HAMILTON TOWNSHIP
FIRE DISTRICT #9
ENERGY ASSESSMENT

for

NEW JERSEY
BUREAU OF PUBLIC UTILITIES

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CHA PROJECT NO. 21180

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APPENDICES

1.0 INTRODUCTION AND BACKGROUND

The Hamilton Township Fire District #9 is a 16,500 square foot facility located at 4201 Crosswicks-Hamilton Square Road on a rural seven acre site. Constructed in 1989, the structure has not undergone any major renovations, and most systems and components are original. The building operates 24 hours per day and is comprised of a radio room, bunk rooms, offices, meeting room, restrooms/locker rooms, lounge, weight room, laundry room, storage areas, maintenance shop, and a large engine room.

New Jersey's Clean Energy Program, funded by the New Jersey Board of Public Utilities, supports energy efficiency and sustainability for Municipal and Local Government Energy Audits. Through the support of a utility trust fund, New Jersey is able to assist state and local authorities in reducing energy consumption while increasing comfort.

2.0 EXECUTIVE SUMMARY

This report details the energy audit results of Hamilton Township Fire District #9, a 16,500 square foot facility located on a rural seven acre site. The building operates 24 hours per day and is comprised of a large engine room, radio room, bunk rooms, and ancillary rooms and offices. The following areas were evaluated for energy conservation measures:

- Rooftop condensers
- Door seals
- Restroom fixture upgrades
- Lighting replacement with controls
- Demand control ventilation
- Boiler replacement and hot water reset
- Domestic hot water heater replacement
- Boiler replacemnt
- Infrared heaters
- Roof replacement
- Insulation upgrades

Various potential Energy Conservation Measures (ECMs) were identified for the above categories. Potential annual savings of $7,100 for the recommended ECMs may be realized with a payback of 9.2 years.

The ECMs identified in this report will allow for the building to reduce its energy usage and if pursued has the opportunity to qualify for the New Jersey SmartStart Buildings Program. A summary of the costs, savings, and paybacks for the recommended ECMs follows:

ECM-1 Install Demand Control Ventilation

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
12,500	0	2,440	1,490	0	2,000	0	2,000	1.4	NA	6.3	NA

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

ECM-3 Replace Rooftop Condensing Units

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
21,300	0	7,550	0	0	1,200	800	2,000	0.9	1,500	10.7	9.9

*Incentive shown is per the New Jersey Smart Start Program, 2010 Electric Unitary HVAC Application.

ECM-7 Install Door Seals

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
500	0	200	70	0	100	0	100	1.0	NA	5.0	NA

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

ECM-11 Install Low-Flow Restroom Faucets

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
800	0	0	0	9.7	100	0	100	0.9	NA	8.0	NA

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

ECM-14 Lighting Replacements with Controls

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
34,100	1.9	26,320	0	0	3,700	0	3,700	0.6	2,200	9.2	8.6

*Incentive shown is per the New Jersey Smart Start Program, 2010 Prescriptive Lighting and Lighting Controls Applications.

3.0 EXISTING CONDITIONS

3.1 Building - General

The Hamilton Township Fire District #9 is a 16,500 square foot facility constructed in 1989, and has not had any major renovations. The building is separated into two areas. The main section contains a radio, weight, meeting, and bunk rooms; offices; restrooms; and lounge. The other section consists of the engine room section, boiler room, storage areas, laundry room, and maintenance shop.

The facility operates 24 hours per day with a crew of at least four people. From 8:00 AM to 4:00 PM, Monday through Friday, there are at least six people occupying the building. The meeting room is used about two to three times per week for several hours at a time. The maximum occupancy of the meeting room is about 50 people; most events typically consist of a maximum of 20 persons.

The main section of the building is a single story structure, with the engine room section being two stories. Exterior walls of the main building consist of 4" split rib concrete block, 1" rigid insulation, 8" concrete masonry unit (CMU) block, 1" furring, and finished with 1/2" gypsum board. The two story engine room walls are comprised of 4" split rib concrete block, 1" rigid insulation and 12" CMU block. Supported by steel joists, the roof assembly of both areas is 1-1/2" metal decking, 2" rigid insulation, rubber membrane and stone ballasts. The roofing membrane is susceptible to leaks and has exceeded its useful life.

Building windows are aluminum frame with 1/8" double pane glass and are in good condition. There are three vestibule areas, two with double glass doors and one with a single glass door. The door assemblies have noticeable gaps around the door perimeter and at the double door center joints. There are also two steel, security type exit doors in the garage area. Additionally, the garage area is equipped with six, 14'x14' overhead doors, four on the front and two at the rear of the building. The overhead doors are insulated and the seals were replaced in 2009.

3.2 Utility Usage

Utilities include electricity, natural gas, and potable water. Electricity and natural gas are purchased from Public Service Electric & Gas Company (PSE&G). Potable water is provided by Aqua America. There are no sewer charges because the facility uses a septic tank and leach field for waste collection. The septic tank is emptied once a year.

From February 2009 through January 2010, electric usage was approximately 121,280 kWh at a cost of about $19,800. Analyzing electricity bills during this period showed that the building was charged at the following rates: supply unit cost of $0.127 per kWh; demand unit cost of $13.55 per kW; and a blended unit cost of $0.163 per kWh. Electricity usage was generally higher in the summer months when air conditioning equipment operates. During the same timeframe, the building heat and domestic hot water (DHW) produced by natural gas-fired equipment required about 8,500 therms. Based on the annual cost of about $9,400, the blended price for natural gas was $1.103 per therm. Natural gas consumption is highest in the winter months when the building is in heating mode.

Review of potable water utility bills from February 2009 through January 2010 determined the facility used a total of 145,000 gallons of water over the course of a year. At a total cost of about $1,200, the unit cost for water was found to be $8.215 per kGal. Water required to fill fire trucks is taken from a connection prior to the service meter, and, therefore, not reflected in the utility bill. Utility data can be found in Appendix A.

Electricity and natural gas commodity supply and delivery is presently purchased from PSE&G. The delivery component will always be the responsibility of the utility that connects the facility to the power grid or gas line; however, the supply can be purchased from a third party. The electricity or natural gas commodity supply entity will require submission of one to three years of past energy bills. Contract terms can vary among suppliers. A list of approved electrical and natural gas energy commodity suppliers can be found in Appendix A.

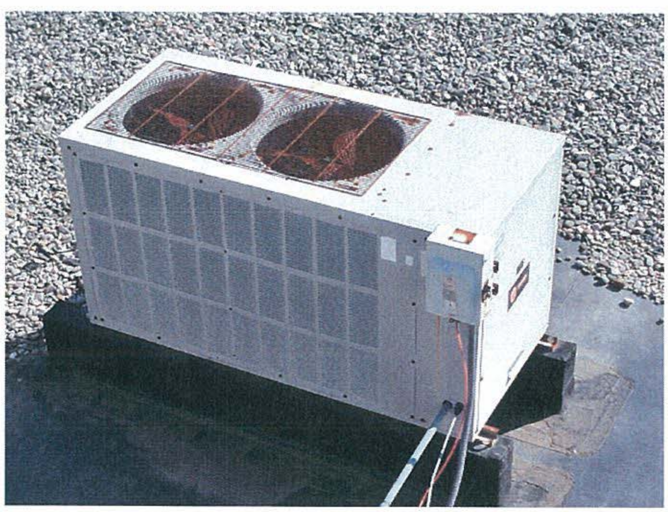
3.3 HVAC Systems

Building heat is generated by an HB Smith 1,491 MBH input, 1,014 MBH output, gas-fired hot water (HW) boiler. Heating hot water (HHW) is distributed to equipment in two zones via pipe mounted in-line circulation pumps (1/2 HP and 3/4 HP). A third 3/4 HP circulation pump is arranged as a standby unit to back up both heating zones. HW terminal heating equipment includes cabinet unit heaters, convection radiator units, and suspended unit heaters. Eight HW unit heaters serve the engine room; there is also one in the storage loft and one in the maintenance shop.

HHW is also supplied to four Trane heating coils located in the ceiling of the main building. Each coil is arranged immediately downstream of a cooling only air handling unit (AHU). A fifth AHU is equipped with both a HW heating coil and cooling section. A 5.0 kW electric reheat coil is positioned in the supply air ductwork serving the Shift Captain's office and computer room. This unit is operated during cooling mode to prevent overconditioning these two spaces in the summer.

All five AHUs provide the building with ventilation air and utilize direct expansion (DX) cooling via remote, air-cooled, rooftop condensing units, manufactured by Trane. The five rooftop condensers provide a total of 27 tons of cooling and are all located on the single story roof of the main building area. Three of the condensers are original to the building; 4 ton and 5 ton replacement units were installed in 2006 and 2004, respectively. While still operational, the three original condensing units have surpassed their useful life and are in need of replacement.

Following is a photo of an original rooftop condensing unit.



Seven exhaust fans are utilized throughout the building. The meeting room, restrooms/locker rooms, lounge, and radio room are each served by a dedicated fractional horsepower rooftop exhaust fan. There are also two large rooftop fans serving the engine room and a small inline blower that exhausts the single restroom at the rear of the engine room. All exhaust fans are switch operated and utilized very sparingly, with the exception to the fan serving the restrooms/locker rooms that runs continuously and has no known controls.

3.4 Lighting/Electrical Systems

3.4.1 Interior Lighting

The building utilizes about 200 fluorescent fixtures for most lighting requirements. Several years ago, the facility participated in a PSE&G energy reduction, lighting improvement program. Through this program, most inefficient T-12 fluorescent fixtures with magnetic ballasts in the building were upgraded to utilize T-8 lamps and electronic ballasts. The (84) 4', two lamp T-12 fixtures within the engine room were not included under the PSE&G program because they are mounted about 15' above the ground.

