

**City Of New Haven
New Haven, CT**



(Final - Energy Audit Report)

For the

**Energy Management and Conservation
Project**

Stimulus- # 28-04-651

Submitted by:



February 12, 2010

Executive Summary

SourceOne was contracted by the City of New Haven to prepare an energy assessment report for multiple City buildings. The facilities include the Hall of Records, City Hall, Police Headquarters, libraries, fire houses, training and park facilities. There were significant opportunities identified to improve energy management.

The SourceOne team toured 23 city buildings and provided an energy system assessment for each location. From this effort, 20 different Energy Conservation Measures (ECMs) were identified. The following table lists the ECMs in order of importance including return on investment, ease of implementation, duration of installation, and contractor scheduling.

Priority	ECM	Estimated ROI (Years) (Cap.Cost/Ann.Sav.)	Priority	ECM	Estimated ROI (Years) (Cap.Cost/Ann.Sav.)
1	Lighting Controls Occupancy Sensors/Photo Sensors	1.93	11	Install VFDs on pumps	7.47
2	Air Handler Controls - Economizer, Eliminate Reheat	1.59	12	New Water Source Heat Pumps and Tower	4.95
3	Upgrade Hot Water Tank System	1.02	13	Commission or Re-commission existing controls/Enhance DDC	6.67
4	T12 or Metal Halide to T8 or T5	3.97	14	Condensing Boiler Upgrade	3.99
5	Boiler Controls	2.39	15	Remove Unit Heaters and Install Waste Oil Burner Units	4.65
6	Infrared Study and Shell Improvements	4.69	16	New Rooftop units with economizers, high efficiency burners and DCV (demand controlled ventilation)	6.80
7	Exterior Lights	1.63	17	Insulate Heating Pipes	4.56
8	Exit Signs	1.80	18	Fuel Conversion - Electric to Gas/Propane	1.83
9	Door Interlocks with Heat	3.00	19	Conduct air balancing and testing on HVAC system	7.64
10	Vend Misers	1.02	20	Instantaneous Domestic Hot Water	10.02

Table 1 - ECM Priority and ROI

Energy or demand savings are determined by comparing measured energy use before and after implementation. Energy Savings = (Baseline Energy Use) – (Post Retrofit Energy Use) +/- Adjustments. Adjustments usually refer to “avoided energy use” and are identified from physical factors. An example of an adjustment is weather. These facilities have the potential to have conditions of variable load and operating hours. A major rain or snow storm could alter the adjustment factor.

This report will provide a general road map in developing a detailed construction submittal that will incorporate the City of New Haven’s priorities with respect to capital equipment expenditures and long range business plans.

Project Overview

SourceOne was contracted by the City of New Haven to prepare an energy assessment report for multiple City buildings. The facilities include the Hall of Records, City Hall, Police Headquarters, libraries, fire houses, training and park facilities. This report presents SourceOne's site facility assessment of the mechanical, electrical and building envelope of the above facilities. Factors critical to the overall energy efficiency of the facilities is also included. This analysis examines potential energy conservation measures and identified general implementation recommendations.

SourceOne has:

- Conducted a facility walk through
- Conducted interviews and met with building management
- Secured and reviewed available electrical and mechanical documentation
- Collected building energy consumption data

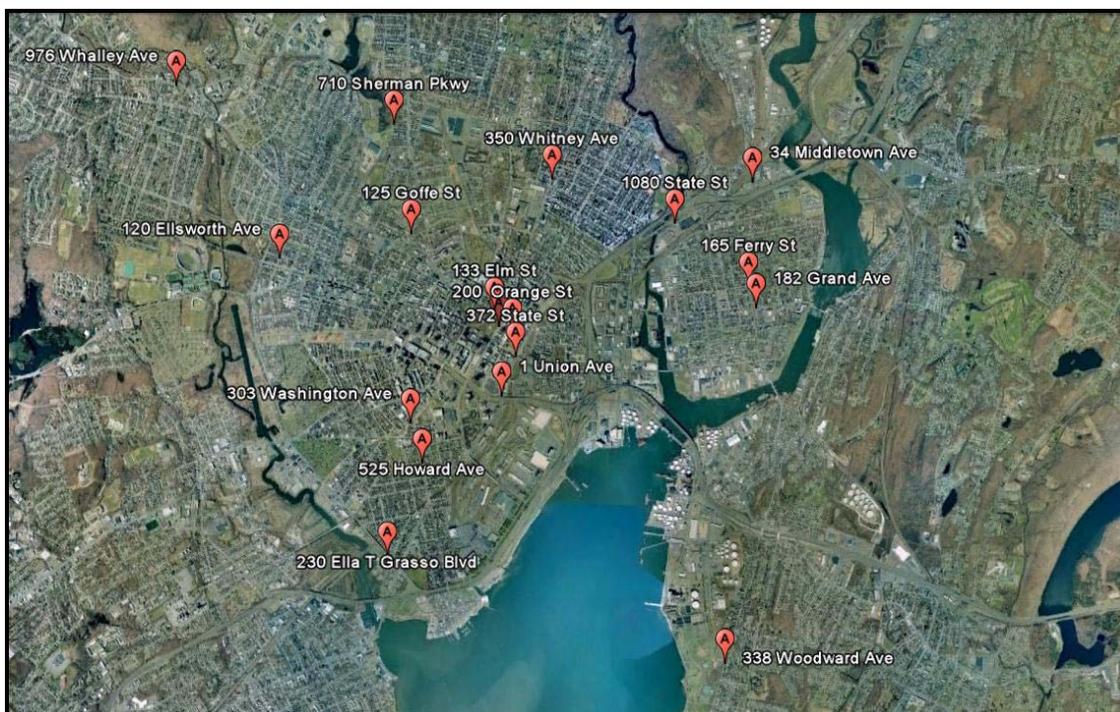


Figure 1 – Aerial View of Top Electric and Gas Consumers

SourceOne has relied upon certain information provided to us by sources known to be familiar with the site and ultimate site objectives. While we believe the use of such information and assumptions to be reasonable for the purpose of our assessment, we offer no other assurances thereto and some assumptions may vary significantly due to unanticipated events and circumstances.

Introduction

The SourceOne team arrived to discuss and survey the facilities during the weeks of December 1st and 8th 2009. There were significant opportunities identified to improve energy management. Energy Conservation opportunities were found in all twenty three buildings and will be discussed in detail below. The energy recommendations that are presented for review are a result of using industry standards and the RS-Means estimating guide for the pricing of local labor rates and equipment costs.

Source One's comprehensive energy assessment protocol has achieved the following:

- Identified cost effective energy conservation measures
- Minimized capital and operating expenditures through cost effective analysis

Purpose of an energy audit:

It is the responsibility of any organization to operate efficiently. An energy cost savings resulting from an energy audit averages 15 to 20 percent savings with relatively little capital outlay. These projects typically have a payback point within five years.

Need for energy cost control:

Energy audits have shown potential reduction of cost and consumption. These costs can be allocated to other sectors of the organization having the audits conducted. Implementation of energy conservation measures can ease the strain on our environment and give the energy producers in the US more time to develop new energy resources. These savings can offset tight budget constraints due to current economic hardships.

Measuring Energy Cost Index (ECI) and Energy Utilization Index (EUI):

The Energy Cost Index (ECI) is a statement of the dollar cost of energy used annually per square foot. The Energy Utilization Index (EUI) is a statement of the annual usage per square foot in (kBtu/sqft). Table 2 below shows the ECI's and EUI's for all twenty five surveyed buildings using both electric and gas consumption cost figures.

For comparison purposes, below are average values

Average building ECI equals \$1.47 per sqft.

Average educational building ECI equals \$1.22 per sqft.

Average mixed use office building ECI equals \$1.71 per sqft.

Average public order and safety building ECI equals \$1.76 per sqft.

Average building EUI equals 94.43 kBtu per sqft.

Average educational building EUI equals 83.05 kBtu per sqft.

Average mixed use office building EUI equals 92.89 kBtu per sqft.

Average public order and safety building EUI equals 115.60 kBtu per sqft.

**These figures are based on the 2003 Commercial Buildings Energy Consumption Surveys by the EIA. This is currently the most recent data; the next update will be released later this year and will be based on 2007 numbers.*

The need to assess and apply the ECI for industry comparison and conservation bench marking is paramount to all thirteen facilities that were surveyed. Further calculations of the ECI is recommended, pending disclosure of procurement practices going forward.

