TO: **Catherine Diviney, West Hartford Energy Manager**
cc: Robert Palmer

FROM: **Steven Weisman and Kaj Huld, Peregrine Energy Group, Inc.**

DATE: **July 9, 2012**

RE: **Energy Assessments of West Hartford Town and School Buildings**

Introduction

As part of our engagement with the Town of West Hartford to help guide ongoing operations, reduce energy-related costs, and identify necessary and cost-effective capital projects, Peregrine Energy Group toured and evaluated BOE/School and Town buildings between March 28 and April 25, 2011 and on February 16th and 17th, 2012 and May 1st and 2nd, 2012.

BOE facilities visited:

- Aiken Elementary School
- Braeburn Elementary School
- Bristow Middle School
- Bugabee Elementary School
- Charter Oak Elementary School
- Conard High School
- Duffy Elementary School
- Hall High School
- King Philip Middle School
- Morley Elementary School
- Nordfeldt Elementary School
- Sedgwick Middle School
- Smith Elementary School
- Webb Hill Elementary School
- Whiting Lane Elementary School
- Wolcott Elementary School

Town facilities visited:

- Bishops Corner Library
- Cornerstone Aquatics Center
- Dog Pound
- Elmwood Community Center

- Fairview Cemetery
- Fire Station No. 1 (Prospect Avenue)
- Fire Station No. 2
- Fire Station No. 3 (New Britain Avenue)
- Fire Station No. 4 (Albany Avenue)
- Fire Station No. 5
- IT Hub
- Noah Webster Library
- Police/Fire Headquarters
- Public Works
- Rockledge Golf Facility
- Town Hall
- Veteran's Memorial Rink

Peregrine's assignment from the Town was to collect information about current energy-related practices and systems, to learn about operating issues and comfort problems in buildings, to understand future plans for building upgrades, and to identify and recommend improvements that would improve operations, increase reliability, and/or reduce energy costs. Working with Robert Palmer, Facilities Director for the Town and Board of Education, and Catherine Diviney, the Town's Energy Specialist, we targeted groups of buildings for evaluation, focusing on issues of particular interest to the Town and considering future plans for each of the buildings visited.

This document summarizes our observations and identifies specific opportunities that we found for energy efficiency improvement, etc. Table 1, following pages, is a matrix that summarizes the opportunities we have identified in each building we have visited and offers our perspective on energy efficiency measures that are common to multiple buildings and could be appropriate for a cross portfolio procurement strategy.

Peregrine has also prepared high-level savings and cost estimates for each measure identified and is providing them in a tabular spreadsheet that West Hartford decision makers can use as a selection tool or pick list to package measures and consider alternative strategies for implementation of opportunities of interest (e.g. cross portfolio treatment as described above, whole building energy upgrades, deferred upgrades until major building renovation, energy saving performance contracting, or a combination of them all and others as well).

Table 1 – Summary of Efficiency Measures by Building

Building	Year Built	Sq. Ft.	EUI kBtu/SF	LIGHTING									CONTROLS																	
				1 General Lighting Update (Existing Proposal)	2 Replace T12 Lighting	3 Install T5 High Bay Lighting	4 Hallway Lighting Redesign	5 Upgrade Fluorescent Lighting to Super T8s	6 Replace Incandescent / Halogen Lighting	7 Update Exterior HID Lighting	8 Install Occupancy Sensor Control	9 Add Photocell Control for Daylit Areas	10 Attention to Thermostat Programming	11 Retro-commissioning	12 Add Programmable / Remote Thermostats	13 Interlock Dishwasher Exhaust Fan	14 Add Kitchen Hood Controls	15 Add HW Reset Control	16 Add VFD to HVAC Fans	17 Add VFD to Pumps	18 Add VFD to Cooling Tower / Other	19 Web-based/programmable Portable TSTATs	20 Update Current Control Operating System	21 Expand DDC System Capability	22 Add Boiler Controller	23 Add Occupancy Based HVAC Control	24 Interlock Overhead Door w/ Bay Heaters	25 Rezone Systems for Improved Control
BOE/Schools																														
Aikens Elementary	1960's	62,028	89	X										X		X							X	X					
Braeburn Elementary	1956	59,742	57	X										X		X			X										
Bristow Middle School	2005	84,430	63						X		X	X		X																
Bugbee Elementary School	1950	68,165	80				X	X	X		X	X			X	X								X						
Charter Oak	1930's	62,741	94	X										X									X						
Conard High School	1957	288,145	74				X	X			X	X		X		X	X		X				X						
Duffy Elementary School	1952	78,991	84				X	X	X		X			X		X						X	X						
Hall High School	1970	277,802	49		X		X	X	X	X	X	X		X			X		X		X	X	X			X			
King Philip Middle School	1954	192,897	80													X								X		X			
Morely	1929	61,085	68	X										X									X						
Nordfelt	1956	61,715	67	X										X									X	X					
Segwick	1930	183,399	58	X													X						X						
Smith	1970's	66,400	71											X		X							X						
Webster Hill Elementary School	1949	77,701	91				X	X	X		X			X		X							X						
Whiting Lane Elementary School	1954	107,771	81				X	X	X		X	X		X		X							X	X		X			
Wolcott	1957	78,850	64	X										X									X						
TOWN																														
Bishops Corner Library	1966	14,992	87										X											X						X
Cornerstone Aquatics Center	1961	47,930	258											X					X	X										
Dog Pound	1971	750	NA		X																									
Elmwood Community Center	1928	68,744	69			X					X		X											X						
Fairview Cemetery	1920	5,000	NA																											
Fire#1	1914	7,900	63																											
Fire#2	1992	5,380	158			X			X		X												X				X	X	
Fire#3	1930	9,000	105	X									X														X		
Fire#4	1954	6,300	38	X																										
Fire#5	1963	4,477	143			X			X		X														X		X	X	
IT Hub	2000	3,000	176								X		X		X															
Noah Webster Library	1937	59,790	85						X		X	X	X	X								X		X		X			
Police & Fire HQ	1910	68,855	79			X						X	X	X					X					X					
Public Works	1958	34,450	131						X						X									?			X		
Rockledge Golf Club	1996	8,200	NA	X																										
Town Hall	1922	142,615	45		X						X			X												X			
Veterans Rink	?	37,765	173											X					X	X	X		X						

Table 1 – Summary of Efficiency Measures by Building (Continued)

Building	HVAC/R																					ENVELOPE											OTHER								
	26 Insulate HW / Refrigeration Piping	27 Replace Old Electric Motors	28 Replace 3-Way Valves w/ 2-Way	29 Steam Trap Maintenance Program	30 Replace Walk-in Cooler Refrigeration	31 New Walk-In Cooler	32 Alternative "Portable" Heating System	33 Gas-Fired HW Booster for Dishwasher	34 Replace Oil-Fired DHW Heater w/ Gas	35 Add Air-Side Economizer Capability	36 Install Ductless Split Unit(s)	37 Update Coils	38 Replace HVAC Unit(s)	39 Add Make-Up Air Capability	40 Seal Ductwork	41 New HVAC System	42 Replace Chiller Plant	43 Replace Boiler Plant	44 Convert from Steam to Hot Water Heating	45 Replace Unit Heaters w/ Ceiling Radiant	46 Exterior Door Weatherization	47 Priority Window Repairs/Replacement	48 Longer Term Window Replacement	49 Overhead Door Repair/ / Replacement	50 Alternate to Automatic Entrance	51 Add Destratification Fans	52 Airseal Building	53 Attic / Wall Insulation	54 Low E Ceiling	55 Install Separating Wall	56 Seal Unused Skylight / Shaft / Other	57 Plug Load Controller	58 Replace CRT Computer Screens	59 PC Sleep Software	60 Replace Refrigerator	61 Swimming Pool Cover	62 Use Chemical Ice Treatment Product	63 Solar Thermal Heating System	64 Cogeneration
BOE/Schools																																								
Aikens Elementary								X				X			X							X		X									X							
Braeburn Elementary	X																					X												X						
Bristow Middle School																											X					X	X	X					
Bugbee Elementary School		X		X	X	?	X											X	X			X		X							X	X	X					
Charter Oak				X												X						X										X							
Conard High School			X				X									X						X										X	X						
Duffy Elementary School		X					X						X									X	X									X	X						
Hall High School	X	X											?	X			X					X	X								X	X	X						
King Philip Middle School		X		X	X	?	X							X					X			X		X							X	X							
Morely				X	X																	X											X							
Nordfelt					X			X				X										X		X									X							
Segwick		X			X																	X											X							
Smith																		X				X		X									X							
Webster Hill Elementary School	X			X												X			X			X	X					?				X	X						
Whiting Lane Elementary School		X		X	X	?	X	X					X						X			X	X									X	X						
Wolcott																						X											X							
TOWN																																								
Bishops Corner Library																						X																		
Cornerstone Aquatics Center										X			X									X			X					X		X		X			X	X	
Dog Pound																X																								
Elmwood Community Center				X												X			X			X										X		X					
Fairview Cemetery																						X													X				
Fire#1																						X	X					X											
Fire#2																		?		?		X		X		X								X						
Fire#3																		?						X																
Fire#4	X																	X																						
Fire#5													X					?		?						X								X						
IT Hub																																								
Noah Webster Library		X														?						X				X			X					X						
Police & Fire HQ																													?				X		X				
Public Works																						X		X									X		X				
Rockledge Golf Club																X						X																	
Town Hall									X																X									X					
Veterans Rink											X											X							X				X		X			?		

General Observations

We commend the Town of West Hartford for its high standards for operating and maintaining both schools and municipal buildings. West Hartford has invested heavily in modernizing facilities, including replacing or upgrading building systems that are not seen by the public. Most of the schools we reviewed were all significantly renovated in the late 90's or newly built. With few exceptions, energy systems appear to be reasonably current, in good working condition, and well maintained.

The significant opportunities we found to make additional improvements generally fall into four categories, described below. There are also longer term opportunities to improve and upgrade building envelope and mechanical systems.

(1) **Lighting.** Lighting is predominantly older generation fluorescent T8s with some compact fluorescent and a small number of incandescent, halogen, and other less efficient lamps. The Town doesn't appear to have adopted the use of occupancy sensors. We suggest immediate updates of older technology and considering standardizing on super T8s with strategically placed occupancy sensors. We note that since Peregrine has begun these evaluations, the Town has proceeded with lighting upgrades in buildings.

(2) **Recommissioning.** Re-commissioning, i.e., ensuring that building controls and the systems they schedule and sequence function consistently with the design intent and current comfort needs, will resolve lingering commissioning and controls-related issues that are impeding optimal efficiency.

(3) **Building Management System.** Older Invensys building controls are all tied together centrally and provide most fundamental energy management functions. These functions include scheduling units off at night and on weekends. We suggest that West Hartford upgrade the BMS capabilities and software in use on the older control systems.

(4) **Variable Speed Drives.** The Town should convert any applicable constant volume systems (e.g. motors, pumps) to variable speed control.

Building Descriptions

The following brief descriptions summarize our observations and findings for each facility we visited, listing specific opportunities identified.

Aiken Elementary School

Aiken Elementary School is located at 212 King Philip Drive and totals 62,000 square feet. The single story brick building was originally opened in the 1960's. In 2002 there was a significant renovation and addition with new classrooms, kitchen and extension of the gym. There are roughly 500 pre-kindergarten through grade five students enrolled in this school. The facility has approximately eighteen classrooms, a gymnasium, cafeteria, auditorium, and administrative offices.

Normal school hours are weekdays approximately 8:00 a.m. to 3:20 p.m. with shorter hours on Wednesdays. The school is typically lightly occupied through the late afternoon. Custodial services are completed in the afternoon and evening. There is no weekend activity. The school sees limited use in the summer, mostly in the café and gym.

Building Envelope

This facility is constructed of brick faced concrete blocks with flat built up roof sections. The roof was recently replaced and additional rigid insulation was added. Insulation materials and effectiveness in the walls is unknown and expected to be minimal in the original structure. Windows in the older sections of the building are metal-framed casement units with single pane glazing and are in overall poor condition. The new addition has operable windows with thermal panes that are in good condition. The exterior doors have seals, some of which could be replaced. There aren't any seals on the inner door sets.

HVAC

Aiken has a variety of space heating and air conditioning systems. Central air conditioning is limited to the Media Center and offices. The staff lounge and server room have unitary A/C units. Four new air handlers were installed in the 2002 renovation, and AHU details are provided in the table below. The make-up air unit serves the six new classrooms, which have baseboard perimeter heating. The remaining older classrooms use unit ventilators with pneumatic controls. There are also two older H&V air handlers. One serves the auditorium and rarely runs. The other serves the locker room. Both are pneumatically controlled and in poor condition. There are two small rooftop units serving the administrative offices.

Table 2 – Air Handler Design Details (2002 Renovation)

Unit	Serves	Type	VFD?	Fan hp	Airflow cfm	HW MBH	DX ton
AHU-S1	Gym	CV	No	7.5	9,000	455	-
AHU-S3	Café	Zone Reheat	No	5	6,850	234	-
AHU-S5	Library	CV	No	5/3	5,800	261	16
AHU-S6	Make-up	100% OSA	No	5	5,025	401	-

Central Boiler Plant

Aiken has a new high efficiency boiler plant consisting of two gas-fired Aerco condensing units (size unknown). Hot water is circulated to the original facility via a pair of 7.5 hp centrifugal pumps (one standby). The new addition has a separate pumping system with two 5 hp pumps one of which is redundant. The boilers are not operating as efficiently as intended since circulating water temperature has to be kept warmer than optimal for this type of boiler. We noted that the design basis for the new air handling coils is 180^{o}F entering water temperature. The system is set up with a hot water temperature reset program that adjusts hot water circulating temperature based on outside air temperature. At the time of our visit hot water was being circulated at 145^{o}F. It looks like this reset has been adjusted as best it can.

Controls

This school uses the older Invensys control system based on a Network 8000 panel. The DDC system has dial up to the main front end at the DPW. The system is tied to the new Aerco boiler controller, newer air handlers and day/night pneumatic controller for scheduling. The setback temperature on the

Invensys is typically 60°F. HVAC is generally scheduled to run from 7 a.m. to 4 p.m. weekdays. Systems are setup with an optimum start feature, but this isn't always working well and staff are incrementally scheduling occupied periods earlier and earlier to assure that spaces are comfortable.

It may be that outside dampers are open during the "warm-up" period. However, the sequence of operation documentation from Invensys indicates that dampers should be closed. This mode of operation should be checked to ensure that outside air dampers are closed.

Lighting

This facility is predominantly lit with T8 fluorescent lamps and ballasts. There are new T5s in the gym as well as many CFLs. The main entrance canopy has PAR spot lamps. There are also incandescent lamps in the kitchen hood. The exterior/parking lot has HID lighting on a time clock setup to run from 4:30 p.m. to 6:30 a.m. A lighting contractor recently completed a full lighting survey and proposal.

Kitchen

The kitchen uses gas-fired appliances. The walk-in cooler has a single fan evaporator with air-cooled compressor. There is a 45 kW electric hot water booster heater for the dishwasher. The dishwasher exhaust system has an approximately 6-inch diameter cleaning port that isn't covered.

Energy Efficiency Opportunities

This facility has a EUI of 89 kBtu/SF, which is on the high side compared to the other elementary schools in West Hartford. We identified many areas for efficiency improvement that are summarized below.

Specific Opportunities Identified:

- Lighting updates as prescribed by contractor
- Replace CRT computer monitors and apply PC power management strategy
- Add/replace exterior door seals and provide proper door alignment
- Seal dishwasher exhaust hole in ductwork
- Interlock dishwasher exhaust fan with dishwasher
- Review control system settings and sequences – i.e. recommissioning (e.g., check setpoints and sequences such as the optimum start program)
- Update Invensys to current standards
- Expand control system to classroom UVs.
- Consider gas-fired hot water heater for dishwasher
- Update heating coils to lower heating hot water temperature for better boiler efficiency and/or comfort
- Window replacement

Bristow Middle School

The Bristow School is located at 34 Highland Street. This school currently serves 420 students in grades 6, 7 and 8. The two-story 84,400 square foot facility was opened in 2005. The building design incorporated and reused an older two story wooden structure that had been part of a private school

campus at the site. This rejuvenated building now serves as the Bristow administration and media center areas. This older building is attached to the new structure by a bridge.

The relatively new school is a showcase of latest construction and teaching environment standards. The school has usual classrooms, full service cafeteria and diner area, gymnasium and library. Normal school hours are weekdays 8:00 a.m. to 2:50 p.m. although the building is typically lightly occupied into the evening with custodial service usually completed before midnight. Except for some use by Leisure Services on Saturdays, there is no other other weekend occupancy. During the summer break the school air conditioning is reset to a higher setpoint and also run at night to pre-cool the building.

Building Envelope

This facility is new, and we expect that it meets current energy standards for insulation and air sealing. It is unlikely that there are any cost-effective improvements that can be made to the new section's building envelope. Insulation in the older reused section of the building is unknown. Windows there are residential style wooden frame single pane with storms. We noted openings in the basement to a piping chase and potentially at the foundation joint.

HVAC

This school has a dual temperature two-pipe system serving air handlers and fan coils with heating and air conditioning capability. There are nine McQuay air handlers in the building, most of which use variable speed drives on supply and return fans. Four of the units employ desiccant heat recovery wheels capturing thermal energy from building exhaust. The distribution system includes variable air volume boxes with hydronic reheat coils. In addition, there is a separate hot water circulation loop serving heating-only devices (reheats, radiation and small air handlers). The kitchen has a gas-fired Modine make-up air unit. The main air handling units are summarized in the table below.

Table 3 – Design Summary of Bristow HVAC Units

Unit	Type	Supply Fan hp	Return Fan hp	Airflow cfm	Coil Clg ton	HW Coil MBH
AHU-1	VAV w/ ERU	25	25	20,000	59	524
AHU-2	VAV w/ ERU	20	20	16,500	49	455
AHU-3	VAV w/ ERU	10	5	7,850	22	204
AHU-4	VAV	5	2	5,475	16	223
AHU-5	VAV w/ ERU	10	10	9,000	26	252
AHU-6	CV	5	-	4,500	-	266
AHU-7	CV	5	-	4,500	-	266
AHU-8	VAV	7.5	3	7,200	26	421
AHU-9	CV	2	-	2,320	12	236
MUA-1	CV	3	-	4,000	-	203

Central Plant

Hot water is provided by a central boiler plant consisting of three gas-fired Smith sectional boilers. Each has a 2,163 MBH Power Flame burner with 1/3 hp forced draft fan. Hot water is distributed by one of two 15 hp dual temperature centrifugal B&G pumps controlled by variable frequency drive (VFD). The heating only loop is circulated by a duplex 5 hp B&G pump set. This is a constant volume system

without VFDs. Chilled water is provided by two identical packaged R22 McQuay chillers. These 123 ton units are split system with roof mounted air-cooled condenser.

