized sheet metal. There was a small hole in the roof that was observed during the field audit. There are been a persistent problem with nails popping from the roof. This is likely caused by expansion and contraction of the steel roofing. With the exception of the small hole, the roof is in fair condition. Attic space below the roof is unconditioned.

Figure 7: Blown Cellulous in Attic Floor

Fenestration Systems

Fenestration systems on the HDPW building include operable sliding windows and partially grazed overhead doors. Consistent with IECC requirements, fenestration performance is measured by the U-factor, the solar heat gain coefficient (SHGC), and air leakage as determined by the unit manufacturer. No manufacturer information was available for the windows or doors therefore compliance with IECC standards for commercial buildings located in Climate Zone 5 cannot be established.

Thermal transfer and air leakage commonly occurs at the seals of operable windows and the interface between the window and the wall opening which was observed using infrared imaging. Recommendations include exterior and interior inspection and re-caulking of window jambs, headers, and sills as needed. If the operable window units have adjustable jambs, they should be inspected and adjusted as necessary to maintain a complete air seal.

Doors

The door units in HDPW building include steel solid doors and steel overhead garage doors with glazing. Based on visual observations and thermal imaging, the insulation values of door units are satisfactory however the seals on door jambs, partings, and thresholds are incomplete allowing air leakage. Recommendations include exterior and interior inspection, weather stripping and re-caulking around windows as needed.

Air Sealing

Based on the thermal imaging survey and visual observations, air leakage occurs through windows and entry doors (Figure 8). Although this is typical even for a modern building, simple measures can significantly reduce air leakage. Recommended measures for windows include: 1) adjusting jamb seals on operating windows; 2) adding weather-stripping; 3) caulking interior frames and moldings; and, 4) locking/clasping windows to maintain a complete seal.

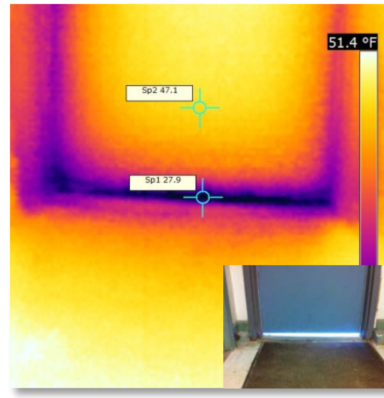


Figure 8: Thermal Transfer around Main Entrance Door

Air sealing of all door units can be improved with commercial weather-stripping. All door and window units should be regularly inspected (every 2 to 3 years) to ensure proper operation, identify faulty seals, and to identify any deteriorated caulking requiring replacement. Other air sealing recommendations include inspecting all exhaust and ventilation ducts to determine if they have a positive pressure actuated damper. Dampers are recommended on all exterior ducting to prevent passive air leakage.

Thermal Imaging Survey

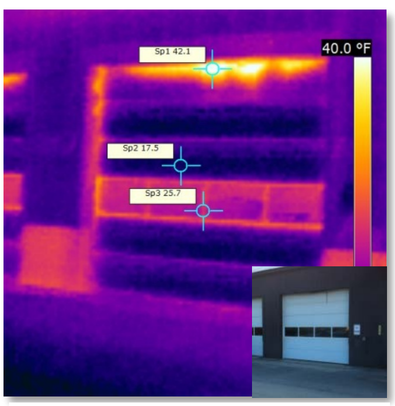


Figure 9: Thermal Transfer through Overhead Doors and Walls

The thermal imaging survey was conducted on January 3rd, 2011, Outdoor ambient temperature was approximately 28°F during the survey. The survey was conducted using a FLIR© B-CAM infra-red (IR) camera. The building exterior and interior envelope and major mechanical and electrical equipment were surveyed with the IR camera. IR camera surveys not only identify heat transfer through building envelopes, they also identify trapped moisture, electrical system overloading, heat loss through ducting and piping, high energy lighting fixtures, and energy intensive plug load equipment. Appendix B presents the survey report.

The IR surveys revealed the following notable observations:

- The integrity of wall insulation is poor. Significant thermal loss occurs in all areas of the building (Figure 9).
- No insulation exists on the exposed concrete foundation walls resulting in high thermal transfer.
- Poorly sealed windows, man doors and overhead doors allow thermal transfer and air leakage.

Electrical Systems

Supply & Distribution

Grid electricity is supplied to DPW building by an underground service to the rear of the building. Several sub-panels are located in the building. Single-phase grid power is supplied to the property by PSNH via overhead transmission lines. Three-phase power is available on Silver Lake Road.

Lighting Systems

As presented in Table 13, there are three (3) types of lighting fixtures and lamp types at the DPW facility. The facility was included as part of the 2011 lighting upgrade project throughout the town. Lighting fixtures in the building consist mainly of recessed mounted high performance T8 fluorescent fixtures. There are a few compact florescent lamps (CFL) and one high pressure sodium (HPS) on the exterior of the building.

Table 13: Lighting Fixture Schedule

Fixture Lamp Type	Location(s)	Control	No. Lamps	Watts	Qty.	Total Watts
T8	Throughout	Switch	1-4	32	46	1,472
CFL	Storage, Lavatory	Switch	1	17	5	85
HPS	Exterior	Switch	1	70	1	70
				Totals:	52	1,564

Table 14 presents the energy consumption by lighting fixture type. Lighting fixtures account for an estimated 10,979 kWh of electricity per year. The high performance T8 fluorescent fixtures are the main source of lighting and account for 96% of all lighting energy consumption annually at an estimated 10,568 kWh/yr. Exterior HPS lamp fixtures consume an estimated 273 kWh/yr. The remaining fixtures each account for less than 2% of total lighting consumption.

The large yard lights are rented at a flat rate from PSNH. Consumption data and rental costs were not available. It may be beneficial to replace these units with LED fixtures and connect them to the building meter. This would require coordination with PSNH.

Table 14: Lighting Fixture Energy Consumption

Fixture Lamp Type	Location(s)	Est. Usage (KWH/yr)	% of Total
T8	Throughout	10,568	96%
HPS	Exterior	297	3%
CFL	Storage, Lavatory	114	1%
	Totals:	10,979	100%

Lighting density measurements in Department of Public Works building were obtained to establish if building illumination is consistent with the *Illuminating Engineer Society of North America* (IESNA) standards for the prescribed use. These measurements were obtained during normal operating conditions on January 3rd, 2011 between the hours of 1418 and 1448. Table 15 presents the lighting density measurements obtained in units of foot-candles (FCs).

IESNA Standards

Lighting densities were measured at ten (10) representative locations. Five (5) of the measurements exceed IESNA recommended standards. As part of the lighting upgrade project these fixtures were designed to be over lit with the intention of them losing their densities over time. While this is an effective way to ensure proper densities are always met it is not the most efficient way of lighting. Methods to reduce lighting densities include reducing the quantity of fixtures, replacing them with lower-wattage fixtures, and installing lower wattage bulbs in the existing fixtures. Other methods to reduce lighting density include replacing overhead lighting with task lighting, adding multiple control zones, adding daylight controls and adding dimming controls. Newer technology fixtures provide higher lighting density per watt than the existing older fixtures and provide improved lighting quality. The lighting density data is included in Appendix C.

Table 15: Illumination Densities

Location	Lighting Density (FC)	Recommended Density (FC) (1)
Receptionist Office	28	30
DPW Director Office	67	30
Men's Lavatory	12	10
Entrance Corridor	31	10
Rear Shop	28	30
Rear Office	35	30
High Bay	21	30
Break Room	25	20
Upstairs Office	55	30
Storage	15	10

(1) Based upon IESNA standards and AEC recommendations.

Plug Loads

Plug loads for the HDPW facility were determined based on equipment nameplate information. The operating time for each item is based on observations, occupant loading, schedule, and typical operating time for the equipment. Plug loads are categorized as either appliances or electronics and office equipment. Appendix F presents an inventory of all plug load equipment.

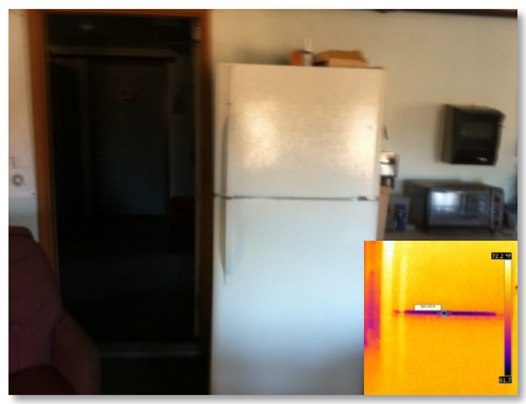


Figure 10: Older Inefficient Refrigerator in 2nd Floor Break Room

Based on this analysis, the total annual plug load is 4,974 kWh/yr. This accounts for 13% of annual consumption at the facility. Appliances account for approximately 62% of consumption and office equipment such as computers and electronics are estimated to consume 38%. The office equipment, computer and miscellaneous electronic loads are about as expected for the size of the building and number of occupants however can still be reduced. Many pieces of equipment are left powered on when the building is unoccupied and can consume a considerable amount of electricity even if they are in a low powered state. Recommendations include placing equipment such as copiers and computers on time programmable smart-strips to automatically power equipment off when the building is unoccupied. Replacing the inefficient refrigerator in the break room (Figure 10) with an ENERGY STAR® rated unit will provide substantial energy savings.

Table 16: Plug Load Energy Consumption

Category	Location(s)	Est. Usage (kWh/year)	% of Total
Appliances	Throughout	56,978	62%
Office Equipment, Computers, Electronics	Throughout	55,360	38%
	Subtotals	112,339	100%

Motors

There are no large electric motors in the DPW.

Emergency Power Systems

A modern diesel powered generator provides electrical power to the building during grid outages. The unit is expected to provide enough capacity to supply critical systems in the event of an outage.

Plumbing Systems

Figure 11: Water Treatment System

Domestic Water Supply

Domestic water supply for the DPW is provided by an on-site well. Water demand includes lavatory and truck washing. Demand is expected to be low.

Domestic Water Treatment Systems

A water filtration system (Figure 11) reduces arsenic levels in the water.

Domestic Hot Water Systems

Domestic hot water is provided by an electric domestic hot water heater. Capacity is expected to exceed demand requirements. It is recommended that the system be replaced with a tankless demand unit.

Hydronic Systems

There is no hydronic system installed in the DPW building.

Mechanical Systems

Figure 12: Waste Oil Furnace

Heating Systems

Heat is provided to the office and break room by electrical baseboards. The high-bay is heated by a waste oil furnace (Figure 12). Most of the waste oil is obtained from the Town's transfer station through a recycling program. If there is not enough supply from the Transfer Station then No. 2 fuel oil purchased from a local supplier is used to fuel the furnace. Currently the volume of waste oil is not metered and actual consumption cannot be determined.

Based on the air emissions, waste oil furnace units are regulated by NHDES under statute Env-A 1400. Units that meet the following criteria are exempt from formal compliance with the rule.

- *The sum of all units are rated at 500,000 Btu per hour or less heat input.*
- *The sum of all units are rated at 3.6 gallons per hour or less of fuel use.*
- *All units burn 8,640 gallons per year or less of waste oil.*
- *Each exhaust stack is 8 inches or less inside diameter.*
- *Each exhaust stack outlet is 20 feet or more above the ground.*
- *Each exhaust stack is vertical.*
- *All units are operated and maintained in accordance with manufacturer's specifications.*

Additional compliance requirements as stated by NHDES: *"If the facility operates recycled oil burners meeting all of the above criteria, NHDES has determined that its emissions are in compliance with Env-A 1400 and the unit would* *be exempt. However, records such as annual fuel use, number of days of operation, and maintenance records must be kept on-site to document that the above criteria are being met. Owners/operators of recycled oil burners that do not meet all of the criteria listed above should contact NHDES and conduct a source specific compliance determination as soon as possible in order to verify the compliance status of the installation."*

Cooling Systems

Cooling is provided to the first floor office space by a through window air conditioner units. Based on size, use and summer electrical demands, cooling demand for the building is assumed to be limited.

Pumps

A single (1) water boost pump is located near the electric hot water heater to pressurize water in the building. There is an additional pump to supply fire suppression water to the sprinkler system. A small supply pump is connected to the waste oil furnace as well.

Controls Systems

The heating system in the building is controlled by non-programmable clock faced thermostats. Recommendations include adding 7-day programmable thermostats for heating systems.

Refrigeration

There is no commercial refrigeration in the DPW building.

Mechanical Equipment Energy Consumption

The electrical energy consumption for mechanical equipment was determined according to nameplate information and building function and occupancy schedules. Table 17 presents a summary of the mechanical equipment and annual energy usage. Appendix E presents the detailed inventory and the associated energy consumption for each piece of mechanical equipment. Total mechanical consumption per year is estimated to be 23,050 kWh per year compared to 10,979 kWh for light fixture loads and 4,974 kWh for plug loads.