Building	Address	Sq Ft	Electric Usage (kWh)	Annual Electric Cost (\$)	Gas Usage (CCF)	Annual Gas Cost (\$)	Total Usage (kBtu)	Total Annual Cost (\$)	ECI (\$/sqft)	EUI (kBtu/sqft)	Notes
POLICE STATION & HQ	1 Union Ave	105,000	2,372,597	\$291,981	74,713	\$82,946	15,568,954	\$374,927	\$3.57	148.28	
PUBLIC WORKS	34 Middletown Ave	91,000	485,608	\$62,517	86,898	\$70,489	10,347,139	\$133,006	\$1.46	113.70	
Traffic and Parking	42 Middletown Ave	17,050	55,680	\$9,854	5,404	\$6,794	730,436	\$16,648	\$0.98	42.84	EUI is low due to 75% of quare footageattributed to open space and storage
FIRE HOUSE	120 Ellsworth Ave	10,000	100,370	\$14,247	12,162	\$16,511	1,558,763	\$30,758	\$3.08	155.88	
FIRE HOUSE	125 Goffe St	11,500	126,800	\$15,687	9,468	\$11,816	1,379,568	\$27,503	\$2.39	119.96	
LIBRARY	133 Elm st	108,000	1,049,400	\$140,359	15,522	\$22,583	5,133,802	\$162,942	\$1.51	47.54	Square footage does not reflect total area of tempered space
LIBRARY	182 Grand Ave	10,600	94,400	\$13,590	4,321	\$6,299	754,287	\$19,889	\$1.88	71.16	
City Hall	165 Church St	120,000	2,987,700	\$368,558	2,778,953 kBtu Thermal	\$231,612	12,975,973	\$600,170	\$4.54	91.53	Combined electric accounts --- Thermal Usage from Central plant (in the gas columns)
Hall of Records	200 Orange St	82,000			5,512,510 kBtu Thermal	\$317,395	5,512,510	\$317,395			
FIRE HOUSE	230 Ella Grasso Blvd	18,000	220,320	\$28,453	18,254	\$21,712	2,577,352	\$50,165	\$2.79	143.19	
LIBRARY	303 Washington Ave	21,075	274,480	\$41,741	16,218	\$17,337	2,558,600	\$59,078	\$2.80	121.40	
PARKS & REC	338 Woodward Ave	10,600	171,680	\$25,273	0	\$0	585,944	\$25,273	\$2.38	55.28	
FIRE HOUSE	350 Whitney Ave	13,700	102,563	\$12,975	9,586	\$11,655	1,308,648	\$24,630	\$1.80	95.52	
FIRE HOUSE	525 Howard Ave	11,500	126,920	\$16,433	12,696	\$15,268	1,702,778	\$31,701	\$2.76	148.07	
POLICE M&R	710 Sherman Pkwy	12,650	218,080	\$27,839	8,605	\$10,447	1,604,807	\$38,286	\$3.03	126.86	
FIRE HQ	952 Grand Ave	33,000	311,520	\$40,225	31,341	\$32,662	4,197,318	\$72,887	\$2.21	127.19	
Stetson Branch Library	200 Dixwell Ave	7,500	61,920	\$10,966	4,407	\$5,854	652,033	\$16,820	\$2.24	86.94	
ICE RINK	1080 State St	6,680	77,187	\$15,062	3,778	\$5,461	641,239	\$20,523	\$3.07	95.99	
Lombard Fire house	428 Lombard St	11,500	59,040	\$9,564	9,569	\$11,319	1,158,404	\$20,882	\$1.82	100.73	
East Grand Fire House	70 East Grand Ave	4,100	30,888	\$5,161	4,897	\$7,342	595,121	\$12,503	\$3.05	145.15	
Parks and Recreation Headquarters	720 Edgewood	4,770	45,148	\$10,969	4,205	\$6,277	574,590	\$17,246	\$3.62	120.46	
Offices and Garages	180 Park Rd	27,956	126,072	\$22,894	34,096	\$42,836	3,839,884	\$65,730	\$2.35	137.35	Square Footage includes all buildings on site.
Atwater Senior Center	26 Atwater Street	12,900	39,840	\$7,419	12,371	\$14,171	1,373,074	\$21,590	\$1.67	106.44	

Table 2- Summary of usage and cost data for all buildings

EXISTING CONDITIONS

The descriptions below detail the existing conditions at each of the buildings during the walkthroughs. The walkthroughs consisted of looking at selected equipment as directed by our guides. Pictures were taken of the selected items for reference and documentation of the equipment.

POLICE STATION & HEADQUARTERS

1 Union Ave

Dept ID 201

The Police Headquarters located at 1 Union Ave is classified as an administrative and office facility. This four story structure was built in 1975 and has 105,000 square feet of conditioned space. Recent renovations include a \$4 million dollar HVAC retrofit, and the installation of two (2) new boilers. The key areas of survey include six (6) large Air Handling Units, two (2) closed loop cooling towers, and a 25 kW backup generator. It was observed that occupancy sensors had recently been installed in selected hallways, office areas.



The exterior lighting, attached to the exterior wall, consisted of Metal Halide HID wall packs. Dual incandescent, metal halide, recessed ceiling fixtures were present in the parking garage. Also observed in the front entrance foyer were recessed incandescent ceiling fixtures.

The two (2) domestic hot water heaters are gas-fired, 200 gallon, self contained units that are approximately 5 years old.

Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBtu)	Total Annual Cost (\$)
POLICE STATION & HQ	1 Union Ave	2,372,597	\$291,981	74,713	\$82,946	15,568,954	\$374,927

PUBLIC WORKS
34 Middletown Ave
Dept ID 137 & 501

The Public Works building located at 34 Middletown Ave is classified as a vehicle repair garage and administrative office space. This 2 story structure was built in 1950 and has approximately 91,000 square feet. Additions were made in 2002 which includes the street light administration and vehicle storage departments.



The key areas that were surveyed targeted the main repair garage, boilers, and office roof top units. Three way control valves located in the street light admin building and lower storage areas were documented.

The second floor administration office area has three (3) 10-tons DX package units that were installed in 2003. The main garage area consists of six (6) roof top exhaust fans and four (4) side wall exhaust blowers. These work in conjunction with the in-operable CO monitoring system.

The administration section has a hot water heating system which includes an electric 120 gallon hot water tank.

The garage also has a steam heating system in the older portion of the facility. The vehicle repair area consists of ceiling hung electric unit and steam heaters.

There is limited control through a simple JCI package which regulates the amount of hot water flow into the three way valves located through this facility. The newly renovated areas have fin and tube heat registers while the older section consists of steam radiators. There is one (1) boiler that facilitates the garage and a portion of the street light administration building that was installed in 1995. A recent installation of a hot water package boiler serves the downstairs offices and the lower street light administration building.

The lighting in the garage has been recently retrofitted with T-5 lights and is in good condition. However, the space might be over illuminated and may need further review.

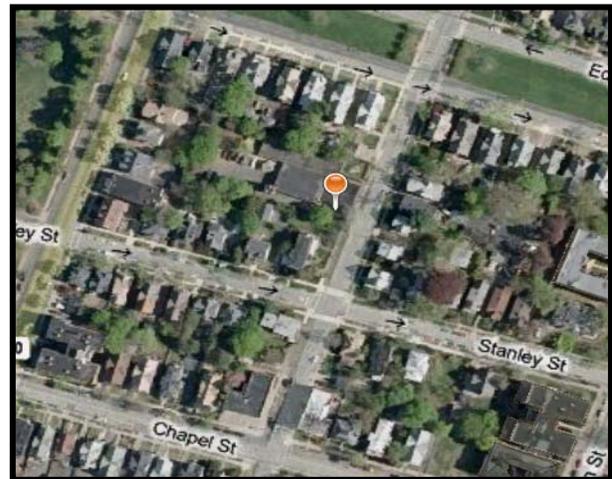
Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBtu)	Total Annual Cost (\$)
PUBLIC WORKS	34 Middletown Ave	485,608	\$62,517	86,898	\$70,489	10,347,139	\$133,006

FIRE HOUSE
120 Ellsworth Ave
Dept ID 202

This fire house is located at 120 Ellsworth Ave and is classified as a vehicle storage and living space. It has a total of 10,000 square feet of tempered space.

Recent improvements to the facility include a Lochinvar boiler with an efficiency rating of 96%. The domestic hot water is provided by a 100 gallon indirect hot water heating tank. The living quarters are cooled with split wall through units. It was observed that the hot water heating pipes were not insulated and that multiple AC units were inoperable and abandoned in place.



Lighting in the building consists of T-12 magnetic ballast fixtures with 2x4 fluorescent lamps. The concentration of these fixtures was found in the basement and truck bay. These were found to be beyond useful life. Overhead infrared heating tubes provided the radiant heat necessary in the truck bays.

New truck bay doors have been recently installed. However, these may not have the correct insulation factor as required.

Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBTU)	Total Annual Cost (\$)
FIRE HOUSE	120 Ellsworth Ave	100,370	\$14,247	12,162	\$16,511	1,558,763	\$30,758

FIRE HOUSE
125 Goffe St
Dept ID 202

The fire house located at 125 Goffe St is a two story structure that has 11,500 square feet of tempered space. The building is classified as storage and living areas.

The areas of focus in this survey were the five (5) gas-fired DX Roof Top Units. These units have an output of 95,000 BTUs with an efficiency rating of 80%. It was observed that they did not have economizer controls for the outdoor air damper.

A 98 gallon, gas fired, hot water heater supplies the domestic hot water to the facility.



Interior lighting consists of 2x4, T-12 magnetic ballast, fluorescent lamps and fixtures. It was observed that the interior lighting including the exit signs were beyond useful life. Also, there were a minimum of 3 vending machines in the living area that operate 24/7.

Annual Electric and Gas Usage

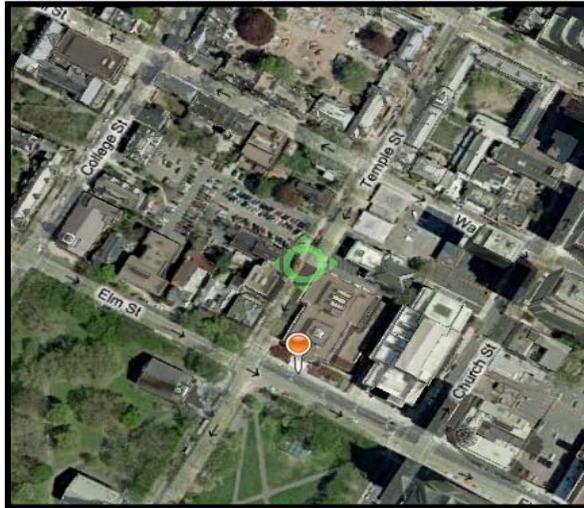
Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBTU)	Total Annual Cost (\$)
FIRE HOUSE	125 Goffe St	126,800	\$15,687	9,468	\$11,816	1,379,568	\$27,503

LIBRARY
133 Elm st
Dept ID 152

The main library located at 133 Elm St is a three story structure which has 108,000 square feet of conditioned space. The building consists of administrative office and periodical storage. The building is conditioned by three (3) dual package air handling units. These units are equipped with VFDs and economizer controls.