Controls

All major HVAC equipment in this facility is controlled by an Invensys direct digital control (DDC) system. The system provides zone temperature control, air handler fan modulation, ventilation management and time of day scheduling of units. In viewing the system, we noted that the variable speed systems appear to be turning down as expected. We also see that the control system may be calling for a lower air handler mixed air temperature setpoint than needed and therefore is wasting heating energy. We were told that outside air flow stations were never operational. Also, the desiccant heat recovery wheels are reported to be stopped in the summer, which is a practice that should be revisited.

Lighting

This facility has original T8 fluorescent lamps and ballasts. The gym has newer compact fluorescent (CFL) based fixtures that are designed to look like metal halide. The auditorium uses CFL flood lamps in the seating area. There is quartz or halogen up lights in the upper part of the atrium that do not appear to be controlled. This school doesn't have any occupancy sensors in place. Staff indicate that lights in classrooms are reliably turned off when they aren't in use.

Domestic Water

This facility has newer low flow toilet and urinal fixtures. Sink aerators are probably reduced flow as well, although unconfirmed. Domestic hot water is generated by two 150 gallon AO Smith units with 199 MBH gas-fired burners.

Other

This school has a 100 kW solar photovoltaic system installed in panel sections covering the roof. The system is by a third party under a power purchase agreement. The kitchen has a walk-in cooler and gas-fired hot water booster for the dishwasher. Hood fans are controlled by wall switch.

Energy Efficiency Opportunities

This facility has a EUI of 63 kBtu/SF, which is quite low. Given that the building is new, has efficient systems, and does not have significant operating or comfort problems, it will be difficult to justify significant projects that would further reduce energy use. Opportunities we recommend for consideration by West Hartford include minor lighting updates and retro-commissioning-type enhancements to tweak the most performance out of the existing HVAC systems.

Specific Opportunities Identified:

- Replace kitchen hood incandescent lamps with CFL
- Replace atrium up fixtures and add photocell controls
- Add daylighting control on walkway bridge and possibly library stacks
- Consider occupancy sensors in hallways, bathrooms, and offices
- Replace CRT computer monitors and apply PC power management strategy
- Air seal the basement of the older section of the wood frame building

- Review control system settings and sequences – i.e. recommissioning (typical areas of opportunity on newer systems are around VAV box settings, incomplete or faulty programming, and ventilation management)

Braeburn Elementary School

Braeburn Elementary School is located at 45 Braeburn Road and totals 59,800 square feet. The single story brick building was originally opened in the 1956. In 1992 and 1996, additional classroom wings were added. There was a major renovation in 2000 (+/-) that included a new HVAC system. Two "portable" classrooms were added in 2010. In addition to classroom wings, the school has an auditorium, gym, library and administrative offices. There are roughly 500 kindergarten through fifth grade students enrolled in this school.

Normal school hours are weekdays 8:00 a.m. to 3:20 p.m. with shorter hours on Wednesdays. On weekdays, there is a daycare service that is open from 7:00 a.m. to roughly 6:30 p.m. Leisure Services programs (basketball, etc.) run weekdays from 5 p.m. to 9 p.m. Custodial services are completed in the afternoon and evening.

There is generally no weekend use of this school. In the summer, the school is vacated, except for office hours kept by the principal and secretary and occasional gym use by local camp programs on rainy days.

Building Envelope

This facility is constructed of masonry block with brick façade with slightly pitched built up roof sections. There is likely to be some rigid insulation in the roofing system. Insulation details in the walls are unknown and believed to minimally effective, if even present at all. Casement windows are double pane in aluminum frames in reasonably good condition. The exterior doors are equipped with weather seals, but some are missing the "sweeps" on the bottom of the door to seal the threshold area. Inner doors in vestibule areas do not have seals.

HVAC

This facility is conditioned by two newer constant volume H&V units in the basement mechanical room that operate in parallel (i.e. essentially functioning as one large unit with two fans). Each has a 25 hp supply fan delivering about 21,000 cfm. Between the two units, 10,800 cfm (minimum) outside air is specified. The hot water coils (2) are rated at 650 MBH each. Conditioned air is distributed to about thirty-seven terminal reheat coils for individual zones within the building. The HVAC systems appear to be in good condition.

The administrative area and library have individual rooftop DX units. AC-1 is rated at 5 tons and AC-2 is rated at 10 tons. Both have hot water coils and are in decent working order. Two rooftop units with electric backup heat condition the portables. Aside from the admin area and library, these classrooms are the only other area in the school that has air conditioning.

Central Boiler Plant

Braeburn has two mechanical rooms, each with its own boilers, one serving the older portion of the building and the other serving the addition. The original plant in the basement mechanical room

consists of two older dual fuel sectional hot water boilers. There is no nametag or other information on either of these old boilers. The 1½ hp Webster burner is rated at 3,074 MBH. Gas is used exclusively (no oil). Hot water is circulated by a pair of constant speed 5 hp centrifugal pumps (one standby). This plant is in poor condition and will require attention within the next five or so years, if not earlier. In the same mechanical area is a newer gas-fired tank-type domestic hot water heater rated at 250 MBH (72 gallon).

The newer addition has its own ground level mechanical room with three Weil McLain gas-fired hot water boilers rated at 133 MBH each. Hot water is distributed by one of two ¾ hp inline pumps (one standby). This plant appears to be in good condition.

Controls

This school uses the older Invensys control system based on Network 8000 and Siebe panels. The DDC system has dial up to the main front end at the DPW. The system monitors and controls the boiler plants, two main air handlers and two A/C units. The system schedules the air handlers and provides hot water temperature reset at both boiler plants. The current program drops the space temperature heating setpoint in the school to 60^{o}F during unoccupied periods. The air handlers are scheduled to run from 7 a.m. to 6 p.m. weekdays.

Lighting

This facility is predominantly lit with T8 fluorescent lamps and ballasts as well as CFLs. Newer lighting fixtures are three-lamp pennant direct/indirect. The gym uses CFL lighting fixtures. The library has 2x2 U-lamp fixtures. The auditorium has about twenty 120W incandescent flood lamps and eight foot T12 fixtures in the stage area. Fluorescent lamps have been selectively removed from hallway fixtures to save energy. This school has some parking lot lighting that runs in the evening until 1 a.m. A lighting contractor recently completed a full lighting survey and proposal.

Kitchen

The kitchen uses gas-fired appliances. The walk-in cooler box and refrigeration is newer. The kitchen exhaust in the dishwasher room is active 24/7.

Energy Efficiency Opportunities

This facility has a EUI of 57 kBtu/SF, which is lowest in the West Hartford's portfolio school properties. There is likely to be limited opportunity for significant improvement. We identified some areas for efficiency improvement that are summarized below.

Specific Opportunities Identified:

- Lighting updates as prescribed by contractor
- Replace CRT computer monitors and apply PC power management strategy
- Add/replace exterior door seals and provide proper door alignment
- Insulate domestic hot water pipe around tank heater
- Interlock dishwasher exhaust (damper or fan control)
- Review control system settings and sequences – i.e. recommissioning (e.g., check setpoints and sequences such as optimum start)

- Consider VFDs on air handlers and possible addition of VAV terminal boxes

Bugbee Elementary School

Bugbee Elementary School is located at 1943 Asylum Avenue and totals 68,200 square feet. The mostly single story building was opened in 1950 and is largely in its original configuration, with a new Media Center added within the past 6 years as well as added "portable" classrooms. There is a partial basement level with classrooms. In addition to classrooms, this facility has an auditorium, gymnasium, kitchen with dining room, and administrative offices. There are 420 students enrolled in this school.

Normal school hours are weekdays 8:10 a.m. to 3:20 p.m. although the building is typically lightly occupied through the afternoon and into the early evening. The auditorium, library, art rooms and gym often remain open until about 9 p.m. Custodial services are normally completed by midnight. There are usually no weekend activities. The building sees some use in the summer during inclimate weather when camp organizations bring kids to the school to use the gym.

Building Envelope

This main building is constructed of concrete blocks with brick façade. The steel deck has a built up asphalt roofing. Insulation materials and effectiveness in the walls and roof are unknown and are expected to be minimal in the original structure. Windows are mostly casement metal framed with single panes, generally in rough condition without seals. There is some decorative glass block in use. The main entrance has an automated swing door. Exterior doors generally don't have weather seals.

The exterior walls of the older section of the portable building were recently rebuilt with new insulation added. Also the portable building roof was replaced with insulation added to establish drainage pitch. The exterior door has a weather seal.

HVAC

This facility is heated by steam via classroom radiators. There are three 1½ hp general exhaust fans that ventilate the building. Make-up air enters the building through unsealed windows. The gym has four steam unit heaters and exhaust fans, but no make-up air system. There are 3-4 window DX units in the administration area and a rooftop unit serving the Media Center. The portable building has all-electric rooftop units.

Steam Plant

Bugbee has central steam boiler plant consisting of two older Smith cast iron sectional boilers. Each boiler has a 4,426 MBH Iron Fireman burner with 3 hp forced draft fan. There is also 1 hp ejector fans on each boiler. Gas is burned exclusively. Steam is distributed at about 5 psi throughout the school. There has never been a formal steam trap maintenance program. Condensate pipe isn't insulated in the boiler room.

Controls

Bugbee School has a mostly pneumatic control system. The system is setup to provide temperature management of steam of radiation via pneumatic control valves and wall thermostats. The system has a day and night setting controlled by system air pressure and twelve hour timers. We understand that

this system provides reliable space temperature reset at night in the school. Compressed air is supplied from a dual 1 hp reciprocating unit. The boiler plant is controlled locally. The portable building uses conventional thermostats.

Lighting

This facility has T8 fluorescent lamps and ballasts dating from the 1999 addition and renovation. There are some compact fluorescent lamps. The gym has newer T5 fixtures. The boiler room uses metal halide lamps. We noted incandescent lamps in use in the auditorium and kitchen hood. We didn't see any occupancy sensors in use at this school.

Domestic Water

This facility has mostly older toilet and urinal fixtures that are not of the low flow type available today. Sink aerators are typically 2.2 gpm. Domestic hot water is generated by a Lochinvar unit rated at 222 MBH and stored in a large tank.

Miscellaneous

The kitchen has gas appliances and an old walk-in cooler with town water cooled condenser. There is 12 kW hot water booster heater for the dishwasher.

Energy Efficiency Opportunities

This facility has a EUI of 80 kBtu/SF, which is about average for similar school buildings in the district. We identified many areas for efficiency improvements which are summarized below.

Specific Opportunities Identified:

- Reconfigure hallway lighting for permanent solution to overlit areas
- Update remaining areas that continue to use incandescent lights
- Consider super T8 retrofit throughout the school.
- Add daylighting controls for lamps in dining room
- Consider occupancy sensors in hallways, bathrooms, gym and offices
- Replace toilets and aerators with low flow fixtures
- Replace CRT computer monitors and apply PC power management strategy
- Install plug load controller for vending machines / other
- Replace walk-in cooler case and refrigeration equipment
- Add programmable or remote controlled thermostats in portable classrooms
- Add/replace exterior door seals and provide door alignment
- Consider alternate options for automatic front door
- Consider DDC building automation controls
- Interlock dishwasher with exhaust fan
- Replace old motors
- Steam trap maintenance program
- Replace windows
- New hydronic heating system

- Gas-fired portable classroom RTUs

Charter Oak Elementary School

Charter Oak is located at 425 Oakwood Avenue and totals 62,800 square feet. The two story plus basement brick building was originally opened in the 1930's. In the late 70's an addition was constructed on the front section of the building, coinciding with other general renovations. The addition includes first floor administrative area and upstairs library – all air-conditioned. The school has classrooms on the 1st and 2nd floors, cafeteria with kitchen, an old auditorium and gymnasium. There are roughly 300 pre-kindergarten through grade five students enrolled in this school. This school is architecturally very similar to Morley Elementary School.

Normal school hours are weekdays approximately 8:30 a.m. to 3:20 p.m. with shorter hours on Wednesdays. On weekdays, there are after school programs that run into the early evening. There is occasional use of the gym of Saturdays. This year, some summer programs are being scheduled.

Building Envelope

This facility is constructed of brick/masonry with flat built up roof sections. There is likely to be rigid roof insulation of some degree in at least the addition. There is unlikely to be any insulation in the walls. Operable windows have double pane glass and appear to be in fair to decent condition. The exterior doors are equipped with weather seals, but generally lack "sweeps" on the bottom of the door to seal the threshold area.

HVAC

Classrooms in this school are equipped with steam-fired perimeter radiators. On the 3rd floor, all the classrooms have older Trane steam-fired unit ventilators. It is unclear why some rooms have ventilation and other don't. There is a large gas-fired DX Mammoth multizone rooftop unit that serves the addition, plus several adjacent classrooms. This unit has a 15 hp supply fan, 7.5 hp return fan serving nine separate zones. The unit has an 800 MBH gas burner. HV-1 with a 2 hp fan serves the gym and is in rough condition. Due to problems with this unit, several ceiling unit heaters were added to the gym that are now not required since HV-1's coils were cleaned. Another older H&V serves the auditorium. There are approximately fourteen window A/Cs. Two smaller all-electric rooftop units serve the portable classrooms.

Central Boiler Plant

This school is heated by two HB Smith steam boilers. The cast iron sectional boilers are each rated at an estimated 3,090 MBH. There is a small heating hot water loop with a pair of 1 hp pumps (one standby). At the time of or tour, building heat was active and the condensate receiver was 160°F. Also, there was no steam apparent in the receiver vent line, indicating that there were no widespread steam trap issues at the time. Domestic hot water is provided by separate gas-fired tank heater rated at 300 MBH, which also has an indirect heating hot water coil. The gas-fired domestic hot water heater was installed in 1994.

Controls

This school uses the older Invensys control system based on a Network 8000 panel. The DDC system has dial up to the main front end at the DPW. The system monitors and controls the boiler plant and rooftop unit. The remainder of the school is pneumatic controlled via newer panel. There are five control zones set up with occupied and unoccupied scheduling via Invensys. Systems are activated in occupied mode from 7 a.m. to 4 p.m. Toilet exhaust fans are also scheduled on/off. Dual 1 hp air compressors generate instrument air.

Lighting

This facility is predominantly lit with T8 fluorescent lamps and ballasts as well as CFLs. There are HID lights in the atrium. The gym has new T5 fixtures. There are metal halide fixtures in the auditorium. Fluorescent lamps have been selectively removed from hallway fixtures to save energy. There may be additional opportunity to reduce light level in the second floor hallway. We noted LED exit signs. This is one of the few schools that hasn't had a recent lighting survey.

Kitchen

The kitchen uses gas-fired appliances. There is a Hussmann walk-in cooler with small refrigeration system. The dishwasher room has an unusually large exhaust and no make-up air provision.

Energy Efficiency Opportunities

This facility has a EUI of 94 kBtu/SF. This 94 kBtu/SF is the highest EUI in this group of schools. It is nearly 30% higher than Morley, which is a very similar school (although Charter Oak has more air conditioning. This EUI indicates that there is opportunity to make improvements. We identified many areas for efficiency enhancements, which are summarized below.

Specific Opportunities Identified:

- Lighting updates
- Replace CRT computer monitors and apply PC power management strategy
- Add/replace exterior door seals and provide proper door alignment
- Steam trap maintenance
- Review control system settings and sequences – i.e. recommissioning (i.e., check building ventilation, control setpoint and sequences)
- Update Invensys to current standards with additional HVAC points and efficiency strategies
- Review kitchen exhaust and make updates as appropriate

Conard High School

This 288,100 square foot high school, located at 110 Beachwood Road, was erected in 1957. There was a major addition and renovations in 1999 that included new rooftop units and a hot water boiler plant. In 2009, there was additional work to modernize the kitchen. There are about 1,500 students enrolled in this school. The multi-level facility has approximately 90 classrooms, a large auditorium with seating for 928, main and auxiliary gymnasiums, full service cafeteria and industrial arts shops. In addition,

there is a separate one story facility referred to as the Reach Building that consists of classrooms only. This facility was built approximately 40 years ago as a temporary building.

Normal school hours are weekdays 7:30 a.m. to 2:15 p.m. although the building is typically lightly occupied through the afternoon and into the early evening. There are typically weekend activity as well as summer programs. Community uses include: Leisure Services, Youth League and a church services on Sundays. During the school summer break, the Town tries to limit air conditioning to areas in use only. Air conditioning is frequently run at night to pre-cool the building in order to avoid electric demand charges.

Building Envelope

This facility is constructed of brick faced concrete blocks with steel decks and membrane roof sections. Insulation materials and effectiveness in the walls and roof are unknown and expected to be minimal in the original structure. The Town has plans to replace some roof sections with additional insulation to makeup the recommended drainage pitch. Windows are mostly casement metal framed with thermal panes. The few windows we saw were in reasonably good condition. Many exterior doors don't have weather stripping and generally are in need of attention to assure proper closure.

HVAC

This facility is conditioned by two large constant volume multizone units and seven roof top units. The multizone system serves the original structure and the rooftops the '99 addition space. Each HVAC system has a 2-pipe heating/cooling coil. The multizones employ two-way valves whereas the rooftops have three-way valve and run-around freeze protection pumps. The units are summarized in the table below. The Reach facility has electric heating strips and a few DX air conditioners.

Table 4 – Design Summary of Conard HVAC Units

Unit	Serves	Type	Supply Fan hp	Airflow cfm	Coil ton
AHU-A	A bldg (classrooms)	Multizone	2 x 20	92,000	304
AHU-B	B Bldg (café, auditorium)	Multizone	2 x 30	121,000	399
RTU-1	New Math Wing	VAV	15	12,750	38
RTU-2	New Gym	CV	10	8,000	29
RTU-3	New Office	VAV	15	12,500	28
RTU-4	New Media Center	VAV	15	15,200	36
RTU-5	Industrial Arts – 1162	CV	5	5,600	19
RTU-6	Industrial Arts – 1171	CV	5	3,400	12
RTU-7	Industrial Arts – 1164	CV	3	3,000	11

Central Plant

The Conard school has central boiler and chiller plants serving the entire facility except the Reach building. The boiler plant consists of two dual fuel Smith cast iron sectional hot water boilers dating from 1999. Each has a 5,704 MBH Cyclonetic burner with 5 hp forced draft fan. Gas is normally used. The Town has plans to decommission the oil storage and handling systems. Hot water is distributed by two of three 60 hp dual temperature centrifugal pumps with variable speed controls. This dual temperature distribution system is used in the summer to circulate chilled water. Chilled water is

generated by two 320 ton air-cooled packaged chillers mounted on the roof of the facility. There are two 15 hp constant volume primary chilled water pumps. The chiller plant and all pumps are in the process of being replaced with similar equipment. The new system will circulate glycol, and the new pumps have an improved external bearing design that is more suitable for chilled water service.