Table 17: Mechanical Equipment Energy Consumption

Equipment Type	Qty.	Consumption (kWh/yr)	% of Total
Electric baseboard heaters	10	19,575	84%
Domestic hot water heater	1	1,440	6%
High bay furnace	1	1,060	5%
Window A/C units	1	975	4%
	Total:	23,050	100%

The electric baseboard heating in the office spaces consume the highest amount of electricity at an estimated 18,600 kWh/yr. The window air conditioning units, domestic hot water heater, and the waste oil furnace in the high bay are estimated to consume the remaining 20%.

Ventilation Systems

Exhaust Ventilation Systems

Exhaust fan units provide several functions including humidity control, odor control, venting of VOC containing materials (e.g., cleaning solvents), chemical gas venting in laboratories, and venting of cooking fumes. Operation frequency and schedules for the fans units should be consistent with the use type and intensity of the vented space. For example, lavatories may be demand ventilated (interlocked with light switch) or they may operate continuously at a low rate during occupied periods. Spaces equipped with exhaust fans are commonly over-ventilated resulting in increased energy consumption. All exhaust controls and rates should be consistent with ASHRAE Standard 62.1. Fan ducting should have pressure actuated dampers to restrict air flow and heat loss when the units are not operating.

Exhaust ventilation systems at the DPW include a large exhaust fan to remove vehicle exhaust fumes in the high bay. This exhaust system does not comply with current code standards for fire safety (International Fire Code, 2009) or air quality (International Mechanical Code, 2009) in a vehicle service/repair facility. Recommendations include installing exhaust ventilation equipment that complies with the minimum code standards.

Exchange Air Ventilation Systems

Exchange air ventilation systems exhaust interior air with high CO_2 concentrations and humidity and replace it with fresh outdoor air. Ventilation rates and system capacity should be designed consistent with the minimum prescribed code standards (ASHRAE 62.1). Systems should be demand (CO_2) controlled with energy recovery capacity (ASHRAE 90.1).

There are no exchange air ventilation systems in the HDPW building. Natural ventilation is provided by operating overhead doors, entry doors, windows, and passive envelope leakage.

Energy Recovery Ventilation Systems

There are no energy recovery ventilation systems installed at the HDPW building. Any new exchange or exhaust air ventilation systems installed in the HDPW building should have energy recovery units.

Indoor Air Quality

Indoor air quality (IAQ) is established based upon temperature (°F), relative humidity (%), and carbon dioxide (CO_2); measured in parts per million (ppm). This data provides the best representation of building ventilation performance and occupant comfort. They are also indicative of conditions that are detrimental to building systems including moisture intrusion and the potential for fungi growth (mold and mildew) and related damage of building materials.

Recommended temperatures vary based on the season, occupant activity, and relative humidity levels. Generally, recommended setpoint heating temperatures in northern New England range between 67°F and 70°F and recommended cooling setpoint temperatures range between 73°F and 76°F. Relative humidity (RH) levels fluctuate consistent with seasonal atmospheric conditions. A range between 30% and 65% is recommended (ASHRAE). While there are no known adverse health effects related to elevated CO_2 concentrations, it can cause acute illness including headaches, drowsiness, lethargy, and nausea. For this reason, the U.S. Environmental Protection Agency (EPA) has established a recommended threshold concentration of 1,000 ppm.

The IAQ in the DPW was measured on January 3rd, 2011 between the hours of 1418 and 1448. The building was normally occupied when the measurements were obtained. Ten (10) IAQ measurements were obtained at representative locations throughout the building. Appendix C presents all of the measurements. Results of the IAQ measurements are summarized as follows:

- Temperatures in the building ranged from 55.2°F in the service area to 71.9°F in the Receptionist Office. The average recorded temperature was 63.5°F.
- Relative humidity measurements ranged from 15.6% in main corridor to 32.7% in the second floor break room. The average relative humidity was 22.0%.
- CO_2 concentrations ranged from 422 ppm in the upstairs storage to 1,252 ppm in the receptionist office with an average of 725 ppm.

Table 18: Summary of IAQ Data

IAQ Metric	Low	High	Avg.	Range of Variance	Recommended
Temperature (°F)	55.2	71.9	63.5	16.7	67 – 70
Relative Humidity (%)	15.6	32.7	22.0	17.1	30 – 65
Carbon Dioxide (ppm)	422	1,252	725	830	<1,000

Temperatures had an overall wide range of variance of 16.7°F. The highest recorded temperature was in the Receptionist Office. Temperatures were noticeably cooler in the high bay and service areas. Relative humidity also varied widely throughout the building with a 17.1% range of variance between the lowest and highest recordings. CO_2 concentrations varied widely as well, with two of the measurements above the recommended threshold (1,000 ppm) in the office areas. This is a result of no exchange air ventilation systems. Figure 13 below graphically depicts the relationships between temperature, relative humidity and CO_2 concentrations.

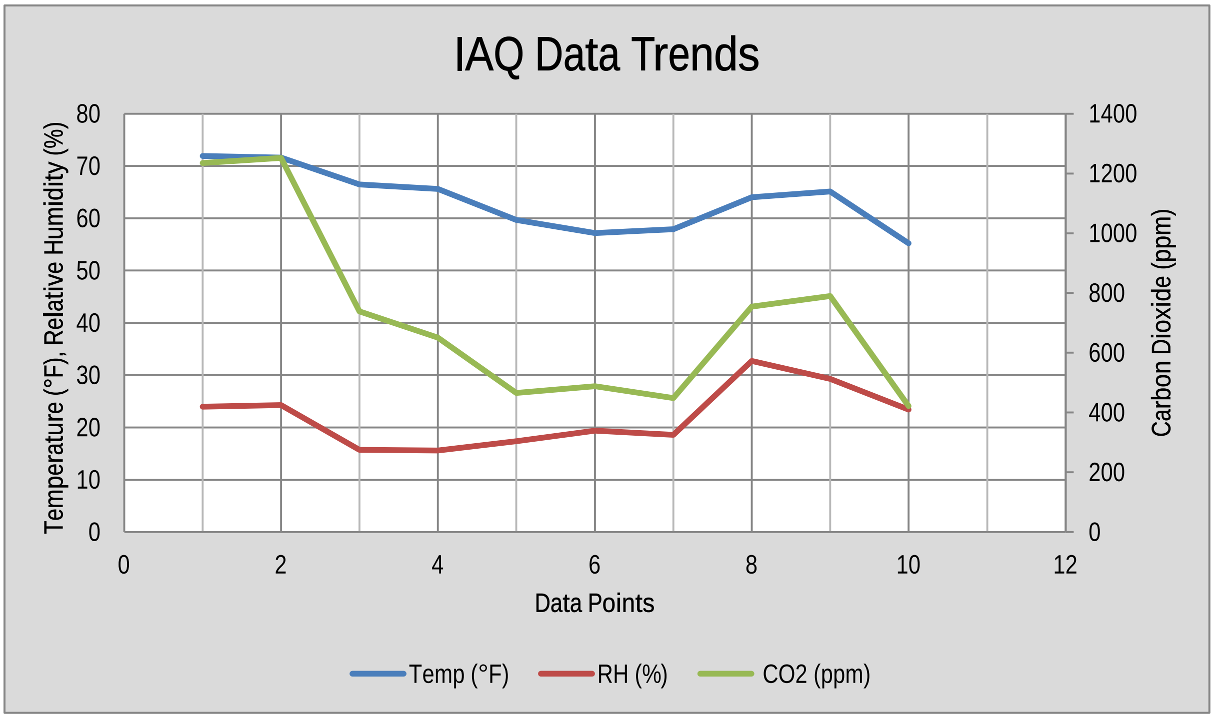


Figure 13: Indoor Air Quality Data Trends

Secondary Observations

Observations noted herein are not directly related to the objective of the energy audit. Investigation of these items is beyond the defined scope of services and these observations are not intended to be inclusive of all building issues and code infractions. They are provided as anecdotal information for the Town's consideration and may warrant further investigation.

Structural Systems

There were no structural system issues noted within the HDPW facility.

Roofing Systems

There was small hole observed in the metal roof of the building. The roof should be inspected annually and repaired as necessary.

Building Code

Exhaust ventilation systems at the DPW include a large exhaust fan to remove vehicle exhaust fumes in the high bay. This exhaust system does not comply with current code standards for fire safety (International Fire Code, 2009) or air quality (International Mechanical Code, 2009) in a vehicle service/repair facility. Recommendations include installing exhaust ventilation equipment that complies with the minimum code standards.

Life Safety Code

No life safety codes were observed during the field review. The building contains a wet sprinkler system.

ADA Accessibility

The building does not appear to fully comply with ADA accessibility. There is no accessibly access to the second floor.

Hazardous Building Materials

Based on the year of construction there is a possibility of hazardous material on site.

E. BUILDING ENERGY MODELING

Source Data

Required source data input for the eQUEST© model includes geographical location, building use type(s), occupancy schedules, building dimensions, envelope systems, fenestration systems, lighting systems, and all mechanical systems (heating, cooling, ventilation domestic hot water). The building characteristics and systems data was obtained during the building site review. Energy usage was provided by the Town for grid electricity and heating oil.

Model Calibration

The quality of the output data is a function of the accuracy of the input data. While eQUEST© is a sophisticated computer simulation program, like any program there are limitations resulting from unusual building characteristics and operating variables that cannot be discretely defined in the program. To ensure that the model simulates the building operation with high accuracy, an iterative model calibration process is completed where actual building energy usage data is checked against the model output values. This process is repeated until the deviation between the energy usage derived from the baseline building simulation and the actual energy consumption is within an acceptable range.

Summary of Model Results

The Hollis Department of Public Works facility was modeled using eQUEST© computer simulation program. Developing an accurate baseline model of the building presented certain challenges including accounting for the high electrical usage and the high heating fuel usage. Once the baseline calibration was completed, several major Energy Efficiency Measures (EEMs) were simulated within the model including:

- Improve insulation on the building
- Replace electric baseboard heat with air source heat pumps

The resulting energy savings and costs for these measures are presented in Section G (Recommendations) and the model output is provided in Appendix I. Tables 19 and 20 present a summary of the model predicted annual energy usage by category for electrical and heating fuel. The actual electrical consumption of 38,420 kWh/yr is slightly lower than the model prediction of 38,710 kWh/yr.

Table 19: Model Predicted Baseline Electrical Usage

Electric Category	Annual Usage (kWh x 1,000)
Space Cooling	1.95
Space Heating	18.5
DHW	1.44
Ventilation Fans	1.06
Plug Loads	4.74
Area Lights	11.02
Total Predicted:	38.71
Total Actual:	38.42

Predicted heating fuel consumption for the building is 139.83 MBtu. No consumption data was available for the waste heating oil used to fuel the furnace.

Table 20: Model Predicted Heating Fuel Usage

Electric Category	Annual Usage (MBtu)
Space Heating	139.83
Total Predicted:	139.83

The energy modeling results are depicted graphically by a monthly bar graph (Figure 14) which breaks down the energy consumption for electricity and gas consumption separately by category. For example, "Area Lighting" is relatively consistent throughout the year while "Space Cooling" and "Space Heating" consumes a variable amount of electricity depending on the time of year.

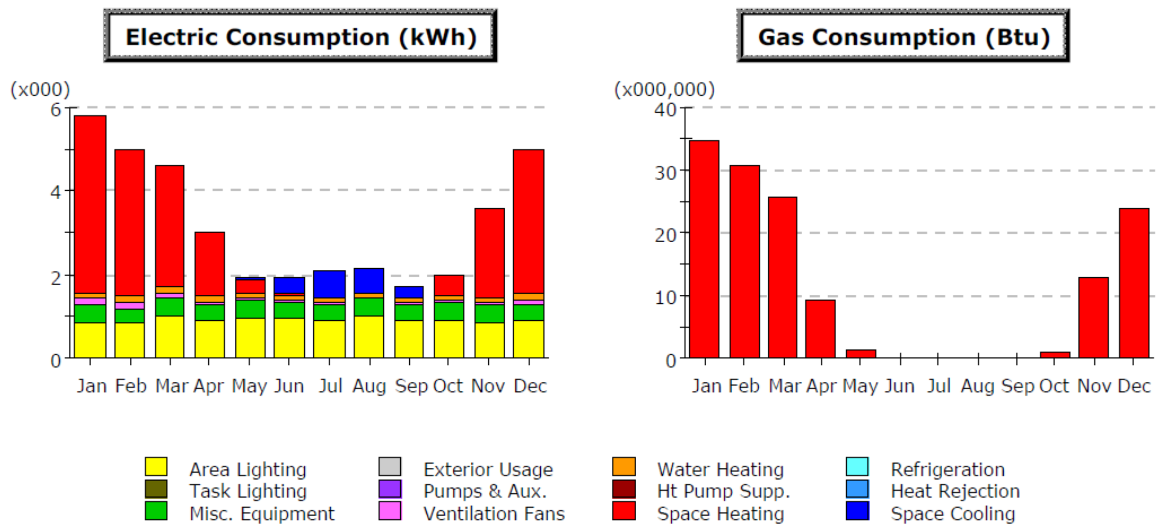


Figure 14: Predicted Monthly Energy Use by Category

F. FACILITY BENCHMARKING

ENERGY STAR for Commercial Buildings

The DPW was benchmarked using the EPA's ENERGY STAR® Portfolio Manager for Commercial Buildings. This benchmarking program accounts for building characteristics, regional climatic data, and user function. It then ranks a building within its defined category amongst all other buildings entered in the program to date. The defining metric is the building Energy Use Intensity (EUI). If a building scores at or above the 75th percentile within its category then it becomes eligible for ENERGY STAR® certification pending an on-site validation review by a licensed Professional Engineer. Currently the program does not have categories for every commercial building type but they can still be entered into the program and checked against similar buildings to determine where the building ranks compared to the current national average. The average energy intensity for every building type category is constantly changing and theoretically is it reducing as more efficient buildings are constructed and existing buildings implement energy efficiency measures. Therefore, buildings that currently meet the eligibility requirements may not be eligible next year when they apply for annual re-certification.