A Honeywell Building Management System is controlled with multi programmable thermostats and sensor plates.

The domestic hot water for the building is generated by an 85 gallon electric water heater that has a booster supply pump located in the basement.



Interior lighting consists of 2x4 T-8 electronic ballast fluorescent fixtures and lamps. It was observed that there were multiple magnetic ballast fixtures in the basement with T-12 lamps.

Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBtu)	Total Annual Cost (\$)
LIBRARY	133 Elm st	1,049,400	\$140,359	15,522	\$22,583	5,133,802	\$162,942

**CITY HALL
165 Church St**

City Hall is located at 165 Chapel St and has 120,000 square feet of tempered space. This six story structure was built in 1930 and is classified as administrative and office space. The weekday hours of operation are typical 9 to 5. The main areas surveyed were the six (6) large AHUs and the Runtell Radiation units. It was observed that the heating and cooling was provided by a 4-pipe system fed from the Central Plant. Each AHU has its own Glycol loop.



Domestic water is supplied to the building by multiple 10-15 gallon electric tank heater units that are scattered throughout the building.

The building maintenance control system consists of a Metasys 12.6 using combined digital and pneumatic control sequencing. This system has had recent program updates.

There are multiple occupancy sensors installed throughout the building that facilitates the retrofitted T-8 lamps and electronic ballasts.

Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBTU)	Total Annual Cost (\$)
City Hall	165 Church St			2,778,953 kBTUs Thermal	\$231,612	2,778,953	\$231,612

Electrical Usage is included in table detailing Hall of Records

LIBRARY
182 Grand Ave
Dept ID 152

The Fair Haven branch of the public library is located at 182 Grand Ave. It has approximately 10,600 square feet of tempered space, and is classified as administrative offices and periodical storage usage.

Targeted survey areas of interest included a 400,000 BTU gas fired boiler, and three (3) Trane Roof Top Package Units.

The HVAC system consists of multiple fan coil units with DX cooling, and hot water circulating fin tube registers.

Interior lighting consists of fluorescent 2x4 lamps, and T-8 fixtures with electronic ballasts.



Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBTU)	Total Annual Cost (\$)
LIBRARY	182 Grand Ave	94,400	\$13,590	4,321	\$6,299	754,287	\$19,889

HALL OF RECORDS

**200 Orange st
Dept ID 137**

The Hall of Records is an 82,000 square feet office building built between 1929 and 1935. This five story structure consists of administrative and office space. Major modifications were made in 1998.



The central energy plant provides all of the heating and cooling medium to the Hall of Records.

Distribution of the heating and cooling medium is provided by a large Air Handling Unit that is equipped with makeup air dampers. Supplemental cooling to the computer server rooms consists of a series of Liebert air cooled stand-up units. Heating and chilled water distribution is provided by a 4 pipe system.

There are separate fan coil units in most office areas that are monitored by simplified Power Logic systems that have limited BMS control.

Domestic hot water for the restrooms is provided by a 50 gallon electric hot water heater, with additional smaller heater units located in the upper floors.

This building lighting was retrofitted with T-8 lights in 2005. There was observed to be no occupancy sensors, nor automatic lighting controls. Most of the lighting branches were of 120/208 voltage circuits.

Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBTU)	Total Annual Cost (\$)
Hall of Records	200 Orange St	2,987,700	\$368,558	5,512,510 kBTUs Thermal	\$317,395	15,709,530	\$685,953

Electric usage includes City Hall electric usage

FIRE HOUSE
230 Ella Grasso Blvd
Dept ID 202

The fire training facility is located at 230 Ella Grasso Blvd. The (2) story building has 3,400 square feet of tempered space, and is classified as classroom and administrative offices. In addition to the main building, a 2-story vehicle storage and repair facility supports the training operation. The key areas surveyed include the three (3) DX Roof Top Units on the main building, and the (2) two air handling units in the vehicle maintenance garage. It was observed that a Reznor Package Air Handler was installed in 1995 to supplement the existing heating and cooling system.



Other systems and equipment surveyed include a recently installed Burnahm boiler, and an 85 gallon electric, domestic hot water tank heater. The primary source of heat in the vehicle maintenance area is infrared tube heating. A 125 kW diesel generator provides standby power in the event of utility power loss. All of the interior lighting has been converted to T-8 electronic ballast fixtures.

Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBtu)	Total Annual Cost (\$)
FIRE HOUSE	230 Ella Grasso Blvd	220,320	\$28,453	18,254	\$21,712	2,577,352	\$50,165

WILSON LIBRARY
303 Washington Ave
Dept ID 152

The library located at 303 Washington Ave has 21,075 square feet of tempered space. This new facility is classified as administrative office and periodical storage. The areas of survey include the self contained Package Air Handling Units, and three (3) large Tekmar boilers that provide hot water heating to the AHU coils.

The HVAC is controlled by an ATC programmable DDC. In addition to the boilers, there is a 65 gallon, gas fired domestic hot water tank.

Interior lighting consists of 2x4, electronic ballasted T-8 and T-5 lamps and fixtures with electronic ballasts. Exterior lighting is provided by a minimum amount of HID wall pack, metal halide fixtures.



Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBTU)	Total Annual Cost (\$)
LIBRARY	303 Washington Ave	274,480	\$41,741	16,218	\$17,337	2,558,600	\$59,078

PARKS & REC
338 Woodward Ave
Dept ID 160

This site located at 338 Woodward Ave consists of two single story structures with approximately 10,600 square footage of total tempered space. These buildings are classified as recreational and vehicle storage facility.

Key areas of survey include the electric unit heaters, located in the offices and ice rink, and the electric hot water heaters serving the garage facility. It was observed that a good portion of the interior lighting was T-12, magnetic ballasted lighting, which was beyond useful life.



Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBtu)	Total Annual Cost (\$)
PARKS & REC	338 Woodward Ave	171,680	\$25,273	0	\$0	585,944	\$25,273

FIRE HOUSE
350 Whitney Ave
Dept ID 202

The fire house located at 350 Whitney Ave. is a two story facility with 13,700 square feet of tempered space.

The areas of focus included a gas fired hot water circulating boiler installed in 1995. A gas fired domestic hot water heater with a capacity of 78 gallons, was found to be in poor condition and leaking.

Interior lighting consists of 2x4, T-8 electronic ballast fixtures and lamps. It was observed that the skylights in the truck bay did not have any lumen sensing. Lights around the perimeter of the building were observed to be on during daylight hours. The exit signs are incandescent fixtures and are beyond useful life.



The truck bay has infrared tube heaters. Multiple forced hot water unit heaters in truck bays were found to be out of service. Radial thermostats in the living spaces control the temperature to specific zones.

The living quarters are cooled by wall through split units. There were multiple vending machines and a kitchen grill in the barracks.

Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBTU)	Total Annual Cost (\$)
FIRE HOUSE	350 Whitney Ave	102,563	\$12,975	9,586	\$11,655	1,308,648	\$24,630

FIRE HOUSE
525 Howard Ave
Dept ID 202

The fire house is located at 525 Howard Ave is a two story facility with 11,500 square feet of tempered space.

The main areas of focus include the gas-fired, 1,100,000 BTU, hot water circulating boiler, a 10 Ton condensing unit, and a Air Handling Unit with outdoor air and hot water reheat. Additional heating is provided through perimeter electric radiation in the barrack spaces.

Domestic hot water is provided by a gas fired, 75 gallon unit.



Multiple infrared tube heaters provide space heating in the truck bays. It was observed in the truck bays that the lighting was T-12 magnetic ballasted fixtures in need of replacement. Exterior lighting consists of antiquated High Pressure Sodium fixtures and lamps. There were multiple vending machines in the barrack spaces.

Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBTU)	Total Annual Cost (\$)
FIRE HOUSE	525 Howard Ave	126,920	\$16,433	12,696	\$15,268	1,702,778	\$31,701

POLICE M&R
710 Sherman Pkwy
Dept ID 201

This building located at 710 Sherman Pkwy is a two story facility with 12,650 square feet of tempered space. It is classified as administrative office, training and vehicle storage and repair.

The main areas of focus include gas fired unit heaters, in the repair bay, one new Moncton, 199,000 BTU, condensing hot water boiler, and a new gas fired, 85 gallon, domestic hot water tank. It was observed that (5) five new Trane Roof Top Units with gas heat and economizer controls, serve the second floor administrative offices.

The interior lighting consists mainly of new 2x4, T-8 electronic ballast fixtures and lamps. There were some scattered T-12 magnetic ballasted fixtures located in the garage space.



Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBtu)	Total Annual Cost (\$)
POLICE M&R	710 Sherman Pkwy	218,080	\$27,839	8,605	\$10,447	1,604,807	\$38,286

FIRE HQ
952 Grand Ave
Dept ID 202

The fire headquarters building located at 952 Grand Ave has approximately 12,600 square feet of space. It is classified as administrative office, living quarters and vehicle storage and repair.