Controls

All major HVAC systems are controlled by an older Invensys direct digital control (DDC) system. This is an overlay system driving existing pneumatic devices on the large multizone units. The system provides zone temperature control, ventilation management and scheduling of equipment. We reviewed some of the features of the system, which, while very old with outdated software, appears to be fully functional. Town staff are familiar with and using the controls system to keep the building operating as best they can. We noted that at least a few CO2 sensors have been overridden due to calibration or other issues, and the ventilation systems were operating at a high minimum setting (25%). The pneumatic system gets its air from a 2 hp reciprocating compressor.

Lighting

This facility has T8 fluorescent lamps and ballasts dating from the mid 90's. There are some compact fluorescent lamps in the main entrance hallway and the auditorium seating area. Gyms have newer T5 fixtures. Every other fixture in the hallways has been depowered to save energy. There aren't any occupancy sensors used at this school. Staff indicate that lights in classrooms are reliably turned off when they aren't in use.

Domestic Water

This facility has older toilet and urinal fixtures that are not of the low flow type available today. Sink aerators are typically 2.2 gpm.

Domestic hot water is generated by two AO Smith gas-fired units feeding a large storage tank. The burners are rated at 680 MBH input each.

Miscellaneous

The auto shop facility has a large reciprocating air compressor (size undetermined). The kitchen has four new walk-in coolers and freezers with cycling evaporator fans and air curtains. Kitchen hood exhaust fans are controlled by wall switches.

Energy Efficiency Opportunities

This facility has a EUI of 74 kBtu/SF, which is average. There should be some potential to reduce energy use through a combination of operational changes and projects. Opportunities we are recommending include widespread lighting updates and also controls modernization with retro-commissioning of building systems. We believe retro-commissioning could be especially effective since the 1999 building renovation did not include commissioning services, and we were told that there were problems with the contractor completing his work.

Specific Opportunities Identified:

- Consider super T8 retrofit throughout the school. May make sense to reconfigure hallway lighting for permanent solution to overlit areas.
- Add daylighting controls for lamps in entrance skylights
- Consider occupancy sensors in hallways, bathrooms, gyms and offices
- Replace toilets and aerators with low flow fixtures
- Replace CRT computer monitors and apply PC power management strategy
- Install plug load controllers for vending machines / other
- Add/replace exterior door seals
- Review control system settings and sequences – i.e. recommissioning (initial areas of concern: ventilation, hot water temperature vs flow sequences, summer space programming and air conditioning strategy)
- Update Invensys to current standards and add additional efficiency strategies
- Add kitchen hood controls
- Interlock dishwasher with exhaust fan
- Replace RTU three-way valve with two-way (saves pumping)
- Review possibility of converting multizone units to variable volume
- Add VFDs to constant volume rooftop units
- Convert Reach building to gas heating
- New VAV air handlers or rooftop units to replace old multizones

Duffy Elementary School

Duffy Elementary School is located at 95 Westminster Drive and totals 79,000 square feet. The two story building was opened in 1952. There was a recent expansion to provide a new Media Center. There are 560 students currently enrolled in this school. The facility has approximately 30 classrooms, an auditorium, a gymnasium, and cafeteria. In addition, there is a separate temporary "portable" building with nine classrooms assembled with multiple prefabricated mobile units.

Normal school hours are 8:30 a.m. to 3:20 p.m., except Wednesday when student classes end at 2 p.m. There is a daycare service that is open until 6 p.m. Custodial services are normally completed by midnight. There are typically very limited weekend and summer activities.

Building Envelope

This facility is constructed of brick faced concrete blocks with flat built up asphalt roof with stone ballast. Insulation materials and effectiveness in the walls and roof are unknown and expected to be minimal given the building's vintage. Windows are mostly casement metal framed with single panes. The few windows we saw were in rough condition, including some that can't close properly. In addition to windows, each classroom has a glass block section, which generally has very poor thermal performance. We noted exterior doors don't have weather stripping and generally are in need of attention to ensure proper closure.

HVAC

Originally this school had a steam heating system. It was converted to a hot water system about 5 years ago. We expect original coils were reused in many applications. Classroom heat is provided by perimeter radiation. The library and portable units are the only air conditioned areas of the building.

This facility has very limited mechanical ventilation. There are exhaust fans that draw air from the tunnels, but no general make-up air units. The tunnel fans were not on at the time of our visit. The gym has a 3 hp H&V unit with a 561 MBH coil. There is also a 2 hp H&V serving the auditorium. Both of these areas have roof exhausters for summer operation. In the winter, the gym unit is frequently not used because it cannot heat supply air adequately. There are two newer cooling only DX rooftop units that serve the Media Center and adjacent computer lab. The portables area has three all electric rooftop units.

Central Boiler Plant

This school has four Weil McClain Model 788 cast iron sectional hot water boilers. Each boiler has a Power Flame burner rated at 2,049 MBH with ¾ hp blower. The burner is dual fuel, but the Town uses gas exclusively. The boilers were installed about 5 years ago and appear to be in good condition. Hot water is circulated by one of two 15 hp variable speed Taco centrifugal pumps.

Controls

All major HVAC systems are controlled by an older Invensys direct digital control (DDC) system. This is a mostly overlay system on pneumatically actuated mechanical devices. The system is setup to schedule equipment run times and a night temperature setback to about 62^{o}F.

Lighting

This facility has T8 fluorescent lamps and ballasts dating from the 1990's. There is some sporadic use of incandescent lamps. The auditorium uses 1,000 watt quartz wall wash fixtures with overhead dome fixtures using three 75 watt incandescent lamps. The cafeteria uses 250 watt mercury vapor lamps. The Media Center has unusual compact fluorescent fixtures that are designed to resemble HID. This area may be excessively lit. Gyms have newer T5 fixtures. Every other fixture in the hallways has been depowered to save energy. There are no occupancy sensors used at this school.

Domestic Water

This facility has mostly older toilet and urinal fixtures that are not of the low flow type available today. Sink fixtures are straight spigots without any way to attach aerators. Domestic hot water is generated by an AO smith heater rated at 199 MBH.

Miscellaneous

The kitchen has a walk-in cooler with older Larkin evaporator and city water-cooled condenser. There is a 45 kW booster heater serving the dishwasher. The dishwasher doesn't have a captive hood.

Energy Efficiency Opportunities

This facility has a EUI of 84 kBtu/SF, which is one of the highest energy use levels in the West Hartford school portfolio. The high use is consistent with the age and type of systems in this facility. There is good opportunity to make improvements. Our recommendations are summarized below.

Specific Opportunities Identified:

- Reconfigure hallway lighting for permanent solution to overlit areas
- Update remaining areas that continue to use incandescent lights
- New auditorium lighting
- Consider super T8 retrofit throughout the school.
- Consider occupancy sensors in hallways, bathrooms, gyms and offices
- Replace toilets and aerators with low flow fixtures
- Replace CRT computer monitors and apply PC power management strategy
- Install plug load controller for vending machines / other
- Add/replace exterior door seals and provide door alignment
- Window repair or replacement program
- Review control system settings and sequences – i.e. recommissioning (initial areas of concern: ventilation, summer space programming and air conditioning strategy, discontinued use of AHU-1 desiccant heat recovery wheel)
- Update Invensys to current standards and add additional efficiency strategies
- Downsize kitchen exhaust and/or add controls
- Interlock dishwasher with exhaust fan
- Replace old motors
- Better controls for the portable classrooms
- Gas-fired RTUs for portables

Hall High School

This 277,800 square foot high school is located at 975 North Main Street. The three story building was opened in 1970. There was a major addition in 1999 that included a new science wing. At that time, there were major renovations throughout the facility including new lighting and replacement of extensive HVAC components including just about everything on the roof. There are over 1,500 students enrolled in this school. The facility has approximately 80 classrooms, a large auditorium, two large gymnasiums, full service cafeteria and industrial arts shops. In addition, there is a separate temporary "portable" building with nine classrooms assembled with multiple prefabricated mobile units.

Normal school hours are weekdays 7:00 a.m. to 2:15 p.m. although the building is typically lightly occupied through the afternoon and into the early evening. Custodial services are normally completed by 11 p.m. There are typically weekend activity as well as summer programs. Community uses include a summer arts festival, athletic programs and periodic blood drives. During the school summer break, the Town tries to limit air conditioning to areas in use. The remaining areas of the school are conditioned to a warmer setpoint.

Building Envelope

This facility is constructed of brick faced concrete blocks with a steel deck and mostly ballasted asphalt roof. Insulation materials and effectiveness in the walls and roof are unknown and expected to be minimal in the original structure. Windows are mostly casement metal framed with single panes. The few windows we saw were in terrible condition with frame and hardware problem that prevent windows from properly closing. The new addition wing has thermal pane plate windows with an operable top section. This is an unusual arrangement requiring a special reaching tool to open/close windows. It is not possible for occupants to see if windows are properly closed without a ladder. We noted exterior doors don't have weather stripping and generally are in need of attention to assure proper closure.

HVAC

This facility is conditioned by a variety of split air handlers and heating-ventilation units. Most of the air handling units are older multizones. All condensing and rooftop units were replaced in 1999. The portable building area is conditioned by nine gas-fired DX rooftop units.

Table 5 – Design Summary of Available Information on Hall HVAC Units

Unit	Serves	Type	VFD?	Supply Fan hp	Airflow cfm	Coil ton
HV-1	Boy's locker room	100% OSA	No	5	NA	-
HV-2	Girl's locker room	100% OSA	No	2	NA	-
HV-2S	Weight Room	CV	No	¾	2,640	-
HV-3	Gym B	CV	No	NA	NA	-
HV-4	Gym B	CV	No	NA	NA	-
HV-5	Gym A	CV	No	NA	NA	-
HV-6	Gym A	CV	No	NA	NA	-
HV-7	Area F	CV	Yes	NA	NA	-
RT-AHU-1	Area H	VAV/reheat	Yes	15	17,745	59
RTU-1	Area F, 1st Flr	CV	No	3	6,000	21
HVAC-1	Bldg B, Library Offices	CV	No	¼	820	-
HVAC-3	Area C, Graphic Arts	VAV	No	5	4,750	-
AH-1	Area A, 2nd Flr	MZ-4	No	8	NA	31
AH-2	Area C, 2nd Flr		No	NA	NA	31
AH-3	Library	MZ-3	No	10	NA	38
AH-4	Library	MZ-3	No	7.5	NA	31
AH-5	Library		No	NA	NA	8
AH-6	Café	MZ-4	No	15	NA	63
AH-7	Area A, Ground		No	NA	NA	50
AH-8	Area E, Ground	MZ-9	No	15	NA	38
AH-9	Area E, Admin		No	NA	NA	15
AH-10	Auditorium	MZ-2	No	15	NA	75
AH-11	Music		No	NA	NA	25
AH-12	Music		No	NA	NA	15

Central Plant

Hall has a central boiler and chiller plant serving the entire facility except the portable classrooms. The boiler plant consists of two dual fuel Kewanee hot water boilers (age unknown). Each has a 17,710 MBH

Iron Fireman Burner with 25 hp forced draft fan. Gas is normally used. The Town has plans to decommission the oil storage and handling systems. Hot water is distributed to heating-only unit ventilators and convectors by one of two 30 hp constant speed centrifugal pumps.

There are two additional 30 hp dual temperature centrifugal pumps. The dual temperature distribution system is used year round to circulate hot water or chilled water to air handler coils. Chilled water is generated by a single Dunham Bush centrifugal packaged chiller in the same mechanical room as the boiler. The chiller uses R22 refrigerant. There are two 10 hp constant volume condenser water pumps. All pumps in the central plant were replaced in 1999. The cooling tower has a two-speed fan and is about 5 years old.

Controls

All major HVAC systems are controlled by an older Invensys direct digital control (DDC) system. This is a mostly electric system with pneumatic overlay on multizone air handler and H&V units. The system provides zone temperature control, ventilation management and scheduling of equipment. We reviewed some of the features of the system, which, while very old with outdated software, appears to be fully functional. Town staff are clearly familiar with and using the controls system to keep the building operating as best they can.

Lighting

This facility has T8 fluorescent lamps and ballasts dating from the 1999 renovation. Many classrooms have three-lamp uplights that hang down from the suspended ceiling. Some areas have compact fluorescent lamps. The auditorium seating area uses incandescent flood lamps. Gyms have newer T5 fixtures. Every other fixture in the hallways has been depowered to save energy. There are some occupancy sensors used at this school.

Domestic Water

This facility has mostly older toilet and urinal fixtures that are not of the low flow type available today. Low flow units are being used in the new addition and administration area. Sink aerators are typically 2.2 gpm. Domestic hot water is generated by four Utica gas-fired units rated at 300 MBH each.

Miscellaneous

There is a small ten panel solar photovoltaic system on the roof the high school.

Energy Efficiency Opportunities

This facility has a EUI of49 kBtu/SF, which is unusually low for a facility of this age and nature.

It is interesting to compare building performance with West Hartford's Conard High School, which has a EUI of 74 kBtu/SF. These schools are very similar in construction, the way they are operated, student population, and even systems. We have no explanation for why Hall should be performing so much better than Conard. As a first step, we suggest confirming that square footage values and input utility use data is accurate.

We identified many areas for efficiency improvements, which are summarized below.

Specific Opportunities Identified:

- Remove hallway lighting fixtures in lower level "H" area. May make sense to reconfigure hallway lighting for permanent solution to overlit areas
- Update remaining areas that continue to use incandescent and T12 fluorescent lights
- Consider super T8 retrofit throughout the school. Add daylighting controls for lamps in entrance skylights
- Replace exterior lights – need brighter security lighting
- Consider occupancy sensors in hallways, bathrooms, gyms and offices
- Replace toilets and aerators with low flow fixtures
- Replace CRT computer monitors and apply PC power management strategy
- Install plug load controller for vending machines / other
- Replace split systems suction pipe insulation on roof
- Add/replace exterior door seals and provide door alignment
- Add ceiling level insulation barrier in guidance area and former greenhouse PC lab
- Window repair and sealing or replacement program
- Review control system settings and sequences – i.e. recommissioning (initial areas of concern: ventilation, summer space programming and air conditioning strategy, discontinued use of AHU-1 desiccant heat recovery wheel)
- Update Invensys to current standards and add additional efficiency strategies
- Downsize kitchen exhaust and/or add controls
- Interlock dishwasher with exhaust fan
- Add gym A make-up air unit(s)
- Consider occupancy based HVAC control in gyms, auditorium and cafe
- Replace old motors
- Add VFDs to select multi-zone unit fans
- Consider VFD control of cooling tower fans
- Replace chiller
- Better controls for portables

King Philip Middle School

This is one of West Hartford's three middle schools and is located at 100 King Philip Drive. The building is mostly one story, plus a partial lower level. The school totals 192,900 square feet. The structure was built in 1954 and much of the equipment in this facility is older or original. In 2001 there was a small addition including the current media center. There are over 880 students currently enrolled in this school. The facility has approximately 65 classrooms, an auditorium, gymnasiums, and full service cafeteria. In addition, there is a separate "portable" building with about twelve classrooms that have been assembled from mobile units. This part of the school is about 10 years old with several new units added recently.

Normal school hours are weekdays 8:00 a.m. to 2:50 p.m. although the building is typically lightly occupied through the afternoon and into the early evening. A theatre company rents the auditorium,

and there is occasional evening and weekend activity in this area of the building. Custodial services are normally completed before midnight on weekdays. There is typically weekend activity in the gyms as well as summer programs every other year.

Building Envelope

This facility is constructed of brick faced concrete blocks with flat built up membrane roof. Insulation materials and effectiveness in the walls and roof are unknown and expected to be minimal in the original 1954-vintage structure. Windows are mostly casement metal framed with single panes. There is some glass block. Windows in the gyms are elevated and difficult to access to see if they are properly sealed. The main entrance has an automatic opening inner and outer door set. Door movement is triggered by a mat that protrudes into the main hallway. Students passing through the hallway tend to trigger the doors to open. We also noted that exterior doors don't have weather stripping and generally are in need of attention to assure proper closure.

HVAC

With the exception of the new wing, this facility is heated by original steam radiation. There is limited make-up air compared to general exhaust and the building tends to run negative. Further, classroom make-up air units are frequently not used in cold weather because the supply air cannot be maintained warm enough. There are fourteen ductless splits providing air conditioning in classrooms. The auditorium has its original 7.5 hp H&V unit. The gyms have exhaust fans without make-up. The kitchen has a gas-fired make-up air unit.

The new wing has a 7.5 hp make-up air unit rated at 7,340 cfm with matching general exhaust. This unit has a 40 ton cooling coil and 570 MBH hot water coil. In addition there are four 4-pipe fan coil units. Air balance is reported to be good in the new wing

"Portables" have all electric space conditioning. We don't know if systems are heat pumps or employ direct resistance heating elements. Floor electric heaters are in use in the hallway.

Central Boiler

King Philip has central steam plant serving the entire facility except the portable classrooms. There is a large gas/oil Kewanee boiler. The burner was replaced in 1994 and is rated at 14,700 MBH. Gas is used exclusively, and oil is being phased out. The forced draft fan is 15 hp. Steam pressure is maintained at approximately 5 psi. This is a two-pipe steam system with a vacuum purge system powered by a 5 hp blower. Condensate is collected in a single receiver with three approximately 3 hp feedwater pumps. There is a small hot water loop for the addition which is circulated by a duplex 5 hp B&G pump set.

Chilled Water Plant

The school has a small chilled water system serving new wing equipment. Chilled water is generated by an approximately 62 ton McQuay packaged air-cooled chiller. Circulation is provided by a pair of 2 hp B&G centrifugal pumps.

Controls

This is predominantly a pneumatic control building. There is a central control panel with timers for each control zone. The timers are setup to run for 12 hours blocks of time. Each morning a building custodian winds up each timer to activate the occupied space temperature setpoints throughout the school. When the timers complete their cycles, zones resume their unoccupied space temperature setpoints. All thermostats are pneumatic. Compressed air is supplied by a dual 2 hp reciprocating compressor. The City invests a considerable effort to keep the pneumatic system functional. The boiler plant operation is entirely manual. There is a small Invensys direct digital control system that manages HVAC associated with the new wing and Media Center.