In addition to fluorescent lighting, spaces such as the meeting room, radio room, and lounge also utilize fixtures with 100W incandescent bulbs for perimeter and accent lighting. In addition, the three bunk rooms are lit by two, 100W incandescent bulbs. The building also uses numerous skylights throughout the facility. Hallways in the main building section are outfitted with four, 4'x4' skylights; and the engine room is equipped with six, 5'x5' skylights. During the energy audit, the skylights were effective at providing natural light to the spaces, reducing the need for artificial lighting.

Following is a photo of a skylight.

There are about five older styles of electric exit signs throughout the building which utilize incandescent lamps and magnetic ballasts.

3.4.2 Exterior Lighting

Site and parking lot lighting primarily consists of 14 light poles; eight are equipped with a single 250W metal halide lamp, and the remaining six are equipped with two metal halide lamps. Lights along the building exterior include seven, 250W metal halide fixtures, similar to those on the light poles; seven recessed fixtures using compact fluorescent bulbs above the three vestibules; and 10 globe lights using 75W incandescent flood lamps. There are also several ground mounted, accent lighting fixtures along the front of the building which are not used.

3.4.3 Emergency Power System

Emergency backup power at the facility is provided by a gas-fired Onan Genset, 18.5 kW, 23 kVA generator, which is located in the maintenance shop. The generator is equipped with a controller that automatically energizes the unit in the event of a power failure. Building personnel manually activate the system once a week to verify proper operation and exercise the generator motor for about 30 minutes. Systems and equipment connected to the emergency power system include the master alarm panel and radio room equipment, telephones, overhead door motors, air handlers, HHW circulation pumps, sewage pumps, air compressor, and select lighting and receptacles.

3.5 Control Systems

3.5.1 HVAC Controls

HVAC controls in the building were recently updated to a Honeywell Rapid Link system. This system utilizes a master controller located in the Chief's office to monitor temperature setpoints and schedules in areas served by the five AHUs. Additionally, the meeting room and weight room are equipped with override timers which transition their corresponding thermostats to occupied mode setpoints when activated. Temperature setpoints vary throughout the main building area; on average, these are 68°F for heating and 73°F for cooling during occupied times; and 60°F for heating and 80°F for cooling during unoccupied times. Since the building is occupied 24 hours per day, spaces such as the lounge and bunk rooms are not programmed for temperature setback.

While all thermostats linked to the control system are electronic units, the remaining thermostats are older mechanical units which control terminal hydronic heating equipment such as cabinet unit heaters, convection radiators, and unit heaters. The eight unit heaters in the engine room are controlled by five older thermostats which are set at about 62°F. These thermostats are manually lowered in the shoulder months when the overhead doors are left open for natural ventilation.

3.5.2 Lighting/Electrical Controls

Most lighting controls within the building are manual switches located within each space. Areas such as the meeting room, lounge, and radio room have multiple switches to control the different lighting fixtures within the room. Fluorescent fixtures are activated by on/off switches; incandescent lighting is typically operated by dimmer switches. Fluorescent lights in the three bunk rooms are also controlled by dimmer switches. Due to the large quantity of fixtures within the engine room, the lighting is broken up into eight zones, each operable by its own wall switch.

All outside lighting is manually operated at a master controller in the radio room. Most lights are turned on for several hours in the evening and then shut down when the fire crew goes to bed. The ten globe lights along the building's exterior are left on throughout the night.

Since Fire District #9 building is an emergency response facility, at least one light fixture in every room has been outfitted with red lamps and interconnected with the master alarm system. The signaling fixture flashes to assist in alerting occupants that they are required to respond to a call when the fire alarm sounds. The six dual fixture light posts in front of the building are also connected to the alarm system and turn on for about 20 minutes when the alarm is activated. All lighting connected to the master alarm is backed by emergency power from the generator.

3.6 Plumbing Systems

Domestic hot water is generated by a 75 gallon, State Industries gas-fired water heater with an input of 75,100 Btuh. This unit is original to the building and located in the boiler room. There is no DHW return system. DHW is generated at 140°F and piped to a thermostatic mixing valve that blends the HW with cold water to produce tempered water at 120°F. The tempered water is delivered to hand sinks and showers. Prior to the mixing valve, 140°F HW is also directed to the laundry room where it serves the mop sink and two washing machines. In addition to the DHW heater, the boiler room is also equipped with a 5 HP Marathon Electric air compressor. This unit is used to charge the air brakes on the fire engines while they are garaged. A dryer unit was recently installed to reduce moisture content in the compressed air.

The building has both men's and women's multi-stall restrooms, each with an adjacent locker room and showers. The men's restroom contains two each of hand sinks, urinals, toilets, and showers; the women's is equipped with three hand sinks and toilets, and a single shower. Along the back wall of the engine room is a single person restroom equipped with a urinal, toilet, and utility sink that uses a gooseneck faucet. All flush valves and hand sink faucets are original to the building and are considered high-flow by present day industry standards.

The laundry room is located at the rear of the engine room adjacent to the single restroom and is outfitted with two standard washing machines, a dryer, and mop sink. Plumbing fixtures in the kitchen area of the lounge include a dishwasher, coffee machine, and dual-bowl stainless steel sink with gooseneck faucet. There are also two electric water coolers in the building, one outside the men's and women's restrooms and one along the back wall of the engine room.

The facility utilizes a septic tank and leach field system for waste collection. Waste water is discharged into a collection pit where it is pumped to the septic tank located behind the building at a higher elevation. Water collected by floor drains in the engine room and maintenance room is diverted through a sediment bed oil interceptor prior to being combined with general waste water.

4.0 ENERGY CONSERVATION MEASURES

4.1 ECM-1 Install Demand Control Ventilation

Three AHUs are used to meet the HVAC requirements of the meeting room, weight room, and lounge. Per building drawings, these units are supplying 1,000 CFM of outdoor air (OA) to the meeting room, 180 CFM OA to the weight room, and 520 CFM OA to the lounge. Each AHU draws fresh air in through an OA intake and blends it with return air prior to being treated and discharged into the respective space. Since there are no controls on the fresh air intakes, the same amount of OA is treated regardless of the ventilation demand determined by occupancy. Therefore, the units are constantly ventilating the areas for maximum occupancy. Utilizing demand control ventilation (DCV) would regulate the amount of OA induced to each space based on the CO_2 levels detected within the room or return air duct. A DCV system is based on the principle that the number of people within the space is proportional to the concentration of CO_2. This ECM evaluates providing only the code required fresh air to the meeting room, weight room, and lounge, which will decrease the amount of OA necessary to be treated and reduce the annual heating and cooling loads.

According to the 2006 International Mechanical Code, the meeting room requires 15 CFM/person of OA. Therefore, based on the occupancy schedule for the room it was determined that the average required amount of OA within the space over a 24 hour period is approximately 31 CFM. The weight room requires a minimum of 20 CFM/person OA; therefore, an average of 13 CFM of OA over a 24 hour period is needed. Code dictates that the lounge requires 15 CFM/person OA, which averaged about 30 CFM per the occupancy schedule. Calculating the energy required to condition the existing and proposed OA rates for each space yielded a combined annual savings of 1,490 therms and 2,440 kWh.

Implementation of this measure requires installation of OA controls on the three AHUs serving the meeting room, weight room, and lounge. This includes installing CO_2 sensors within the return air ducts and upgrades to the OA damper actuators. Additionally, a programmable logic controller (PLC) will be necessary to control the OA damper position based on the CO_2 readings.

DCV equipment has an expected life of 15 years, according to ASHRAE, and total energy savings over the life of the project are estimated at 22,350 therms and 36,600 kWh, totaling $30,000.

The implementation cost and savings related to this ECM are presented in Appendix B and summarized below:

ECM-1 Install Demand Control Ventilation

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
12,500	0	2,440	1,490	0	2,000	0	2,000	1.4	NA	6.3	NA

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

This measure is recommended.

4.2 ECM-2 Boiler Replacement with Hot Water Temperature Reset

Heating hot water is provided by an H.B. Smith Series 28A-5 gas-fired, hot water boiler. The boiler is rated at 1,491 MBH input, 1,014 MBH output, with an efficiency of 68%. This ECM evaluated replacing the original unit with a high efficiency, condensing boiler with a hot water (HW) temperature reset control system. By installing a HW reset system, heat losses from the building's HHW piping system can be greatly reduced. Additionally, combining the control system with a condensing boiler can improve firing efficiency up to 95%, or higher.

The benefits of applying HW temperature reset were evaluated by generating a spreadsheet that compared the existing piping system losses to those of the proposed system (Appendix C). Using building drawings of the existing HHW hydronic system and bin weather data, with an average HHW temperature of 160°F, the current annual heat loss by the system was found to be about 87,200 MBh. With a HW reset control system in place, the average HHW temperature can be reduced to about 105°F. The resulting annual heat loss from the HHW piping system is reduced to approximately 51,800 MBh.

Piping heat losses calculated for the existing system and with HW reset in place were then applied to the proposed boiler efficiency rates to determine the required therms to overcome these losses. Since the efficiency of the proposed condensing boiler varies based on the return water temperature, the efficiency curve for an Aerco Benchmark 1.5 boiler was used to input the different firing efficiencies with the HW reset system. Averaging the boiler firing efficiencies yielded an annual thermal efficiency of 92.3%. The difference between the existing and proposed therms required to overcome heat losses result in an annual energy savings of about 380 therms of natural gas.