The areas of focus at this facility include the heating and cooling equipment throughout the building. It was observed that the water source heat pumps located on the roof, were in an extremely poor condition. The cooling tower circulating pumps and the boiler were operating with no apparent switchover controls. (2) Two gas boilers with 1,240,000 BTU output were observed to be approaching the end of their useful life. A 90 gallon, gas fired domestic hot water heater had an additional booster circulation pump with a return sensor to provide hot water to the barracks and the pressure washer.

It was also observed that the hot water loop reset controller and bypass valve re-circulators are very old and likely out of service. The forced hot water piping is un-insulated. Various fan coil units on the second floor are hot water heating only. The outside air ducts had closed dampers. Newly installed infrared tube heaters were located in the high bay truck garage.

Interior lighting consists of 2x4, T-8 electronic ballast fixtures and lamps throughout the facility.

Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBtu)	Total Annual Cost (\$)
FIRE HQ	952 Grand Ave	311,520	\$40,225	31,341	\$32,662	4,197,318	\$72,887

**Stetson Branch Library
200 Dixwell Ave**

The library located at 200 Dixwell Ave is a one story building that has approximately 7,500 square feet of tempered space. It is classified as administrative office and periodical storage. It was conveyed to the survey team that the library is a temporary site which may be relocated in the future. Main areas of focus include two DX roof top units using setback thermostatic controls.

The interior lighting consisted of 2x4, T-5 and T-8 fixtures and lamps. Multiple skylights provide natural lighting to offset lamp usage during the day.

Annual Electric and Gas Usage



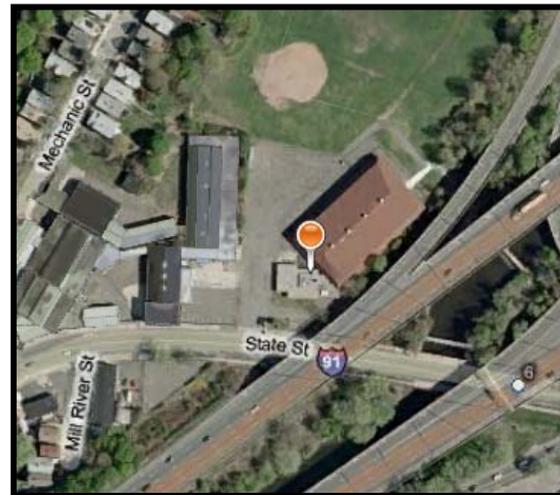
Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBTU)	Total Annual Cost (\$)
Stetson Branch Library	200 Dixwell Ave	61,920	\$10,966	4,407	\$5,854	652,033	\$16,820

ICE RINK
1080 State St
Dept ID 160

The Ice Rink facility located at 1080 State St consists of an administrative building and full size skating facility. It has approximately 6,700 square feet of tempered space.

Areas of survey include gas fired unit heaters located in the lobby, locker rooms and resurface shed. Each of these unit heaters are controlled by individual thermostats. It was also observed that a fireplace provides supplemental heating to a portion of the lobby.

The ice cooling system consists of two (2), 20 HP brine pumps, two (2) R502, 105 HP Bohn Chillers, and auxiliary cooling tower equipment.



Interior administrative lighting consists of 2x4, T-12 magnetic ballasts fixtures and lamps. The interior lighting at the rink includes (36) 1,500 W metal halide fixtures.

There are six (6) vending machines inside the lobby.

Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBtu)	Total Annual Cost (\$)
ICE RINK	1080 State St	77,187	\$15,062	3,778	\$5,461	641,239	\$20,523

LOMBARD FIRE HOUSE

Lombard St

The Lombard Fire House has 11,500 square feet of tempered space and is classified as a vehicle storage and “livable quarters” facility. Areas that were surveyed include a 780,000 BTU hot water boiler that was installed in 1995. A 75 gallon domestic hot water heater provides source hot water to the lavatory and kitchen area.

The Forced Hot Water heating pipes were not insulated. The living quarters has wall through split cooling units. All exit signs use incandescent bulbs.

The truck bay has infrared tube heaters along with T-8 lighting ballasts and fixtures.



Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBTU)	Total Annual Cost (\$)
Lombard Fire house	428 Lombard St	59,040	\$9,564	9,569	\$11,319	1,158,404	\$20,882

EAST GRAND FIRE HOUSE
East Grand Ave

The East Grand Fire House located on East Grand Ave has 4,100 square feet of space and is designated as vehicle storage and livable quarters. An atmospheric steam boiler with an output of 440,000 BTUs is in poor condition and beyond useful life. A gas fired domestic hot water heater was just recently installed. The building has a single zone thermostat that controls the steam supply to conventional steam radiators throughout the building.



Cooling is provided by window AC units.

Interior lighting consists of T-8 EB ballasted fixtures, along with assorted incandescent lights.

Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBtu)	Total Annual Cost (\$)
East Grand Fire House	70 East Grand Ave	282,240	\$40,225	4,897	\$7,342	1,452,985	\$47,568

PARKS AND RECREATION HEADQUARTERS 720 Edgewood

This building is classified as a residential type office space that has a gas fired hot water atmospheric boiler with an output of 400,000 BTUs. Multiple window Air Conditioner units, ranging in size from 18,000 – 25,000 BTU provide the cooling. A Honeywell, radial zone thermostat controls the heating temperature. An electric domestic hot water heater, with a capacity of 50 gallons provides the hot water to the upper level. A smaller 20 gallon hot water heater provides domestic water to the lower level

Recently retrofitted T-8 lighting illuminates the interior structure.



Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBTU)	Total Annual Cost (\$)
Parks and Recreation Headquarters	720 Edgewood	45,148	\$10,969	4,205	\$6,277	574,590	\$17,246

PARKS AND RECREATION OFFICES

180 Park St

This building is a residential build type office that has a gas fired hot water atmospheric boiler with an output of 200,000 BTUs. Multiple window Air Conditioner units, ranging in size from 18,000 – 25,000 BTU provide the cooling. A Honeywell radial zone thermostat controls the heating temperature. An electric domestic hot water heater, with a capacity of 50 gallons, provides the hot water.

Recently retrofitted T-8 lighting illuminates the interior structure.

The garage and repair buildings in close proximity are old and in need of immediate repair. The forced air furnaces are beyond useful life.



Lighting in the garages are T-12 fixtures that are also beyond useful life.

Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBTU)	Total Annual Cost (\$)
Offices and Garages	180 Park Rd	126,072	\$22,894	34,096	\$42,836	3,839,884	\$65,730

ATWATER SENIOR CENTER 26 Atwater St

The Atwater Senior Center located at 26 Atwater St., is a two story structure that has approximately 13,000 sq feet of tempered space. The building is designated as a recreational use and administrative office facility.

The key areas of interest suggested by the New Haven personnel were the rooftop units and the 1.2 mil BTU condenser boiler. The heating and cooling is provided by a common 2-pipe system.

A 50 gallon gas fired hot water heater provides domestic water to the lavatories.



The interior lighting has a mix of T-8 EB and T-12 MB, 2x4 Fluorescent fixtures. Exterior lighting is provided by a minimal amount of HID fixtures.

Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBtu)	Total Annual Cost (\$)
Atwater Senior Center	26 Atwater Street	39,840	\$7,419	12,371	\$14,171	1,373,074	\$21,590

TRAFFIC AND PARKING
42 Middletown Ave

The building located at 42 Middletown Ave is a single story structure. It has approximately 17,050 square feet of tempered space and consists of storage and administrative offices. This building serves as the department of Traffic and Parking as well as the department of Streetlights.

The Key areas of survey were the Lochinvar air handlers and the rooftop duct distribution. The air balance was observed to be deficient. A small 20 gallon electric hot water tank supplied the hot water to the lavatories.



Interior lighting consists of T-8 EB 1x4 fluorescent fixtures.

Annual Electric and Gas Usage

Building	Address	Annual Electric Usage (kWh)	Annual Electric Cost (\$)	Annual Gas Usage (CCF)	Annual Gas Cost (\$)	Annual Total Usage (kBTU)	Total Annual Cost (\$)
Traffic and Parking	42 Middletown Ave	55,680	\$9,854	5,404	\$6,794	730,436	\$16,648

Energy Conservation Measures

The table below shows a summary of all SourceOne recommendations as presented in the report above from the observations and life cycle audit conducted. The table shows the energy conservation measures, projected total costs, and the expected return on investment in years for each measure. These total costs and projected ROI figures are estimates calculated from the following industry standards: BOMA (Building Owners and Managers Association), RS Means 2009, and similar SourceOne projects. They should be used strictly for referencing proposed work, and not considered investment grade audit, as actual costs may vary.