The Hollis Department of Public Works is defined as a "Service (Vehicle Repair)" use building and cannot be certified in the Commercial Building ENERGY STAR® program do to its use category. Utility data for electric and heating fuel for the preceding twelve (12) months was input into the benchmarking program. Table 21 presents the annual energy use (through December 2011) and Table 22 presents a summary of the Statement of Energy Performance (SEP) benchmarking results. The SEP is presented in Appendix G.

Table 21: Annual Energy Consumption

Energy	Site Usage (kBtu)
Electric – Grid	131,089
Heating Fuel (waste oil)	138,691
Total Energy:	269,780

Table 22: SEP Benchmarking Summary

Location	Site EUI (kBtu/ft²/yr)	Source EUI (kBtu/ft²/yr)
Hollis Department of Public Works	36	77
National Median (Service (Vehicle Repair))	45	96
	% Difference:	-20%
	Portfolio Manager Score:	N/A

Compared to the office buildings that have entered data into Portfolio Manager to date, the DPW facility energy use is considerably lower than the national average. The source EUI for the DPW building is 77 kBtu/ft²/yr while the national average is 96 kBtu/ft²/yr, meaning it uses 20% less energy than the average Service/Vehicle Repair facility.

G. RECOMMENDATIONS

Energy Conservation Measures

Based on the observations and measurements of the HDPW, several energy conservation measures (EEMs) are proposed for consideration (Tables 23 to 25). These recommendations are grouped into three tiers based on the cost and effort required to implement the EEM. EEMs are ranked within each tier based on the capital cost for implementation versus the net estimated energy cost savings.

Tier I EEMs are measures that can be quickly implemented with little effort for no or little cost. They include routine maintenance items that can often be completed by facility maintenance personnel and changes in occupant behavior or building operation. Tier II items generally require contracted tradesmen to complete but can generally be implemented at low cost and within operating building maintenance budgets. EEMs that require large capital expenditure and budgetary planning (one year or greater) are categorized as Tier III measures.

Simple payback is calculated for the proposed EEMs. The cost to implement the measure is estimated based on current industry labor and equipment costs and the annual cost savings represents the reduced costs for energy savings. The net energy and cost savings for smaller EEMs is based on the estimated reduction of the associated energy consumption as defined in the model and equipment inventory. Using these costs, the payback period is then calculated as the number of years at which the capital cost of implementation equals the accumulated energy cost savings. Other qualitative considerations that do not influence the Simple Payback Method calculation but should be considered by the owner during the decision-making process include:

- Occupant comfort.
- Relative operation and maintenance requirements.
- Remaining useful life of equipment and systems to be replaced.

Energy cost savings are based current cost of electricity at $0.14 per kWh (PSNH) and the current price of oil of $4.05 per gallon (NHOEP March 12, 2012).

Tier I Energy Efficiency Measures

Tier I EEMs are measures that can be quickly implemented with little effort for zero or little cost (Table 23). They include routine maintenance items that can often be completed by facility maintenance personnel, and changes to occupant behavior or building operation. Six (6) Tier I EEMs are recommended.

Table 23: Tier I Energy Efficiency Measures

EEM No.	EEM Description	Capital Cost	Annual Cost Savings	Payback (yrs.)	SIR
T1-1	Maintain a log of all waste oil used for the waste oil furnace (NHDES requirement).	$0	$0	-	-
T1-2	Reduce lighting density in DPW Directors office and second floor office by removing lamps and replacing with lower wattage units.	$0	$82	0	-
T1-3	Remove compact refrigerator in rear office.	$0	$102	0	-
T1-4	Complete intensive air-sealing/weather-stripping program including all overhead doors, entry door jambs, partings, headers, thresholds, moldings (interior and exterior), and wall and ceiling penetrations.	$2,000	$780	2.6	2.7
T1-5	Replace refrigerator in break room with an ENERGY STAR® model.	$500	$63	7.9	1.9
T1-6	Replace two (2) old CRT monitors with LCD ENERGY STAR® rated units.	$250	$31	8.1	1.5

Recommended Tier I EEMs include reducing the lighting densities in the two offices with high densities by removing one of two lamps from each fixture. The compact refrigerator uses a considerable amount of energy and the refrigerator in the break room upstairs could be utilized. The full-sized refrigerator in the break room is an older unit and replacing it with an ENERGY STAR® rated unit would be cost effective. CRT monitors use over five times the amount of energy an LCD monitor uses and it is recommended replacing the two (2) units with LCD ENERGY STAR® rated units. Considering the condition of the existing building, completing an intensive air sealing program will substantially reduce air leakage and energy consumption for heating and cooling.

Tier II Energy Efficiency Measures

Tier II items generally require contracted tradesmen to complete but can be implemented at low cost and within operating building maintenance budgets. Three (3) recommended Tier II EEMs are presented in Table 24. *Completion of a HDPW facility feasibility study is recommended prior to appropriating funding for the Tier II EEMs. This should consider constructing a new facility consistent with current code standards and use requirements for HDPW operations.*

Table 24: Tier II Energy Efficiency Measures

EEM No.	EEM Description	Capital Cost	Annual Cost Savings	Payback (yrs.)	SIR
T2-1	Insulate exposed interior sections of the concrete foundation wall with 2-inches of foil-faced polyisocyanurate rigid insulation and spray-foam entire top of wall/sill plate.	$1,518	$120	12.7	2.4
T2-2	Replace the existing electric domestic hot water heater with an electric demand tankless unit.	$2,622	$210	12.5	1.2
T2-3	Install 2-inches of foil-faced polyisocyanurate rigid insulation on overhead garage doors (4).	$8,223	$287	28.6	1.0

(1) Tier II EEM investment costs include fees for design & engineering, construction management, and a 15% cost contingency.

A considerable amount of energy is lost through breaks around door and window seals. It is recommended a complete air-sealing be conducted on all entry door jambs, partings, headers, thresholds and moldings. The domestic hot water heater uses a considerable amount of electricity and is estimated the production exceeds demand resulting in wasted energy. It is recommended replacing the unit with a tankless demand unit. Heat rises in the high-bay to the ceiling where it is not useful and is eventually partially lost through the ceiling. De-stratification fans would circulate this conditioned air back to the floor level where it would benefit the users.

Tier III Energy Efficiency Measures

EEMs that require large capital expenditure and budgetary planning (one year or greater) are categorized as Tier III measures. Two (2) Tier III EEMs are provided in Table 25 for the DPW facility. *Completion of a HDPW facility feasibility study is recommended prior to appropriating funding for the Tier III EEMs. This should consider constructing a new facility consistent with current code standards and use requirements for HDPW operations.*

Table 25: Tier III Energy Efficiency Measures

EEM No.	EEM Description	Capital Cost	Annual Cost Savings	Payback (yrs.)	SIR
T3-1	Add 6" of blown cellulose insulation on attic floor.	$15,939	$1,200	13.3	2.3
T3-2	Replace waste oil furnace in high-bay area with a self-contained pellet stove fan unit.	$28,118	$2,050	13.7	1.8
T3-3	Install a high-efficiency inverter driven electric heat-pump VRF system in office spaces for heating and cooling. Include ERV units for exchange air ventilation.	$42,723	$1,575	27.1	1.0

(1) Tier III EEM investment costs include fees for design & engineering, construction management, and a 15% cost contingency.

Insulation values of the building envelope are insufficient and do not meet current code requirements allowing a significant amount of thermal transfer. Recommendations include adding 6-inches of blown cellulous insulation to the attic floor. The waste oil furnace is relatively inefficient unit and air emissions are a concern. Increasingly stringent air quality regulations may restrict the use of these units in the future. Because of the amount of pollutants created by burning waste oil it is recommended that the unit be replaced with a biomass heating system. Replacing the unit with a self-contained pellet fired furnace with a fan unit would eliminate air emission concerns and provide a renewable heating fuel source. Heating and cooling systems in the office spaces are inefficient and there are no exchange air ventilation systems as required by code. Installing a high-efficiency air-source electric heat pump system with variable refrigerant flow (VRF) is a economical solution. Energy recovery ventilators can be incorporated with the system to provide exchange air ventilation consistent with code requirements.

The energy cost savings and resulting payback are based upon each independent measure implemented for the building in its current condition and function. There are interdependencies among measures that will affect the net realized energy savings. For example, replacing lighting fixtures with lower energy units reduces heat load to the building thereby requiring more heating fuel to compensate for the loss in heat from the inefficient light fixtures. Also, many of the larger capital Tier III EEM projects may include some of the smaller dependent Tier I and II EEMs.

Capital costs are provided for budgetary planning only. They are estimated based on current industry pricing for materials and labor. A detailed cost estimate should be developed prior to appropriating capital funds for the more costly measures.

EEMs Considered but not Recommended

The following measures were identified as part of the building evaluation but are not recommended as best-value EEMs. Considerations include the cost feasibility and payback term and occupant comfort concerns.

1. A lighting retrofit project was recently completed (2011) and replacing the modern fixtures with higher efficiency units is not cost practical at this time.
2. Exterior light fixtures are metal halide lamps and replacing these with LED units generally provides a favorable payback. However only one of the yard lights is owned by HDPW and the remaining units are rented from PSNH. If the Town can assume the fixtures and add a meter then replacing all of the yard lights with LED units would be recommended.
3. Radiant in-floor heating systems are very efficient for large vehicle service facilities. However, retrofitting an existing building with in-floor radiant heating is costly with a long payback term.
4. High thermal efficiency windows would reduce energy consumption and improved occupant comfort however the payback term is long.
5. Destratification fans or wind curtain fans can reduce uncontrolled air exchanges when the overhead doors are operated. Based on the low consumption of heating fuel, they fans units do not provide a favorable payback.
6. Wall insulation in the existing is rather poor however improving the walls will be costly relative to the reduced energy consumption.

O&M Considerations

O&M and considerations are provided for existing systems and for proposed EEMs. They are intended to provide best-value practices for the building manager and to identify any O&M requirements for the proposed EEMs.

1. A new warranted heating furnace will reduce maintenance and repair costs and replacement parts are readily available.
2. A new warranted domestic hot water heating unit will reduce maintenance and repair costs and replacement parts are more readily available.

Indoor Air Quality Measures

Based upon the measured indoor air quality in the HDPW, 8 of 10 areas were below the EPA CO_2 recommended threshold of 1,000 ppm. CO_2 concentrations ranged between 422 and 1,252 with an average of 725 ppm. No exchange air ventilation equipment is installed in the HDPW building therefore ventilation is provided by uncontrolled exchanges (door operation) and through passive envelope leakage. Providing adequate ventilation to the receptionist's office and the DPW Directors office can be achieved by installing the heat-pump system with interlocked ERV units.

The exhaust ventilator in the service area does not comply with current fire or mechanical code standards. Direct vehicle exhaust ventilators and maintaining negative pressure ventilation is recommended.

Renewable Energy Considerations

While renewable energy systems generally require a higher capital investment, they provide a significant reduction in the consumption of non-renewable fossil fuel energies. Other obvious benefits include a reduction in ozone depleting gas emissions (as measured by CO_2 equivalency), otherwise referred to as the "carbon footprint". Renewable energy systems also reduce the reliance upon fossil fuels derived from foreign nations and mitigate pricing fluctuations in a volatile and unpredictable market.

Evaluating the practicality of a renewable energy system for a specific facility should consider several facility specific variables including:

- Geographical location.
- Building orientation.
- Adjacent and abutting land features.
- Site footprint and open space.
- Building systems configuration and condition.
- Local zoning or permitting restrictions.
- Currently available financial resources (grants, utility provider rebates, tax incentives).