The proposed ECM also projected savings for boiler replacement. Calculations determined that the boiler consumes about 7,360 therms annually. Applying the 68% boiler efficiency to its annual natural gas usage established a baseline boiler load of approximately 500,480 MBH per year. With the improved efficiency determined in the HW reset calculation, the proposed condensing boiler will require 5,420 therms to meet this load, resulting in a savings of about 1,940 therms of natural gas per year. As previously stated, the proposed boiler efficiency rating is based on the use of an Aerco Benchmark 1.5 boiler for the calculation. Exact boiler selection and sizing cannot be completed without a more detailed analysis of the building's hydronic heating system and generation of a load profile.

For implementation of this measure, one new gas-fired, condensing, hot water boiler would be installed, along with a HW temperature reset control system. New immediate HW supply and return piping must also be installed; valves would be reused where possible. A new exhaust flue system will also be required.

Condensing boiler and hot water reset control system have an expected life of 25 years, according to ASHRAE, and total energy savings over the life of the project are estimated at 58,000 therms, totaling $65,000.

The implementation cost and savings related to this ECM are presented in Appendix C and summarized as follows:

ECM-2 Boiler Replacement with Hot Water Temperature Reset

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
44,500	0	0	2,320	0	2,600	0	2,600	0.5	2,600	17.1	16.1

*Incentive shown is per the New Jersey Smart Start Program, 2010 Gas Heating Application.

This measure is not recommended.

4.3 ECM-3 Replace Rooftop Condensing Units

Cooling for the five AHUs is produced by five, remote rooftop condensing units located on the single story roof of the main building area. Condensing units 1 (4 tons), 2 (4 tons) and 3 (10 tons) are original to the building (over 20 years' old) and operate at an average Energy Efficiency Ratio (EER) of about 7.5. Replacing these three older units with energy efficient models can increase the EER to about 12.8 and reduce electrical energy consumption.

Using bin weather data for Newark, NJ and an estimated percent time of operation at each OA temperature above the building's cooling setpoint, the total annual operating hours of the condensing units was established. EER values were then converted to kWh and applied to the estimated hours of operation to determine the energy consumption for the existing and proposed condensing units. Replacing the three remote condensing units with new energy efficient models will produce an annual savings of approximately 7,550 kWh.

Rooftop condensing units have an expected life of 20 years, according to ASHRAE, and total energy savings over the life of the project are estimated at 151,000 kWh, totaling $40,000.

The implementation cost and savings related to this ECM are presented in Appendix D and summarized below:

ECM-3 Replace Rooftop Condensing Units

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
21,300	0	7,550	0	0	1,200	800	2,000	0.9	1,500	10.7	9.9

*Incentive shown is per the New Jersey Smart Start Program, 2010 Electric Unitary HVAC Application.

This measure is recommended.

4.4 ECM-4 Install Infrared Heaters – Engine Room

The engine room is heated by eight HW unit heaters suspended from the ceiling. Since the unit heaters utilize HHW supplied by the boiler plant, the units generate heat at the same efficiency as the boiler, or 68%. This ECM evaluated replacement of the HW unit heaters with infrared gas fired heaters. Infrared heaters distribute heat more effectively than traditional unit heaters, have higher burner efficiencies, and do not require an air circulation fan.

To determine the existing heating load for the space, a block load spreadsheet for the engine room was generated using the same methodology described in section 4.1.2. Using the block load spreadsheet and thermal efficiency of the boilers, it was determined that the unit heaters require 6,460 therms of energy per year to meet the heating load.

To calculate the benefits of installing infrared heaters, a block load building model was created to approximate the existing energy load of the engine room. The block load, provided in Appendix E, modeled the maximum overall heating load for the space, taking into account various parameters such as roof, wall, and window construction; total envelope surface area; ventilation and infiltration loads; building occupancy; internal heat generation; and other sources of heat gain and loss. By entering these calculated maximum loads into a spreadsheet containing bin temperature data, the total accumulated year-round heating energy requirements were determined. Bin data for Hamilton, NJ was not available; therefore, data from nearby Newark, NJ was used. The bin temperature spreadsheets are included in Appendix E.

The proposed infrared heaters have a burner efficiency of 85% and will transfer heat more effectively via radiation. Using the block load spreadsheet and applying efficiency improvements, it was determined that the annual heating gas energy required using infrared heaters is about 2,300 therms, compared to the 3,380 therms currently consumed. Electrical energy savings will also be realized by eliminating the need to operate the air circulation fans utilized by the existing unit heaters. The electrical energy saving was calculated by applying the annual heating operating hours from the bin data spreadsheet to the power requirement for the existing unit heaters and proposed infrared heaters. The total annual electrical savings for this ECM is estimated to be 1,070 kWh.

Implementation of this measure requires running natural gas piping from the service line to the proposed units. New exhaust flue stacks and electrical wiring will also be necessary. Flue stacks for the heaters can be combined per the manufacturer's installation instructions. To calculate the budgetary cost, four infrared heaters were used as outlined in the cost estimate. The quantity, size, and capacity of the heaters were used for estimating purposes only. Exact heater selection and sizing cannot be completed without generating a heating load profile for the space.

ECM-2 and ECM-4 are not recommended due to the long payback. However, it is important to note that application of this measure will significantly reduce the load on the hot water boiler. Therefore, if this ECM was combined with replacing the boiler, a much smaller boiler would be adequate to meet the reduced building HHW load, reducing the initial cost of a new boiler.

Infrared heaters have an expected life of 18 years, according to ASHRAE, and total energy savings over the life of the project are estimated at 19,440 therms and 19,260 kWh, totaling $25,200.

The implementation cost and savings related to this ECM are presented in Appendix E and summarized as follows:

ECM-4 Install Infrared Heaters – Engine Room

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
28,700	0	1,070	1,080	0	1,400	0	71,400	(0.1)	NA	20.5	NA

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

This measure is not recommended.

4.5 ECM-5 Roof Replacement

The roof consists of 1-1/2" metal decking, 2" rigid insulation, rubber membrane and stone ballasts. This construction assembly has a thermal resistance, or R-value, of about 11.5, which is considered low. Additionally, the roofing membrane, which is original to the building's construction, has exceeded its useful life and is now susceptible to leaks. This measure proposed removing the existing stone ballasts and membrane; and installing additional foam insulation and applying a highly reflective roof coating to minimize heat energy losses in the winter and gains in the summer.

To calculate the savings of applying an additional 3" of spray foam insulation, the heat transfer values through the roof were found using the existing assembly's R-value and bin weather data for Newark, NJ. The values were totaled to determine the existing annual heat losses. Heat loss values were then determined with the proposed thermal resistance value which included the additional foam insulation (R-30.7 total). The annual energy savings of the additional roof insulation alone is expected to be about 1,670 therms and 470 kWh.

Solar Reflectance (SR) and Infrared Emittance (IE) are measurements of a roof's ability to reject solar heat, where the higher the values the more solar heat is prevented from being absorbed into the building. The existing stone ballast roof has an SR value of 12 and an IE value of 90. However, the SR and IE values of the proposed highly reflective roof are 82 and 91, respectively. In order to find the savings offered by applying a highly reflective roof coating, the Department of Energy (DOE) Cool Roof Calculator was utilized to model both the existing and proposed roofs, where only the SR and IR values were changed between the two models (Appendix F). Applying the energy numbers generated from these models to the roof of the Fire District #9 building yielded an annual energy savings of about 1,370 kWh, where an additional 20 therms of heat will be required to replace the lost solar heat gain in the winter.

Due to deteriorated condition; the roof will require replacement in the near future; therefore, the budgetary cost estimate reflects only the incremental cost of installing additional insulation and a highly reflective roof coating, over a traditional ballasted roofing membrane. A complete cost estimate for each roof replacement strategy can be found in Appendix F.

The new highly reflective roof and foam insulation have an expected life of 30 years, according to the manufacturer, and total energy savings over the life of the project are estimated at 49,500 therms and 55,200 kWh, totaling $81,000.

The implementation cost and savings related to this ECM are presented in Appendix F and summarized as follows:

ECM-5 Roof Replacement

Budgetary Cost (Incremental Only)	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
68,400	0	1,840	1,650	0	2,200	500	2,700	0.2	NA	>25	NA

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

This measure is not recommended.

4.6 ECM-6 Increase Wall Insulation – Engine Room

The exterior walls of the two story engine room are constructed of 4" split rib concrete block, 1" rigid insulation and 12" CMU block which has a low R-value of about 7.5. This ECM addressed adding 2" polyisocyanurate board insulation (R-14.0) to the interior side of the CMU block walls in the engine room to minimize heat energy losses. This insulation must have a flame spread resistant backing in order to comply with local fire codes.

To calculate the savings, the heat losses through the exterior walls of engine room were found using the existing walls' R-value and bin weather data for Newark, NJ. The values were then totaled to determine the existing annual heat losses. The heat loss values were then determined with a thermal resistance which included the additional R-14.0 insulation. The annual energy savings of adding insulation to the exterior block walls is expected to be about 600 therms.

Wall board insulation has an expected life of 20 years, according to ASHRAE, and total energy savings over the life of the project are estimated at 12,000 therms and $14,000.

The implementation cost and savings related to this ECM are presented in Appendix G and summarized below:

ECM-6 Increase Wall Insulation – Engine Room

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
9,100	0	0	600	0	700	0	700	0.5	NA	13.0	NA

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

This measure is not recommended.