Priority	ECM	Number of Buildings	Estimated Capital Cost	Estimated Percentage Savings (Reduction in portion of building use for occupancy lighting)	Estimated Total Annual Savings	Estimated ROI (Years) (Cap.Cost/Ann.Sav.)
1	Lighting Controls Occupancy Sensors/Photo Sensors	ALL	\$56,335	7%	\$29,130	1.93
2	Air Handler Controls - Economizer, Eliminate Reheat	5	\$47,782	15%	\$30,000	1.59
3	Upgrade Hot Water Tank System	1	\$11,242	40%	\$11,000	1.02
4	T12 or Metal Halide to T8 or T5	12	\$73,040	20%	\$18,401	3.97
5	Boiler Controls	13	\$36,681	15%	\$15,367	2.39
6	Infrared Study and Shell Improvements	11	\$51,600	15%	\$11,000	4.69
7	Exterior Lights	4	\$29,049	20%	\$17,856	1.63
8	Exit Signs	ALL	\$10,350	1%	\$5,762	1.80
9	Door Interlocks with Heat	11	\$25,650	2%	\$8,550	3.00
10	Vend Misers	ALL	\$16,560	2%	\$16,313	1.02
11	Install VFDs on pumps	2	\$30,950	17%	\$4,141	7.47
12	New Water Source Heat Pumps and Tower	1	\$52,950	25%	\$10,694	4.95
13	Commission or Re-commission existing controls/Enhance DDC	ALL	\$161,500	15%	\$24,225	6.67

Condensing Boiler Upgrade	1	\$28,350	13%	\$7,102	3.99
Remove Unit Heaters and Install Waste Oil Burner Units	1	\$35,800	25%	\$7,700	4.65
New Rooftop units with economizers, high efficiency burners and DCV (demand controlled ventilation)	3	\$139,500	5%	\$20,493	6.81
Insulate Heating Pipes	6	\$6,840	2%	\$1,500	4.56
Fuel Conversion - Electric to Gas/Propane	1	\$12,286	50%	\$6,710	1.83
Conduct air balancing and testing on HVAC system	3	\$42,000	5%	\$5,500	7.64
Instantaneous Domestic Hot Water	9	\$35,062	2%	\$3,500	10.02
		Estimated Total Cost \$903,527		Estimated Annual Savings \$254,944	

Reviewing Energy Conservation Measures

Energy or demand savings are determined by comparing measured energy use before and after implementation. Energy Savings = (Baseline Energy Use) – (Post Retrofit Energy Use) +/- Adjustments. Adjustments usually refer to “avoided energy use” and are identified from physical factors. An example of an adjustment is weather. These facilities have the potential to have conditions of variable load and operating hours. A major rain or snow storm could alter the adjustment factor. Parameters that are not measured are estimated. These estimations are held constant and reflect information gathered from industry standards. An example of this estimate is lighting efficiencies.

#	ECMs	Whitney Fire House	Lombard Fire House	E Grand Ave Fire House	Woodward Fire House	Howard Fire House	Goffe Fire House	Ellsworth Fire House	Ice Rink	Woodward	Edgewood	180 Park (includes 2 garage bldgs)	Elm St. Library	182 Grand Library	Stetson Library	Wilson Library	Fire HQ	Police M & R	Atwater Senior Center	Hall of Records	City Hall	Public Works	Police Headquarters	Fire Training Facility	Traffic and Parking 42 Middletown
1	Lighting Controls - Occupancy Sensors/Photo Sensors	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X				X	X	X
2	Air Handler Controls - Economizer, Eliminate Reheat					X							X	X	X	X									X
3	Upgrade Hot Water Tank System												X												
4	T12 or Metal Halide to T8 or T5				X	X	X	X	X	X	X	X					X	X	X	X				X	
5	Boiler Controls - Outside Air Hot water reset, setback thermostats	X	X	X	X	X			X		X			X		X	X	X	X						
6	Infrared Study and Shell Improvements	X		X	X		X	X			X	X	X	X			X	X	X	X		X	X	X	X
7	Upgrade Exterior Lights					X			X								X						X		
8	Upgrade Exit Signs	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
9	Door Interlocks with Heat	X	X	X	X	X	X	X	X		X	X					X	X							
10	Vending Misers	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
11	Install VFDs on pumps																				X				
12	New Water Source Heat Pumps and Tower																X								
13	Commission or Re-commission existing controls															X	X		X	X	X	X	X		
14	Boiler Upgrade			X																					
15	Remove Unit Heaters and Install Waste Oil Burner Units																					X			
16	New Rooftop units with economizers, high efficiency burners and DCV (demand controlled ventilation)						X																	X	
17	Insulate Heating Pipes		X	X	X			X						X			X								
18	Fuel Conversion Electric to Gas/Propane									X															
19	Conduct air balancing and testing on HVAC system																			X	X	X			
20	Instantaneous Domestic Hot Water	X	X		X	X	X									X	X	X						X	

Table 3 - Matrix of ECMs vs. Buildings

Energy Conservation Measure 1

Requirement Information

Location	All buildings	ECM#	1
Inspection Date:	12/8/09	Estimated Cost:	\$56,335
		Estimated Annual Savings:	\$29,130
		Estimated Payback:	1.8 years

Requirement Description

It was observed that there were very limited lighting controls in the various buildings surveyed. Exterior lighting did not have lumen sensing. Occupancy sensors were installed in a limited amount of spaces.

Photos



Action Description:

Install lumen sensors and day lighting controls in restrooms, offices and conference rooms. Lumen sensing should be applied to all lighting arrays on the exterior window walls and sky lit areas. Labor is included in the unit cost. Frequency controllers and dimming modules are not included.

Estimate:

Item	Description	Quantity	Unit	Unit Cost	Total Cost
Occupancy sensors	Fixture mount with time delay	275	ea	\$129	\$35,475
Photo / lumen sensor	Sensor and controller	70	ea	\$398	\$27,860

Labor included

Requirement Payback

Utility Rate = \$0.11/kWh

O&M Savings reduced lamp replacement = 170 x \$29 per lamp = \$4,930

kWh savings per year = 220,000kWh

Utility Contribution = \$7,000

Yearly Cost Savings = \$29,130

Construction Cost = \$63,335

Total Cost = \$56,335

Estimated Payback = 1.8 years

Energy Conservation Measure 2

Requirement Information

Location	5 Buildings	ECM#	2
Inspection Date:	12/8/09	Estimated Cost:	\$47,782
		Estimated Annual Savings:	\$30,000
		Estimated Payback:	1.6 years

Requirement Description

It was observed that current configuration has supply fans maintaining continuous static pressure and OA dampers in non-gradient incremental positions which in turn created unnecessary reheat of OA that increased energy consumption. The areas of main concern were Elm St, Wilson, Stetson, and Grand Library

Photos



Action Description:

Install occupancy sensors, CO2 level sensors, and static head sensors in the various buildings where applicable. Install temperature sensors in each selected VAV's. Install DDC control points to measure temp and enthalpy. Reconfigure the OA damper from manual to automatic to ensure free heating and cooling. Install DDC controllers and points in accordance with economizer protocols.

Estimate:

<u>Item and Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost</u>	<u>Total Cost</u>
Sensors and wiring including CO2, SH, and temp sensors	22	ea	\$639	\$14,070
DDC points and controller including terminal strips	32	ea	\$866	\$27,712
Honeywell upgrade module with additional	5	ea	\$3,700	\$18,500

Requirement Payback Utility Rate = \$0.11/kWh
 Economizer controls and OA vent automation results in an industry average 10% savings.
 Ave estimated BTU/yr savings = 4,500 CCF x 100.2 = 450,900 BTU/yr savings

kWh savings per year = 231,700 kWh
 Construction Cost = \$60,282
 Utility Rebate = \$12,500
 Yearly Cost Savings = \$30,000
Total Cost = \$47,782
 Estimated Payback = 1.6 years

Energy Conservation Measure 3

Requirement Information

Location	Elm St Library	ECM#	3
Inspection Date:	12/8/09	Estimated Cost:	\$11,242
		Estimated Annual Savings:	\$11,000
		Estimated Payback:	1.6 year

Requirement Description

It was observed that current configuration of the domestic hot water provides low temperature supply and crossover to the coldwater supply. It was found that the current system is oversized for a Library Application.

Photos



Action Description:

Remove the existing 120 gallon hot water heater and booster circulation pump. Install two (2) small 20 gallon electric hot water heaters in the janitorial closet on each level. Remove crossover piping to the domestic cold water system.

Estimate:

Item and Description	Quantity	Unit	Unit Cost	Total Cost
Electric hot water heater 20 gallon	2	ea	\$4,398	\$8,796
Piping and Shelves with labor	2	ea	\$788	\$1,576
Removal and crossover troubleshoot and repair	1	ea	\$1,370	\$1,370

Requirement Payback Utility Rate = \$0.11/kWh
 kWh savings/yr = 53 kW/hr x 1300 hrs = 70,000
 +30,000 ave = 100,000 KW/yr
 Construction Cost = \$11,742
 Utility Rebate = \$500
 Yearly Cost Savings = \$11,000
Total Cost = \$11,242

Energy Conservation Measure - 4

Requirement Information

Location	Multiple	ECM#	4
Inspection Date:	12/8/09	Estimated Cost:	\$73,040
		Estimated Annual Savings:	\$18,401
		Estimated Payback:	3.9 Yrs

Requirement Description

It was observed that multiple buildings still had T-12 and older technological lights in place. These lights are usually either in basement and mechanical spaces or in truck bays.

This ECM applies to the following buildings: Woodward Fire House, Howard Fire House, Goffe Fire House, Ellsworth Fire House, the ice rink, park facilities on Woodward St, Parks and Facilities headquarters on Edgewood, office and garages at 180 Park St, Elm St Library (basement), Fire Headquarters on Grand Ave, Police maintenance facility, Atwater Senior Center, Hall of Records and the Fire Training facility.

Photos



Action Description:

Replace all T-12 lights with newer, more efficient T-8 lights.