Table 26 provides a summary description of the more common and proven renewable energy technologies. The Table also provides a preliminary feasibility assessment for implementing each technology at the DPW facility. Additionally, each renewable energy technology is scored and graded based on technology and facility specific characteristics. Appendix H presents the criteria used to develop the score and grade for each renewable energy technology. A more rigorous engineering evaluation should be completed if the Town is considering implementing any renewable energy system.

Table 26: Renewable Energy Considerations

Renewable Energy System	System Description & Site Feasibility
Biomass Heating Systems	System Description: Biomass heating systems include wood chip fueled furnaces and wood pellet fueled furnaces. For several reasons, wood chip systems are generally practical only in large scale applications. Wood pellet systems can be practical in any size. Wood chip systems are maintenance intensive based on the market availability and procurement of woodchip feedstock and variability of woodchip characteristics (specie, size, moisture content, bark content, Btu value) which affect the operating efficiency of the furnace and heating output. They require a constant feed via a hopper and conveyor system and feed rates must vary according to feedstock Btu value and heating demand. For these reasons they typically require full-time maintenance and are practical only in large scale applications. Wood pellet systems are much less maintenance intensive and feedstock availability and consistency is less of an issue. Both systems reduce the dependency on fossil-fuels and feedstock can be harvested locally.
Score: 87%	***Site Feasibility:*** ***A conventional pellet boiler unit may be a practical heating system for the building however, this requires additional effort for procurement of pellets, storing pellets, periodic filling the pellet hopper during the heating season, and emptying the ash. There are new systems with automated feed and ash removal systems that could be a practical application at the DPW. This is a recommended EEM for the high-bay area.***
Geothermal Heating & Cooling	System Description: Geothermal heating systems utilize solar energy residing in the upper crust of the earth. Cooling is provided by transferring heat from the building to the ground. There are a variety of heating/cooling transfer systems but the most common consists of a deep well and piping loop network. All systems include a compressor and pumps which require electrical energy. Geothermal systems are a proven and accepted technology in the New England region. Site constraints and building HVAC characteristics determine the practicality.
Score: 83%	***Site Feasibility:*** ***Considering the facility configuration and use, a closed-loop ground-source heat pump system with air side distribution is a practical consideration. Additionally, there is ample land available for the below-grade well and loop system.***
Solar Domestic Hot Water	System Description: Solar domestic hot water (DHW) systems include a solar energy collector system which transfers the thermal energy to domestic water thereby heating the water. These are typically used in conjunction with an existing conventional DHW system as a supplemental water heating source. Because of the high capital cost, solar DHW systems are only feasible for facilities that have a relatively high demand for DHW.
Score: 76%	***Site Feasibility:*** ***Based on the limited demand for domestic hot water, a solar hot-water system may be a practical consideration for the building. The capital cost could be offset with substantial utility rebates and incentives. The system could provide primary DHW during summer months when demand is low. In colder months, it would provide secondary heating.***
Ground-Mounted Solar Photovoltaic Systems	System Description: A ground-mounted PV system is composed of the same solar collector panels used for a roof-mount system. The collectors are mounted on a frame support system on the ground verses a roof structure. This is advantageous when roof framing cannot accommodate the increased load of the collector panel and the ease of installation and access for maintenance and repair.
Score: 74%	***Site Feasibility:*** ***There is an ample amount of grounds open at the DPW where a medium- (10kW-30kW) to large- (30kW-75kW) sized system could be installed. This would require a design and permitting process with the local utility for a grid-tie connection. Current utility incentives and renewable energy grants would help offset the capital cost for the system.***
Wind Turbine Generator	System Description: Wind turbine generators (WTGs) simply convert wind energy into electrical energy via a turbine unit. WTGs may be pole mounted or rooftop mounted however system efficiency improves with increased elevation. Due to cost and site related constraints, WTG technology in New England is only practical for select sites. Constraints include local geographical and manmade features that alter wind direction, turbulence, or velocity. Other technology constraints include local variability of wind patterns and velocity. Additionally, WTGs require permitting (local, state, FAA) and local zoning that may restrict systems due to height limitations, and/or, visual detraction of the local landscape. Presently, WTG technology is not widely used in New England based on the relatively high capital cost compared to the energy savings.

Score: 69%	***Site Feasibility:*** *There is adequate site space to install a small (<5kW) to medium-sized pole-mounted wind turbine. However, considering the relatively low mean wind speeds in the region, a WTG unit may not be a cost practical consideration.*
Roof-Mounted Solar Photovoltaic Systems	System Description: Photovoltaic (PV) systems are composed of solar energy collector panels that are electrically connected to DC/AC inverter(s). The inverter(s) then distributes the AC current to the building electrical distribution system. Surplus energy is sent into the utility grid via net metering and reimbursed by the utility at a discounted rate. The capital investment cost for PV systems is high but the technology is becoming increasingly more efficient thereby lowering initial costs. The building is in the need of replacement. It its recommended that is be addressed before solar panels are installed.
Score: 65%	***Site Feasibility:*** *There is an ample amount of roof space which could accommodate a mid-sized (20kW-35kW) system. This would require a design and permitting process with the local utility for a grid-tie connection. Current utility incentives and renewable energy grants would help offset the capital cost for the system. A structural evaluation of the roof framing system would be required to ensure that it could accommodate the increased loading. The existing electrical systems may require upgrade especially if the PV system is interconnected to the grid. Other concerns include the condition of the existing roof which should be replaced prior to installing any roof-mounted equipment.*
Combined Heat & Power (CHP)	System Description: Combined heat and power (CHP) systems are reliant on non-renewable energies. Systems are composed of a fossil-fuel powered combustion engine and electrical generator. Electrical current is distributed to the building distribution system to reduce reliance on grid supplied electricity. Byproduct thermal energy derived from the combustion engine is recovered and used to heat the building (this is generally considered to be renewable energy). Another benefit of CHP systems is that they provide electrical energy during power outages in buildings that do not have emergency power backup. Larger CHP units require a substantially large fuel supply and if natural gas is not available then a LPG tank must be sited.
Score: 64%	***Site Feasibility:*** *Considering the relatively small electric and heating demand for the DWP, a CHP may not be cost practical. There is no natural gas within the Town and costs associated with the infrastructure development for a large propane tank would be high. CHP systems also require intensive maintenance and have a low expected service life. However, with DPW staff available to maintain the CHP unit, it may be a practical consideration.*
Solar Thermal Systems	System Description: Similar to a roof-mounted solar PV system, solar thermal systems are most commonly installed on rooftops. These systems utilize solar energy for heating of outdoor air. The most common application is for pre-heating of outdoor air used for air exchanges systems in buildings. This reduces the heating fuel required to maintain setpoint temperatures in interior spaces.
Score: 62%	***Site Feasibility:*** *If the exhaust ventilation systems for the high-bay service area are improved to comply with code requirements (constant negative pressure) then a solar thermal system may be prudent to provide heated outdoor air during colder periods.*

H. ENERGY EFFICIENCY INCENTIVE AND FUNDING OPPORTUNITIES

The State of New Hampshire along with the utility companies offer multiple programs designed to improve the energy efficiency of municipal and school buildings through financial incentives and technical support. Some of the currently available programs are presented herein however building managers are encouraged to explore all funding and incentive opportunities as some programs end and new programs are developed. For a current listing of advertised programs and initiatives, visit www.dsireusa.org.

New Hampshire Public Utilities Commission

New Hampshire Pay for Performance

This program addresses the energy efficiency improvement needs of the commercial and industrial sector. The Program is implemented through a network of qualified Program Partners. Incentives will be paid out on the following three payment schedule: Incentive # 1: Is based on the area of conditioned space in square feet. Incentive #2: Per kWh saved and Per MMBTU saved based on projected savings and paid at construction completion. Incentive #3: Per kWh saved and Per MMBTU saved based on actual energy savings performance one year post construction. Total performance incentives (#2 and #3) will be capped at $300,000 or 50% of project cost on a per project basis. For more information visit http://nhp4p.com.

New Hampshire Public Utilities Commission's Renewable Energy Rebates

The Sustainable Energy Division provides an incentive program for solar electric (photovoltaic or PV) arrays and solar thermal systems for domestic hot water, space and process heat, with a capacity of 100 kW or equivalent thermal output or less. The rebate for PV systems as follows: $1.00 per Watt, capped at 25% of the costs of the system or $50,000, whichever is less. For solar hot water (SHW) systems, the base rebate is $0.07 per rated or modeled kBtu/year, capped at 25% of the cost of the facility or $50,000, whichever is less, as a one-time incentive payment. http://www.puc.state.nh.us/Sustainable%20Energy/RenewableEnergyRebates-CI.html.

New Hampshire Community Development Finance Authority

New Hampshire Community Development Finance Authority Revolving Loan Fund

The Enterprise Energy Fund is a low-interest loan and grant program available to businesses and nonprofit organizations to help finance energy improvements and renewable energy projects in their buildings. The loans will range from $10,000 to $500,000. Larger amounts will be considered on a case by case basis. The program is available to finance improvements to the overall energy efficiency performance of buildings owned by businesses and nonprofits, thereby lowering their overall energy costs and the associated carbon emissions. More information about the program can be found on their website www.nhcdfa.org. These activities may include:

- Improvements to the building's envelope, including air sealing and insulation in the walls, attics and foundations;
- Improvements to HVAC equipment and air exchange;
- Installation of renewable energy systems;
- Improvements to lighting, equipment, and other electrical systems; and
- Conduction of comprehensive, fuel-blind energy audits.

Public Service of New Hampshire (PSNH)

Commercial (Electric) Energy Efficiency Incentive Programs

This program targets any commercial/industrial member building a new facility, undergoing a major renovation, or replacing failed (end-of-life) equipment. The program offers prescriptive and custom rebates for lighting and lighting controls, motors, VFDs, HV AC systems, chillers and custom projects. http://www.psnh.com/SaveEnergyMoney/For-Business/Energy-Saving-Programsand-Incentives.aspx

SmartSTART

The SmartSTART (Savings Through Affordable Retrofit Technologies) advantage is simple – pay nothing out of pocket to have energy efficiency products and services installed in your building. The Smart Start program is limited to PSNH's municipal customers only and includes schools. The program is available on a first-come, first served basis to projects which have been pre-qualified by PSNH. The cost of the improvements is fronted by PSNH which is then repaid over time by the municipality or school using the savings generated by the products themselves. This program is for lighting and lighting controls, air sealing, insulation and other verifiable energy savings measures which have sufficient kilowatt-hour savings. For more information on this program visit: http://www.psnh.com/SaveEnergyMoney/For-BusinesslMunicipal-Smart-Start-Program.aspx

Clean Air - Cool Planet

Community Energy Efficiency

CA-CP works with communities throughout the Northeast to find solutions to climate change and build constituencies for effective climate policies and actions. Much of their work focuses on successful models for energy efficiency and renewable energy planning. They advise and partner with citizens, educators, faith groups, small businesses, municipal governments, and other local leaders. They explore cost-effective opportunities that exist for communities to reduce their emissions as well as their vulnerability to climate impacts. One such example is CA-CP's partnership with the University of New Hampshire, NH Sustainable Energy Association and UNH Cooperative Extension to create www.myenergypian.net . A groundbreaking suite of web and outreach tools for individual action used by households, schools and community groups around the northeast. http://www.cleanair-coolplanet.orglfor_communities/index.php .

APPENDIX A

Photographs

DAYLIGHT SEEN UNDERNEATH ENTRY DOOR

UNINSULATED HOT WATER PIPE IN HIGH BAY

SECRETARY OFFICE

POOR AIR SEAL ON GARAGE DOOR


WASTE OIL TRANSFER FOR HEATING FACILITY


UNINSULATED HOT WATER PIPES IN HIGH BAY

GARAGE SPACE IN HIGH BAY


UNINSULATED HOT WATER PIPES IN HIGH BAY

WATER SOFTENER TREATMENT AND PUMP

HOT WATER HEATER AND BOOSTER PUMP


GARAGE DOOR IN HIGH BAY

DAYLIGHT SEEN UNDERNEATH EXTERIOR DOOR IN HIGH BAY


REFRIGERATOR IN BREAK ROOM


ATTIC SPACE


COMMUNICATION EQUIPMENT IN BREAK ROOM


ATTIC SPACE


UPSTAIRS OFFICE


WORKSHOP ON FIRST FLOOR


INTERIOR OF BUILDING ROOF


OFFICE SPACE


BUILDING ENTRANCE ON EAST SIDE


NORTHEAST CORNER OF BUILDING AND GENERATOR


EAST SIDE OF BUILDING


EAST SIDE OF BUILDING

APPENDIX B

Thermal Imaging Survey Reports

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Department of Public Works
Address	90 Main Street	Site Address	10 Muzzey Road, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

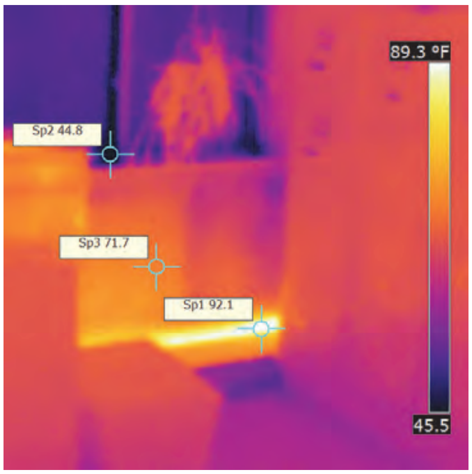


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:14:43 PM
Image Name	IR_2125.jpg
Emissivity	0.96
Reflected apparent temperature	93.0 °F
Object Distance	8.0 ft

Text Comments

Description

Varying thermal properties in corner of receptionist office. Heat emits from baseboard heat radiator while window frame shows poor thermal transfer allowing cool air inside.