Lighting

A contract has been awarded to update all the lights at this school, and, therefore, we did not include a lighting review during our walk through. We understand the lighting scope of work includes replacing all fluorescent lamps with 28 watt T8s, new electronic ballasts throughout the school, new T5 fixtures in the gyms, new auditorium lights, and occupancy sensors in select areas. West Hartford should see a noticeable reduction of electrical power use once this project is completed.

Domestic Water

This facility has a mix of older toilet and urinal fixtures that are not of the low flow type and new units that have low flow ratings. Sink aerators are typically 2.2 gpm.

Domestic hot water is generated by a PVI gas-fired unit rated at 399 MBH. There is a separate 180 MBH domestic hot water heater providing the kitchen with 150^{o}F water.

Miscellaneous

The kitchen has an original wood-sheathed walk-in cooler with antiquated McQuay evaporator. The condensing unit is water cooled using city water. The school has one hydraulic elevator.

Energy Efficiency Opportunities

This facility has a EUI of 80 kBtu/SF, which is somewhat high compared to other public schools in West Hartford. Higher energy use is not surprising given the age and type of equipment in the building. There is excellent opportunity make improvements. By changing operating practices and updating systems, it should be possible to reduce energy use in this building by 20-30 percent.

Specific Opportunities Identified:

- Replace toilets and aerators with low flow fixtures
- Replace CRT computer monitors and apply PC power management strategy
- Install plug load controller for vending machines / other
- Discontinue automatic door and reconfigure for push button operation
- Add/replace exterior door seals and provide door alignment
- Steam trap maintenance program
- Replace walk-in refrigeration equipment (consider replacing entire walk-in enclosure)
- Install DDC controls on HVAC systems

- Interlock dishwasher with exhaust fan
- Add make-up air to gyms
- Consider occupancy based HVAC control in gyms, auditorium and cafe
- Replace old motors
- Review portable classroom HVAC systems – add thermostat controls and consider alternative to electric heating.

Morley Elementary School

Morley Elementary School is located at 77 Bretton Road and totals 61,100 square feet. The two story plus basement brick building was originally opened in the 1929. In 1976 an addition was constructed on the front section of the building coinciding with other general renovations. The addition includes first floor administrative area and upstairs library, all of which are all air-conditioned. The school has classrooms on the 1st and 2nd floors, a cafeteria with kitchen, an old auditorium, and a gymnasium. There are roughly 300 pre-kindergarten through fifth grade students enrolled in this school. This school's architectural design and systems are very similar to the Charter Oak School.

Normal school hours are weekdays approximately 8:00 a.m. to 3:20 p.m. with shorter hours on Wednesdays. On weekdays, there is a daycare service open until 6:30 p.m. and a winter basketball program that runs until 9 p.m. Custodial services are completed in the afternoon and evening. There is generally no weekend activity. There is limited summer use of this school.

Building Envelope

This facility is constructed of brick/masonry with flat built up roof sections. New roofing was added over the gym and auditorium and included a generous amount of rigid insulation. Otherwise, roof insulation thickness (or even its existence at all) elsewhere in the building is unknown. We suspect that there is no insulation in the walls. Operable windows with thermal pane glass are from the 1980's and are in fair condition. Some single pane windows remain in stairwells, etc. The exterior doors are equipped with weather seals, but generally lack "sweeps" on the bottom of the door to seal the threshold area.

HVAC

Classrooms in this school are equipped with steam-fired perimeter radiators. Some classrooms also have old Trane steam-fired unit ventilators. It is unclear why some rooms have ventilation and other don't. Two of the classrooms have window air conditioners. There is a large gas-fired DX Mammoth multizone rooftop unit that serves the 1976 addition areas, plus several adjacent classrooms. This unit has a 15 hp supply fan, 7.5 hp return fan serving nine separate zones. There is a 2 hp H&V unit serving the gym, which has roof exhauster as well. The auditorium has an additional H&V unit, but it rarely runs. There are two A/C units in the cafeteria that generally run daily through the cooling season.

Central Boiler Plant

Morley is heated by two Weil McLain gas-fired steam boilers. The cast iron sectional boilers are each rated at 3,000 MBH. Separate gas-fired tank heater rated at 1,357 MBH provides domestic hot water. The kitchen has its own small 140°F DHW heater system that is on timer controls.

Controls

This school uses the older Invensys control system based on a Barbra Coleman Network 8000 panel. The DDC system has dial up to the main front end at the DPW. The system monitors and controls the boiler plant and rooftop unit. The remainder of the school is pneumatic controlled via newer panel. There are five-control zones setup with occupied and unoccupied scheduling via Invensys. The unoccupied setpoint is typically around 60^{o}F. Toilet exhaust fans are also scheduled on/off. A 2 hp air compressor generates instrument air.

Lighting

This facility is predominantly lit with T8 fluorescent lamps and ballasts as well as CFLs. The gym has new T5 fixtures. There are metal halide fixtures in the auditorium. We noted a few incandescent lamps in use in the kitchen hood and in table lamps. Fluorescent lamps have been selectively removed from hallway fixtures to save energy. There may be additional opportunity to reduce light level in the second floor hallway. Exist signs are LED. A lighting contractor recently completed a full lighting survey and proposal.

Kitchen

The kitchen uses gas-fired appliances. The walk-in cooler box is out-of-date. Refrigeration may be water-cooled (we were unable to access the mechanical space). The kitchen and dishwasher area exhaust systems are tied together.

Energy Efficiency Opportunities

This facility has a EUI of 68 kBtu/SF, which is fairly low compared to the other elementary schools in West Hartford and much lower than Morley's, this school's counterpart. We identified several areas for efficiency improvement that are summarized below.

Specific Opportunities Identified:

- Lighting updates as prescribed by contractor
- Replace CRT computer monitors and apply PC power management strategy
- Add/replace exterior door seals and provide proper door alignment
- Steam trap maintenance
- Review control system settings and sequences – i.e. recommissioning
- Update Invensys to current standards and add additional efficiency strategies
- Walk-in refrigeration updates

Nordfeldt Elementary School

Nordfeldt Elementary School is located at 35 Barksdale Road and totals 61,700 square feet. The facility was originally opened in 1956. This school has two interconnected sections. The single story section includes the administrative area, auditorium, library, and cafeteria/kitchen. The adjacent two-story classroom wing also includes the gym. Approximately 10 years ago, there was an expansion of the gym and addition of a new library space and four "portable" classrooms. There are about 420 kindergarten through fifth grade students enrolled in this school.

Normal school hours are weekdays approximately 8:30 a.m. to 3:20 p.m. with shorter hours on Wednesdays. There are some after school programs in the cafeteria that are completed by 6 p.m. There is also a basketball program in the evenings from 5 p.m. to 9 p.m. Custodial services are completed in the afternoon and evening. There is no weekend or summer activity.

Building Envelope

This facility is constructed of brick faced concrete blocks with flat built up roof sections. Insulation materials and their effectiveness in the roof and walls are unknown and expected to be minimal. The thermal barrier on the portable buildings is less than optimal. Windows are single pane casement in very poor condition. Exterior doors were recently replaced and have weather seals, some of which need adjustments.

HVAC

Nordfeldt employs classroom radiators. The heating system was recently converted from steam to hot water. There are two general ventilation exhaust fans per floor in the academic wing. The gym has two newer ceiling hung H&V units. There is also a small (approximately 2 hp) gas-fired VAV rooftop unit that serves the library. All air conditioning is turned off for the summer.

Central Boiler Plant

Nordfeldt has a new high efficiency boiler plant consisting of two gas-fired Aerco condensing units (size unknown). Hot water is circulated via a pair of 5 hp centrifugal pumps (one standby). The boilers are not operating as efficiently as intended as circulating water temperature has to be kept warmer than optimal for this type of boiler, otherwise the gym and adjacent offices get too cold. The plant's control system is setup with a hot water temperature reset program that adjusts hot water circulating temperature based on outside air temperature. At the time of our visit, hot water was being circulated at 145^{o}F. The reset program has been adjusted as best as it can be to keep water temperature as low as possible. The perception is that this new condensing boiler plant is operating better than the similar boiler installation and operating situation at Aiken. Domestic hot water is generated by a newer AO Smith tank unit (150 MBH/100 gallons).

Controls

This school uses the older Invensys control system with dial up to the main front end at the DPW. The system is tied to the new Aerco boiler controller, fully manages the gym and library AHUs, and provides day/night scheduling input to the older pneumatic controller, which has eight zones. Systems are setup with an optimum start feature, but this isn't working. Staff schedule equipment to start at 5 a.m. to ensure that the school is comfortable when the building opens. Classrooms have old JCI pneumatic thermostats in poor condition. The stats are setup for 72^{o}F (day) and 55^{o}F (night), but it is unlikely that these exact setpoints are being achieved.

Lighting

This facility is predominantly lit with T8 fluorescent lamps and ballasts. There are T12s in the portables and new T5 fixtures in the gym. There are also incandescent lamps in the kitchen hood. Every other

light in hallways has been de-energized to save electricity. A lighting contractor recently completed a full lighting survey and proposal.

Kitchen

The kitchen has gas-fired appliances. The walk-in cooler case is old and out-of-date, as is the refrigeration equipment. This school also has a full size walk-in freezer that is used by multiple schools in West Hartford. There is a 45 kW electric hot water booster heater for the dishwasher. There is a timer on the dishwasher exhaust fan switch.

Energy Efficiency Opportunities

This facility has a EUI of 67 kBtu/SF, which is on the low side compared to the other elementary schools in West Hartford. We identified areas for efficiency improvements that are summarized below.

Specific Opportunities Identified:

- Lighting updates as prescribed by contractor (if not included, we recommend daylighting control in library alcove)
- Replace CRT computer monitors and apply PC power management strategy
- Adjust/replace exterior door seals where not sealing well on the new doors
- Review control system settings and sequences – i.e. recommissioning (e.g. resolve optimal start issue)
- Update Invensys to current standards
- Consider DDC update from pneumatic thermostat control
- Replace walk-in cooler and refrigeration
- Consider gas-fired hot water heater for dishwasher

Sedgwick Middle School

Sedgwick Middle School is located at 128 Sedgwick Road and totals 183,400 square feet. The three level building was originally opened in the 1930. There have been a multitude of additions and renovations over the years. More recent work includes the 1990 “sixth grade wing” addition. In 2000, the library was expanded, and in 2004, there was additional construction in the 6th grade area.

The school has classrooms on all levels, a cafeteria with kitchen, an auditorium and three gymnasiums. There are approximately 1,000 sixth through eighth grade students enrolled in this school.

Normal school hours are weekdays, approximately 8:00 a.m. to 2:50 p.m. Staff arrive as early as 6:30 a.m. During part of the school year, Leisure Services has evening programs in gyms and several classrooms. Activities are typically on weekdays from 4:30 to 10 p.m. Custodial services are completed in the evening. There is limited weekend activity at the school. This year there will not be a summer school program.

Building Envelope

This facility is constructed of brick/masonry with flat built up roof sections. There is likely to be at least some rigid insulation in most, if not all, roof sections. We doubt there is wall insulation in older parts of

the building. Newer construction is likely to be adequately insulated. The few widows we observed had double thermal panes and were in decent condition. Many of the exterior doors require attention to seal properly.

HVAC

This school has a wide variety of HVAC systems that vary considerably in age and condition.

- There are four large penthouse DX air handlers that serve the older parts of the building. This equipment is in poor condition, especially the outdoor condensing units.
- The sixth grade addition has three newer air handlers, two of which have DX cooling capability.
- There are two older DX air handlers serving the auditorium and associated music room.
- There are also several additional H&V units for gyms.
- Some classrooms are conditioned by ducted air, others have perimeter radiation, and some have both.
- The kitchen has exhaust through an architectural tower on the roof of the building.
- Science lab fume hoods are rarely used.

The table below summarizes available information on air handling units.

Table 6 – Summary of Sedgwick Air Handlers

Unit	Location	Serves	Type	VFD?	Fan hp	DX Cooling
AHU-1	Penthouse West	1st & 2nd Flr West	VAV	Yes	50	Yes
AHU-2	Penthouse West	3rd Flr West	VAV	Yes	40	Yes
AHU-3	Penthouse East	1st & 2nd Flr East	VAV	Yes	40	Yes
AHU-4	Penthouse East	3rd Flr East	VAV	Yes	40	Yes
AHU-1	6th Grade Add'n MER	6th Grade	VAV/FPB	Yes	10	Yes
AHU-2	6th Grade Add'n MER	Interior 6th Grade	CV	No	1.5	Yes
AHU-3	6th Grade Add'n MER	Lockers	H&V	No	Small	No
AHU-4	6th Grade MER	Gym C	H&V	No	5	No
N/A	Gym MER	Weight Rm	100% OSA	No	3	No
AHU-5	2nd Flr Fan Rm	Auditorium	CV/MZ	No	7.5	Yes
AHU-6	2nd Flr Fan Rm	Band & Choral	CV	Yes	5	Yes
H&V-2, -3	2nd Flr Fan Rm	Gym	CV	No	5	No
McQuay RTU	Roof	2004 addition	Unknown	Unknown	15/10	Yes
Trane RTU	Roof	Library	Unknown	Unknown	5	Yes

Central Boiler Plant

The Middle School's boiler plant consists of two large Cleaver Brooks firetube boilers. The boilers date to 1974 and are slated for replacement. Each dual fuel boiler is rated at 8,369 MBH. Currently, and in the recent past, gas has been used exclusively, and that is the plan going forward. There are five constant speed centrifugal hot water pumps ranging from 2 to 7.5 hp. Domestic hot water is generated via indirect tank heater.

There is a small gas-fired AO Smith tank heater, but it does not work. This means the main boiler plant must be kept on-line year-round.

Controls

This school is primarily pneumatically controlled, but also has a very limited DDC interface via older Invensys control system. The DDC system has dial up to the main front end at the DPW and includes monitoring and control of the boiler plant, one of the RTUs and two small split systems. Most of the air handlers are scheduled via 10-hour mechanical timers activated by janitorial staff in the morning. Generally, the equipment turns off by 4 p.m. on weekdays and is generally kept off on weekends. On occasion, the auditorium units are kept on for performances, rehearsals, etc.

This school's controls are completely out-of-date, and a major controls update is needed. That being said, since the current operation is exceptionally lean on equipment use, updating these controls is unlikely to create much financial return from energy use reduction.

Lighting

This facility is predominantly lit with T8 fluorescent lamps and ballasts as well as CFLs. There are metal halide fixtures in the auditorium and gyms. In most hallways, the four lamp fixtures are operating with only two lamps to save energy. This school has parking and exterior lights that operate from roughly 4 p.m. to midnight. A lighting contractor recently completed a full lighting survey and proposal.

Kitchen

The kitchen uses gas-fired ranges and ovens as well as electric kettles. There is an old hood to remove cooking smoke and heat. The dishwasher has exhaust ducting connected to the main hood exhaust system. The walk-in cooler box is antiquated. Associated refrigeration appears to be water-cooled. There is also a small walk-in freezer with air-cooled refrigeration. The kitchen has a general exhaust to remove heat.

Energy Efficiency Opportunities

This facility has a EUI of 58 kBtu/SF, which is excellent performance for a middle school. We suspect that the building's low energy use is largely due to minimized use of the HVAC in the off hours. We identified several areas for efficiency improvements that are summarized below.

Specific Opportunities Identified:

- Lighting updates as prescribed by contractor
- Replace CRT computer monitors and apply PC power management strategy
- Add/replace exterior door seals and provide proper door alignment
- Add thermostatic control to kitchen exhaust fan
- Update Invensys to current standards with recommissioning and sequence updates
- Expand control system to include balance of air handlers and classroom thermostats (poor payback expected)
- Update old motors
- Walk-in refrigeration updates

Smith Elementary School

Smith Elementary School is located at 64 James Street and totals 66,400 square feet. The single and two level brick-building complex was originally opened in the 1970's. The school was expanded in 1995 with all new HVAC systems added. There are roughly 380 pre-kindergarten through grade five students enrolled in this school. The facility has approximately twenty-two classrooms, a gymnasium, cafeteria, auditorium, and administrative offices.

Normal school hours are weekdays approximately 8:30 a.m. to 3:30 p.m. The school is typically lightly occupied through approximately 6 p.m. Custodial services are completed in the afternoon and evening. There is no weekend activity. The school sees quite a bit of summer activity due to air conditioning capability, including adult English classes.

Building Envelope

This facility is constructed of architecturally treated concrete blocks with flat built up roof sections. The nature of any insulation materials and its effectiveness in the walls are unknown. Insulation is expected to be minimal in the original structure. Windows in the older sections of the building are metal-framed casement units with single pane glazing and are in overall poor condition. Some do not fully close. The new addition has operable windows with thermal panes that are in good condition. The exterior doors have seals, some of which could be replaced. There are no seals on the inner door sets.

HVAC

Smith has a variety of space heating and air conditioning systems. Central air conditioning is provided to most of the school via 1995 air handling units (see table below). The balance of the school has four-pipe unit ventilators. There are likely to be some remaining steam-fired unit ventilators without air conditioning.

Table 7 – Air Handler Design Details (1995 Renovation)

Unit	Serves	Type	CFM	Fan hp	CHW Ton	HW MBH
AHU-1	Café	CV	3,300	2	11	215
AHU-2	Auditorium	CV	5,300	3	17	345
AHU-3	Gym & Corridor	CV	4,200	3	14	273
AHU-4	Art / Music / Library	VAV	12,500	15	40	813
AHU-5	Corridor & Classrooms	VAV	8,400	10	27	547
AHU-6	Kitchen	CV	4,500	2	-	439
AHU-7	Office pre K	VAV	6,200	7.5	20	202

Central Boiler Plant

Smith has two Cleaver Brooks low pressure steam boilers that may be original to the building. The Cyclometric /Webster dual fuel burners are rated at 2,678 MBH each. Natural gas is used exclusively. At the time of our visit in the spring, the condensate receiver was at 150^{o}F. This low temperature indicates the likelihood that there are not widespread steam trap issues, but a better test of steam trap effectiveness would be in colder weather. We were told that the steam traps are regularly maintained.

There is hot water loop with water circulated by one of two 7.5 hp centrifugal pumps. It is unclear which and how many systems remain direct steam-fired in this school. Assuming there are limited steam systems left, there is an excellent opportunity to install higher efficiency hot water boilers. Under normal conditions, the boiler plant is turned off at 5 p.m.

Central Chiller Plant

There is central water-cooled Trane R22 centrifugal chiller serving the air-handling unit and four-pipe unit ventilators in the school. The chiller is rated at 172 tons. Chilled water is distributed by one of two 15 hp centrifugal pumps (one standby). Condenser water is circulated by one of two 15 hp centrifugal pumps (one standby). In the summer the plant is active from 8 a.m. to 5 p.m. for summer school programs.