Estimate:

Item	Description	Quantity	Unit	Unit Cost	Total Cost
4x2 T-8 Fixtures	Includes hardware and labor	480	Fixture	201	\$96,480
Lighting Inventory Study	Utility program	1	N/A	\$2,000	\$2,000

Requirement Payback

Utility Rate = \$0.11/kWh

Current annual operating hours = 3,900 hours

Current elec. usage: 0.128 kW x 480 x 3,900hrs = 239,616kWh

Proposed elec. Usage: 0.064 W x 480 x 3,900hrs = 119,808kWh

kWh savings per year = 119,808 kWh x .11cents = \$13,178

Lamp maintenance savings = \$5,223

Yearly Cost Savings = \$18,401

Utility Rebate (\$53 per fixture) = \$25,440

Total Cost = \$73,040

Estimated Payback = 3.9 years

Energy Conservation Measure 5

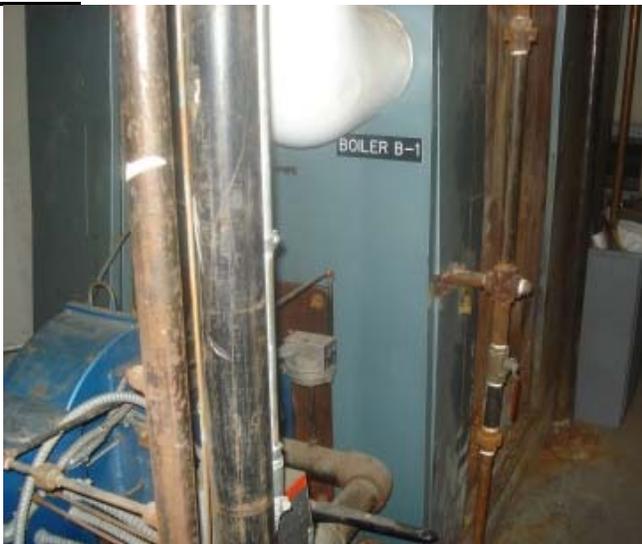
Requirement Information

Location	13 buildings	ECM#	5
Inspection Date:	12/8/09	Estimated Cost:	\$36,681
		Estimated Annual Savings:	\$15,367
		Estimated Payback:	2.1

Requirement Description

It was observed in thirteen (13) locations that the current boiler operation is programmed to maintain space temperature without any consideration of outside air temperature. There was significant heat loss in the hot water/steam loops and therefore minimized the return condensate/steam loop to drive down efficiency.

Photos



Action Description:

Install setback thermostats and controls based on Outside air monitoring. Install additional temperature sensing on the hot water/steam supply loops. Install DDC control points to measure temp and enthalpy. Reconfigure the DDC BACnet program to include these monitoring and control points. Existing sensors and points should be utilized.

Estimate:

Item and Description

<u>Item and Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost</u>	<u>Total Cost</u>
Sensors and wiring including pressure, and temp sensors	13	ea	\$639	\$8,3070
DDC points and controller including terminal strips	39	ea	\$366	\$14,274
Boiler re-commissioning	13	ea	\$1,700	\$22,100

Requirement Payback

Utility Rate = \$0.11/kWh
 Boiler controls and OA monitoring results in an industry average 15% savings.
 Ave kbtu 150,000 kbtu saved per year

kWh savings per year = 274,700 kWh
 Construction Cost = \$44,681
 Utility Rebate = \$8,000
 Yearly Cost Savings = \$15,367
Total Cost = \$36,681
 Estimated Payback = 2.1 years

Energy Conservation Measure 6

Requirement Information

Location	11 buildings	ECM#	AB-6
Inspection Date:	12/8/09	Estimated Cost:	\$51,600
		Estimated Annual Savings:	\$11,000
		Estimated Payback:	4.6 years

Requirement Description

It was observed in several locations of external building shell gaps that allowed the escape of cool and hot air from the interior occupied spaces. It was also observed in various locations of thermal and cooling air leakage through window casements and exterior doors.

Photos



Police HDQTRS, front entrance, front wall and exterior ceiling visual dust residue from air draft velocity from interior.

Action Description:

Conduct infrared and thermal analysis to include below 40 degree and above 80 degree day analysis. HVAC controls should be modified to initiate a positive air pressure and negative air pressure conditions. Conduct a low cost weatherization based on findings.

Estimate:

<u>Item and Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost</u>	<u>Total Cost</u>
Infrared and thermal analysis	22	ea	\$2,200	\$48,000
Low cost weather stripping and caulking.	22	ea	\$300	\$6,600

Requirement Payback Utility Rate = \$0.11/kWh
 Building Weatherization results in an industry average 15% savings.
 733,000 kbtu of gas savings

kWh savings per year = 63,700 kWh
 Construction Cost = \$54,600
 Utility Rebate = \$3,000
 Yearly Cost Savings = \$11,000
Total Cost = \$51,600
 Estimated Payback = 4.61 years

Energy Conservation Measure 7

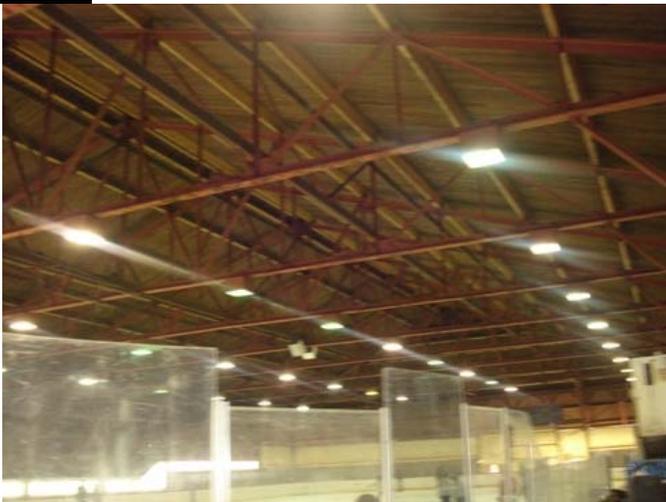
Requirement Information

Location	4 buildings	ECM#	7
Inspection Date:	12/8/09	Estimated Cost:	\$26,149
		Estimated Annual Savings:	\$17,856
		Estimated Payback:	1.4 years

Requirement Description

It was observed in the Police Head quarters lower parking area and the Ice Rink that the lighting levels were found to be excessive and in-efficient. The lower parking area has eighty (80) recessed fixtures that contain two (2) 150 w metal halide lamps. The Ice Rink was observed to have thirty-six (36) 1500w metal halide fixtures. Both of these locations require a lighting upgrade to energy efficient lighting.

Photos



Action Description:

Replace (36) Metal Halide 1500 W fixtures and lamps in the Ice Rink and (80) 300w incandescent recessed lights in the Police Headquarters Lower parking Garage with (40) in the Ice rink, (20) in the lower parking garage, all 4x4, T5 fluorescent fixtures, complete with (4) 54 W lamps, conical- shaped reflective down lenses, and low amp energy efficient electronic ballasts. The reflectance factor will be set at 80% floor, 40% wall, and 5% ceiling. This will increase pupil lumens from 50 to 85.

Estimate:

Item and Description

<u>Item and Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost</u>	<u>Total Cost</u>
4x4 T5 fluorescent fixture arena lighting mount and lens	60	ea	\$326	\$19,560
Wire whips and install mounts	60	ea	\$75	\$4,500
Solid state control and labor	1		\$4,989	\$4,989

Requirement Payback Utility Rate = \$0.11/kWh

Yearly operating hours = 2,400 hours

Ave Energy Savings per fixture = Ice Rink 43 KW, Police 19 KW

Cost Savings per fixture per year = 2400 x 0.12 x 62kw = \$17,856

Installation cost per fixture= \$326

Total Construction Cost = \$29,049

Estimated Rebate = \$2,900

Actual Cost after Rebate = \$26,149

Annual Savings = \$17,856

kWh savings per year = 148,800 kWh

Simple Payback - Years = 1.6 years *** This is a conservative estimate, rebates could be higher.

Energy Conservation Measure 8

Requirement Information

Location	All buildings	ECM#	8
Inspection Date:	12/8/09	Estimated Cost:	\$10,350
		Estimated Annual Savings:	\$5,762
		Estimated Payback:	1.8 years

Requirement Description

It was observed that all Exit Signs, throughout most buildings, use old incandescent bulb technologies. It is estimated that there are around 230 Exit Signs in all the buildings. These require around 30 W of power each for normal operation. They also operate 24/7, so they are on for 8,760 hours of the year.

Photos



Action Description:

Replace all incandescent Exit Signs within all buildings with low cost, newer LED based Exit Signs. These would decrease power usage for each Exit Sign from 30 W to 4 W.

Estimate:

<u>Item</u>	<u>Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost</u>	<u>Total Cost</u>
LED Exit Sign	Installation of Exit Signs	230	Ea	\$45	\$10,350
				Total:	\$10,350

Requirement Payback

Utility Rate = \$0.11/kWh
 Exit Signs annual operating hours = 8,760 hours
 # of Exit Signs = 230
 Current power usage per Exit Sign = 30 W
 Exit Sign unit cost (includes installation)= \$45

Exit Sign kWh savings per year = 52,385 kWh

Yearly Cost Savings = \$5,762
Total Exit Signs Cost = \$10,350

Estimated Payback = 1.8 years

Energy Conservation Measure 9

Requirement Information

Location	11 Buildings	ECM #:	9
Inspection Date:	12/8/10	Estimated Cost:	\$25,650
		Estimated Savings	\$8,550
		Estimated Payback	3 years

Requirement Description

Multiple facilities with large doors like fire stations and repair facilities currently have no means to prevent excessive heating if a door is left open. It was observed at a few sites that the heat was running in order to counterbalance the outside air coming through the open doors.