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Department of Public Works
Address	90 Main Street	Site Address	10 Muzzey Road, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

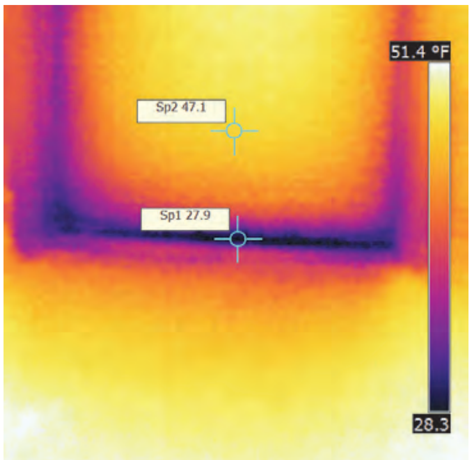


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:15:15 PM
Image Name	IR_2126.jpg
Emissivity	0.96
Reflected apparent temperature	26.0 °F
Object Distance	4.0 ft

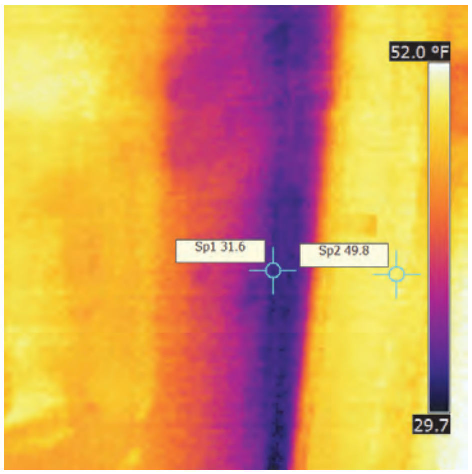
Text Comments

Description

Main entrance doorway IR image taken from inside hallway shows thermal transfer underneath doorway and cold air breaching inside. Photograph to right shows daylight underneath. Recommend weather sealing all entry doors and windows. Refer to EEM T1-4

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Department of Public Works
Address	90 Main Street	Site Address	10 Muzzey Road, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



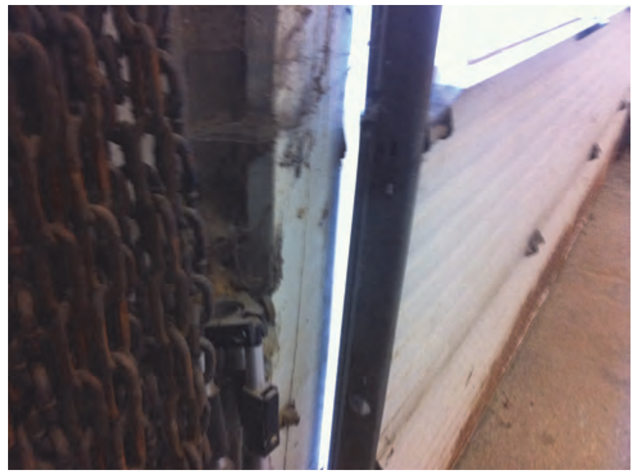


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:15:38 PM
Image Name	IR_2127.jpg
Emissivity	0.96
Reflected apparent temperature	30.0 °F
Object Distance	1.0 ft

Text Comments

Description

Edge of garage door IR reveals air break, allowing for thermal transfer and cold air breaching indoors. Recommend weather stripping all entry doors and windows. (EEM T1-4)

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Department of Public Works
Address	90 Main Street	Site Address	10 Muzzey Road, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

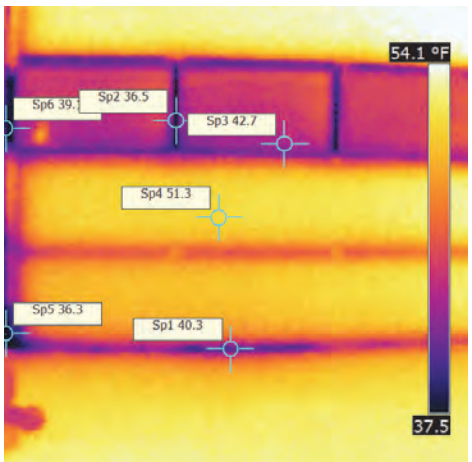


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:16:12 PM
Image Name	IR_2128.jpg
Emissivity	0.96
Reflected apparent temperature	36.0 °F
Object Distance	15.0 ft

Text Comments

Description

IR of interior side of garage door reveals where thermal transfer is taking place. Cold air is breaching underneath and along the sides of the garage door while also breaching through the garage window frame and windows. (EEM T1-4)

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Department of Public Works
Address	90 Main Street	Site Address	10 Muzzey Road, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

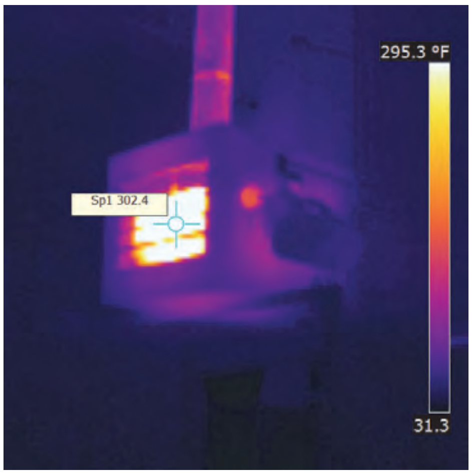


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:16:23 PM
Image Name	IR_2129.jpg
Emissivity	0.96
Reflected apparent temperature	302.0 °F
Object Distance	10.0 ft

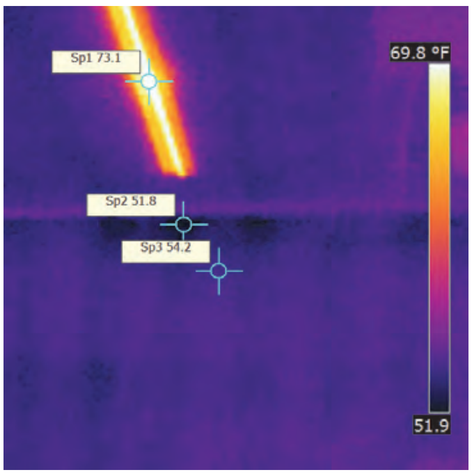
Text Comments

Description

Clean Burn furnace produces heat using previously used oil and is setup in the high bay area.

Inspection Report

Report Date	5/30/2012
Company	AEC
Address	90 Main Street
Thermographer	Hans Kuebler
Customer	Hollis Department of Public Works
Site Address	10 Muzzey Road, Hollis, NH 03049
Contact Person	



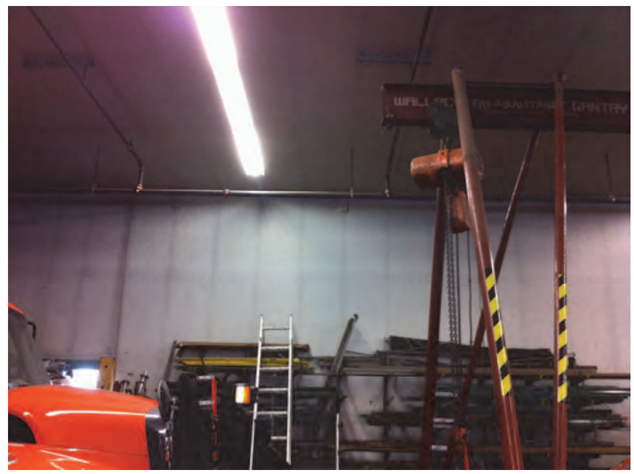


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:17:36 PM
Image Name	IR_2131.jpg
Emissivity	0.96
Reflected apparent temperature	73.0 °F
Object Distance	12.0 ft

Text Comments

Description

IR in high bay area of T8 light shows heat that it radiates. Deteriorating sealing is also noticeable between wall and ceiling with cold air starting to breach indoors. (EEM T3-1)

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Department of Public Works
Address	90 Main Street	Site Address	10 Muzzey Road, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

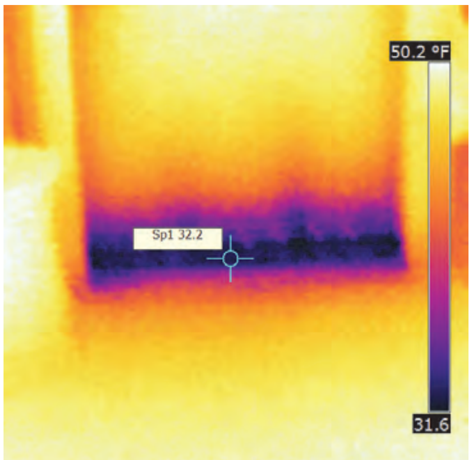


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:19:02 PM
Image Name	IR_2132.jpg
Emissivity	0.96
Reflected apparent temperature	30.0 °F
Object Distance	8.0 ft

Text Comments

Description

Indoor IR image of exterior door to back work station reveals thermal transfer underneath doorway and cold air breaching inside. Image to right reveals daylight underneath doorway. Recommend weather stripping all entry doors and windows. (EEM T1-4)

AEC

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Department of Public Works
Address	90 Main Street	Site Address	10 Muzzey Road, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

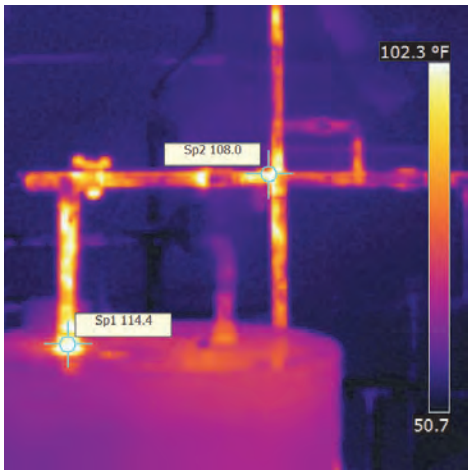


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:19:28 PM
Image Name	IR_2133.jpg
Emissivity	0.96
Reflected apparent temperature	116.0 °F
Object Distance	4.0 ft

Text Comments

Description

Uninsulated hot water pipes, here attached to the mor-flo water heater, cause heat loss from water into pipes and out of the system, resulting in more conditioned water for hot water demand and unwated heat loss. (EEM T2-2)

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Department of Public Works
Address	90 Main Street	Site Address	10 Muzzey Road, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

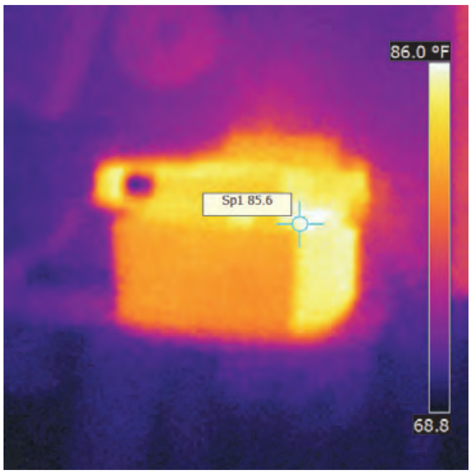


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:20:41 PM
Image Name	IR_2134.jpg
Emissivity	0.96
Reflected apparent temperature	86.0 °F
Object Distance	3.0 ft

Text Comments

Description

IR of the CB station in the upstairs work room shows it gets hot and produces thermal energy when powered on.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Department of Public Works
Address	90 Main Street	Site Address	10 Muzzey Road, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

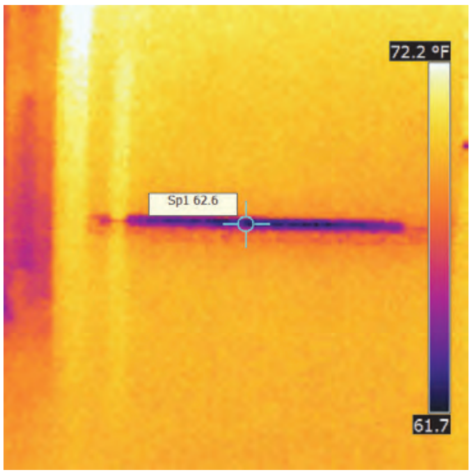


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:21:03 PM
Image Name	IR_2135.jpg
Emissivity	0.96
Reflected apparent temperature	62.0 °F
Object Distance	5.0 ft

Text Comments

Description

IR of refrigerator in break room reveals poor seal and air break between refrigerator and freezer doors. Recommend replacing old refrigerators with Energy Star rated unit (EEM T1-5).