Controls

This school uses the older Invensys control system based on a Network 8000 panel. The DDC system has dial up to the main front end at the DPW. The system is tied to the boiler and chiller plant as well as air handlers and unit ventilators. The setback temperature on the Invensys is typically 60^{o}F. HVAC is generally scheduled to run from 7 a.m. to 4 p.m. weekdays. Systems are setup with an optimum start feature, but this isn't always working well, and staff are incrementally scheduling the occupied periods earlier and earlier to ensure that spaces are comfortable.

Outside dampers may be open during the "warm-up" period. However, the sequence of operation documentation from Invensys indicates that these dampers should be closed. This mode of operation should be checked to ensure that outside air dampers are closed as intended.

Domestic Water

This school is believed to have mostly standard flow toilet and urinal fixtures. Domestic hot water is generated indirectly off the steam plant. In the summer when the steam plant is down, an electric backup unit serves the kitchen.

Lighting

This facility is received a lighting update within the last year. Most lights are T8s. There are new T5s in the gym as well as many CFLs. There are motion sensors in use in appropriate areas in the building.

Kitchen

The kitchen uses gas-fired appliances. The kitchen make-up air and hood exhaust fan run together off a wall switch. The dishwasher exhaust fan operates whenever the area light is on. There is a walk-in cooler and freezer.

Energy Efficiency Opportunities

This facility has a EUI of 71 kBtu/SF, which is average compared to the other elementary schools in West Hartford. We identified many areas for efficiency improvement that are summarized below.

Specific Opportunities Identified:

- Replace CRT computer monitors and apply PC power management strategy
- Add/replace exterior door seals and provide proper door alignment
- Interlock dishwasher exhaust fan with dishwasher
- Review control system settings and sequences – i.e. recommissioning (e.g., check setpoints and sequences such as the optimum start program)
- Update Invensys to current standards
- Install new hot water boiler plant with conversion of remaining steam Univents to hot water
- Window replacement

Webster Hill Elementary School

The Webster Hill School is located at 125 Webster Hill Boulevard. This school serves 440 children from pre-kindergarten to 5th grade. The two-story 77,700 square foot facility was opened in 1949. A major addition and renovation was completed in 1999. The facility has classrooms, cafeteria, gymnasium and a new library. Normal school hours are weekdays 8:30 a.m. to 3:20 p.m. although the building is typically lightly occupied into the late afternoon with custodial service typically completed by about 11:30 p.m. There are normally no weekend activities. The building is usually unoccupied in the summer, but air conditioning is provided during in the summer to the library and offices.

Building Envelope

This facility is constructed of brick faced concrete blocks with a flat membrane roof. Insulation materials and effectiveness in the walls and roof are unknown. We would expect wall insulation to be poor in the original 1949 structure.

Originally, the windows were much larger walls of glass. These were eliminated in the 1970's and replaced with smaller windows. The remaining unglazed voids were framed in with wood that may or may not be properly insulated. The smaller windows are double casement metal framed with non-thermal panes. These window systems are in terrible condition with frame corrosion, no seals on operable sections and latching hardware that doesn't work well. Many exterior doors don't have weather stripping.

HVAC

Classrooms and hallways in the original part of the facility are heated by steam radiation. In 1999, nine steam makeup air units were added to provide mechanical ventilation to the original section of the building. The new addition has hot water heating and three small air conditioning units. Air handlers are summarized in the table below.

Table 8 – Design Summary of Web Hill HVAC Units

Unit	Type	Supply Fan hp	Airflow cfm	Coil Clg ton	Stm Coil PPH	HW Coil MBH	Elec Coil kW
AC-1	CV	2.0	4,000	10	-	270	-
AC-2	CV	0.5	1,300	3	-	-	8
AC-3	CV	0.5	1,000	2	-	-	7
AHU-1	100% OSA	1.0	2,000	-	181	-	-
AHU-2	100% OSA	1.5	2,400	-	217	-	-
AHU-3	100% OSA	1.0	1,800	-	163	-	-
AHU-4	100% OSA	1.0	1,800	-	163	-	-
AHU-5	100% OSA	1.0	1,800	-	163	-	-
AHU-6	100% OSA	1.0	1,800	-	163	-	-
AHU-7	100% OSA	1.0	2,250	-	100	-	-
AHU-8	100% OSA	1.5	2,775	-	250	-	-
AHU-9	100% OSA	3.0	4,500	-	407	-	-

Central Plant

The Webster Hill School has a central steam boiler plant. The boiler plant consists of two dual-fuel Weil McLain cast iron sectional steam boilers that are about 10 years old. Each has a 4,763 MBH Cyclonetic burner with 3 hp forced draft fan. Gas is normally used, and the Town has plans to decommission the oil storage and handling systems.

We noted that both boilers were firing together rather than one taking the lead. Condensate pipe in the boiler room isn't insulated and the area is very hot, resulting in "too much heat" problems in the office above the boiler room. There is a small steam to hot water converter with duplex 1 hp pumps. The hot water system includes controls that reset circulation temperature based on outdoor conditions. The Town last tested and serviced all the steam traps in mid 1990's.

Controls

Local pneumatic valves control steam radiation in the building. The pneumatic system includes electro-mechanical time clocks driving an air pressure-based occupied/unoccupied setpoint strategy. The Town spends a considerable amount of attention attempting to keep this system functional. The newer HVAC systems in the library are controlled by an Invensys direct digital control (DDC) system. The DDC system provides zone temperature control and time of day scheduling of units. The music room apparently has a thermostat location issue and is regularly too hot. Occupants typically open the window to control the space temperature. Other smaller air-handling units are controlled by local thermostat only.

Lighting

This facility has T8 fluorescent lamps and ballasts dating from the mid 90's. A large amount of hallway fixtures have been depowered to save energy. The gym has new T5 fixtures. There are ten elaborate wall sconce fixtures in the auditorium with 300-watt incandescent lamps. There are also 100 watt colored lights for the stage that aren't used very often. This school doesn't have any occupancy sensors in place. Staff indicates that lights in classrooms are reliably turned off when they aren't in use.

Domestic Water

This facility has older toilet and urinal fixtures that are not of the low flow type available today. The urinals are the vintage built in type that may be difficult to replace. Sink aerators are typically 2.2 gpm.

A 250-gallon PVI unit in the boiler room generates domestic hot water. This unit's gas burner is rated at 1,000 MBH input.

Other

The kitchen has a less-than-10-year old walk-in cooler. Hood fans are controlled by wall switch.

Energy Efficiency Opportunities

This facility has a EUI of 91 kBtu/SF, the highest of all of West Hartford's schools. There should be strong potential to reduce energy use through a combination of operational changes and projects. Opportunities we recommend be analyzed and pursued include lighting retrofits, controls modernization, and adjustments to how the building is used. It should also be possible to tighten this building's envelope and better manage mechanical ventilation.

Specific Opportunities Identified:

- Replace auditorium lamps with CFLs
- Consider super T8 retrofit throughout the school. May make sense to reconfigure hallway lighting for permanent solution to proper light level.
- Consider occupancy sensors in hallways, bathrooms, and offices
- Replace CRT computer monitors and apply PC power management strategy
- Install plug load controllers for vending machines / other
- Replace toilets and aerators with low flow fixtures
- Add/replace exterior door seals
- Evaluate and improve insulation in panel sections where windows are installed
- Consider new windows
- Review control system settings and sequences – i.e. recommissioning (initial areas of possible improvement: on-demand ventilation control, establish boiler staging, schedule boiler plant off in mild weather, relocate music room thermostat)
- Update Invensys to current standards and add additional efficiency strategies
- Interlock dishwasher with exhaust fan
- Establish routine steam trap preventative maintenance program
- Insulate condensate piping in the boiler room
- Check small A/C units to see if they have electric or hot water heating
- Replace make-up units with energy recovery units
- Convert building to hot water heating system

Whiting Lane Elementary School

Whiting Lane Elementary School is located at 47 Whiting Lane and totals 107,800 square feet. The mostly single story building was originally opened in 1954. Among many updates over the years, there

was a major addition in 1999 that included an entirely new academic wing that encloses the current courtyard. There are over 450 pre-kindergarten through grade five students enrolled in this school. The facility has dozens of classrooms including a special needs area with full air conditioning, gymnasium, cafeteria, small auditorium, and offices. Locker rooms have been converted to offices. Like most other schools in West Hartford, Whiting Lane has a separate "portable" building with several temporary classrooms.

Normal school hours are weekdays approximately 7:00 a.m. to 2:15 p.m. although the building is typically lightly occupied through the afternoon and into the early evening. Custodial services are normally completed in the evening. The auditorium sees very little use as school performances are usually conducted at other schools with more auditorium seating. The gym is periodically used during later afternoons by a high school gymnastics program. There are summer programs and activity for special needs students.

Building Envelope

This facility is constructed of brick faced concrete blocks with steel decks and mix of bare and ballasted membrane roof sections. Insulation materials and effectiveness in the walls and roof are unknown and expected to be minimal in the original structure. Windows in the older sections of the building are metal-framed casement units with single pane glazing. Many of the windows, especially in the dining room, are in poor condition with failed caulking and failing hardware. The new addition has operable windows with thermal panes that are in good condition. Some sections of the school have glass blocks. We noted that exterior doors don't have weather stripping and generally are in need of attention to assure proper closure.

HVAC

Whiting Lane has a variety of space heating and air conditioning systems.

- Air conditioning is limited to the Media Center, offices, and special needs classrooms, plus the portable classrooms.
- The Media Center has a York 5 hp / 15 ton DX rooftop unit with steam duct heater in the ceiling of the library.
- There are two DX split units serving offices (4.5 and 7.5 tons).
- Classrooms in the older building have cabinet mounted steam radiators with piping feed from tunnels. A 5 hp general exhaust fan with ducting to each classroom induces ventilation via the unsealed windows.
- New addition classrooms each have a ceiling unit ventilator with perimeter fin tube radiation (total of thirteen units). Six of these classrooms have 4-ton DX coils with rooftop condensing units.
- The gym and auditorium have older steam-fired H&V units.
- Air handling units serving the old locker rooms (now offices) are in failed condition.
- The kitchen make-up air unit doesn't work.
- The portable classroom building is conditioned by two rooftop units each with 11.9 kW heating coil.

Central Boiler Plant

Whiting Lane has central steam plant that consists of two identical HB Smith sectional steam boilers rated at 4,696 MBH output each. The boilers have Cyclometric gas burners with 3 hp forced draft fans. 5-6 psi steam is used in the old part of the facility. The new addition has a hydronic system. Hot water is generated by a separate heat exchanger in the boiler room and circulated by one of two 2 hp centrifugal pumps (one pump is standby).

Controls

The new addition's mechanical equipment, as well as the Media Center rooftop unit, is managed by an Invensys direct digital control (DDC) system. The system controls air handlers (2), rooftop unit (1) and unit ventilators (13). DDC system functions include zone temperature control, time of day and day of week scheduling, static pressure and ventilation management.

The remainder of the facility uses an older pneumatic system with time clocks. The system is setup with nine zones that have day/night space temperature settings controlled by air pressure in the system. The pneumatic system uses a dual 1.5 hp reciprocating compressor. H&V units are manually operated including ventilation rate and summer/winter operating mode.

Lighting

This facility has T8 fluorescent lamps and ballasts dating from the 1999 renovation. Many classrooms have uplights that hang down from the suspended ceiling. The gym has new T5 lights. Several areas use compact fluorescent fixtures, including the auditorium stage. We noted incandescent lights in the auditorium seating area and halogen lights in the art room. There is an occupancy sensor in the back stairwell near the gym; otherwise this school doesn't use motion sensors to control lights.

Domestic Water

This facility has mostly older toilet and urinal fixtures that are not of the low flow type available today. Sink aerators are typically 2.2 gpm, although some low flow units were seen.

Domestic hot water is generated by a 1,000 MBH / 250 gallon gas-fired PVI unit.

Miscellaneous

The kitchen uses gas-fired appliances; ranges have standing pilots. The walk-in cooler is original to the building with wooden door and likely compromised box insulation. The older refrigeration system has a city-water cooled condenser. There is a 36 kW electric hot water booster heater for the dishwasher.

Energy Efficiency Opportunities

This facility has a EUI of 81 kBtu/SF, which is about average compared to the other elementary schools in West Hartford. We identified many areas for efficiency improvements, which are summarized below.

Specific Opportunities Identified:

- Replace incandescent and halogen lights with LED
- Consider upgrading fluorescent lighting to super T8's throughout the school
- Add daylighting control in the main entrance area

- Consider occupancy sensors in hallways, bathrooms, gym and offices
- Replace toilets and aerators with low flow fixtures
- Replace CRT computer monitors and apply PC power management strategy
- Install plug load controllers for vending machines / other
- Add/replace exterior door seals and provide proper door alignment
- Window maintenance or replacement program
- Steam trap maintenance program
- Interlock dishwasher exhaust fan with dishwasher
- Review control system settings and sequences – i.e. recommissioning
- Update Invensys to current standards and add additional efficiency strategies
- Consider occupancy based HVAC control in the gym
- Expand control system to H&V units and exhaust fans (possibly classroom radiation)
- Replace old motors
- Replace walk-in cooler and refrigeration system (consider replacing walk-in enclosure)
- Consider gas-fired hot water heater for dishwasher
- Replace former locker room air handlers and kitchen make-up air unit
- Consider gas-fired portable rooftop units
- Convert building to full hot water heating system

Wolcott Elementary School

Wolcott Elementary School is located at 71 Wolcott Road and totals 78,800 square feet. The single story brick building was originally opened in the 1957. A new wing was added in 2004. In addition to classroom wings, the school has a central auditorium/library, cafeteria, gym and administrative offices. There are roughly 500 kindergarten through fifth grade students enrolled in this school.

Normal school hours are weekdays 8:30 a.m. to 3:20 p.m. On weekdays, there is a daycare service that is open from roughly 7:00 a.m. to 6:00 p.m. During the winter there are evening basketball programs in the gym. Custodial services are completed in the afternoon and evening. There is generally no weekend or summer use of this school.

Building Envelope

This facility is constructed of masonry block with brick façade with built up roof sections. There is likely to be some rigid insulation in the roofing system. Insulation details in the walls are unknown, and insulation is suspected to be minimal, if even present at all. Casement windows date to 2004 and are double pane in aluminum frames. The exterior doors are equipped with weather seals, but generally lack “sweeps” on the bottom of the door to seal the threshold area. Inner doors in vestibule areas also do not have seals.

HVAC

This facility has radiant floor heating in most of the building, except the new wing, which has perimeter baseboard. In 2002, a fresh air ventilation system was added (see Table below). There are three old H&V units in the fan room that supply the auditorium (1½ hp fan), café (¾ hp fan), and gym (2 hp fan).

These units see minimal run time. The administrative area has a window DX unit. Otherwise there isn't any air conditioning at this facility.

Table 9 – Air Handling Equipment Installed in 2002

Unit	Serves	Type	Fan hp	Fan cfm	HW MBH
AHU-1	CR Ventilation	100% OSA	5	6,100	513
AHU-2	CR Ventilation	100% OSA	2	3,300	273
AHU-3	CR Ventilation	100% OSA	5	4,350	368
AHU-4	CR Ventilation	100% OSA	5	4,350	368
AHU-B1	Art/Music Rooms	Mixed Air	2	3,150	158

Central Boiler Plant

Wolcott has three Burnham gas-fired hot water boilers that were installed in 2006. Each boiler is rated at 3,680 MBH and has a 1½ hp Power Flame burner. There are seven heating hot water pumps that serve the radiant floor heating system, make-up air handlers, and perimeter radiation in the new wing. These centrifugal pumps range in size from 3 hp to 7.5 hp. Domestic hot water is generated via indirect coil off heating hot water.

Controls

This school uses the older Invensys control system to control a limited portion of the schools HVAC system, including boiler plant and five newer air handler. The DDC system has dial up to the main front end at the DPW. The system schedules the air handlers and provides a boiler plant hot water temperature reset. Local pneumatic devices manage the balance of the school. Eight-hour timers are manually wound each school day morning at roughly 7 a.m. to activate occupied setpoint status. During moderate or sunny winter weather, staff will only partially wind the timers to reduce run time.

The H&V units serving the auditorium, café, and gym are manually controlled and generally see very limited run time.

The hot water circulation pumps are not controlled and generally run continuously during the heating season.

Lighting

This facility is predominantly lit with T8 fluorescent lamps and ballasts as well as CFLs. Newer lighting fixtures are three-lamp pennant direct/indirect. The gym has newer T5 lights. Fluorescent lamps have been selectively removed from hallway fixtures to save energy. A lighting contractor recently completed a full lighting survey and proposal.

Kitchen

The kitchen was renovated about two years ago. Appliances are gas-fired. The walk-in cooler box and associated refrigeration was replaced as part of the renovation. The cooking hood has integrated make-up air with a dedicated gas-fired rooftop unit. The dishwasher has a steam reclaim feature and is not equipped with an exhaust hood.

Energy Efficiency Opportunities

This facility has a EUI of 57 kBtu/SF, which is lowest in the West Hartford's portfolio school properties. There is not likely to be much opportunity for significant improvement.

Specific Opportunities Identified:

- Lighting updates as prescribed by contractor
- Replace CRT computer monitors and apply PC power management strategy
- Add/replace exterior door seals and provide proper door alignment
- Review control system settings and sequences – i.e. recommissioning (e.g., check setpoints and optimum start program)
- Update Invensys to current standards and add pump motor control points

Bishops Corner Library

The Bishops Corner Library and community Senior Center are co-located at 15 Starkel Road. The library section of the building is about 8,000 square feet and was built in 1966. It is a largely open area with stacks and central circulation desk. This part of the building has been scheduled for a comprehensive remodel in fall 2011. Operating hours are Monday and Wednesday 10 a.m. to 6 p.m., Tuesday and Thursday 1 p.m. to 9 p.m., and Sunday 10 a.m. to 5 p.m.

The Senior Center was added to the library in 2005 and is about 7,000 square feet. The center has two main multifunctional rooms with divider, a small kitchen, offices and exercise room. The facility sees heavy use with 200 to 250 visitors per day. The center is open 8:30 a.m. to 4:30 p.m. and sees intermittent evening and weekend use.

Building Envelope

The original facility has wooden siding and structural beam and roof deck. The roof is built up with rigid insulation and asphalt covering. Insulation details are not available. Windows are older, and there is an automatic sliding entrance door that appears to be problematic. The Town intends to eliminate the second street entrance that currently sees very limited use.