4.7 ECM-7 Install Door Seals

Doors at each of the three vestibule areas have noticeable gaps around the door perimeter and at the center joint of the two double door assemblies. The lack of effective door seals results in air infiltration and heat transfer between the conditioned space and the outdoors. Installing new door seals would minimize infiltration and reduce energy consumption year round.

The energy savings calculation compared the existing estimated infiltration rate of 0.5 CFM/LF to the proposed infiltration rate of 0.2 CFM/LF, based on installation of the new door seals. It is assumed that the infiltration air is constant throughout the year and weather bin data was used to determine the annual heating load generated as a result. It was determined that installing new seals on doors located at the three vestibules of the main building will save an estimated 70 therms and 200 kWh annually.

Door seals have an expected life of 10 years, according to the manufacturer, and total energy savings over the life of the project are estimated at 700 therms and 2,000 kWh, totaling $1,000.

The implementation cost and savings related to this ECM are presented in Appendix H and summarized below:

ECM-7 Install Door Seals

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
500	0	200	70	0	100	0	100	1.0	NA	5.0	NA

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

This measure is recommended.

4.8 ECM-8 Replace Domestic Hot Water Heater

Domestic hot water for the Fire District #9 building is generated by a gas-fired, 75 gallon, State Industries water heater with an input of 75,100 Btuh and a thermal efficiency of about 80%. Original to the building, the unit is over 20 years' old and has surpassed its useful life. According to the Department of Energy (DOE), DHW's of this size and age have an Energy Factor (EF) of about 0.53. The EF indicates a water heater's overall energy efficiency based on the amount of hot water produced per unit of fuel consumed over a typical day. This value takes into account recovery efficiency, standby losses, and cycling losses. Replacing the existing DHW with a new unit that has a higher EF will produce hot water more cost effectively and save energy throughout the year.

Following review of natural gas utility data over a one year period, it was determined that the existing DHW heater consumes about 75 therms per month, or 900 therms per year. Applying the current EF to annual fuel consumed by the DHW heater, it was found that the energy required to meet the building's hot water demand is about 47,700 MBh. A modern condensing gas-fired DHW heater of similar capacity to the existing unit has an EF of about 0.66 and would require about 720 therms per year to meet the building hot water demand. Therefore, installation of a new DHW heater is expected to save approximately 180 therms annually.

Condensing hot water heaters have an expected life of 18 years, according to ASHRAE, and total energy savings over the life of the project are estimated at 3,240 therms, totaling $3,600.

The implementation cost and savings related to this ECM are presented in Appendix I and summarized as follows:

ECM-8 Replace Domestic Hot Water Heater

Budgetary Cost	Annual Utility Savings						Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total							
$	kW	kWh	Therms	kGals	$		$	$		$	Years	Years
3,900	0	0	180	0	200		0	200	(0.1)	100	19.5	19.0

*Incentive shown is per the New Jersey Smart Start Program, 2010 Gas Water Heating Application.

This measure is not recommended.

4.9 ECM-9 Install Low-Flow Urinals and Flush Valves

There are three urinals within the building, each is original and has a flush valve that operates at 1.5 gallons per flush (Gpf). Modern urinal and flush valve combinations can reduce water usage to as low as 1/8 gpf (0.125 Gpf). This measure estimates the annual water savings of installing low-flow urinals and flush valves in place of the three existing units.

Following review of the building's occupancy schedule, it was estimated that all three urinals combined are flushed approximately 22 times per day. Applying the number of flushes to the existing and proposed values for Gpf, it was determined that installing new urinals and flush valves can reduce water consumption by about 11.0 kGals per year.

Urinals and flush valves have an expected life of 15 years, according to the manufacturer, and total savings over the life of the project are estimated at 166 kGals, totaling $1,500.

The implementation cost and savings related to this ECM are presented in Appendix J and summarized below:

ECM-9 Install Low-Flow Urinals and Flush Valves

Budgetary Cost	Annual Utility Savings						Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total							
$	kW	kWh	Therms	kGals	$		$	$		$	Years	Years
2,500	0	0	0	11.0	100		0	100	(0.4)	NA	25.0	NA

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

This measure is not recommended.

4.10 ECM-10 Install Low-Flow Flush Valves on Toilets

The men's and women's restrooms have a combined total of six toilets, each utilizing flush valves that consume water at a rate of 3.5 Gpf. Replacing the old flush valves on the six toilets with modern units which only use 1.28 gpf will conserve domestic water year round.

Using the same method as in section 4.9, the building's occupancy schedule was used to estimate that all six toilets combined are flushed approximately 10 times per day. Applying the number of flushes to the existing and proposed values for Gpf, it was found that installing new flush valves on the toilets can reduce water consumption by about 8.1 kGals per year.

Flush valves have an expected life of 15 years, according to the manufacturer, and total savings over the life of the project are estimated at 122 kGals, totaling $1,500.

The implementation cost and savings related to this ECM are presented in Appendix K and summarized below:

ECM-10 Install Low-Flow Flush Valves on Toilets

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
2,700	0	0	0	8.1	100	0	100	(0.4)	NA	>25	NA

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

This measure is not recommended.

4.11 ECM-11 Install Low-Flow Restroom Faucets

Restrooms within the building have a total of five hand-sink faucets which operate at a flow rate of about 3.0 gallons per minute (Gpm). Modern low-flow faucets use 0.5 Gpm of domestic water. This measure estimates the annual water savings of replacing the existing restroom faucets with low-flow units.

With an approximated operating time of 20 seconds per use, it was determined that the existing faucets use 1.0 gallon of water per use; the proposed faucets will use 0.17 gallons. Using the building occupancy schedule, it was estimated that all five faucets combined are used approximately 32 times per day. After applying the existing and proposed water usage rates to the average uses per day, it was determined that replacing the restroom faucets with low-flow units will save an estimated 9.7 kGals per year.

Low-flow faucets have an expected life of 15 years, according to the manufacturer, and total savings over the life of the project are estimated at 146 kGals, totaling $1,500.

The implementation cost and savings related to this ECM are presented in Appendix L and summarized below:

ECM-11 Install Low-Flow Restroom Faucets

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
800	0	0	0	9.7	100	0	100	0.9	NA	8.0	NA

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

This measure is recommended.

4.12 ECM-12 Lighting Replacements

During the site visit, a comprehensive fixture survey was conducted of the entire building. Each switch and circuit was identified, as well as the number of fixtures, locations, approximate operating times, and existing wattage consumption. The Fire District #9 engine room utilizes (84) 4', two lamp T-12 fixtures with magnetic ballasts to illuminate the space, which is inefficient by current standards. Additional inefficient lighting includes five older style exit signs, and 10 exterior globe lights which operate 75W incandescent flood lamps.

This measure addressed the expected energy savings of replacing the T-12 engine room fixtures with high output T-5 fluorescent lamps; installing energy efficient LED type exit signs in place of the existing incandescent exit signs; and replacing the 75W incandescent flood lamps in the 10 exterior globe lamps with 26W compact fluorescent flood lamps. Other inefficient lighting fixtures such as those using 100W incandescent bulbs in the lounge were not addressed because they are controlled by dimmer switches.

Energy savings for this measure were calculated by applying the existing and proposed fixture wattages to the estimated time of operation to determine their annual electricity consumptions. The difference resulted in an annual savings of about 11,700 kWh per year. Supporting calculations, including all assumptions for lighting hours and the annual energy usage for each fixture is provided in Appendix M.

Lighting has an expected life of 15 years, according to the manufacturer, and total energy savings over the life of the project are estimated at 175,500 kWh, totaling $27,000.

The implementation cost and savings related to this ECM are presented in Appendix M and summarized below:

ECM-12 Lighting Replacements

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
14,000	1.9	11,700	0	0	1,800	0	1,800	0.9	800	7.8	7.3

*Incentive shown is per the New Jersey Smart Start Program, 2010 Prescriptive Lighting Application.

This measure is not recommended in lieu of ECM-14.

4.13 ECM-13 Install Lighting Controls

Most lighting fixtures throughout the building are manually switched on and off. Since the Fire District #9 building is occupied 24 hours per day, many lights are left on even though the space may be unoccupied. The Chief's office, Captain's office, Fire Prevention office, weight room, men's locker room and restrooms, lounge and radio room all experience intermittent occupancy and could benefit from lighting controls such as occupancy sensors. Additionally, the roof of the engine room was constructed with six, 5'x5' skylights. Installing photovoltaic (PV) daylight sensors to turn off the engine room lights during times when the skylights admit an acceptable amount of daylight to the space, would reduce electricity consumption throughout the year. This measure was not considered for the women's restroom/locker room because currently there are no women employees.

As stated in section 4.12, a comprehensive lighting fixture survey was conducted during the site visit to identify approximate operating times and existing wattage consumption of each fixture. By reviewing the building occupancy schedule and typical traffic patterns for each space, the necessary operating time for the lighting in each space identified above was established. The energy savings for installing occupancy sensors were calculated by applying the known fixture wattages in each space to the existing and necessary times of operation for each fixture. Taking the difference between the two values, the electric savings was found to be about 3,590 kWh. Supporting calculations, including cost estimates all assumptions for existing and proposed lighting hours per each space, can be found in Appendix N.

To calculate the savings provided by daylighting in the engine room, the amount of available sunlight for the geographic region was first established. Historical weather data for Sea Brook, NJ, the nearest location for which this data was available, indicated an average of 4.21 hours of available sunlight per day, which equates to about 1,537 hours per year that the engine room lights could be turned off. The resulting energy savings is approximately 10,330 kWh. Implementing daylighting controls would require several PV daylight sensors to be connected into the existing lighting circuits and master lighting controller.