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Department of Public Works
Address	90 Main Street	Site Address	10 Muzzey Road, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

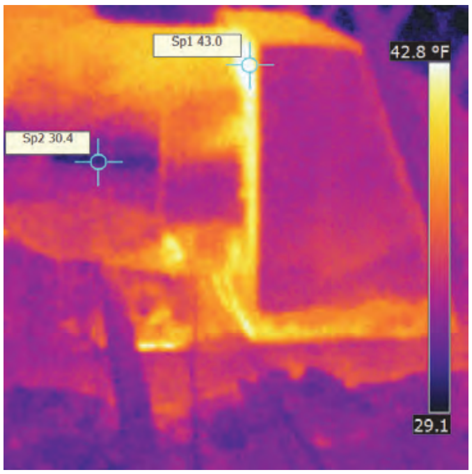


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:26:12 PM
Image Name	IR_2136.jpg
Emissivity	0.83
Reflected apparent temperature	41.0 °F
Object Distance	6.0 ft

Description

Ductwork in attic shows poor seal and loss of warm air. Recommend sealing all leaks in ductwork (EEM 3-1)

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Department of Public Works
Address	90 Main Street	Site Address	10 Muzzey Road, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

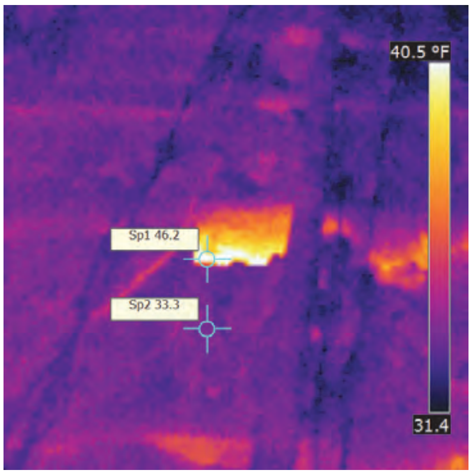


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:27:04 PM
Image Name	IR_2137.jpg
Emissivity	0.96
Reflected apparent temperature	45.0 °F
Object Distance	8.0 ft

Description

Large disparity of temperatures in attic where insulation is installed and where it is missing. Heat rises through these cracks into attic and to the exterior. Recommend re-installing insulation in all missing portions (EEM T3-1).

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Department of Public Works
Address	90 Main Street	Site Address	10 Muzzey Road, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

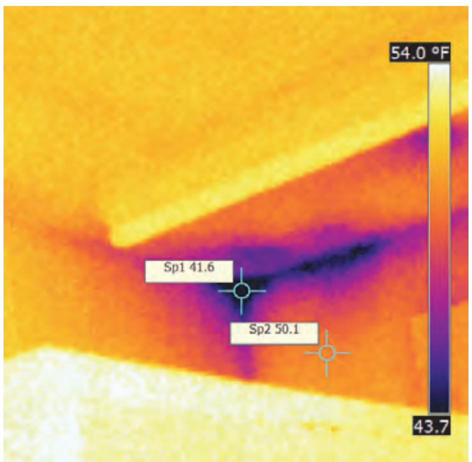


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:31:40 PM
Image Name	IR_2139.jpg
Emissivity	0.96
Reflected apparent temperature	40.0 °F
Object Distance	5.0 ft

Description

IR in the back office behind the bookshelf (foreground) reveals poor seal at corner of office where two walls and the ceiling meet.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Department of Public Works
Address	90 Main Street	Site Address	10 Muzzey Road, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

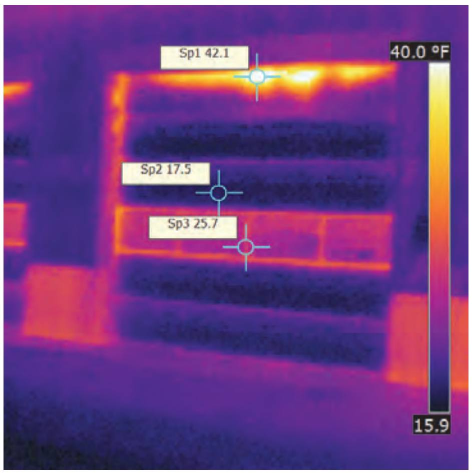


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:34:10 PM
Image Name	IR_2140.jpg
Emissivity	0.96
Reflected apparent temperature	40.0 °F
Object Distance	25.0 ft

Text Comments

Description

Exterior side of garage door reveals significant thermal loss through top of door and some loss through window frame and window. Recommend weather stripping all entry doors and windows (EEM T1-4).

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Department of Public Works
Address	90 Main Street	Site Address	10 Muzzey Road, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

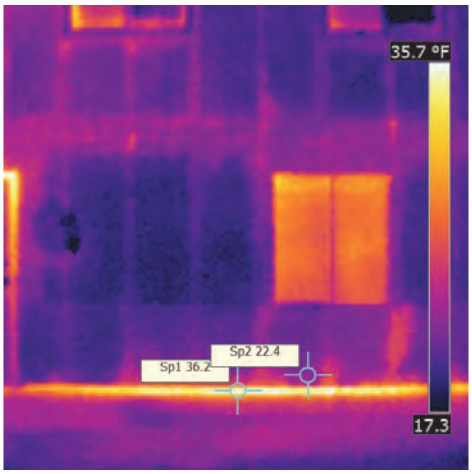


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:34:27 PM
Image Name	IR_2141.jpg
Emissivity	0.95
Reflected apparent temperature	34.0 °F
Object Distance	20.0 ft

Text Comments

Description

IR of exterior wall to the right of the entrance door on the east side of the building reveals a constant thermal transfer between the bottom of the wall, which lies on a concrete slab floor, and the ground. Also evident are boards behind exterior siding.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Department of Public Works
Address	90 Main Street	Site Address	10 Muzzey Road, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

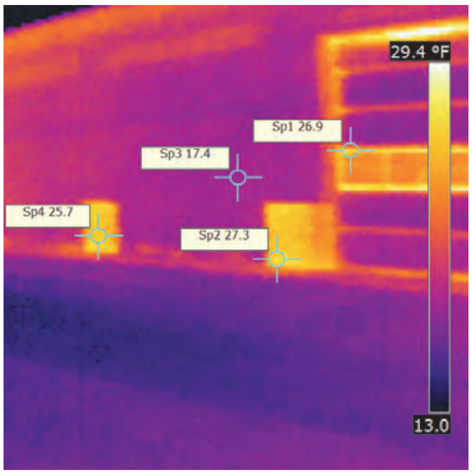


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/3/2012 2:34:45 PM
Image Name	IR_2142.jpg
Emissivity	0.96
Reflected apparent temperature	25.0 °F
Object Distance	25.0 ft

Text Comments

Description

IR of the southeast exterior reveals thermal transfer between another garage door as well as at locations of missing siding (orange squares). Recommend replacing siding or adding insulation in these locations to limit thermal transfer.

APPENDIX C

Indoor Metering Data

INDOOR METERING DATA

Facility:	Location:	Date:	Ambient Outdoor:
Hollis DPW	Hollis, NH	01/03/2012	Temp= 28 RH= 30 CO2= 315

Location /Use Description	Time	Occupied	Air Quality			Lighting Density		Notes
			Temp (°F)	RH (%)	CO2 (ppm)	Horiz (FC)	Vert (FC)	
Receptionist	1418	Y	71.9	24	1235		27.2	
Jeff babel	1421	Y	71.6	24.3	1252		66.7	
Mens room	1424	N	66.5	15.7	738		11.4	
Entrance hallway	1426	N	65.6	15.6	651		31.2	
Back shop	1428	N	59.7	17.4	466		28.3	
Back office	1430	N	57.2	19.4	488		34.6	
High bay	1433	N	57.9	18.6	449		21.3	
Break room	1440	Y	64	32.7	755		25.3	
Upstairs office	1443	N	65.1	29.3	790		54.5	
Parts, filters, etc.	1448	N	55.2	23.4	422		14.4	
Average			**63.5**	**22.0**	**725**			

APPENDIX D

Lighting Fixture Inventory

LIGHTING FIXTURE INVENTORY

Facility:		Location:			Date:		
Hollis DPW		Hollis, NH			01/03/2012		
Location /Use Description	**Fixture**	**Watts/fixture**	**Qty**	**Controls**	**Total watts**	**Est. Hr/Wk**	**Est. KWH Consumption/Yr**
Exit	Led	5	0		0	168	0
Receptionist	T8	64	4		256	50	666
Jeff babel	T8	64	3		192	50	499
Ladies room	Cfl	17	1		17	20	18
Men's room	Cfl	17	1		17	20	18
Entrance hallway	T8	64	3		192	45	449
Entrance hallway	Cfl	17	1		17	45	40
Water heater room	T8	64	1		64	0.5	2
Back shop	T8	64	8		512	50	1,331
Back office	T8	64	1		64	50	166
High bay	T8	192	8		1,536	55	4,393
Break room	T8	64	6		384	50	998
Upstairs office	T8	64	4		256	50	666
Upstairs lobby	T8	64	2		128	50	333
Parts, filters, etc.	T8	64	2		128	50	333
Parts, filters, etc.	T8	64	2		128	50	333
Sign storage	Cfl	12	2		24	50	62
Sand pit storage	T8	192	2		384	20	399
Exterior	Hps	70	1		70	75	273
Totals:			52		4,369		10,979

APPENDIX E

Mechanical Equipment Inventory

MECHANICAL EQUIPMENT INVENTORY			
Facility:		Location:	Date:
Hollis DPW		Hollis, NH	01/03/2012
Location /Use Description	**Qty**	**Affiliated System**	**Estimated Consumption (kWh)**
Electric Hot Water Heater	1	DHW	1,440
Electric Baseboard Heat	10	HEAT	19,575
High Oil Heater	1	HEAT	1,060
Through Window AC Units	1	AC	975
		Total	**23,050**

APPENDIX F

Plug Load Inventory

PLUG LOAD INVENTORY

Facility:		Location:			Date:		
Hollis DPW		Hollis, NH			01/03/2012		
Location /Use Description	**Unit**	**Watts/fixture**	**Qty**	**Total watts**	**Est. Hr/Wk**	**Est. kWh/Yr**	**Notes**
Back shop	Bandsaw	375	1	375	1	20	
High bay	Bandsaw	375	2	750	1	39	
Back shop	Bench grinder	1200	1	1,200	1	62	
High bay	Bench grinder	1200	1	1,200	1	62	
Break room	Cb radio	4	1	4	168	35	
Break room	Coffee maker	1200	2	2,400	1.5	187	
Upstairs office	Deskjet	35	1	35	0.5	1	
Receptionist	Desktop	95	1	95	45	222	
Jeff babel	Desktop	95	1	95	35	173	
Back office	Desktop	95	1	95	35	173	
Upstairs office	Desktop	95	1	95	35	173	
High bay	Drill press	780	1	780	1	41	
Back shop	Dryer	3360	1	3,360	2	349	
Receptionist	Fan	15	1	15	5	1	Summertime use
Break room	Fan	15	1	15	5	1	Summertime use
Receptionist	Laminator	1500	1	1,500	0.25	20	
Back office	Lamp	60	1	60	45	140	
Receptionist	Laserjet	500	1	500	0.5	13	
Jeff babel	Laserjet	500	1	500	1	26	
Receptionist	Lcd	15	1	15	45	35	
Jeff babel	Lcd	15	1	15	45	35	
Back office	Microwave	1000	1	1,000	1	52	
Break room	Microwave	1000	2	2,000	3	312	
Back office	Mini fridge	150	1	150	40	312	
Back shop	Misc tools	300	1	300	1	16	
Jeff babel	Modem	5	1	5	168	44	
Back office	Old monitor	85	1	85	30	133	
Upstairs office	Old monitor	85	1	85	30	133	
Receptionist	Photojet	500	1	500	1	26	
Break room	Refrigerator	800	1	800	40	1,664	
Receptionist	Shredder	200	1	200	0.5	5	
Break room	Single cup coffee	800	1	800	1	42	
Back office	Space heater	1100	1	1,100	10	176	wintertime use
Jeff babel	Speakers	15	1	15	10	8	
Break room	Toaster oven	1800	1	1,800	0.5	47	
Break room	Tube tv	185	1	185	10	96	
Water heater room	Vacuum	750	1	750	0.5	20	
Men's room	Washing machine	1200	1	780	2	81	
Totals:			41	23,659		4,974	