The new addition has metal siding to loosely match the original library with metal deck and similar roofing system. Information on insulation systems isn't known, but properties should be adequate given the recent construction and code requirements. Windows are operable thermal pane. The exterior doors do not have effective weather seals.

HVAC

The library has two DX split air handlers and a small gas-fired boiler. The Town intends to replace this older equipment with gas-fired rooftop units and eliminate the boiler. The senior center has five Carrier gas-fired DX rooftop units.

Controls

All HVAC systems are controlled locally via thermostat. The Senior Center has programmable thermostats, but they may require attention to ensure that space temperature is being reset properly.

The divided multifunction rooms are difficult to control since they do not have separate zoning. The Carrier rooftop units are reported to have enthalpy economizer control. Several RTUs were in cooling mode at the time of our visit (outside temperature 57°F), and we question if the systems are properly tuned to achieve the best performance.

Lighting

Lighting in the library is dated and unattractive. The Town plans to replace the lighting system during the remodel. Lighting in the Senior Center is a mix of T8 and compact fluorescent. Use of this facility appears to be high enough that occupancy sensors may not make sense.

Domestic Water

Toilet and urinal fixtures in the library aren't low flow rated, but are low flow in the addition. Sink aerators are 2.2 gpm.

Energy Efficiency Opportunities

This facility has a EUI of 87 kBtu/SF based on 2010 utility data. While we are not recommending any projects at the library due to the impending renovation, we have identified several areas for moderate efficiency improvement in the Senior Center.

Specific Opportunities Identified:

- Add / repair weather seals on exterior doors
- Attention to scheduling and setpoints on thermostats
- Check economizer functionality and setpoints
- Rezone card room to improve temperature control
- Add DDC controls

Cornerstone Aquatics Center

West Hartford Cornerstone Aquatics Center is located at 55 Buena Vista Road. The swimming facility was originally opened in 1961, but was extensively expanded and updated in 1991 to its current configuration at 47,900 square feet. The facility has a large lap pool maintained at 79°F. There is second large recreational pool that is kept at 86°F and includes separate shallow section for children and/or exercising. There is also a triangular shaped hot spa (103°F). In addition, the facility has a fitness room, multipurpose room, life guard station, main entrance and apparel store, plus locker rooms and offices. Management of the Aquatics Center has been outsourced, and the Town has limited responsibility for operations and utility costs.

The facility sees heavy year-round use with an average of 1,000 visitors per day. Operating hours are weekday 6 a.m. to 9 p.m., Saturday 7:30 a.m. to 8:30 p.m., Sunday 1 p.m. to 8:30 p.m.

Building Envelope

This facility is constructed of masonry block with brick facing. The original section of the building has wooden beams supporting a pitched metal deck. Newer sections have metal trusses supporting flat deck with fairly new asphalt roofing. Insulation thickness in the built up roof sections is unknown. Each

pool area has skylights. It is unlikely that wall sections in the older parts of the building have insulation. Windows date from 1991 and are in relatively good shape. Some exterior doors don't close well, and/or have poor weather seals. The main entrance has automated sliding doors that are fairly slow and expose the front desk and hallway areas to blasts of summer/winter outside air.

HVAC

The Aquatic Center's swimming pool areas are dehumidified and heated/cooled by four identical Dectron rooftop units that were installed in 2007. These units employ heat recovery for pool water heating as well as make-up air preconditioning from exhaust air. The unit serving the recreational pool ramp and spa area is considerably oversized and operating staff often manually cycle the unit on/off. Locker rooms are ventilated by two air-to-air energy recovery units. These units are in poor condition with compromised heat exchangers and should be replaced. The balance of the facility uses older single zone air handlers with hot water heating coils and DX cooling coils. See table below for summary of air handling equipment. There is perimeter fin tube radiation in some parts of the building.

Table 10 – Design Summary of Available Information on Aquatic Center HVAC Units

Unit	Serves	Type	VFD?	Fan hp	Airflow cfm	HW MBH	DX ton
AHU-1	Meeting Room	CV	No	3	4,000	151	10
AHU-2	Lobby/Hallway	CV	No	2	3,000	113	6
AHU-3	Admin Offices	CV	No	3/4	1,000	38	3
AHU-4	Fitness Center	CV	No	~1	NA	NA	~4
AHU-5	Fitness Center	CV	No	~1	NA	NA	~4
ERU-1	Men's Locker	CV	No	3/2	3,000	-	-
ERU-2	Women's Locker	CV	No	3/2	3,000	-	-
PRU-1	Recreational Pool	CV	No	10	NA	NA	NA
PRU-2	Recreational Pool	CV	No	10	NA	NA	NA
PRU-3	Lap Pool	CV	No	10	NA	NA	NA
PRU-4	Lap Pool	CV	No	10	NA	NA	NA

Boiler Plant

This facility has two HB Smith gas-fired sectional hot water boilers. Each identical boiler has a 3,172 MBH Webster burner with 1 hp forced draft fan. The boiler plant is in operation year-round. Heating hot water is used to provide: (1) winter space heating of general areas, (2) nearly year-round space heating of recreation and lap pool rooms which are maintained at 88^{o}F and 82^{o}F respectively, (3) indirect pool and spa water heating via heat exchanger, and (4) indirect heating of domestic hot water via tank exchanger system. Heating hot water is circulated by two of three 5 hp constant volume centrifugal pumps.

Controls

This facility operates with a mix of local controls. The pool recovery Dectron units each have proprietary Dry-O-Tron controllers that manage ventilation and heat recovery functions of the rooftop units. At night when the building is closed the units continue to run, but are programmed to discontinue ventilating the space. All other air handling units and the energy recovery units serving the locker rooms operate on time clocks and are shutdown during unoccupied periods. The boiler plant has a Heat Timer

controller, but the controls have been overridden. This is because it is not possible to reset hot water circulation temperature below about 160°F without adversely affecting the domestic hot water and the spa heating systems.

Lighting

The Town has a current contract to update all the lights at the Aquatic Center. We therefore did not review lighting systems here. The lighting update should result in a noticeable reduction in electrical use, and we commend the Town for moving forward with this project.

Domestic Water

This facility has standard flow toilet and urinal fixtures. Sink aerators are 2.2 gpm. There are at least fourteen shower stalls. Shower head flows could not be determined, but are likely to be high volume units. Domestic hot water is generated indirectly by heating hot water in an approximately 500 gallon storage tank.

Miscellaneous

The lap pool is circulated by one of two 25 hp centrifugal pumps (second pump is standby). Variable speed drives were added to the pumps to adjust pump output to filter specifications. However, a new pool water treatment chemical system (MIOX®) was added recently that requires differential pressure for venture effect injection without use of a pump. To achieve proper MIOX® dosing, the VFD has been ramped back up to full speed and pump discharge valves partially closed. This is true for the recreation pool (dual 10 hp pumps) and spa (dual 5 hp pumps). There are several 1 hp and smaller pumps that circulate pool water to heat recovery circuits on the Dectron units. Sand filter on all systems were replaced in 2005.

Energy Efficiency Opportunities

This facility has a EUI of 258 kBtu/SF. High energy use is to be expected for a heated indoor swimming pool facility. It is difficult to benchmark swimming pool facilities due to wide variety and number of pools in use and the way facilities are operated.

Specific Opportunities Identified:

- Install plug load controllers for vending machines / other
- Toilet, urinal, shower head, and sink aerator updates to save water
- Attention to exterior door seals
- Reconfigure sliding doors to manual swing doors or add an air curtain
- Purchase spa cover. Consider automated covering system for larger pools
- Add metering pumps to inject MIOX® and restore use of lap pool pump VFD
- Add VFDs to remaining pool water pumps to eliminate use of throttle valves. Consider scheduling further reduction of pool water flow at night
- Add VFDs to oversized spa/ramp Dectron unit
- Add outside air economizer capability to fitness center AHUs
- Build wall separating recreational and spa pool area (88°F) from lap pool area (82°F)

- Replace end of life locker room ERUs
- Consider solar thermal pool heating system
- Possible application for cogeneration unit

Dog Pound

The Town operates an animal pound adjacent to the DPW facility. The roughly 750 square foot building was constructed in 1971. The building includes an indoor kennel area, office and bathroom. The building is staffed during typical business hours with animals temporarily living at the kennel around the clock.

Building Envelope

This facility is block and wood construction on slab. The attic is insulated with batt insulation over plaster ceiling. There is unlikely to effective wall insulation. There may not be insulation in the slab. Construction details aren't available in the drawing archive at the Town Hall. There are two exterior doors and limited single pane windows.

HVAC

An oil-fired furnace heats the building with ducting to the office and kennel. The furnace is beyond its expected service life. There is no tag on the furnace, but the burner is rated at approximately 140 MBH input. The Town has plans to bring a gas pipeline to the building this summer, creating an excellent opportunity to update this furnace system. There is a 5,000 Btu window A/C unit that is insufficient to cool the office space, also an excellent opportunity to improve comfort with a new central system as part of the furnace update.

Controls

There is a local thermostat controlling the building's heat. The setting is typically 70^{o}F. Some areas in the office are often too cold and supplemented with a portable electric unit. The kennel must be kept in the mid to high 60's at all times during the winter.

Lighting

Lighting is the building is predominantly linear T12 (kennel) and T8s in the office, including a U-lamp. There are incandescent and quartz exterior lamps. It is unclear if exterior lights are used

Energy Efficiency Opportunities

Utility data for this small building is not available. We expect the EUI is fairly high. Our ideas for improvements are listed below.

- Update lighting
- Replace furnace with gas-fired condensing unit. Consider adding split DX coil for central air conditioning with auto dampers to separate kennel and office area as separate zones.

Elmwood Community Center

The Elmwood Community Center is a former three story elementary school building constructed in 1928. The structure is located at 1106 New Britain Avenue. The Center is about 66,700 square feet and includes multipurpose former classrooms, a daycare area, senior center area on the 3rd floor, auditorium, gym, fitness room, computer lab and two small kitchen and dining areas. The kitchens see limited use, mostly in heating prepared meals. While there have been piecemeal updates to this facility, the building is largely original and in need of attention. Operating hours are Monday through Friday 6:30 a.m. to about 8:30 p.m. There is variable use on weekends. The activity schedule is constantly in flux.

Building Envelope

This is a brick faced building with flat ballasted membrane roof. No information is available on building insulation, which is expected to minimal at best. Windows are newer with operable thermal panes. Exterior doors are lacking weather seals.

HVAC

The Community Center is heated by a steam system via unit ventilators, radiators and older air handling units. Some of the area unit ventilators have split DX coils. There are also some window DX units, generally where unit ventilator cooling has failed. There are a number of smaller fresh air systems that are in failed condition and are no longer used. The gym is heated and ventilated by a 1.5 hp H&V unit with steam coil – the outside air damper on this unit is frozen shut with missing actuator. The auditorium has an older Carrier cooling-only DX rooftop unit (unseen).

Steam Plant

Elmwood's steam plant consists of two newer Smith sectional boilers with 2,718 MBH gas burners. The low pressure plant runs continuously during the heating season, cycling as necessary to maintain 6-7 psi and staging boilers on/off. Radiator traps were recently replaced. Otherwise there has been little work on system steam traps and no formal inspection plan.

Controls

This facility has an Invensys direct digital control (DDC) system that drives the space temperature setpoint day/night schedules via the original pneumatic control system. Radiator pneumatic valves were replaced recently. Many of the former classrooms have mechanical timers limiting run time on unit ventilators. There is also a Trane Rover electronic timer system that provides similar run-time limiting on unit ventilators. Space temperature control in several areas is poor and occupants end up opening windows in the winter to gain comfortable.

Lighting

Lighting is predominately T8 with some compact fluorescent. There are metal halide fixtures in the gym. There doesn't appear to be use of occupancy sensors in this building.

Domestic Water

Toilet and urinal fixtures are older without low flow ratings. Sink aerators are generally 2.2 gpm. Domestic hot water is generated in a 100 gallon AO smith unit with 150 MBH burner.

Energy Efficiency Opportunities

This facility has a EUI of 69 kBtu/SF based on 2010 utility data. This value indicates fairly reasonable performance for an older facility with limited HVAC controls. The biggest need for this facility is to update and standardize the mixed bag HVAC and control systems which are becoming increasingly troublesome to keep operating.

Specific Opportunities Identified:

- Replace gym HID lights with new T5 fixtures with self contained motion sensors
- Add vending machine plug load controller
- Add/repair weather seals on exterior doors
- Replace toilets, urinal flush valves and add sink aerators to save water
- Attention to scheduling and setpoints on thermostats
- Steam trap maintenance program
- Consider expanding DDC control to H&V units and unit ventilators
- Consider replacing HVAC system. Options include: direct replacement with similar steam / DX units, new 4-pipe system adding chiller and hot water system, or possibly installing central air system with gas-fired DX rooftop units.

Fairview Cemetery

The Town operates and maintains the Fairview cemetery. The facilities include a maintenance building, a storage building, and offices located in the basement of the chapel, which is no longer in use. The oldest building is the chapel from 1920. The storage building was built in 1940 as an attachment to chapel. The maintenance building dates to 1961 with bay area added in 1972. Combined, the buildings total about 5,000 square feet.

Building Envelope

Maintenance building: Constructed of masonry block with wood framed pitched roof sections. Insulation details are not known. Since the two-door bay isn't heated, we do not expect there is any insulation in this section. The few windows in the office area are fixed single pane in wooden frames. The windows are in rough shape, but probably offer reasonable resistance to draft. There is no weather stripping on the exterior door.

Storage Building: This is block construction with steel framed flat roof. Insulation details are not available and expected to be at best minimal. There is one large overhead door that has effective weather seals. The exterior door could use some attention to its seals.

Chapel Offices: This is a renovated basement area of historic chapel. Construction and insulation details are not known. The exterior door has damaged weather seals.

HVAC

Maintenance building: This office area in this building has two electric baseboard units on local thermostats. When not in use, the thermostats are reported to be turned all the way down.

Storage building: There is old oil-fired furnace that is used to maintain 45°F in the winter (higher when people are working in the space).

Chapel offices: This building is heated by electric baseboard and air conditioned via winIn the winter, the space is maintained at 55°F during unoccupied periods.

Lighting

These buildings mostly employ T8s lights with motion sensors. There are CFLs and an induction exterior light as well.

Energy Efficiency Opportunities

We do not have utility data for these facilities. Worthwhile opportunities to reduce energy use are listed below.

- Consider replacing maintenance shop refrigerator with much smaller Energy Star unit
- Attention to exterior door weather seals

Fire Station No. 1

The Town's Fire Station No. 1 is located at 561Prospect Avenue and totals 7,900 square feet. The 2½-story building was opened in 1914 and remains largely original. The facility has an open apparatus bay on the main floor with two bay doors, plus break room, offices and a dispatch room. The upper level has bunkrooms and exercise area. The attic level is partially finished, but is not used. The building is manned continuously.

Building Envelope

This station is wood construction with exterior stucco finish. There is no insulation in this building. The two main garage doors are in decent condition with effective weather seals. There is a set of large original wooden doors in back of the bay, which are beautiful, but are not particularly weather resistant. Double hung windows are older and in terrible condition. Basement windows need to sealed.

HVAC

This used to be a steam-heated building. It has been converted to hot water while retaining cast iron radiators. The Smith boiler is 4-5 years old and controlled by Tekmar controller. Two ¼ hp in-line pumps circulate hot water. Local thermostat or radiator Danfoss valves control all heating zones. The bay is maintained at 60-63°F in the winter. There are several window A/C units, which are removed for the winter heating season.

Lighting

Lighting in the station is mostly T8 that was updated in 2006. Motion sensors have been added to the stairwell, bathrooms and upstairs lounge.

Domestic Water

This facility has mostly standard flow toilet and urinal fixtures. Information on the domestic hot water isn't available.

Miscellaneous.

This station has two personal effects washing machines. Run hours on the unit are believed to be light.

Energy Efficiency Opportunities

This facility has a EUI of 63 kBtu/SF, low for a fire station. Low EUI is unexpected and a bit mystifying given 24/7 use and the very poor building envelope. We identified several areas for efficiency improvements, which are summarized below.

- Seal back wooden door
- Seal windows
- Add attic Insulation

Fire Station No. 2

The Town's Fire Station No. 2 is located at 20 Brace Road and totals 5,400 square feet. The building was opened in 1992 and remains largely original. The facility has an open apparatus bay on the main floor, plus break room, offices and a dispatch room. The upper level has bunk rooms. There is also a basement with fitness areas and mechanical room. The building is manned continuously. There are usually five staff members on duty.

Building Envelope

This station is brick faced block with upper level vinyl siding. Construction plans show 3½ inch batt wall insulation and 6 or 9½ inches of batt insulation in the attic ceiling depending on building section. There are five overhead doors. The front doors have extensive windows. Weather seals on the front overhead doors are not working effectively. Rear overhead door seals are in good condition. We understand that the overhead doors often remain open for extended periods in cold weather. Windows are operable with vinyl frames and thermal panes and are in good condition.

HVAC

Living and office space in this facility is conditioned by two split system air handlers. Design details are summarized in the table below. The original design indicates that the 1st floor A/C unit has three zone VAV boxes with bypass damper fan output control. The upper level A/C unit is single zone and there is only one thermostat serving the five or so rooms on the 2nd floor. The engine bay has four hydronic unit heaters. The basement level has perimeter radiation and no air conditioning.

Table 11 – Design Summary of Available Information on Fire Station No. 2 HVAC Units

Unit	Type	VFD?	Supply Fan hp	Airflow cfm	HW MBH	DX Coil ton
AHU-1	VAV	No	1.5	2,100	34.2	5
AHU-2	CV	No	1.5	2,400	38.7	6

Heating Plant

This facility has a single Weil McLain gas-fired hot water boiler with ½ hp Power Flame burner rated at 810 MBH. Hot water is circulated by dual 1 hp pumps.

Controls

All controls are local. There is a Trane Summit system that controls the two A/C units. However, there may be software or other issues that prevent proper control. The upper floor system is single zone with five resident rooms being served. Temperature control in this area is very poor and we understand it is common for staff to open windows to keep their areas from being over-cooled. The boiler has a local controller that includes hot water temperature reset and outside temperature based pump control. All systems remain on-line 24/7 and there are no space temperature resets.

Lighting

Lighting in the engine bay is provided by eight foot T12s. Lighting in the remainder of the station is T8 and compact fluorescent. We noted at least a few incandescent lamps in use. There aren't any occupancy sensors in use at this fire station.

Domestic Water

This facility has mostly standard flow toilet and urinal fixtures. Sink aerators are typically 2.2 gpm. Domestic hot water is generated by a 75 MBH unit with 75 gallon storage. This Fire Station runs out of hot water when crew return from an event and hits the showers.