Lighting controls have an expected life of 15 years, according to the manufacturer, and total energy savings over the life of the project are estimated at 208,800 kWh and $34,500.

The implementation cost and savings related to this ECM are presented in Appendix N and summarized below:

ECM-13 Install Lighting Controls

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
6,600	0	13,920	0	0	2,300	0	2,300	4.2	200	2.9	2.8

*Incentive shown is per the New Jersey Smart Start Program, 2010 Lighting Controls Application.

This measure is not recommended in lieu of ECM-14.

4.14 ECM-14 Lighting Replacements with Controls

This measure is a combination of ECMs 12 and 13 to allow maximum energy and demand reduction. Due to interactive effects, the energy and cost savings for lighting upgrades and controls are not cumulative.

Since upgrading lighting in the engine room to utilize high output T-5 lamps would require the complete replacement of each fixture, when combined with daylighting controls, the proposed ballasts are dimmable to take advantage of further energy savings and incentives.

The lighting upgrades and controls have an expected lifetime of 15 years, according to the manufacturer, and total energy savings over the life of the project are estimated at 394,800 kWh, totaling $55,500.

The implementation cost and savings related to this ECM are presented in Appendix O and summarized as follows:

ECM-14 Lighting Replacements with Controls

Budgetary Cost	Annual Utility Savings						Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total							
$	kW	kWh	Therms	kGals	$		$	$		$	Years	Years
34,100	1.9	26,320	0	0	3,700		0	3,700	0.6	2,200	9.2	8.6

*Incentive shown is per the New Jersey Smart Start Program, 2010 Prescriptive Lighting and Lighting Controls Applications.

This measure is recommended.

5.0 PROJECT INCENTIVES

5.1 Incentives Overview

5.1.1 New Jersey Pay For Performance Program

The building will be eligible for incentives from the New Jersey Office of Clean Energy. The most significant incentives will be from the New Jersey Pay for Performance (P4P) Program. The P4P program is designed for qualified energy conservation projects in facilities whose demand in any of the preceding 12 months exceeds 200 kW. However, the 200 kW/month average minimum has been waived for buildings owned by local governments or municipalities and non-profit organizations. Facilities that meet this criterion must also achieve a minimum performance target of 15% energy reduction by using the EPA Portfolio Manager benchmarking tool before and after implementation of the measure(s). If the participant is a municipal electric company customer, and a customer of a regulated gas New Jersey Utility, only gas measures will be eligible under the Program. American Recovery and Reinvestment Act (ARRA) funding, when available, may allow oil, propane and municipal electric customers to be eligible for the P4P Program. Available incentives are as follows:

Incentive #1: Energy Reduction Plan – This incentive is designed to offset the cost of services associated with the development of the Energy Reduction Plan (ERP). The standard incentive pays $0.10 per square foot, up to a maximum of $50,000, not to exceed 50% of facility annual energy cost, paid after approval of application. For building audits funded by the New Jersey Board of Public Utilities, which receive an initial 75% incentive toward performance of the energy audit, facilities are only eligible for an additional $0.05 per square foot, up to a maximum of $25,000, rather than the standard incentive noted above.

Incentive #2: Installation of Recommended Measures – This incentive is based on projected energy saving and designed to pay approximately 60% of the total performance-based incentive. Base incentives deliver $0.11/kWh and $1.10/therm not to exceed 30% of total project cost.

Incentive #3: Post-Construction Benchmarking Report – This incentive is paid after acceptance of a report proving energy savings over one year utilizing the Environmental Protection Agency (EPA) Portfolio Manager benchmarking tool. Incentive #3 base incentives deliver $0.07/kWh and $0.70/therm not to exceed 20% of total project cost.

Combining incentives #2 and #3 will provide a total of $0.18/ kWh and $1.8/therm not to exceed 50% of total project cost. Additional incentives for #2 and #3 are increased by $0.005/kWh and $0.05/therm for each percentage increase above the 15% minimum target to 20%, calculated with the EPA Portfolio Manager benchmarking tool, not to exceed 50% of total project cost.

5.1.2 New Jersey Smart Start Program

For this program, specific incentives for energy conservation measures are calculated on an individual basis utilizing the 2010 New Jersey Smart Start incentive program. This program provides incentives dependent upon mechanical and electrical equipment. If applicable, incentives from this program are reflected in the ECM summaries and attached appendices.

If the building qualifies and enters into the New Jersey Pay for Performance Program, all energy savings will be included in the total building energy reduction, and savings will be applied towards the Pay for Performance incentive. A project is not applicable for both New Jersey incentive programs.

5.1.3 Energy Efficient and Conservation Block Grant

Following is a brief summary of the Energy Efficient and Conservation Block Grant (EECBG) program. The Energy Efficiency and Conservation Block Grant Complete Program Application Package should be consulted for rules and regulations.

Additional funding is available to local government entities through the EECBG, a part of New Jersey's Clean Energy program (NJCEP). The grant is for local government entities only, and can offset the cost of energy reduction implementation to a maximum of $20,000 per building.

This program is provided in conjunction with NJCEP funding and any utility incentive programs; the total amount of the three incentives combined cannot exceed 100% of project cost. Funds shall first be provided by NJCEP, followed by the EECBG and any utility incentives available to the customer. The total amount of the incentive shall be determined TRC Solutions, a third party technical consulting firm for the NJCEP.

In order to receive EECBG incentives, local governments must not have received a Direct Block Grant from the US Department of Energy. A list of the 512 qualifying municipalities and counties is provided on the NJCEP website. Qualifying municipalities must participate in at least one eligible Commercial & Industrial component of the NJCEP, utility incentive programs, or install building shell measures recommended by the Local Government Energy Audit Program. Eligible conservation programs through NJCEP include:

- Direct Install
- Pay for Performance
- NJ SmartStart Buildings for measures recommended by a Local Government Energy Audit (LGEA) or an equivalent audit completed within the last 12 months
- Applicants may propose to independently install building shell measures recommended by a LGEA or an equivalent audit. The audit must have been completed within the past 12 months.
- Any eligible utility energy efficiency incentive program

Most facilities owned or leased by an eligible local government within the State of New Jersey are eligible for this grant. Ineligible facilities include casinos or other gambling establishments, aquariums, zoos, golf courses, swimming pools, and any building owned or leased by the United States Federal Government. New construction is also ineligible.

5.1.4 ARRA Initiative "Energy Efficiency Programs through the Clean Energy Program"

The American Recovery and Reinvestment Act (ARRA) Initiative is available to New Jersey oil, propane, cooperative and municipal electric customers who do not pay the Societal Benefits Charge. This charge can be seen on any electric bill as the line item "SBC Charge." Applicants can participate in this program in conjunction with other New Jersey Clean Energy Program initiatives including Pay for Performance, Local Government Energy Audits, and Direct Install programs.

Funding for this program is dispersed on a first come, first serve basis until all funds are exhausted. The program does not limit the municipality to a minimum or maximum incentive, and the availability of funding cannot be determined prior to application. If the municipality meets all qualifications, the application must be submitted to TRC Energy Solutions for review. TRC will then determine the amount of the incentive based on projected energy savings of the project. It is important to note that all applications for this incentive must be submitted before implementation of energy conservation measures.

Additional information is available on New Jersey's Clean Energy Program website.

5.2 Building Incentives

5.2.1 New Jersey Pay For Performance Program

Under incentive #1 of the New Jersey Pay for Performance Program, the 16,500 square foot building is eligible for about $800 toward development of an Energy Reduction Plan. When calculating the total amount under Incentives #2 and #3, all energy conservation measures are applicable as the amount received is based on building wide energy improvements. Since the overall energy reduction for the building is estimated to exceed the 15% minimum, the building is eligible to receive monies based as discussed above in section 5.1.1. In total, incentives through the NJ P4P program are expected to total about $18,800, reducing the total project payback from 13.8 years to 12.4 years. See Appendix P for calculations.

5.2.2 New Jersey Smart Start Program

The Hamilton Township Fire District #9 building is eligible for several incentives available under New Jersey Smart Start Programs. The total amount of all qualified incentives is about $6,400 and includes installing a high efficiency gas-fired boiler and rooftop condensing units, new gas-fired DHW heater and upgrades to the lighting system.

Incentives cannot be obtained under multiple NJCEP programs.

6.0 ALTERNATIVE ENERGY SCREENING EVALUATION

6.1 Geothermal

Geothermal heat pumps (GHP) transfer heat between the constant temperature of the earth and the building to maintain the building's interior space conditions. Below the surface of the earth throughout New Jersey the temperature remains in the low 50°F range throughout the year. This stable temperature provides a source for heat in the winter and a means to reject excess heat in the summer. With GHP systems, water is circulated between the building and the piping buried in the ground. The ground heat exchanger in a GHP system is made up of a closed or open loop pipe system. Most common is the closed loop in which high density polyethylene pipe is buried horizontally at 4-6 feet deep or vertically at 100 to 400 feet deep. These pipes are filled with an environmentally friendly antifreeze/water solution that acts as a heat exchanger. In the summer, the water picks up heat from the building and moves it to the ground. In the winter the system reverses and fluid picks up heat from the ground and moves it to the building. Heat pumps make collection and transfer of this heat to and from the building possible.

The building uses a gas-fired, hot water boiler and split system AHUs with DX cooling and hot water duct coils to meet the HVAC requirements. The existing systems and available land at the building site offer a suitable scenario for implementation of a geothermal heat pump system. To take advantage of the consistent temperature of the ground, the existing AHUs and remote condensing units would have to be removed and replaced with a water to water heat pumps system. The hot water boiler would have to remain in place to serve the remaining hydronic equipment, however it could be replaced with a much smaller and more efficient unit.