APPENDIX G

ENERGY STAR® Statement of Energy Performance

STATEMENT OF ENERGY PERFORMANCE
Public Work

Building ID: 3077126
For 12-month Period Ending: December 31, 2011[1]
Date SEP becomes ineligible: N/A

Date SEP Generated: March 29, 2012

Facility
Public Work
10 Muzzy Road
Hollis, NH 03049

Facility Owner
Town of Hollis
7 Monument Square
Hollis, NH 03049

Primary Contact for this Facility
N/A

Year Built: 1970
Gross Floor Area (ft²): 7,522

Energy Performance Rating[2] (1-100) N/A

Site Energy Use Summary[3]

Electricity - Grid Purchase(kBtu)	131,089
Fuel Oil (No. 2) (kBtu)	138,691
Natural Gas - (kBtu)[4]	0
Total Energy (kBtu)	269,780

Energy Intensity[4]

Site (kBtu/ft²/yr)	36
Source (kBtu/ft²/yr)	77

Emissions (based on site energy use)

Greenhouse Gas Emissions ($MtCO_2e$/year)	25

Electric Distribution Utility
Public Service Co of New Hampshire [Northeast Utilities]

National Median Comparison

National Median Site EUI	45
National Median Source EUI	96
% Difference from National Median Source EUI	-20%
Building Type	Service (Vehicle Repair/Service, Postal Service)

Stamp of Certifying Professional

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

Meets Industry Standards[5] for Indoor Environmental Conditions:

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

Certifying Professional
N/A

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

ENERGY STAR® Data Checklist for Commercial Buildings

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

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

CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	☑
Building Name	Public Work	Is this the official building name to be displayed in the ENERGY STAR Registry of Labeled Buildings?		☐
Type	Service (Vehicle Repair/Service, Postal Service)	Is this an accurate description of the space in question?		☐
Location	10 Muzzy Road, Hollis, NH 03049	Is this address accurate and complete? Correct weather normalization requires an accurate zip code.		☐
Single Structure	Single Facility	Does this SEP represent a single structure? SEPs cannot be submitted for multiple-building campuses (with the exception of a hospital, k-12 school, hotel and senior care facility) nor can they be submitted as representing only a portion of a building.		☐

garage (Other)

CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	☑
Gross Floor Area	7,522 Sq. Ft.	Does this square footage include all supporting functions such as kitchens and break rooms used by staff, storage areas, administrative areas, elevators, stairwells, atria, vent shafts, etc. Also note that existing atriums should only include the base floor area that it occupies. Interstitial (plenum) space between floors should not be included in the total. Finally gross floor area is not the same as leasable space. Leasable space is a subset of gross floor area.		☐
Number of PCs	4(Optional)	Is this the number of personal computers in the space?		☐
Weekly operating hours	50Hours(Optional)	Is this the total number of hours per week that the space is 75% occupied? This number should exclude hours when the facility is occupied only by maintenance, security, or other support personnel. For facilities with a schedule that varies during the year, "operating hours/week" refers to the total weekly hours for the schedule most often followed.		☐
Workers on Main Shift	10(Optional)	Is this the number of employees present during the main shift? Note this is not the total number of employees or visitors who are in a building during an entire 24 hour period. For example, if there are two daily 8 hour shifts of 100 workers each, the Workers on Main Shift value is 100.		☐

ENERGY STAR® Data Checklist for Commercial Buildings

Energy Consumption

Power Generation Plant or Distribution Utility: Public Service Co of New Hampshire [Northeast Utilities]

Fuel Type: Electricity

Meter: electric (kWh (thousand Watt-hours))
Space(s): Entire Facility
Generation Method: Grid Purchase

Start Date	End Date	Energy Use (kWh (thousand Watt-hours))
12/01/2011	12/31/2011	2,780.00
11/01/2011	11/30/2011	2,360.00
10/01/2011	10/31/2011	1,910.00
09/01/2011	09/30/2011	1,590.00
08/01/2011	08/31/2011	1,560.00
07/01/2011	07/31/2011	1,590.00
06/01/2011	06/30/2011	1,960.00
05/01/2011	05/31/2011	2,740.00
04/01/2011	04/30/2011	4,130.00
03/01/2011	03/31/2011	6,090.00
02/01/2011	02/28/2011	6,200.00
01/01/2011	01/31/2011	5,510.00
electric Consumption (kWh (thousand Watt-hours))		**38,420.00**
electric Consumption (kBtu (thousand Btu))		**131,089.04**
Total Electricity (Grid Purchase) Consumption (kBtu (thousand Btu))		**131,089.04**
Is this the total Electricity (Grid Purchase) consumption at this building including all Electricity meters?		☐

Fuel Type: Fuel Oil (No. 2)

Meter: fuel (Gallons)
Space(s): Entire Facility

Start Date	End Date	Energy Use (Gallons)
12/01/2011	12/31/2011	1,000.00
11/01/2011	11/30/2011	0.00
10/01/2011	10/31/2011	0.00
09/01/2011	09/30/2011	0.00
08/01/2011	08/31/2011	0.00
07/01/2011	07/31/2011	0.00
06/01/2011	06/30/2011	0.00
05/01/2011	05/31/2011	0.00
04/01/2011	04/30/2011	0.00
03/01/2011	03/31/2011	0.00

02/01/2011	02/28/2011	0.00
01/01/2011	01/31/2011	0.00
fuel Consumption (Gallons)		**1,000.00**
fuel Consumption (kBtu (thousand Btu))		**138,690.50**
Total Fuel Oil (No. 2) Consumption (kBtu (thousand Btu))		**138,690.50**
Is this the total Fuel Oil (No. 2) consumption at this building including all Fuel Oil (No. 2) meters?		☐

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

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

Certifying Professional

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

Name: ____ Date: _____________

Signature: _____________________________________

Signature is required when applying for the ENERGY STAR.

FOR YOUR RECORDS ONLY. DO NOT SUBMIT TO EPA.

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

Facility
Public Work
10 Muzzy Road
Hollis, NH 03049

Facility Owner
Town of Hollis
7 Monument Square
Hollis, NH 03049

Primary Contact for this Facility
N/A

General Information

Public Work	
Gross Floor Area Excluding Parking: (ft^2)	7,522
Year Built	1970
For 12-month Evaluation Period Ending Date:	December 31, 2011

Facility Space Use Summary

garage	
Space Type	Other - Service (Vehicle Repair/Service, Postal Service)
Gross Floor Area (ft^2)	7,522
Number of PCs o	4
Weekly operating hours o	50
Workers on Main Shift o	10

Energy Performance Comparison

	Evaluation Periods		Comparisons		
Performance Metrics	**Current** (Ending Date 12/31/2011)	**Baseline** (Ending Date 12/31/2011)	**Rating of 75**	**Target**	**National Median**
Energy Performance Rating	N/A	N/A	75	N/A	N/A
Energy Intensity					
Site (kBtu/ft^2)	36	36	0	N/A	45
Source (kBtu/ft^2)	77	77	0	N/A	96
Energy Cost					
$/year	N/A	N/A	N/A	N/A	N/A
$/ft^2/year	N/A	N/A	N/A	N/A	N/A
Greenhouse Gas Emissions					
$MtCO_2e$/year	25	25	0	N/A	31
$kgCO_2e$/ft^2/year	3	3	0	N/A	4

More than 50% of your building is defined as Service (Vehicle Repair/Service, Postal Service). This building is currently ineligible for a rating. Please note the National Median column represents the CBECS national median data for Service (Vehicle Repair/Service, Postal Service). This building uses 20% less energy per square foot than the CBECS national median for Service (Vehicle Repair/Service, Postal Service).

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

APPENDIX H

Renewable Energies Screening Worksheets

RENEWABLE ENERGY SCREENING SUMMARY

Building/Facility:	Hollis Department of Public Works	Location:	Hollis, NH
Gross Area (sf):	7,522	Date:	3/20/2012
Use Category:	DPW	EUI (kBtu/sf/yr):	17
Heating Fuel(s):	Waste Oil/Electric	PM Grade:	NA
Heating System(s):	Air	Cooling System(s):	Window AC

RE Technology	Score (out of 70 pts.)	Grade	Notes/Comments
Biomass Heating	61.0	87%	Pellet feed system recommended.
Geothermal Heating/Cooling	58.0	83%	Closed-loop GSHP system.
Solar DHW	53.0	76%	DHW demand should be confirmed.
Ground Photovoltaic	52.0	74%	Large system 30kw - 75kw.
Wind Turbine Generator	48.5	69%	Permit requirements are height dependent.
Roof Photovoltaic	45.5	65%	Large system 30kw - 75kw.
Combined Heat & Power	44.5	64%	75kW system.
Solar Thermal	43.5	62%	Medium-temperature system.

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	Hollis Department of Public Works	Location:	Hollis, NH
Gross Area (sf):	7,522	Date:	3/20/2012
Use Category:	DPW	EUI (kBtu/sf/yr):	17
Heating Fuel(s):	Waste Oil/Electric	PM Grade:	NA
Heating System(s):	Air	Cooling System(s):	Window AC

Technology: **Biomass Heating Systems (wood, chips, pellets)**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	4.5	Well demonstrated technology. Some woodchip and pellet feed units are newer technology.
2	Expected service life/durability	4	Expected service life is 20 yrs.
3	Geographical considerations	4	Limited fuel in Southern NH.
4	Energy demand	5	Heating energy is high in the building.
5	Facility/systems conditions	5	Woodchips/pellets could be stored inside or outside building.
6	Facility/systems compatibility	5	Woodchips/pellets could be stored inside or outside building.
7	Permitting constraints	5	No special permits required.
8	Abutter concerns	5	Systems located inside our outside building would not have impact on abutting properties.
9	Capital investment	4.5	Low capital cost.
10	O&M requirements	4.5	Wood and woodchip units require constant attending and feedstock must be sourced. Pellet systems with hoppers are less intensive and feedstock is commercially available.
11	Financial incentives	3	Limited incentives.
12	Owner initiatives	5	Owner is highly interested biomass heating.
13	CO2e emissions	3.5	Biomass does emit CO2 but the net reduction from the oil system will be significant.
14	Public awareness/education	3	Limited public use. Information could be displayed in the building so users are aware of biomass heating system.
	Total Score:	**61**	
	Total Possible Score:	**70**	
	Grade:	**87%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	Hollis Department of Public Works	Location:	Hollis, NH
Gross Area (sf):	7,522	Date:	3/20/2012
Use Category:	DPW	EUI (kBtu/sf/yr):	17
Heating Fuel(s):	Waste Oil/Electric	PM Grade:	NA
Heating System(s):	Air	Cooling System(s):	Window AC

Technology: **Geothermal Heating & Cooling**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	4.5	Well demonstrated technology but does require engineering design.
2	Expected service life/durability	4.5	Well field and loop system has +50 year service life. Equipment has +20 yr service life.
3	Geographical considerations	4.5	Abundant geothermal energy reserves.
4	Energy demand	3.5	Heating and cooling energy consumption is high.
5	Facility/systems conditions	5	Air side distribution.
6	Facility/systems compatibility	5	Air side distribution.
7	Permitting constraints	5	No special permitting required for a closed-loop system (open-loop would require state permit and is not recommended).
8	Abutter concerns	5	Abutters with water supply wells can be sensitive to geothermal wells but a closed-loop system will have no impact.
9	Capital investment	2.5	High capital cost.
10	O&M requirements	4.5	Very low O&M except routine equipment maintenance.
11	Financial incentives	2.5	Limited incentives in NH.
12	Owner initiatives	4	Owner is open to renewable options.
13	CO2e emissions	4.5	The building currently uses a high amount of oil.
14	Public awareness/education	3	Moderately high public use. Information could be displayed in the building so users are aware of geothermal system.
	Total Score:	**58**	
	Total Possible Score:	**70**	
	Grade:	**83%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	Hollis Department of Public Works	Location:	Hollis, NH
Gross Area (sf):	7,522	Date:	3/20/2012
Use Category:	DPW	EUI (kBtu/sf/yr):	17
Heating Fuel(s):	Waste Oil/Electric	PM Grade:	NA
Heating System(s):	Air	Cooling System(s):	Window AC