Photos



Action Description:

Introduce an interlock that cuts off the heat if doors are left open. This would provide an incentive for the occupants to keep the door closed. Additional safety measures would need to be put in place to prevent damage that could be caused by extremely low temperatures. This ECM would apply to all fire stations, the police repair facility and the parks and recreation garages.

Cost Calculations

Number of Buildings Affected:	14
Estimated Cost:	\$25,650
Estimated Annual Savings:	\$8,550
Simple Payback – Years:	3

Energy Conservation Measure 10

Requirement Information

Location	All Buildings	ECM#	10
Inspection Date:	12/8/09	Estimated Cost:	\$16,560
		Estimated Annual Savings:	\$16,313
		Estimated Payback:	1 year

Requirement Description

It was observed that there were multiple cold drink vending machines located throughout the buildings. There is a potential for energy cost savings by reducing the running time and the off-hour usage of these machines using Vending Miser

Photos



Action Description:

Install Vending Miser controls on vending equipment throughout City buildings.

Estimate:

Item	Description	Quantity	Unit	Unit Cost	Total Cost
Vending Miser	Installation of Vending Misers	92	Ea	\$169	\$16,560
				Total:	\$16,560

Requirement Payback

Utility Rate = \$0.11/kWh
 Facility occupied hours per year = 3,900 hours
 # cold drink vending machines = 92
 Power usage per vending machine = 400 W
 Vending Miser unit cost = \$169

Cold drink kWh savings per year = 148,304 kWh

Yearly Cost Savings = \$16,313

Total Cost = \$16,560

Estimated Payback = 1 year

Energy Conservation Measure 11

Requirement Information

Location	City Hall	ECM#	11
Inspection Date:	12/8/09	Estimated Cost:	\$30,950
		Estimated Annual Savings:	\$4,141
		Estimated Payback:	7.47

Requirement Description

It was observed that the hot water and cold water circulating pumps ran at a constant volume. The 4-pipe system was found to be inefficient especially during the shoulder months. The glycol loop was found to have a constant volume condition.

Photos



Action Description:

Install VFD's on the hot water circulating pumps and glycol loop

Estimate:

Item and Description	Quantity	Unit	Unit Cost	Total Cost
VFD controller and drive	4	ea	\$5,200	\$20,800
DDS points and controller	7	ea	\$750	\$5,250
Labor	1		\$4,989	\$4,900

Requirement Payback Utility Rate = \$0.11/kWh
 Yearly operating hours = 4,400 hours
 Ave Energy Savings with install 17% of total 221,441KW
 Each pump has 12 kW of output per nameplate
 Installation cost per pump= \$5,200
Total Construction Cost = \$30,950

Estimated Rebate = \$4,000
 Actual Cost after Rebate = \$26,950
 Annual Savings = \$4,141
 kWh savings per year = 37,645 kWh
 Simple Payback - Years = 7.47 years *** This is a conservative estimate, rebates could be higher.

Energy Conservation Measure 12

Requirement Information

Location	Fire HDQTRS	ECM#	12
Inspection Date:	12/8/09	Estimated Cost:	\$51,950
		Estimated Annual Savings:	\$10,694
		Estimated Payback:	4.95 years

Requirement Description

It was observed that the heat pump and the cooling tower at the Fire Headquarters were well beyond useful life. The 4-pipe system was found to be inefficient especially when both heating and cooling equipment were operating simultaneously.

Photos



Action Description:

Install new equipment on both the hot water and cooling tower circulating pumps. Install DDC controls on equipment to both monitor and operate flows in an efficient manner.

Estimate:

Item and Description

<u>Item and Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost</u>	<u>Total Cost</u>
Pumps and equipment	4	ea	\$7,200	\$28,800
DDC points and controller	21	ea	\$0	\$18,250
Labor	1		\$4,989	\$5,900

Requirement Payback Utility Rate = \$0.11/kWh

Yearly operating hours = 4,400 hours

Ave Energy Savings with install 25% of total 356,464KWh

Each pump ave 20 kW of output per nameplate

Installation cost per pump= \$7,200

Total Construction Cost = \$52,950

Estimated Rebate = \$1,000

Actual Cost after Rebate = \$51,950

Annual Savings = \$10,694

kWh savings per year = 89,116 kWh

Simple Payback - Years = 4.95 years *** This is a conservative estimate, rebates could be higher.

Energy Conservation Measure 13

Requirement Information

Location	All Buildings	ECM#	12
Inspection Date:	12/8/09	Estimated Cost:	\$161,500
		Estimated Annual Savings:	\$24,225
		Estimated Payback:	6.6 years

Requirement Description

It was observed that all buildings surveyed were experiencing control problems and the absence of a central DDS with a reporting feature to notify personnel of corrections. Lack of re-commissioning vital equipment contributes to excessive energy usage.

Photos



Action Description:

Install a BACnet DDC controller panels with monitoring points for space temperature and all inclusive control points for all facilities. Sensor plates and wiring for all space enclosures associated with the HVAC systems are included. Alarm monitoring also included. Combine existing DDS controls on equipment that both monitors and operates existing systems. This includes the boiler control ECM.

Estimate:

Item and Description

<u>Item and Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost</u>	<u>Total Cost</u>
DDC Controllers, Router, Accessories	7	ea	\$17,600	\$123,200
Additional DDS points and wiring	42	ea	\$1,100	\$46,200
Labor and re-commissioning	1		\$12,000	\$12,000

Requirement Payback

Utility Rate = \$0.12/kWh
 Yearly operating hours = 4,400 hours
 Ave Energy Savings with install 15%
 Total Construction Cost = \$181,400
 Estimated Rebate = \$20,000
 Actual Cost after Rebate = \$161,500

Annual Savings = \$24,225
 kWh savings per year = 101,000 kWh
 Simple Payback - Years = 6.6 years *** This is a conservative estimate, rebates could be higher.

Energy Conservation Measure 14

Requirement Information

Location	East Grand Fire	ECM#	14
Inspection Date:	12/8/09	Estimated Cost:	\$28,350
		Estimated Annual Savings:	\$7,102
		Estimated Payback:	3.9

Requirement Description

It was observed that the boiler in the East Grand Fire Station was found to be in poor condition. It was found to have a steam to hot water heat exchanger that further reduces efficiency.

Photos



Action Description:

Replace boiler with an industrial energy star AFUE 90% rated 500000 BTU package boiler. Install BAS controls and additional thermostats on Outside air monitoring and Demand response controls. Install additional temperature sensing on the hot water supply loop. Install DDC control points to measure temp and enthalpy. Existing sensors and points should be utilized.

Estimate:

Item and Description

<u>Item and Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost</u>	<u>Total Cost</u>
AFUE 90% efficiency hot water boiler package = \$29,500	1	ea	\$29,500	\$29,500
BAS controller, points and wiring	6	ea	\$850	\$5,100
Boiler re-commissioning	1	ea	\$1,750	\$1,750

Requirement Payback

Utility Rate = \$0.11/kWh

Annual Savings = (2343 gal x \$2.50 = \$5857) + (10,381 kWh x .12 = \$1245) = \$7,102

Boiler install and controls results in an industry average 13% savings.

kWh savings per year = 111,400 kWh

Construction Cost = \$36,350

Utility Rebate = \$8,000

Total Cost = \$28,350

Yearly Cost Savings = \$7,102

Estimated Payback = 3.9 years

Energy Conservation Measure 15

Requirement Information

Location	Public Works Garage	ECM#	15
Inspection Date:	12/8/09	Estimated Cost:	\$35,800
		Estimated Annual Savings:	\$7,700
		Estimated Payback:	4.6 years

Requirement Description

It was observed that the Public Works Garage had waste oil storage on site. The combination of steam and electric unit heaters heating the space were beyond useful life. Utilizing the waste oil would reduce energy expenditures by about 80%

Photos



Action Description:

Replace steam and electric unit heaters with “Clean Burn Waste oil boilers with an industrial energy star AFUE 90% rated 250000 BTU. Install BAS controls and additional thermostats on Outside air monitoring and CO monitoring. Install additional sensing on the exhaust fans control sequencing. Install DDC control points to measure temp, CO, and enthalpy. Existing sensors and points should be utilized.

Estimate:

Item and Description

<u>Item and Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost</u>	<u>Total Cost</u>
AFUE 90% efficiency waste oil boiler package = \$29,500	1	ea	\$30,500	\$30,500
BAS controller, points and wiring	8	ea	\$850	\$6,800
Flue and supply duct and accessories	1	ea	\$2,500	\$2,500

Requirement Payback

Utility Rate = \$0.11/kWh

Annual Savings = \$7,700 includes 4-steam unit heaters and 2 electric units

Alarm monitoring is included.

kWh savings per year = 68,700 kWh

Construction Cost = \$39,800

Utility Rebate = \$4,000

Yearly Cost Savings = \$7,700

Total Cost = \$35,800

Estimated Payback = 4.65 years

Energy Conservation Measure 16

Requirement Information

Location	Goffe St Firehouse	ECM #:	16
Inspection Date:	12/8/09	Estimated Cost:	\$139,500
		Yearly Savings	\$20,493
		Payback	6.8 years

Requirement Description

It was observed that the (5) existing package rooftop units that feed the fire station are beyond useful life. It was observed the frames had corrosion and the coils were found to be in poor condition.

Photos



Action Description:

Replace all (5) roof top units with Seer 15.5, high efficient, 100,000 BTU DX package units. Install DDC controller with termination points for BAS control. Install additional ductwork to accommodate cross duct arrangement to limit operation and to allow for maintenance. New unit to have ASHRAE 90.1-2010 minimum standard Install DCV controls in the BAS.