A detailed analysis of the implementation cost and energy savings related to this ECM are presented in Appendix Q and summarized below:

Geothermal Heat Pump System

Budgetary Cost	Annual Utility Savings					Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total						
$	kW	kWh	Therms	kGals	$	$	$		$	Years	Years
289,600	0	1,750	4,190	0	4,900	0	4,900	(0.7)	13,300	>25	>25

*Incentive shown is per the New Jersey Smart Start Program, 2010 Ground Source Heat Pump Application.

This measure is not recommended.

6.2 Solar

6.2.1 Photovoltaic Rooftop Solar Power Generation

The facility was evaluated for the potential to install rooftop photovoltaic (PV) solar panels for power generation. Present technology incorporates the use of solar cell arrays that produce direct current (DC) electricity. This DC current is converted to alternating current (AC) with the use of an electrical device known as an inverter. The building's roof has sufficient room to install a large solar cell array. A structural analysis would be required to determine if the roof framing could support a cell array.

The PVWATTS solar power generation model was utilized to calculate PV power generation. The New Jersey Clean Power Estimator provided by the New Jersey Clean Energy Program is presently being updated; therefore, the site recommended use of the PVWATT solar grid analyzer version 1. The closest city available in the model is Newark, New Jersey and a fixed tilt array type was utilized to calculate energy production. The PVWATT solar power generation model is provided in Appendix R.

The State of New Jersey incentives for non-residential PV applications is $1.00/watt up to 50 kW of installed PV array. Federal tax credits are also available for renewable energy projects up to 30% of installation cost. Municipalities do not pay federal taxes; therefore, would not be able to utilize the federal tax credit incentive.

Installation of (PV) arrays in the state New Jersey will allow the owner to participate in the New Jersey solar renewable energy certificates program (SREC). This is a program that has been set up to allow entities with large amounts of environmentally unfriendly emissions to purchase credits from zero emission (PV) solar-producers. An alternative compliance penalty (ACP) is paid for by the high emission producers and is set each year on a declining scale of 3% per year. One SREC credit is equivalent to 1000 kilowatt hours of PV electrical production; these credits can be traded for period of 15 years from the date of installation. The cost of the ACP penalty for 2009 is $700; this is the amount that must be paid per SERC by the high emission producers. The expected dollar amount that will be paid to the PV producer for 2010 is expected to be $600/SREC credit. Payments that will be received from the PV producer will change from year to year dependent upon supply and demand. Renewable Energy Consultants is a third party SREC broker that has been approved by the New Jersey Clean Energy Program. As stated above there is no definitive way to calculate an exact price that will be received by the PV producer per SREC over the next 15 years. Renewable Energy Consultants estimated an average of $487/ SERC per year and this number was utilized in the cash flow for this report.

The building had a maximum electricity demand of 31.5 kW and a minimum of 22.8 kW, from February 2009 through January 2010. The monthly average over the observed 12 month period was 26.4 kW. The existing load does not justify the use of the maximum incentive cap of 50 kW of installed PV solar array; therefore, a 25 kW system size was selected for the calculations. The system costs for PV installations were derived from the most recent NYSERDA (New York State Energy Research and Development Agency) estimates of total cost of system installation. It should be noted that the cost of installation is currently $8 per watt or $8,000 per kW of installed system. This has increased in the past few years due to the rise in national demand for PV power generator systems. Other cost considerations will also need to be considered. PV panels have an approximate 20 year life span; however, the inverter device that converts DC electricity to AC has a life span of 10 to 12 years and will need to be replaced multiple times during the useful life of the PV system.

The implementation cost and savings related to this ECM are presented in Appendix R and summarized as follows:

Photovoltaic (PV) Rooftop Solar Power Generation – 25 kW System

Budgetary Cost	Annual Utility Savings				Total Savings	New Jersey Renewable Energy Incentive*	New Jersey Renewable SREC**	Payback (without incentive)	Payback (with incentives)
	Electricity		Natural Gas	Total					
$	kW	kWh	Therms	$	$	$	$	Years	Years
200,000	0	29,575	0	4,800	4,800	25,000	14,400	>25	9.1

*Incentive based on New Jersey Renewable Energy Program for non-residential applications of $1.00 per Watt of installed capacity
** Estimated Solar Renewable Energy Certificate Program (SREC) for 15 years at $487/1000 kWh

While the payback period is within the parameters for recommended measures, further investigation of possible installation locations, required system maintenance, and local installation costs are suggested prior to consideration for implementation.

6.2.2 Solar Thermal Hot Water Plant

Active solar thermal systems use solar collectors to gather the sun's energy to heat water, another fluid, or air. An absorber in the collector converts the sun's energy into heat. The heat is then transferred by circulating water, antifreeze, or sometimes air to another location for immediate use or storage for later utilization. Applications for active solar thermal energy include providing hot water, heating swimming pools, space heating, and preheating air in residential and commercial buildings.

A standard solar hot water system is typically composed of solar collectors, heat storage vessel, piping, circulators, and controls. Systems are typically integrated to work alongside a conventional heating system that provides heat when solar resources are not sufficient. The solar collectors are usually placed on the roof of the building, oriented south, and tilted around the site's latitude, to maximize the amount of radiation collected on a yearly basis.

Several options exist for using active solar thermal systems for space heating. The most common method involves using glazed collectors to heat a liquid held in a storage tank (similar to an active solar hot water system). The most practical system would transfer the heat from the panels to thermal storage tanks and transfer solar produced thermal energy to use for domestic hot water production. DHW is presently produced by a gas fired water heater and, therefore, this measure would offer natural gas savings.

Currently, an incentive is not available for installation of thermal solar systems. A Federal tax credit of 30% of installation cost for the thermal applications is available; however, the Hamilton Township does not pay Federal taxes and, therefore, would not benefit from this program.

The implementation cost and savings related to this ECM are presented in Appendix S and summarized as follows:

Solar Thermal Domestic Hot Water Plant

Budgetary Cost	Annual Utility Savings				Total Savings	New Jersey Renewable Energy Incentive	Payback (without incentive)	Payback (with incentive)
	Electricity		Natural Gas	Total				
$	kW	kWh	Therms	$	$	$	Years	Years
27,100	0	0	170	200	200	NA	>25	NA

* No incentive is available in New Jersey at this time.

This measure is not recommended.

6.3 Wind

Small wind turbines use a horizontal axis propeller, or rotor, to capture the kinetic energy of the wind and convert it into rotary motion to drive a generator which usually is designed specifically for the wind turbine. The rotor consists of two or three blades, usually made from wood or fiberglass. These materials give the turbine the needed strength and flexibility, and have the added advantage of not interfering with television signals. The structural backbone of the wind turbine is the mainframe, and includes the slip-rings that connect the wind turbine, which rotates as it points into changing wind directions, and the fixed tower wiring. The tail aligns the rotor into the wind.

To avoid turbulence and capture greater wind energy, turbines are mounted on towers. Turbines should be mounted at least 30 feet above any structure or natural feature within 300 feet of the installation. Smaller turbines can utilize shorter towers. For example, a 250-watt turbine may be mounted on a 30-50 foot tower, while a 10 kW turbine will usually need a tower of 80-120 feet. Tower designs include tubular or latticed, guyed or self-supporting. Wind turbine manufacturers also provide towers.

The New Jersey Clean Energy Program for small wind installations has designated numerous pre-approved wind turbines for installation in the State of New Jersey. Incentives for wind turbine installations are based on kilowatt hours saved in the first year. Systems sized under 16,000 kWh per year of production will receive a $3.20 per kWh incentive. Systems producing over 16,000 kWh will receive $51,200 for the first 16,000 kWh of production with an additional $0.50 per kWh up to a maximum cap of 750,000 kWh per year. Federal tax credits are also available for renewable energy projects up to 30% of installation cost for systems less than 100 kW. However, as noted previously, municipalities do not pay federal taxes and is, therefore, not eligible for the tax credit incentive.

The most important part of any small wind generation project is the mean annual wind speed at the height of which the turbine will be installed. The Fire District #9 building sits on a large rural lot and has plenty of open space for a tower. However, the map indicates a mean annual wind speed of 10 miles per hour in the Hamilton area.

A wind speed map and aerial site photo are included in Appendix T.

This measure is not recommended due to the low mean annual wind speed.

6.4 Combined Heat and Power Generation (CHP)

Combined heat and power, cogeneration, is self-production of electricity on-site with beneficial recovery of the heat byproduct from the electrical generator. Common CHP equipment includes reciprocating engine-driven, micro turbines, steam turbines, and fuel cells. Typical CHP customers include industrial, commercial, institutional, educational institutions, and multifamily residential facilities. CHP systems that are commercially viable at the present time are sized approximately 50 kW and above, with numerous options in blocks grouped around 300 kW, 800 kW, 1,200 kW and larger. Typically, CHP systems are used to produce a portion of the electricity needed by a facility some or all of the time, with the balance of electric needs satisfied by purchase from the grid.

Any proposed CHP project will need to consider many factors, such as existing system load, use of thermal energy produced, system size, natural gas fuel availability, and proposed plant location. The Fire District #9 building has sufficient need for electrical generation and the ability to use most of the thermal byproduct during the winter, thermal usage during the summer months is low. Thermal energy produced by the CHP plant in the warmer months will be wasted. An absorption chiller could be installed to utilize the heat to produce chilled water; however, there is no chilled water distribution system in the building. The most viable selection for a CHP plant at this location would be a reciprocating engine natural gas-fired unit. Purchasing this system and performing modifications to the existing HVAC and electrical systems would greatly outweigh the savings over the life of the equipment.

