Multi-Family Building
Energy Audit

Property Management, Inc.

Main Street Apartments

123 Main St.

Smalltown, PA 12345

February 2, 2011

P.O. Box 2445
Philadelphia, PA 19147

BONE energy SERVICES

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1 INTRODUCTION

On November 22, 2010, Bone Energy Services performed an on-site assessment of a 3-story apartment building in Smalltown, PA in order to identify opportunities to improve the energy usage, comfort, health and environmental performance of the building. The basic attributes of this complex are:

Owner:	Property Management
Property Manager:	John Jones
Site Manager:	Manny Martinez
Size:	3 Stories, est. total 19,000 square feet (including basement)
	15 units
Age:	est. 1910 (100 years)
Configuration:	Common Entry, Walk-up
Structure:	Conditioned Basement (Apartment & Laundry Area)
	Concrete Block Foundation Walls
	Brick Exterior Walls with Plaster & Lath
	Wood Framed Floors and Ceilings
	Flat Wood-Framed Roof
Occupancy:	Market Rate
Utilities:	Central Oil Tank for Heat
	Central-Metered Natural Gas for Hot Water
	Individual-Metered Natural Gas for Cooking
	Individual-Metered Electric

During the site visit, we performed a thorough visual inspection and several specific tests that quantify energy efficiency attributes.

In addition, we performed a review of available fuel usage information.

This report is a summary of our findings and recommendations regarding changes that are expected to improve the performance of the building.

Evaluation Staff – Site Visit and Written Report

- Dave Bone – BPI Building Analyst & BPI Multifamily Building Analyst

2 EXECUTIVE SUMMARY

Main Street Apartments was built in the early 1900's with the materials and technology typical of that time. Based on the utility bills, the largest cost savings opportunities are in reducing water heating gas and heating oil consumption. Some opportunities also exist for reducing water and electricity consumption, but these are more limited.

Several Energy Conservation Measures (ECM's) are sensible for this building, and they can be accomplished at relatively low cost by the owner/manager:

	Measure	Installed Cost	Annual Cost Savings	Savings Benefit	Payback	Life Cycle Savings	Measure Life
		$	$		years	$	years
1	Low Flow Showerheads & Aerators	$ 380	$ 1,659	Owner	0.23	$ 9,958	7
2	Lighting Upgrades	$ 578	$ 663	Both	0.87	$ 3,731	7
3	Air Sealing Measures	$ 3,965	$ 2,332	Owner	1.70	$ 17,610	11
4	Hot Water Recirc Pump - Install Thermostat	$ 642	$ 352	Owner	1.83	$ 3,555	15
5	DHW - Control Boiler Based on Tank Temperature	$ 855	$ 451	Owner	1.90	$ 4,530	15
6	Flush Boiler	$ 204	$ 50	Owner	4.08	$ (108)	2
7	Insulate Boarded Basement Windows	$ 246	$ 54	Owner	4.52	$ 404	15
8	Insulate Steam Pipes in Boiler Room	$ 1,305	$ 119	Owner	11.00	$ 112	15
	Total Package	**$ 8,176**	**$5,680**		**1.44**	**$40,278**	**10**

Note: Savings estimates are for budgetary purposes only. They are based on the experience of Bone Energy Services with other similar buildings. They are not based on computer modeling of this specific building. Cost estimates assume prevailing wage rates. Some measures could be implemented at lower costs using the maintenance staff at the complex.

See the Appendix for detailed descriptions of recommended measures.

3 Manager Interview

The site manager, Manny Martinez, was interviewed during the site visit. In general, the goal of the management team is to improve the comfort and energy efficiency of their portfolio in an effort to reduce operating costs and improve tenant retention. No significant comfort/energy issues were noted.

- The building is generally comfortable. No significant cold or hot areas were noted by the management or residents.
- No moisture-related issues were noted.

Recent and planned changes were noted:

- Several years ago, all of the windows in the building were replaced.
- Several years ago, insulation was installed in the attic cavity.
- Shower heads have been replaced with low-flow models as practical.
- The front entry doors will be replaced with a similar aluminum-framed unit that seals better.