Miscellaneous.

This station has an on-site breathing air compressor and filter system. Run hours on the unit are believed to be light.

Energy Efficiency Opportunities

This facility has a EUI of 158 kBtu/SF which is high for a fire station, even considering 24/7 use. We understand one reason for high electrical use may be excessive air conditioning of office and bunk spaces in the summer. This is due to poor HVAC control of the unit serving these areas. Also, the apparatus bay overhead doors are less than optimal and may be left open from time to time wasting fuel.

Specific Opportunities Identified:

- Updates apparatus bay lighting to T5 or T8 system
- Change incandescent lamps to CFLs
- Add occupancy sensors (workout rooms, break room, offices, engine bay)
- Replace toilets, shower heads and sink aerators with low flow fixtures
- Consider new front overhead doors with better thermal properties and weather seal system
- Add overhead door alarm and integrate with bay space heaters
- Consider ceiling fans in apparatus bay

- Confirm attic and wall insulation was installed as per design
- Investigate Trane Summit control system issues and update as necessary
- Add local VAV zones to each room for upstairs A/C unit
- Consider high efficiency condensing boiler
- Consider gas-fired radiant in the apparatus bay

Fire Station No. 3

The Town's Fire Station No. 3 is located at 1068 New Britain Avenue and totals 9,000 square feet. The 3-story facility dates to 1930. There was a major addition and renovation in 1990. This fire station sees the most intensive use of all the stations in West Hartford, including central vehicle maintenance services. Areas in the station include two main apparatus bays on the street level, a lower level garage bay and parts storage area, dispatch office, upper level lounge, offices and bunk rooms. There is exercise equipment in the partially finished attic. The building is manned continuously.

Building Envelope

This station is brick, concrete and wood construction. The pitched roof includes steel supports. The attic appears to have batt insulation above the ceiling. Per drawings dated September 1990, there is two inches of rigid insulation in the wall sections. There is a good chance there is no wall insulation in the original building. Double hung windows with thermal panes are being installed throughout the building replacing older units. The four overhead garage doors are in good condition. The main level overhead doors (2) are not weatherized, nor have effective weather seals. The few exterior doors seen closed tightly.

HVAC

Bays at this station employ newer hydronic H&V and unit heaters. Baseboard units heat the occupied areas of the station. The third level exercise room has an approximately 5 ton DX air handler with remote condensing unit. The rest of the building's air conditioning is via window A/C units. We understand that most of these window units are removed for the winter heating season.

Local thermostats control heat. The bay's thermostats are kept at 50-55^{o}F, although actual space temperature is believed to be much higher. At the time of our tour, the heat was on and the main bay was at 64^{o}F. There are no temperature resets in effect at this 24/7 fire station.

Boiler

A single Weil McLain 88 sectional boiler rated at 1,004 MBH generates heating hot water. The boiler has a 1/3 hp Cyclometric gas burner and two hot water circulation pumps (unable to determine size). The plant appears to be in decent working order.

Lighting

Lighting in the station is mostly T8, including some "U" lamps in offices. In addition, there are CFLs and a few halogen lights. We do not know of any motion sensors in use here.

Domestic Water

This facility has mostly standard flow toilet and urinal fixtures. Sink aerators are typically 2.2 gpm. A 75-gallon Bradford White unit with 76 MBH gas burner generates domestic hot water.

Miscellaneous.

This station has two washing machines.

Energy Efficiency Opportunities

This facility has a EUI of 105 kBtu/SF, which is typical for a high use fire station that is active 24/7. The new windows may improve heating performance slightly. It will be challenging to make a significant improvement in energy performance.

Specific Opportunities Identified:

- Potential lighting updates, including sensors
- Lower heating setpoint in bays, if actual temperature is generally well above setpoint. Consider relocating thermostats for more accurate control.
- Consider interlocking bay doors with heat (if open doors are determined to be a problem)
- Replace street level overhead doors
- Consider condensing boiler when existing boiler reaches the end of its service life

Fire Station No. 4

The Town's Fire Station No. 4 is located at 2458 Albany Avenue and totals 6,300 square feet. The single level facility dates to 1954. The station has a four-door apparatus bay with dispatch offices, lounge and living quarters. There is exercise equipment in the partially finished basement area. The building is manned continuously.

Building Envelope

This station is brick with flat membrane roof and concrete foundation. There isn't any known wall insulation. Drawings indicate two inches or rigid insulation in the built up roofing. Windows are newer thermal pane casement type and are in good condition. Overhead and exterior doors are in good condition and close tightly.

HVAC

This station employs a hydronic heating system with perimeter baseboards heaters and four ceiling hung unit heaters in the bay. Most areas are kept at about 67^{o}F in the winter. There is some difficulty in parts of the building maintaining good heating control due to thermostat location. Living quarters are air conditioned by two small rooftop units, which we couldn't access. We understand these are newer units and in good condition. Per drawings dated April 1994, these rooftop units are rated at 1,000 cfm (2½ tons cooling capacity) and 2,000 cfm (5 tons cooling capacity). The rooftop units are set to maintain 76^{o}F in the summer.

Boiler

A single oil-fired HB Smith sectional boiler generates heating hot water. The boiler has a ¼ hp burner rated at 840 MBH input. There are two approximately ½ hp circulation pumps. Some of the pipe insulation is missing from the hot water pipes.

Lighting

Lighting in the station is mostly T8, including some "U" lamps in offices. There are two exterior HID lights. This station employs many lighting motion sensors.

Domestic Water

This facility has mostly standard flow toilet and urinal fixtures. Domestic hot water is generated by an 80 gallon Bradford White unit with 4.5 kW heating element. The heater was installed in 2005

Miscellaneous.

This station has a large commercial washer and electric drier that are used for crew uniforms district wide.

Energy Efficiency Opportunities

This facility has a EUI of 38 kBtu/SF, which is one of the lowest we've ever seen at a fire station. It will be worth reviewing input data to make sure the square footage and utility consumption is correct. As with the other fire station, it will be difficult to make significant improvements given the constraints of 24/7 operations.

Specific Opportunities Identified:

- Potential lighting updates, including more sensors
- Insulate hot water pipe in boiler room
- Replace boiler with high efficiency gas-fired unit, bringing gas in from the street.
- Rezone heating pipes to solve control issue (no savings)

Fire Station No. 5

The Town's Fire Station No. 5 is located at 51 Berkshire Road. The building was opened in 1963 and totals 4,500 square feet. A recreation room was added about 15 years ago; otherwise the facility is in its original configuration. The station has an open apparatus bay, break room, several offices, and an open area with partitioned living quarters. The building is manned continuously. There are usually four staff members on duty.

Building Envelope

This station is a brick faced block with concrete flat roof. Insulation type and thickness is not known but believed to be minimal in the roof and non-existent in the block walls. There are two overhead doors that have moderately effective weather seals. Exterior doors have good weather seals. Windows are original operable units with aluminum frames and single pane glass. The windows are in fair condition.

HVAC

This Fire Station has baseboard fin tube radiation throughout office and living quarters. The apparatus bay has a single hydronic unit heater. There are four older window DX units that provide air conditioning. The newer recreation room addition is conditioned by an air-source heat pump.

Heating Plant

This facility has a single AO Smith gas-fired hot water boiler rated at 442 MBH. Hot water is circulated in two zones by fractional horsepower in-line pumps. Outdoor combustion air is supplied to the boiler room via a vent in the wall; there aren't any automated dampers to seal the area when the boiler is down. Hot water pipe insulation may contain asbestos.

Controls

There are three non-programmable thermostats that control building heat in the station and apparatus bay. One control zone serves the kitchen/breakroom and office areas as well as the living quarter section of the building. There is a tendency for the kitchen/breakroom area to be too hot in the winter. Other parts of the building in the same zone, but father downstream on the hot water loop are difficult to keep warm. Boiler operations are entirely manual, and the boiler remains active (cycling as necessary) once turned on in the fall until it is turned off in the spring.

Lighting

Lighting in the engine bay is provided by eight foot T12s. Lighting in the remainder of the station is T8 and compact fluorescent. The fire alarm system includes incandescent overhead lights that blink briefly. There aren't any occupancy sensors in use at this facility.

Domestic Water

This facility has standard flow toilet and urinal fixtures. Sink aerators are 2.2 gpm. Domestic hot water is generated by a 50 MBH Bradford White unit with 50 gallons of storage.

Energy Efficiency Opportunities

This facility has a EUI of 143 kBtu/SF, which is slightly better than West Hartford's No. 2 station, but still high none-the-less. It is likely that space temperature control issues are a contributing factor to high fuel use.

Specific Opportunities Identified:

- Updates apparatus bay lighting to T5 or T8 system
- Change incandescent lamps to CFLs
- Add occupancy sensors (workout rooms, break room, offices, engine bay)
- Replace toilets, shower heads and sink aerators with low flow fixtures
- Add ceiling fans in apparatus bay and turn down heating setpoint
- Add overhead door alarm and integrate with bay space heater
- Remove fin tube section in kitchen/breakroom area
- Add additional heating pipe zone(s) to improve building temperature control

- Add boiler controls
- Replace window DX units with ductless split units
- Consider high efficiency condensing boiler
- Consider gas-fired radiant in the apparatus bay

IT Hub

The Town operates a central server hub in a residential styled building at 130 South Main Street. The roughly 3,000 square foot facility is two stories, plus basement and was constructed in approximately 2000. A cable communication company originally owned the building. The Town purchased the building in 2008 and uses the facility for traffic light signal control and Town building fiber optic connections to IT systems. Areas include a main server room on the ground floor with adjacent open area used for office space, plus a bathroom. The basement includes garage space, machine room with UPS (not in use) and an additional server room (not in use). The upper level is vacant.

The building's equipment is 24/7. However, IT staff drop by only one to three times weekly. Likewise, maintenance staff are in the building only a few times a week. There is a space temperature and relative humidity monitoring service from Siemens that notifies IT staff if the server area conditions are out of compliance.

Building Envelope

This facility is brick/wood construction with multiple pitch roof sections. The basement is concrete. Insulation details are not known, but are expected to be up to current standards due to recent construction. Windows in the facility are double hung with thermal frames. Most are setup with an illuminated back panel that prevents anyone from seeing into the building. There are two ground level entrances with mahogany doors that have minor gaps to the outside. The basement garage door is reasonably well sealed from the elements.

Servers

This data center facility is very lightly loaded at this time. There are roughly sixteen 110-volt servers plugged into strip UPS devices. The server load is not known, but is expected to be less than 5 kW. The main UPS system in the basement has a one-hour reserve capacity. This UPS unit is not being used.

HVAC

The server room is conditioned by two Compu-Aire split units with electric reheat and ultrasonic humidification. Space condition setpoint are 74^{o}F and 45% relative humidity. A third Compu-Aire unit serves the open area (office). There are three ½ hp Trane fan coil units with electric heating. Heating requirements in this building are reported to be minimal. Aside from bathroom exhaust, there is no mechanical ventilation in this building.

Controls

All controls in this building are local non-programmable thermostats. Staff are instructed to set back the stats in all areas except the server room when they leave the building. This isn't always happening.

Lighting

Lighting is the building is predominantly T8. CFLS are used to provide the illusion of occupancy in the window panels.

Energy Efficiency Opportunities

This facility has a EUI of 176 kBtu/SF, but EUI isn't a particularly useful metric to gauge performance at a data center facility. This particular site is highly underutilized, which is not an efficient use of resources and results in excessive space conditioning.

Specific Opportunities Identified:

- Turn off second A/C unit in the server room (one unit was experimentally turned off at the time of our tour to see if there was any operational consequence)
- Add lighting motion controls
- Add programmable or timer-based thermostats for basement level HVAC

Noah Webster Library

The Noah Webster Library is located at 20 South Main Street in downtown West Hartford. The building dates from 1937 with multiple additions and renovations that bring the facility to its current 59,800 square feet. The three level library includes an open main stack area with perimeter mezzanine, also including stacks. The lower level is dedicated to the children's department, plus there is a function room and several offices. The original front section of the library has additional reading rooms as well as offices on the third floor. The library is open Monday through Thursday 10 a.m. to 9 p.m., Friday 10 a.m. to 6 p.m., Saturday 10 a.m. to 5 p.m. and Sunday 1 p.m. to 5 p.m.

Building Envelope

This is a brick facility with mostly flat roof. The original building has a pitched roof with conventional open attic space. The attic floor is insulated with about 8-12 inches of chopped fiberglass under floor boards. Insulation thickness isn't consistent and the area is poorly sealed from the heated lower level. Otherwise, building insulation isn't known and is believed to be generally poor except in the newer additions. Windows are a mix of older and new units with thermal glass. The older windows have single pane glass, but appear to reasonably tight in most areas. The main entrance has automatic sliding double door sets that normally both open together and are not very effective at keeping air exchange to a minimum.

HVAC

This facility is conditioned by nine 4-pipe air handlers and five DX rooftop units. There is one large Carrier air handler serving the main library stack and checkout area. This unit is 5 years old and has an estimated 7.5 hp fan with static pressure controlled variable frequency drive (VFD). The VFD was observed to be operating at full speed even though building load was light. There are also five smaller Magic Aire air handlers replaced in the same time period. These units have ½ hp fans equipped with VFD to balance the system (no active control). There are also three older air handlers with steam heating and cooling coils. The fan sizes on these older units range from 1 to 3 hp. These units are in

rough, but serviceable condition. The motors are all antiquated and should be replaced. We also understand that the cooling coils are in bad condition and require immediate replacement. The Town is currently abating asbestos from piping and duct insulation in these mechanical rooms. All air handlers have three-way chilled water valves. Steam coils, valves and piping are going to be replaced this spring and summer (see below). The five rooftop units provide air conditioning and ventilation to offices and perimeter areas (no heating). Two of the units are 3 hp and the other three are 1 hp. The library has perimeter steam radiators and an unknown quantity of VAV boxes with steam reheat coils that will be soon replaced with hot water coils.

Central Steam Plant

This facility has a single HB Smith section steam boiler plant that is currently being replaced. The new plant is going to be hot water, and steam will be eliminated from the building. The existing steam to hot water exchanger will be removed and new hot water pumps and piping added. Steam coils in air handlers are presently being replaced with hot water coils and new perimeter and reheat systems will be installed soon. This is an excellent upgrade to the library. We commend the Town on this large infrastructure investment which should result in considerably better heating plant efficiency as well as improved space temperature control in the building.

Chilled Water Plant

Chilled water is generated by an approximately 150 ton Carrier R134a water-cooled screw chiller. Chilled water is distributed by two 5 hp and one 3 hp constant volume centrifugal pumps. Condenser water is circulated by a pair 7.5 hp condenser water pumps (one standby). Condenser water heat is rejected by an Evapco cooling tower with two two-speed fans that is located above the mechanical area on the roof of the library.

Controls

The Noah Webster Library has a Johnson Controls Inc (JCI) Metasys direct digital control (DDC) system that controls a significant portion of the buildings HVAC systems. Items under JCI control include the six newer air handlers, five rooftop units and associated reheats, plus the boiler and chiller plants. The JCI system provides space temperature control as well as time of day and day of week scheduling. The remainder of the building retains pneumatic controls that have been updated with electronic time-clocks that shut systems down at night. Other pneumatic system functions include basic temperature and outside air (economizer) control. There is one dual 1 hp reciprocating compressor that serves the pneumatic system. The Town is planning to update the three pneumatic air handlers to DDC with the new boiler project currently underway.

Lighting

Lighting in the library is predominant T8 and compact fluorescent systems. There are new T5 fluorescent lights in the Records Room. The children's section on the lower floor has abundant light and it may make sense to employ occupancy devices to save power. We noted occupancy sensors in bathrooms and they may be in use in other areas of the building, but certainly not in all applicable areas.

Domestic Water

This facility has mostly low flow toilet and urinal fixtures. Sink aerators are typically 2.2 gpm.

Energy Efficiency Opportunities

This facility has a EUI of 84 kBtu/SF, which is typical for this type and age facility. We expect the new boiler project will result in a noticeable reduction in fuel use. We identified several other areas for efficiency improvement.

Specific Opportunities Identified:

- Add photocell controls in daylit areas (e.g. New Book section)
- Add occupancy sensors (children's play room, 2nd floor stacks, offices, meeting rooms)
- Consider LED alternative to Halogen track lighting in art viewing area
- Change automatic sliding entrance door configuration to reduce thermal losses
- Improve attic insulation and seal around lighting fixtures and access stairwell
- Replace old motors with new premium efficient motors
- Review control system setting / retro-commission control and building systems
- Add occupancy based HVAC control for multi-function room
- Expand control system to include VAV boxes, reheats and perimeter radiation (if not already under the new boiler renovation)
- Replace older air handlers

Police/Fire Department

The West Hartford Police and Fire Headquarters is located at 103 Raymond Street. The facility was originally a school built in 1910. At a later time it included a court facility. There have been multiple additions and renovations over the years and the three story facility now totals 68,900 square feet. The most recent work was completed in 2007 that includes the current Sallyport, booking and holding cell areas as well as new office area. The remainder of this building is mostly office space, but also includes meetings rooms, a break room and fitness area. There is a three bay heated vehicle garage. The building is in use continuously although some areas see much less use at night and on weekends.

Building Envelope

The original facility is brick construction with pitched roof section. The additions are brick faced concrete blocks with steel decks and flat asphalt roofing. Insulation materials and effectiveness in the walls is unknown and expected to be minimal in the original and older structures. We were unable to access the attic of the original building to check insulation there. Windows throughout the facility have thermal panes and are in good condition. Exterior doors appear to close well and have effective weather seals.

HVAC

This facility is conditioned by five fairly new gas-fired packaged DX rooftop units. Air distribution systems employ zone variable air volume (VAV) boxes with hydronic reheat coils. There is perimeter radiation in most of the building. The garage and Sallyport have ceiling hung hot water unit heaters.

Table 12 – Design Summary of Available Information on Police/Fire Headquarters HVAC Units

Unit	Serves	Type	Flow Control	Supply Fan hp	Airflow cfm	Burner MBH	Coil ton
RTU-1	1st Flr Old Bldg	VAV	Bypass	5	2,000	203	15
RTU-2	2nd Flr Old Bldg	VAV	Bypass	10	3,900	284	30
RTU-3	3rd Flr Old Bldg	VAV	Bypass	7-1/2	2,200	203	20
RTU-4	Office – New Bldg	VAV	Bypass	3	2,000	203	15
RTU-5	Prisoner Area	VAV	Bypass	1	735	122	6

Central Boiler Plant

There is a central hot water boiler plant serving perimeter radiation and reheat coils throughout the building. The plant consists of two older dual fuel Kewanee units. Each has a Gordon Piatt burner rated at 2,250 MBH with 1.5 hp forced draft fan. Natural gas is the primary fuel, and the town has plans to remove oil systems. Hot water is circulated by a pair of centrifugal pumps. The building's energy management system resets the hot water supply water temperature based on outside conditions.