This measure is not recommended.

6.5 Biomass Power Generation

Biomass power generation is a process in which waste organic materials are used to produce electricity or thermal energy. These materials would otherwise be sent to the landfill or expelled to the atmosphere. To participate in NJCEP's Customer On-Site Renewable Energy program, participants must install an on-site sustainable biomass or fuel cell energy generation system. Incentives for bio-power installations are available to support up to 1MW-dc of rated capacity.

*Class I organic residues are eligible for funding through the NJCEP CORE program. Class I wastes include the following renewable supply of organic material:

- Wood wastes not adulterated with chemicals, glues or adhesives
- Agricultural residues (corn stover, rice hulls or nut shells, manures, poultry litter, horse manure, etc) and/or methane gases from landfills
- Food wastes
- Municipal tree trimming and grass clipping wastes
- Paper and cardboard wastes
- Non adulterated construction wood wastes, pallets

The NJDEP evaluates biomass resources not identified in the RPS.

Examples of eligible facilities for a CORE incentive include:

- Digestion of sewage sludge
- Landfill gas facilities
- Combustion of wood wastes to steam turbine
- Gasification of wood wastes to reciprocating engine
- Gasification or pyrolysis of bio-solid wastes to generation equipment

* from NJOCE Website

This measure is not recommended due to of noise issues and because the building does not have a steady waste stream to fuel the power generation system. Additionally, purchasing this system and performing modifications to the existing HVAC and electrical systems would greatly outweigh the savings over the life of the equipment.

6.6 Demand Response Curtailment

Presently, electricity is delivered by PSE&G, which receives the electricity from regional power grid RFC. PSE&G is the regional transmission organization (RTO) that coordinates the movement of wholesale electricity in all or parts of 13 states and the District of Columbia including the State of New Jersey.

Utility Curtailment is an agreement with the PSE&G regional transmission organization and an approved Curtailment Service Provider (CSP) to shed electrical load by either turning major equipment off or energizing all or part of a facility utilizing an emergency generator; therefore, reducing the electrical demand on the utility grid. This program is to benefit the utility company during high demand periods and PSE&G offers incentives to the CSP to participate in this program. Enrolling in the program will require program participants to drop electrical load or turn on emergency generators during high electrical demand conditions or during emergencies. Part of the program also will require that program participants reduce their required load or run emergency generators with notice to test the system.

A PSE&G pre-approved CSP will require a minimum of 100 kW of load reduction to participate in any curtailment program. The Hamilton Township Fire District #9 building had a monthly average electricity demand of 26.4 kW and a maximum demand of 31.5 kW from February 2009 through January 2010.

This measure is not recommended because the facility does not have adequate load to meet the required minimum load reduction.

7.0 EPA PORTFOLIO MANAGER

The United States Environmental Protection Agency (EPA) is a federal agency in charge of regulating environment waste and policy in the United States. The EPA has released the EPA Portfolio Manager for public use. The program is designed to allow property owners and managers to share, compare and improve upon their facility's energy consumption. Inputting such parameters as electricity, heating fuel, building characteristics and location into the website based program generates a naturalized energy rating score out of 100. Once an account is registered, monthly utility data can be entered to track the savings progress and retrieve an updated energy rating score on a monthly basis.

The Fire District #9 building is considered a below average energy consumer per the Portfolio Manager with a Site Energy Usage Index (EUI) of 73 kBTU/ft^2/year. The EUI can be improved by addressing wasted energy from overventilation, inefficient HVAC equipment, a lack of insulation, and inefficient lighting systems. By implementing the measures discussed in this report, it is expected that the EUI can be reduced to approximately 32 kBTU/ft^2/year; the national average for this building type is 78 kBTU/ft^2/year. The EPA Portfolio Manager did not generate an energy rating score for this building because the building type (Fire Station/Police Station) is not eligible for an energy star rating.

A full EPA Energy Star Portfolio Manager Report is located in Appendix U.

The user name and password for the building's EPA Portfolio Manager Account has been provided to Chief Mark Antozzeski of the Hamilton Township Fire District #9.

8.0 CONCLUSIONS & RECOMMENDATIONS

The energy audit conducted by CHA at the Hamilton Township Fire District #9 identified potential ECMs for rooftop condensers, door seals, restroom fixture upgrades, lighting replacement with controls, and demand control ventilation. Potential annual savings of $7,100 may be realized for the recommended ECMs, with a summary of the costs, savings, and paybacks as follows:

ECM-1 Install Demand Control Ventilation

Budgetary Cost	Annual Utility Savings						Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total							
$	kW	kWh	Therms	kGals	$		$	$		$	Years	Years
12,500	0	2,440	1,490	0	2,000		0	2,000	1.4	NA	6.3	NA

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

ECM-3 Replace Rooftop Condensing Units

Budgetary Cost	Annual Utility Savings						Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total							
$	kW	kWh	Therms	kGals	$		$	$		$	Years	Years
21,300	0	7,550	0	0	1,200		800	2,000	0.9	1,500	10.7	9.9

*Incentive shown is per the New Jersey Smart Start Program, 2010 Electric Unitary HVAC Application.

ECM-7 Install Door Seals

Budgetary Cost	Annual Utility Savings						Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total							
$	kW	kWh	Therms	kGals	$		$	$		$	Years	Years
500	0	200	70	0	100		0	100	1.0	NA	5.0	NA

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

ECM-11 Install Low-Flow Restroom Faucets

Budgetary Cost	Annual Utility Savings						Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total							
$	kW	kWh	Therms	kGals	$		$	$		$	Years	Years
800	0	0	0	9.7	100		0	100	0.9	NA	8.0	NA

* There is no incentive available through the New Jersey Smart Start Program for this ECM.

ECM-14 Lighting Replacements with Controls

Budgetary Cost	Annual Utility Savings						Estimated Maintenance Savings	Total Savings	ROI	Potential Incentive*	Payback (without Incentive)	Payback (with Incentive)
	Electricity		Natural Gas	Water	Total							
$	kW	kWh	Therms	kGals	$		$	$		$	Years	Years
34,100	1.9	26,320	0	0	3,700		0	3,700	0.6	2,200	9.2	8.6

*Incentive shown is per the New Jersey Smart Start Program, 2010 Prescriptive Lighting and Lighting Controls Applications.

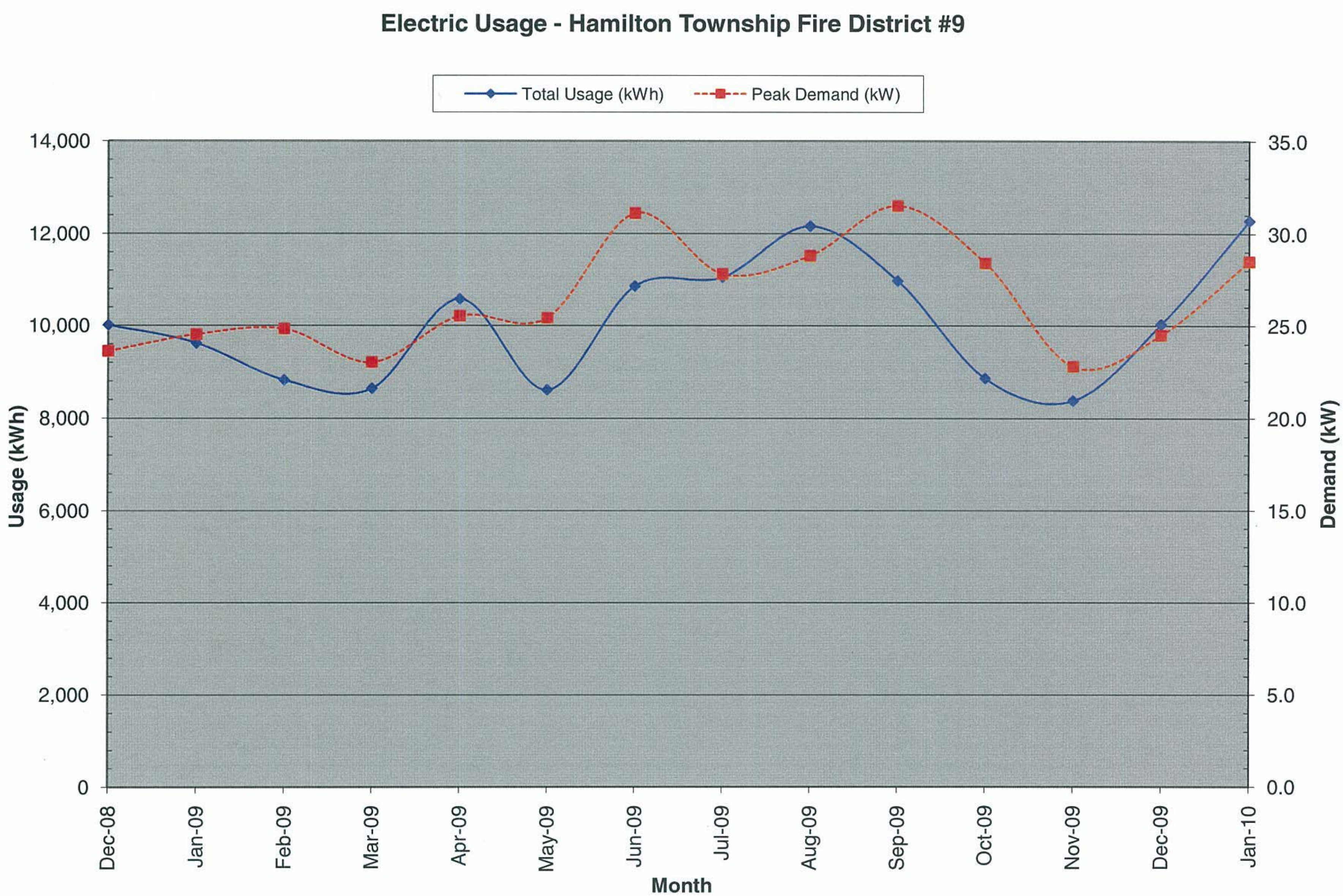
APPENDIX A

Utility Usage Analysis

New Jersey BPU Energy Audit Program
CHA Project No.: 21180
Hamilton Township Fire District #9
PSE&G - Electric Service