Yearly operating range = 12 months

Utility Rate = \$0.11/kWh

Yearly Energy Savings (30% red for start up, 15% red for DCV BAS control) = 26,165 kWh/yr x .11 = \$2,878 x 5 = \$14,390

Yearly Cost Savings from maintenance and compressor replace per year = \$6,103

Annual Cost Savings = \$20,493

Yearly KWH Savings = 130,825 kwh

Rooftop Unit x 5 Installation cost = \$26,000 x 5 = \$130,000

BAS controls = \$7,000

Ductwork install and modification = \$8,500

Total Construction Cost = \$145,500

Estimated Rebate = \$6,000 based upon high efficient unit and enhanced DCV BAS controls

Actual Cost after Rebate = \$139,500

Simple Payback - Years = 6.8 years *** This is a conservative estimate; a catastrophic failure due to the age of the existing units could result. Rebates could be higher based on submittal plan.

Energy Conservation Measure 17

Requirement Information

Location	All buildings	ECM#	17
Inspection Date:	12/8/09	Estimated Cost:	\$6,840
		Estimated Annual Savings:	\$1,500
		Estimated Payback:	4.56 years

Requirement Description

It was observed that most heating pipes in smaller size facilities were not insulated. This problem leads to excessive radiant heat loss and increased energy cost.

Photos



Action Description:

Install insulation around all thermal pipes in order to prevent heat loss and lower energy costs. This ECM applies to the Lombard Fire House, East Grand Ave Fire House, Woodward Fire House, Ellsworth Fire House, Grand Ave Library and the Fire Headquarters. Insulated pipes typically increase the temperature of water within by 2-4 degrees F.

Estimate:

<u>Item</u>	<u>Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost</u>	<u>Total Cost</u>
Pipe Insulation	Pipe insulation wrap or fiberglass insulation	1800	Feet	\$4	\$7,200
				5% Discount:	\$360
				Total:	\$6,840

Requirement Payback

Annual Savings = \$1,500
 Payback = 4.56 years

Energy Conservation Measure 18

Requirement Information

Location	Park and Recreation	ECM#	PR-18
Inspection Date:	12/8/09	Estimated Cost:	\$12,286
		Estimated Annual Savings:	\$6,710
		Estimated Payback:	1.8 years

Requirement Description

The Park and Rec facility is heated by (6) Electric Unit Heaters mounted on the ceiling and wall. These heaters are 15 kW units. Some of these units appear to have coil degradation which increases energy use by a factor of 1.5. The total electric draw is 90 kW at 480 volts. Each of these unit heaters is on an individual thermostat. In operation they are turned on in the fall and left in operation until the spring.

Photos



Action Description:

Install (6) gas fired unit heaters in place of the existing electric unit heaters. Piping of low pressure gas will be required from service entry meter. Install temperature sensor plates with auto shutoff controls.

Estimate:

Item	Description	Quantity	Unit	Unit Cost	Total Cost
Gas fired unit heater	50,000 BTU	6	Ea	\$981	\$5,886
Removal and pipe modifications		400	Lf	\$16	\$6,400

Requirement Payback

Utility Rate = \$0.11/kWh
 Cost gas unit heater installed = \$981 x 6 = \$5,886
 5 months of operation at 50% load factor = 90 kw x 150 days x
 12 = 122,000 kwh/yr x .11 cents = \$17,820 x 50%
 Assuming installation of gas at 50% commodity reduction

kWh savings per year = 122,000
 Yearly Cost Savings = \$6,710
Total Cost = \$12,286
 Estimated Payback = 1.8 years
 Gas would be provided to property line at no cost

Energy Conservation Measure 19

Requirement Information

Location	All Buildings	ECM#	AB-19
Inspection Date:	12/8/09	Estimated Cost:	\$42,000
		Estimated Annual Savings:	\$5,500
		Estimated Payback:	7.6 years

Requirement Description

Multiple buildings had problems with air balancing and pressure. It is the intent of the air balancing and testing of HVAC system to avoid increased operating and maintenance cost. Most of all, the air balancing will increase occupant comfort and thereby increase productivity

Photos



Bi-level office at 42 Middletown is heated and cooled with (2) separate systems yet open floor plan.

Action Description:

Conduct air balance testing on selected buildings identified in this survey. Check the following: Ductwork intact and properly sealed, Ductwork installed according to as-built drawings, Terminal boxes, coils etc. are all functioning, Return air ducts has an unobstructed path, DDC controls online.

Estimate:

Item	Description	Quantity	Unit	Unit Cost	Total Cost
Air balance and testing study		1	Ea	\$42,000	\$42,000
Includes DDS corrections and simple fixes		20	Ea	\$0	\$0

Requirement Payback

Utility Rate = \$0.11/kWh
 Cost of survey = \$42,000
 Assuming industry average savings is approximately 5% on conservative findings without major modifications.
 BTU savings =

kWh savings per year = 100,000
 Yearly Cost Savings = \$5,500
 Estimated Payback = 10 years
 Cost of deferred maintenance may be higher in some cases and will decrease the 10 year payback to 5-7 years.

Energy Conservation Measure 20

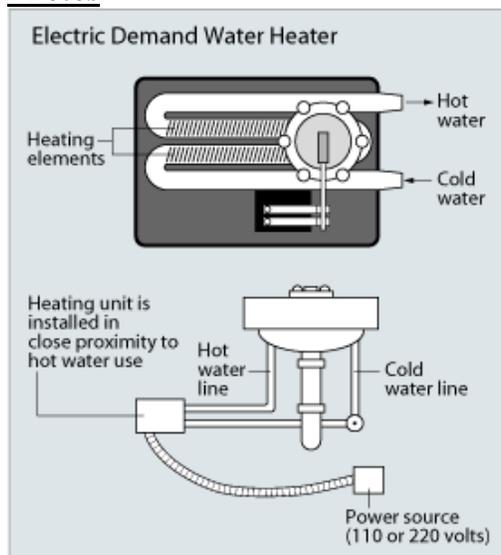
Requirement Information

Location	All Buildings	ECM#	AB-20
Inspection Date:	12/8/09	Estimated Cost:	\$35,062
		Estimated Annual Savings:	\$3,500
		Estimated Payback:	10 years

Requirement Description

It was observed that (9) facilities were equipped with oversized gas fired tank type DHW heaters. It was found that the standby heat loss outweighed the delta T during instantaneous demand.

Photos



Action Description:

Remove the existing 80-120 gallon hot water heaters and booster circulation pumps in the (9) facilities. Install (9) Electric Demand Water Heaters.

Estimate:

Item and Description

<u>Item and Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost</u>	<u>Total Cost</u>
Instantaneous hot water heater 2-5 GPM	9	ea	\$3,740	\$33,600
Piping and mounting	9	ea	\$288	\$2,592
Removal and labor	1	ea	\$3,370	\$3,370

Requirement Payback Utility Rate = \$0.11/kWh
 Removal of gas fired unit 180,000 btu/hr and booster pump with no constant recirculation and makeup offset with install of (9) small electric demand hot water heaters averages to about 11% savings., and 50% reduction of operation

kWh savings/yr = 53 kW/hr x 1300 hrs = 70,000 KW/yr
 Construction Cost = \$39,562
 Utility Rebate = \$4,500
 Yearly Cost Savings = \$3,500
Total Cost = \$35,062
 Estimated Payback = 10 years

Energy Retrofits

Per current Connecticut state grants, electricity consumers that install energy efficiency equipment to reduce energy use during peak times might be eligible for a rebate of up to \$600 per kW. All new and retrofitted facilities located in Connecticut are eligible to apply. The consideration for qualifying is that the energy efficiency measures result in peak demand shaving during the winter peak (5 pm and 7 pm in December and January) and summer peak (1 pm and 5 pm in June, July, and August).

HVAC Re-Commissioning

The purpose of HVAC re-commissioning is to ensure the buildings control systems are operating to maximum potential. Another result of Re-Commissioning will be to verify the systems are running as efficiently as possible to keep energy costs to a minimum. Proper re-commissioning will uncover potential problems with the existing systems and provide solutions. It is the intent of the re-commissioning to avoid increased operating and maintenance cost. Most of all, the re-commissioning will increase occupant comfort and thereby increase productivity.

The following is a general list of items to be checked by maintenance personnel prior to re-commissioning:

1. Ductwork intact and properly sealed
2. Ductwork installed according to as-built drawings
3. Terminal boxes, coils etc. are all functioning
4. Return air ducts have an unobstructed path
5. DDC controls online and operational

Additional Recommendations

The preceding report should be reviewed thoroughly. Once reviewed, it will provide a general road map in developing a detailed submittal that will incorporate the City of New Haven's priorities with respect to capital equipment expenditures and long range business plans.

The recommendations listed below are to be used as guidelines for further discussion but not necessarily for immediate implementation. These recommendations require more information before leading to additional energy measures:

- Install exhaust restrictors on all boilers to increase boiler combustion efficiency by 15%. Conduct heat and excess air balance test to determine optimum efficiency.
- Institute a steam trap maintenance program to ensure the recovery operation of the condensate return system in all condensate recovery applications.

- Procure an on-line fuel management system in order to analyze daily fuel usage based on spot market purchase price.
- Install a supplemental Energy Management System (EMS) program for all the City buildings. The new DDC program would have a feature that will provide additional set point control for all major equipment and all lighting. This will enable full participation in Demand Response and self selective energy reduction operation.