Technology: **Solar Domestic Hot Water**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	4	Well demonstrated technology although system design and function can vary.
2	Expected service life/durability	3	Expected service life of heating panels is 15 years.
3	Geographical considerations	3.5	Limited solar availability in New England.
4	Energy demand	5	Expected DHW demand is low.
5	Facility/systems conditions	4	No large storage currently on site.
6	Facility/systems compatibility	4	No large storage currently on site.
7	Permitting constraints	5	No special permitting required.
8	Abutter concerns	5	Low visibility/impact.
9	Capital investment	2.5	High capital cost.
10	O&M requirements	4	Panel replacement and normal DHW system maintenance.
11	Financial incentives	2.5	Limited incentives in NH.
12	Owner initiatives	4	Owner is open to renewable options.
13	CO2e emissions	3.5	Moderate reduction of electric use based on DHW demand.
14	Public awareness/education	3	Limited public use.
	Total Score:	**53**	
	Total Possible Score:	**70**	
	Grade:	**76%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	Hollis Department of Public Works	Location:	Hollis, NH
Gross Area (sf):	7,522	Date:	3/20/2012
Use Category:	DPW	EUI (kBtu/sf/yr):	17
Heating Fuel(s):	Waste Oil/Electric	PM Grade:	NA
Heating System(s):	Air	Cooling System(s):	Window AC

Technology: **Ground-Mounted Solar PV**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	5	Well demonstrated technology with more efficient panel systems in development.
2	Expected service life/durability	3	Expected service life of collector panels is 15 years.
3	Geographical considerations	3.5	Limited solar availability in New England.
4	Energy demand	3	Moderate electrical demand.
5	Facility/systems conditions	5	Building need to be repalced, however can be reused.
6	Facility/systems compatibility	4.5	Multiple areas where system could be installed.
7	Permitting constraints	2.5	Utility grid connection permit is long-lead and may require a designed/engineered system.
8	Abutter concerns	5	School not visible from abutting properties.
9	Capital investment	3	High capital cost.
10	O&M requirements	3.5	Vegetative cutting and panel replacement.
11	Financial incentives	2.5	Limited incentives in NH.
12	Owner initiatives	4	Owner is open to renewable options.
13	CO2e emissions	4.5	Electrical source energy is NH has lower than average CO2 emissions.
14	Public awareness/education	3	limited high public use.
	Total Score:	**52**	
	Total Possible Score:	**70**	
	Grade:	**74%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility: Hollis Department of Public Works
Location: Hollis, NH
Gross Area (sf): 7,522
Date: 3/20/2012
Use Category: DPW
EUI (kBtu/sf/yr): 17
Heating Fuel(s): Waste Oil/Electric
PM Grade: NA
Heating System(s): Air
Cooling System(s): Window AC

Technology: **Wind Turbine Generator**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	4.5	A well demonstrated technology but proper site selection is critical.
2	Expected service life/durability	3.5	Some turbine units have proven unreliable (design flaws). Selection of a reputable manufacturer is critical.
3	Geographical considerations	3	Limited wind energy but a feasibility study is required.
4	Energy demand	5	Electric energy consumption is high.
5	Facility/systems conditions	2	Building needs to be replaced
6	Facility/systems compatibility	2	Building needs to be replaced
7	Permitting constraints	3	Special permits are required depending on the height of the pole-mounted turbine. Roof-mounted turbines may be practical however they provide less energy.
8	Abutter concerns	2.5	Pole-mounted turbines have a large visual impact.
9	Capital investment	3.5	Moderate capital cost.
10	O&M requirements	3.5	Routine maintenance required. Units are subject to damage from elements.
11	Financial incentives	3	Limited incentives in NH.
12	Owner initiatives	4	Owner is open to renewable options.
13	CO2e emissions	4	Electrical source energy is NH has lower than average CO2 emissions.
14	Public awareness/education	5	High visibility.
	Total Score:	**48.5**	
	Total Possible Score:	**70**	
	Grade:	**69%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	Hollis Department of Public Works	Location:	Hollis, NH
Gross Area (sf):	7,522	Date:	3/20/2012
Use Category:	DPW	EUI (kBtu/sf/yr):	17
Heating Fuel(s):	Waste Oil/Electric	PM Grade:	NA
Heating System(s):	Air	Cooling System(s):	Window AC

Technology: **Roof-Mounted Solar PV**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	5	Well demonstrated technology with more efficient panel systems in development.
2	Expected service life/durability	3.5	Expected service life of collector panels is 15 years.
3	Geographical considerations	3.5	Limited solar availability in New England.
4	Energy demand	3	High grid electrical demand.
5	Facility/systems conditions	1	Building is in the need of replacement
6	Facility/systems compatibility	1	Building is in the need of replacement
7	Permitting constraints	2.5	Utility grid connection permit is long-lead and may require a designed/engineered system.
8	Abutter concerns	5	Limited abutting properties and roads.
9	Capital investment	2.5	High capital cost.
10	O&M requirements	3.5	Increased roof maintenance and panel replacement.
11	Financial incentives	3	Limited incentives in NH.
12	Owner initiatives	4.5	Owner is open to renewable options.
13	CO_2e emissions	4.5	Electrical source energy in NH has lower than average CO_2 emissions.
14	Public awareness/education	3	Limited Public Use
	Total Score:	**45.5**	
	Total Possible Score:	**70**	
	Grade:	**65%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	Hollis Department of Public Works	Location:	Hollis, NH
Gross Area (sf):	7,522	Date:	3/20/2012
Use Category:	DPW	EUI (kBtu/sf/yr):	17
Heating Fuel(s):	Waste Oil/Electric	PM Grade:	NA
Heating System(s):	Air	Cooling System(s):	Window AC

Technology: **Combined Heat & Power System**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	5	Smaller CHP units are relatively new technology. Larger units (+75kW) are more reliable.
2	Expected service life/durability	3.5	Expected service life for a small CHP unit is 10 yrs. Large CHPs have a 20 yr. service life.
3	Geographical considerations	4	NH has a low electrical energy cost.
4	Energy demand	3	Electric energy consumption is low.
5	Facility/systems conditions	3	Building is in need of replacement
6	Facility/systems compatibility	1	No renewables currently on site.
7	Permitting constraints	5	No special permits required.
8	Abutter concerns	5	Modern CHPs are relatively quiet and would be inside of the building.
9	Capital investment	2.5	High capital cost.
10	O&M requirements	3.5	Frequent maintenance required. Large system manufacturers require that they complete maintenance for warranty validation. Personel could be trained to maintain.
11	Financial incentives	2	Limited incentives.
12	Owner initiatives	4	Owner is open to renewable options
13	CO2e emissions	1	CHPs consume a large amount of fuel and emissions relative to the re-used energy.
14	Public awareness/education	2	Limited Public use facility. Information regarding system could be displayed.
	Total Score:	**44.5**	
	Total Possible Score:	**70**	
	Grade:	**64%**	

RENEWABLE ENERGY SCREENING WORKSHEET

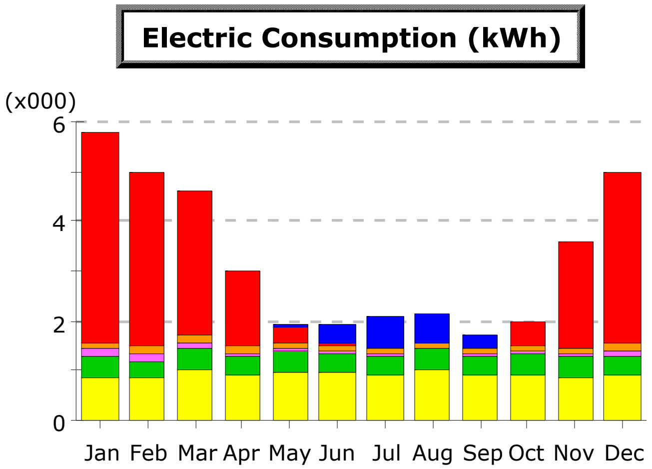
Building/Facility:	Hollis Department of Public Works	Location:	Hollis, NH
Gross Area (sf):	7,522	Date:	3/20/2012
Use Category:	DPW	EUI (kBtu/sf/yr):	17
Heating Fuel(s):	Waste Oil/Electric	PM Grade:	NA
Heating System(s):	Air	Cooling System(s):	Window AC

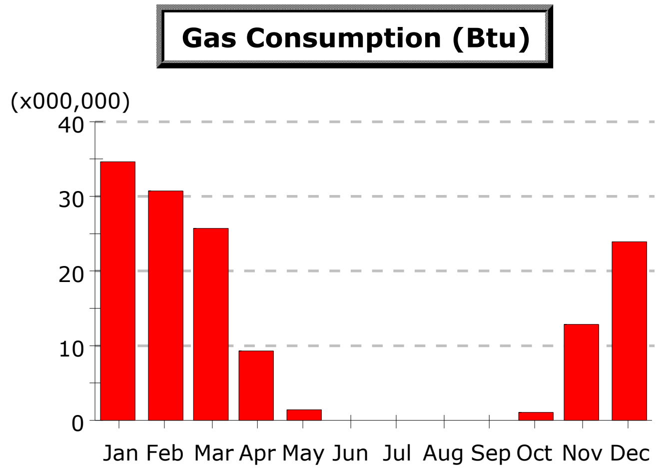
Technology: **Solar Thermal HVAC**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	3.5	Well demonstrated technology but supply limited. More efficient than regular PV.
2	Expected service life/durability	4	Expected service life of system is 20 years.
3	Geographical considerations	3	Limited solar availability in New England.
4	Energy demand	3	No instaled Ventilation
5	Facility/systems conditions	3	No instaled Ventilation
6	Facility/systems compatibility	1	No instaled Ventilation
7	Permitting constraints	2.5	Utility grid connection permit is long-lead and may require a designed/engineered system.
8	Abutter concerns	5	School not visible from abutting properties.
9	Capital investment	2	High capital cost.
10	O&M requirements	3	Vegetative cutting for ground mount, roof maintenance for roof mount, panel replacement.
11	Financial incentives	2.5	Limited incentives in NH.
12	Owner initiatives	4	Owner is open to renewable options.
13	CO2e emissions	4	Electrical source energy is NH has lower than average CO2 emissions.
14	Public awareness/education	3	Limited Public Use
	Total Score:	**43.5**	
	Total Possible Score:	**70**	
	Grade:	**62%**	

APPENDIX I

eQUEST® Energy Efficiency Measure Modeling





Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	0.00	0.09	0.38	0.65	0.57	0.25	0.01	-	-	1.95
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	4.22	3.48	2.89	1.51	0.31	0.00	-	-	0.01	0.49	2.15	3.45	18.50
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.13	0.13	0.15	0.13	0.13	0.12	0.10	0.11	0.10	0.11	0.12	0.13	1.44
Vent. Fans	0.17	0.15	0.14	0.08	0.05	0.05	0.05	0.05	0.04	0.05	0.09	0.13	1.06
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.38	0.36	0.43	0.38	0.41	0.41	0.38	0.43	0.38	0.40	0.38	0.38	4.74
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	0.88	0.84	0.99	0.90	0.96	0.95	0.90	0.99	0.90	0.92	0.88	0.90	11.02
Total	5.78	4.96	4.60	3.00	1.95	1.90	2.09	2.15	1.69	1.97	3.62	4.99	38.71

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	34.82	30.77	25.62	9.36	1.43	-	-	-	-	0.93	13.01	23.89	139.83
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	34.82	30.77	25.62	9.36	1.43	-	-	-	-	0.93	13.01	23.89	139.83

APPENDIX J

Cost Estimates

BUDGETARY COST ESTIMATE

Facility: **Hollis DPW**
Date: **3/29/2012**

EEM	Design + Engineering	Installed Cost				Construction Management	Contingency (15%)	Total Investment
		Pricing Unit	Price	Qty	Subtotal			
Insulate exposed interior sections of the concrete foundation wall with 2-inches of foil-faced polyisocyanurate rigid insulation and spray-foam entire top of wall/sill plate.	$ -	EA	$ 1,200	1	**$ 1,200**	$ 120	$ 198	**$1,518**
Add 6" of blown cellulose insulation on attic floor.	$ -	EA	$ 12,600	1	**$ 12,600**	$ 1,260	$ 2,079	**$15,939**
Replace waste oil furnace in high-bay area with a self-contained pellet stove fan unit.	$ 800	EA	$ 21,500	1	**$ 21,500**	$ 2,150	$ 3,668	**$28,118**
Replace the existing electric domestic hot water heater with an electric demand tankless unit.	$ 300	EA	$ 1,800	1	**$ 1,800**	$ 180	$ 342	**$2,622**
Install 2-inches of foil-faced polyisocyanurate rigid insulation on interior of overhead garage doors (5).	$ -	EA	$ 1,300	5	**$ 6,500**	$ 650	$ 1,073	**$8,223**
Install a high-efficiency inverter driven electric heat-pump VRF system in office spaces for heating and cooling.	$ 2,500	EA	$ 31,500	1	**$ 31,500**	$ 3,150	$ 5,573	**$42,723**
Install de-stratification fans in the high-bay to create an air curtain along overhead doors.	$ 300	EA	$ 800	4	**$ 3,200**	$ 320	$ 573	**$4,393**