4201 Crosswicks-Hamilton Square Rd.
Account No.: 62 575 052 59
Meter No.: 62085665

			Charges			Unit Costs		
Month	Consumption (kWh)	Demand (kW)	Total ($)	Demand ($)	Consumption ($)	Blended Rate ($/kWh)	Consumption ($/kWh)	Demand ($/kW)
December-08	10,005	23.6	$1,372.92	$253.30	$1,119.62	$ 0.137	$ 0.112	$ 10.73
January-09	9,615	24.5	$1,356.93	$258.73	$1,098.20	$ 0.141	$ 0.114	$ 10.56
February-09	8,820	24.8	$1,309.26	$261.43	$1,047.83	$ 0.148	$ 0.119	$ 10.54
March-09	8,640	23.0	$1,302.07	$254.42	$1,047.65	$ 0.151	$ 0.121	$ 11.06
April-09	10,575	25.5	$1,510.37	$264.16	$1,246.21	$ 0.143	$ 0.118	$ 10.36
May-09	8,610	25.4	$1,269.95	$264.11	$1,005.84	$ 0.147	$ 0.117	$ 10.40
June-09	10,860	31.1	$1,968.82	$529.97	$1,438.85	$ 0.181	$ 0.132	$ 17.04
July-09	11,055	27.8	$2,103.70	$508.07	$1,595.63	$ 0.190	$ 0.144	$ 18.28
August-09	12,165	28.8	$2,283.28	$519.26	$1,764.02	$ 0.188	$ 0.145	$ 18.03
September-09	10,980	31.5	$2,121.67	$550.19	$1,571.48	$ 0.193	$ 0.143	$ 17.47
October-09	8,865	28.4	$1,413.06	$310.79	$1,102.27	$ 0.159	$ 0.124	$ 10.94
November-09	8,385	22.8	$1,265.70	$289.72	$975.98	$ 0.151	$ 0.116	$ 12.71
December-09	10,035	24.5	$1,465.31	$296.38	$1,168.93	$ 0.146	$ 0.116	$ 12.10
January-10	12,285	28.5	$1,756.13	$315.39	$1,440.74	$ 0.143	$ 0.117	$ 11.07
Total	140,895	31.5	$22,499.17	$4,875.92	$17,623.25	$ 0.160	$ 0.125	$ 13.17
Most Recent Yr	121,275	31.5	$19,769.32	$4,363.89	$15,405.43	$ 0.163	$ 0.127	$ 13.55



Utility Data - Hamilton.xls
Electricity Chart

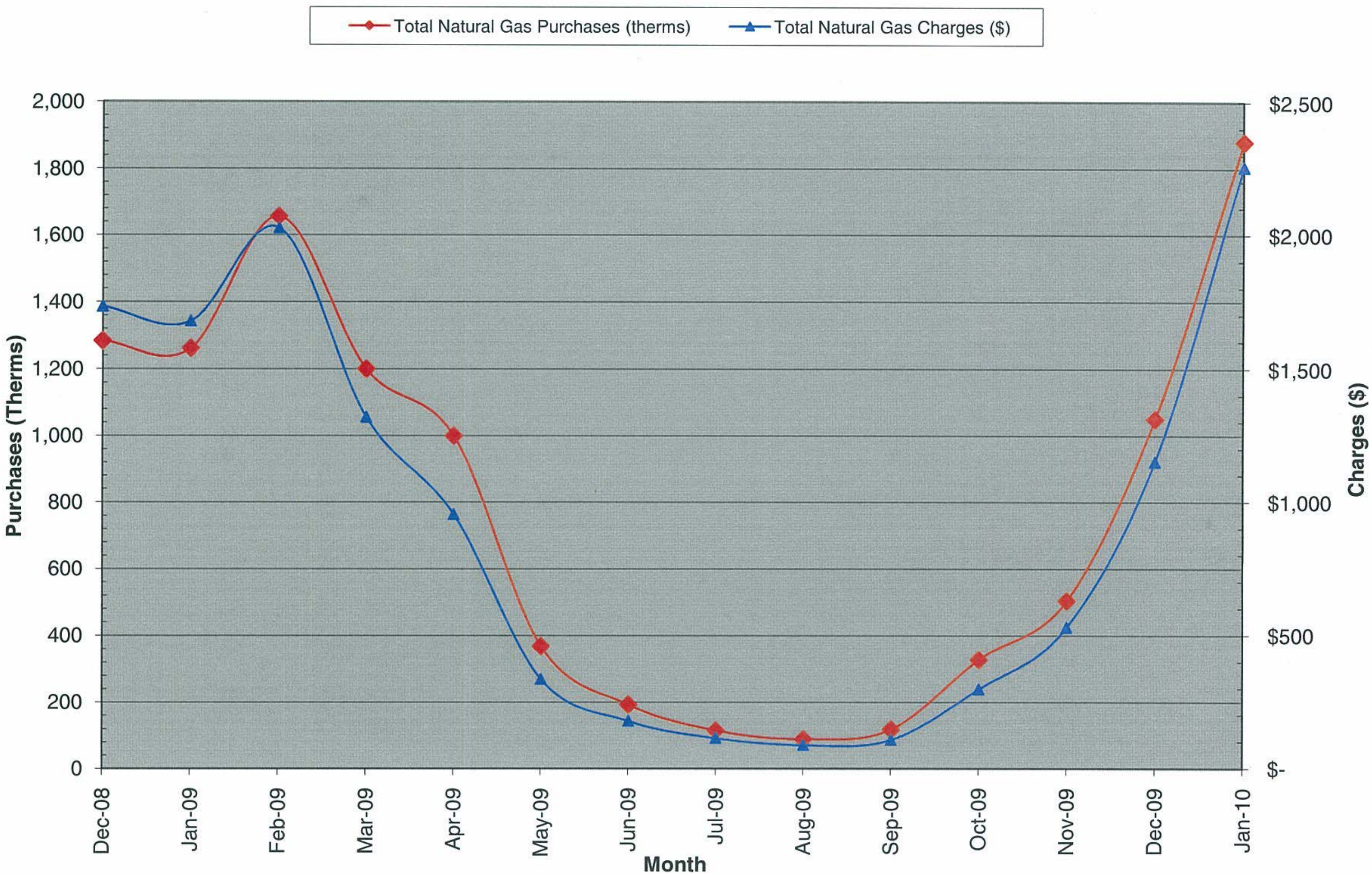
New Jersey BPU Energy Audit Program
CHA Project No.: 21180
Hamilton Township Fire District #9
PSE&G - Natural Gas Service

4201 Crosswicks-Hamilton Square Rd.
Account No.: 62 575 052 59
Meter No.: 1477164

Month	Therms	Charges ($)	($/Therm)
December-08	1,283	$ 1,732.28	$ 1.350
January-09	1,261	$ 1,677.79	$ 1.331
February-09	1,655	$ 2,025.79	$ 1.224
March-09	1,199	$ 1,319.70	$ 1.101
April-09	998	$ 954.28	$ 0.956
May-09	367	$ 336.98	$ 0.918
June-09	192	$ 179.47	$ 0.936
July-09	115	$ 115.47	$ 1.008
August-09	89	$ 89.84	$ 1.014
September-09	118	$ 109.55	$ 0.928
October-09	328	$ 299.60	$ 0.915
November-09	504	$ 531.76	$ 1.055
December-09	1,051	$ 1,153.88	$ 1.098
January-10	1,881	$ 2,257.87	$ 1.201

Total	11,038	$ 12,784.26	$ 1.158
Most Recent Yr	8,495	$ 9,374.19	$ 1.103

Natural Gas Usage - Hamilton Township Fire District #9



Utility Data - Hamilton.xls
Natural Gas Chart

New Jersey BPU Energy Audit Program
CHA Project No.: 21180
Hamilton Township Fire District #9
Aqua America

4201 Crosswicks-Hamilton Square Rd.
Account No.: 1018232 732938

Month	Usage (gallons)	Charges ($)	Rate ($/1000 Gal)
December-08	15,000	$111.29	$ 7.42
January-09	18,000	$123.66	$ 6.87
February-09	11,000	$94.80	$ 8.62
March-09	11,000	$94.80	$ 8.62
April-09	12,000	$98.92	$ 8.24
May-09	17,000	$119.53	$ 7.03
June-09	12,000	$98.92	$ 8.24
July-09	13,000	$103.04	$ 7.93
August-09	12,000	98.92	$ 8.24
September-09	11,000	$94.80	$ 8.62
October-09	11,000	$94.80	$ 8.62
November-09	10,000	$90.68	$ 9.07
December-09	13,000	$103.04	$ 7.93
January-10	12,000	$98.92	$ 8.24

Total	178,000	$1,426.12	$ 8.01
Most Recent Yr	145,000	$1,191.17	$ 8.21