Controls

All HVAC systems in the Police and Fire Headquarters are controlled by a Johnson Controls Inc (JCI) Metasys direct digital control (DDC) system. Functions include basic temperature and outside air (economizer) control, plus boiler control as mentioned above. The system can be accessed by laptop computer or via website. There are no pneumatic systems remaining in this building.

Lighting

The predominant lighting system at this facility is T8 fluorescent lamps with electronic ballasts. 2x2 biax fixtures are used in some hallways. There are also some compact fluorescent fixtures and what appears to be metal halide in the Sallyport (we were unable to access Sallyport or holding cell area during the time of our visit). Occupancy sensors are in widespread use throughout the station. There is opportunity to employ daylighting control for lights in the main entrance atrium.

Domestic Water

This facility has mostly older toilet and urinal fixtures that are not of the low flow type available today. Low flow units are being used in the new addition and administration area. Sink aerators are typically 2.2 gpm. Domestic hot water in the original building is generated by two 98 gallon gas-fired units in the main boiler room rated at 75 MBH each. There are also two 18 kW units, presently not in use. The new addition has a 100 gallon AO Smith gas-fired condensing unit rated at 150 MBH.

Energy Efficiency Opportunities

This facility has a EUI of 79 kBtu/SF, which is unusually good performance for a twenty-four hour a day facility of this type.

Specific Opportunities Identified:

- Add daylighting control for entrance atrium
- Replace what appears to be HID lights in Sallyport

- Install plug load controllers for vending machines / other
- Replace toilets and aerators with low flow fixtures
- Consider lowering space temperature in vehicle garage
- Schedule VAV boxes off in zones that aren't used at night and/or weekends
- Add VFDs to larger rooftop units
- Check attic insulation in old section of building and improve as appropriate

Public Works

The West Hartford DPW is located at 17 Brixton Street. The vehicle and grounds maintenance facility totals 34,500 square feet and includes two main bay areas, multiple shops, break room, offices and a basement shooting range. Shop occupancy is generally from 6 a.m. to 2:30 p.m., subject to snow events when the facility is often open around the clock. Office hours are typically 8 a.m. to 4:30 p.m.

Building Envelope

This is a masonry block building with steel supported flat roof decks and built up membrane roofing. The single floor office section has a brick façade. Insulation material and thicknesses isn't known, but believed to be minimal. Many bay areas have skylights. There are roughly 36 automatic overhead insulated doors. Weather seals on many of the overhead doors isn't effective and is missing on most exterior man doors. Windows at the office are in reasonable condition. The vehicle bay has fixed windows above the overhead doors.

HVAC

The DPW is heated and conditioned by a variety of HVAC systems. The equipment bay is heated by ceiling hung direct fired infrared units. There are nine gas-fired rooftop units, some with air conditioning capability for offices. Details follow in the table below.

Table 13 – Summary of Available Information on DPW HVAC Units

Unit	Serves	Type	VFD?	Fan hp	DX Clg tons	Gas Htg MBH
3 x Carrier RTUs	Offices	VAV / bypass	No	~11/2	4	115
Reznor	Part Crib	H&V	No	NA	-	NA
MUA	Shooting range	H&V	No	10	-	NA
Carrier RTU	Sign Room	CV	No	~1	3	82
Trane RTU	Auto Offices	CV	No	1/4	2.5	40
Carrier RTU	Street Light Office	CV	No	~1	3	48
Absolutaire	Shops	H&V	No	NA	-	NA

Controls

HVAC systems at the DPW are controlled by local thermostats. Most systems remain in operation during off-hours.

Lighting

Lighting in the DPW is predominant T8, including the two main high bays. T5s are in use in the welding bay. Lamps and ballast are believed to be fairly new. The shooting range uses quartz lamps. Occupancy sensors are in use in the bathroom, breakroom and other areas.

Domestic Water

The DPW has staff showers. Shower head flow rating couldn't be determined. Toilet and urinal fixtures are low flow rated. Sink aerators are 2.0 gpm.

Miscellaneous

This facility has a plethora of equipment and tools that consume electricity. Most uses are intermittent with light loading. The only significant electrical draw is associated with the shop compressed air system (compressor size unknown) and welding machines.

Energy Efficiency Opportunities

This facility has a EUI of 131 kBtu/SF based on 2010 utility data. We usually see high energy use at town garage facilities, but the West Hartford DPW's energy use is higher than expected. Poor building control and weather seals are likely contributing factors to high energy use.

Specific Opportunities Identified:

- Replace quartz lighting in the shooting range
- Install plug load controllers for vending machine / other
- Check shower heads and update to low flow as appropriate
- Add / repair weather seals on exterior overhead bay and man doors
- Review building ventilation and adjust accordingly
- If not already, shut down air compressor at night
- Add programmable thermostats to bay heating systems
- Interlock bay heating systems with garage doors
- Add simple building control system to manage RTUs and exhaust fans

Rockledge Golf Club

The Town operates the Rockledge Gold Club, which includes the following facilities:

Clubhouse: There is a two-level guest building that was opened in 1996 and totals 8,200 square feet. This building includes an upper level restaurant and banquet facility with commercial kitchen with food storage in the attic. There are locker rooms and a pro shop in the lower level. This facility is open year-round, but with more activities in the golf season, typically from May through November.

Concession Stand: Public restrooms and drinks/light snacks are available on the golf course at a small concession building. The building consists of men's and women's restrooms and open kitchen/serving area. The building is shutdown for the winter.

Maintenance Building: This building was constructed in 1972 with additions in 1990, 2000 and 2008. It totals 6,300 square feet and includes vehicle maintenance bay, washdown bay, parts room, unheated bays, machine and wood shops, breakroom and office and it sees use between approximately 7 a.m. and 4 p.m. weekdays. Unheated parts of the building are isolated from the main building for the winter season.

Pumping: There are three 50 hp pumps to irrigate the course. The pumps were recently updated with variable speed drives and controls under a CL&P project.

Building Envelope

Club House: This facility is masonry block and wood construction with pitched roof. There is batt insulation in the attic flooring. Most of the walls have horizontal siding. Wall insulation is unknown, but there is expected to be batt insulation based on the more recent construction. Exterior doors have issues with worn or missing weather stripping. Thermal pane windows are in good condition.

Maintenance Building: This facility is masonry block with wood framed pitched roof sections. There is batt insulation under the roof, but it is unlikely to have any effective wall insulation. The overhead garage doors are weatherized and in good condition. The few windows, mostly behind the building, are older single pane units in wooden frames. There is some glass block.

HVAC

Club House: This building has four DX air handlers with hot water coils (see table below). The attic units have issues with freezestats tripping. This is probably due to poor mixing of outside air. Outside air has been restricted to the units to keep them operational. Heat is supplemented via perimeter radiation. The pro shop has a ductless split heat pump unit. The programmable thermostats are setup with setbacks to 55^{o}F in the winter. At least one of the thermostats has the wrong time and date. Attention to the thermostats is recommended.

Table 14 - Clubhouse Air Handler Information

Unit	Location	Serves	Type	Fan hp	DX Ton	HW MBH
AHU-1	Storage	Kitchen	CV	<1	2	-
AHU-2	Attic	Tavern	CV	2	10	112
AHU-3	Attic	Restaurant	CV	3	12	155
AHU-4	M. Locker	Lockers	CV	1	-	122

Two gas-fired Slat Fin boilers rated at 522 MBH supply hot water. The boilers are controlled by a Honeywell aquastat, which appears to adjust supply water temperature based on outside conditions. This is a useful energy savings feature that minimizes hot water distribution system losses. Two approximately ¾ hp circulation pumps distribute hot water to the air handlers and radiators. There isn't any insulation on hot water piping in the boiler room.

Maintenance Building: This building has forced hot air heating systems. A Carrier oil-fired furnace is located on the mezzanine and has an approximately 2 hp fan. This unit is beyond its expected service

life. The burner is rated at 315 MBH input. The furnace is controlled by thermostat. There is a ductless split unit in the office. Otherwise there is no air conditioning at this facility.

Domestic Water

Facilities at the golf course have mostly standard flow toilet and urinal fixtures. At the clubhouse, two 80-gallon Bradford White units with 199 MBH input gas burners generate domestic hot water.

Lighting

Lighting in the Club House is T8 in back of house areas and the lower level public bathrooms. There are T12s in the attic storage area. The dining rooms and bar area have at total of about twenty-two dimmable incandescent lights. The lower level hallway has an additional six incandescent lights. The pro shop has 2x2 "U" lamps and halogen spotlights. The outdoor deck has CFL lighting. Timer controls the approximately five HID exterior lights. There are motion sensors in the restrooms.

The Maintenance Building includes T12 and T8 fluorescent lighting. The pesticide & chemical rooms have explosion proof fixtures. There are also several HID lights. The crew room and parts room have occupancy sensors.

The concession stand has T8 and CFL lights. The restrooms lights are on occupancy sensors.

Kitchen

The kitchen facility at the Club House has a gas fired range and ovens. The range has six standing pilots with excessively large flames, which is wasteful of gas. There is a walk-in cooler, ice machine and dishwasher. The kitchen hood exhaust fan is wall switch controlled.

Energy Efficiency Opportunities

We do not have utility data for the golf course facilities. There are several areas of opportunity to reduce energy use.

Specific Opportunities Identified:

- Adjust range pilots for reduced flame
- Lighting updates in Club House and Maintenance Building, including additional motion sensors where applicable
- Attention to door weather seals
- Relocate Club House AHU-2, -3 freezestats or other modification such as adding mixing louvers to assure uniform mixed air temperature at the coil
- Replace Maintenance Building furnace. Consider high efficiency propane-fired unit.

Town Hall

The West Hartford Town Hall is located at 50 South Main Street. Originally the building was the Hall High School. Construction was completed in 1922. The facility remained a school until 1970 when the current Hall High School was built. It remained vacant for many years until 1987 when the building was renovated, including new lighting and mechanical systems, and became the Town Hall,. About four years ago, there was a small addition to the building. Today the Town Hall totals 142,600 square feet on

four floors. It primarily houses department offices, and there is a small print shop and auditorium. A bank leases space on the north side of the building. The facility is open during normal weekday business hours.

The auditorium is available for rental use, and it occasionally has evening and weekend use.

Building Envelope

This is a brick facility with flat built up roof sections and interior courtyard. Building insulation isn't known and believed to be generally poor except in older parts of the building. Windows were replaced in 1987 with thermal pane units. The main entrance has automatic sliding double door sets in a glassed in vestibule that are currently under review for replacement. Other manual exterior doors generally don't have weather seals and in some cases have frame damage and large gaps to the outside.

HVAC

This facility is conditioned by a 4-pipe fan coil system, supplemented by six DX air handlers and an approximately 25 ton Trane gas-fired rooftop unit with 15 hp supply fan. In addition there are two smaller rooftop units serving the bank area. Design details on the air handling units aren't available at this time.

Central Plant

This facility has three HB Smith section hot water boilers. The 1 hp Power Flame burners are rated at 3,080 MBH each and fire on natural gas. Hot water is circulated by a pair of 10 hp B&G centrifugal pumps (one is standby). The equipment is in good condition. There is also a single approximately 180 ton McQuay R134a screw chiller that provides chilled water throughout the facility. Chilled water is circulated by a 20 hp variable speed centrifugal pump. Condenser water is circulated by a constant speed Armstrong pump. The Evapco cooling tower has 30 hp fan motor that operates with variable speed control.

Controls

The Town Hall has Johnson Controls Inc (JCI) direct digital control system. HVAC equipment is scheduled to turn on at 6 a.m. and off at 7 p.m. weekdays. While in occupied mode, the system will restart HVAC as necessary to maintain 60^{o}F at night in the winter. The JCI system also controls the chiller and boiler plants, including hot water temperature reset.

Lighting

Lighting in the Town Hall is predominant T8 with some compact fluorescent systems. Lamps and ballast are believed to be fairly new. There are a few remaining T12 lamps (e.g. near entrance, Continuing Education office and Records Vault on the 1st floor). There are also a few metal halide lamps in use at the main entrance. There doesn't appear to be use of occupancy sensors in this building.

Domestic Water

This facility's toilet and urinal fixtures aren't low flow rated. Sink aerators are typically 2.2 gpm.

Domestic hot water is supplied by a 119 MNH oil-fired Aero heater located in the boiler room. A ¼ hp oil pump runs continuously to provide oil to the unit. There are also other local 4.5 kW heating units.

Miscellaneous

There is a 3 kW solar photovoltaic system on the roof.

Energy Efficiency Opportunities

This facility has a EUI of 45.1 kBtu/SF, which is exceptional performance for an older building with mixed systems. We suggest rechecking the total building square footage and the utility input data to confirm this performance calculation. We identified several areas for moderate efficiency improvement.

Specific Opportunities Identified:

- Update remaining T12 lighting systems
- Add occupancy sensors offices, hallways and bathrooms
- Change automatic sliding entrance door configuration to reduce thermal losses
- Change DHW heater to gas-fired and shut off oil pump
- Review control system setting / retro-commission control and building systems
- Add condenser water reset controls algorithm
- Consider adding VFD control of cooling tower fan
- Add occupancy based HVAC control for multi-function rooms
- Consider eliminating the condenser water drain back tank with tower modifications so that the sump is in the basin of the tower (reduces pumping energy)

Veterans Memorial Ice Rink

The West Hartford public ice rink is located at 56 Buena Vista Boulevard, just across the street from the Aquatics Center. The facility was completely renovated in 2000 with an addition for the front lobby, support area and locker rooms. The facility includes a single ice rink with bleachers. There is a large open area in the lobby with benches for changing footwear. This area includes the front desk, ice skate rentals, skating shop, a game room and offices. There are four public changing rooms and two changing rooms dedicated to the high school hockey teams. Altogether, the facility is 37,800 square feet and is in operation year-round. Hours are typically from 7 a.m. to 11 p.m. An electric powered Zamboni conditions the ice about eight times a day.

Building Envelope

The original arena and new additions are constructed with masonry block with a brick facade. The arena has an arched steel roof with membrane roof. There is 2 inches of insulation in the built up roofing. There is no insulation in the original wall structure. The arena has glass block on upper sections. The facility has very few windows, which are fixed units with thermal panes. Exterior doors have weather seals, but there are significant gaps to the outside.

HVAC

The arena is conditioned by a rooftop desiccant dehumidification unit which runs continuously, but rarely is used to air condition the space which is cooled by the ice and refrigeration system. A former fitness area is now being used for office space and is supplied with ducted air from the dehumidification unit. This area is generally uncomfortably cold. The balance of the facility is conditioned by seven Carrier rooftop units. All equipment dates from 2000 and is in fair to good condition.

Table 15 – Summary of Available Information on Memorial Ice Rink HVAC Units

Unit	Serves	Type	VFD?	Fan hp	Flow cfm	DX Clg tons	Gas Htg MBH
Dehumid	Rink	CV	No	25 / 7.5	12,000	30	1,741
RTU-1	Lobby	CV	No	2	4,000	10	150
RTU-2	Pro Shop	CV	No	0.75	1,965	5	90
RTU-3	Offices	CV	No	0.75	1,500	4	90
RTU-4	Game Room	CV	No	0.4	1,050	3	80
RTU-5	Party Room	CV	No	0.4	1,050	3.0	80
RTU-6	Dress Room	CV	No	0.4	1,050	3.0	80
RTU-7	Dress Room	CV	No	0.4	1,050	3	80
RTU-8	Dress Room	CV	No	0.4	1,050	3	80

Refrigeration

The facility has a 150 ton ammonia refrigeration system that was replaced in 2000. The plant consists of two 75 hp reciprocating compressors. There is single evaporator that generates low temperature glycol for circulation to the rink coils. Suction pressure setpoint is about 25 psi. The plant is water-cooled with condenser water circulation to a Cimco cooling tower adjacent to the mechanical room with indoor drain back tank. Condenser water is circulated by 5 hp in-line pump. The approximately 10 hp tower fan cycles on/off to maintain a 120 psi minimum condensing pressure. There are two 25 hp constant volume glycol circulation pumps (one standby). The system has a 3 hp heat recovery loop that circulates warm water to a pit to melt ice discharge from the facility's Zamboni. There is another loop with 3 hp pump to circulate hot water to the slab to prevent freezing, but the buried pipes in this system have corroded and the system is no longer in use. The refrigeration system doesn't have oil recovery and staff regularly drains oil from the evaporator for disposal.

Controls

HVAC and refrigeration equipment at the Memorial Rink are controlled and monitored by an older Invensys direct digital control (DDC) system. The DDC system manages space temperature and relative humidity in the arena and schedules the rooftop units off at night. The dehumidification unit remains on 24/7 to maintain proper arena relative humidity. The refrigeration plant usually cycles off at night when the ice temperature setpoint is raised. At the time of our visit, there was a computer software compatibility issue, and there is no access to the system's front end.

Lighting

Lighting at this facility was recently upgraded. The arena has twelve-lamp T5 fixture with circuiting that allows various combinations of lamps to be used. Normally only two lamps per fixture are on, except

during a hockey game when more light is preferred. The remainder of the facility has low wattage T8s. The facility uses occupancy sensors.

Domestic Water

Toilet and urinal fixtures aren't low flow rated. Sink aerators are 2.2 gpm. Domestic hot water is generated in a 400 gallon PVI unit with gas 800 MBH burner.

Energy Efficiency Opportunities

This facility has a EUI of 172 kBtu/SF. Energy use at ice rinks is inherently high due to refrigeration and space dehumidification demands. Due to the wide variability of ice arena buildings and systems, it is difficult to benchmark these facilities. Energy use at West Hartford's facility does appear to be low, which is consistent with the energy efficient systems and operating policies in place.

Specific Opportunities Identified:

- Install plug load controllers (vending machines, video games)
- Repair/replace exterior door weather stripping and adjust doors for tight closure
- Consider low E roof system
- Install ductless split unit for offices in former fitness area
- Update Invensys control system to current standards and recommission systems
- Consider using ice treatment product to eliminate need for hot water resurfacing
- Add VFDs to glycol pumps for scheduled night slowdown
- Add VFD to cooling tower fan
- Magnetic water treatment (potential to reduce condenser fouling)
- Investigate viability of adding VFDs to dehumidification unit with RH control
- Investigate if there is an oil recovery and reuse system for the compressors