4 AS-FOUND CONDITIONS

Building Envelope:

Location	***Structure***	***Insulation***
Foundation Walls	Concrete Block	None
Above Grade Walls	Brick Structure, Lath/Plaster on Interior	None
Flat Roof	Wood Framed with Plywood Sheathing Asphalt Roll Roofing	5-8" Blown Cellulose
Windows	Double-Hung, Aluminum-Framed, 2-Pane Glass, No Low-e Coating	
Doors	Main Entries: Aluminum-Framed, Single Pane Glass Other Entries & Roof: Solid Wood	

Mechanical Equipment:

Function	***Details***
Heating	Oil Boiler, 2-Pipe Steam Outdoor Reset Controller, No Interior Temperature Sensors No Thermostatic Radiator Valves No Pipe Insulation
Domestic Hot Water	Natural Gas Boiler with Indirect Fired Storage Tank Recirculation Loop (Runs 100%) No Pipe Insulation, Loop Temp Measured at 122-124°F
Cooling	Window Air Conditioners (Various Models)
Ventilation	None in Corridors, Kitchens, or Bathrooms

Common Area Lights and Appliances:

Function	***Details***
Corridor Lights	Compact Fluorescent Lamps
Exit Signs	LED Lamps
Laundry Room Lights	T12 Fluorescent, Magnetic Ballasts, Manual Switch
Boiler Room Lights	T12 Fluorescent, Magnetic Ballasts, Manual Switch
Exterior Lights	Mix of Incandescent Reflector Lamps And High Pressure Sodium Lamps
Laundry Appliances	High Efficiency Clothes Washer & Natural Gas Clothes Dryer

Apartment Conditions:

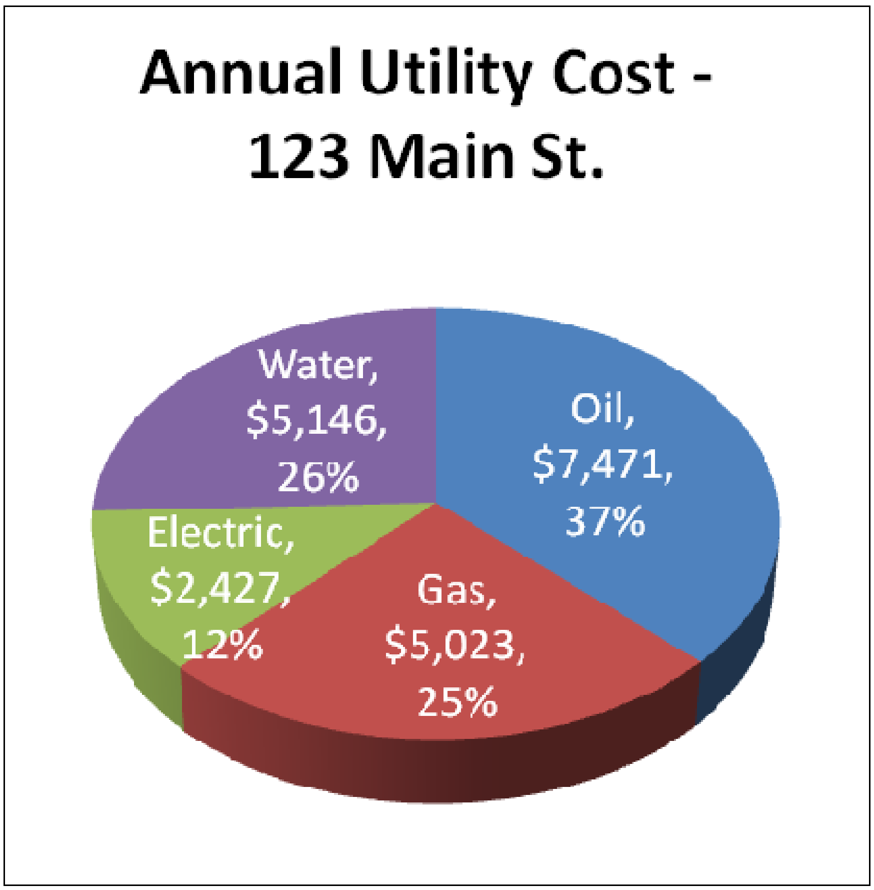
Function	***Details***
Lights	75% Incandescent, 25% Compact Fluorescent
Refrigerators	Post-2000, Less than 500 kWh/yr
Dishwashers	Not Energy Star labeled
Faucet Aerators	2.2 gpm
Shower Heads	1.6 gpm
Toilets	1.6 gpf
Smoke & CO Detectors	Yes (Combination Detectors)

5 UTILITY BILL ASSESSMENT

Utility usage data was provided for 12 months of consumption. This data included only oil, natural gas, electricity, and water paid for by the building management. No tenant electric or gas consumption data was collected. This information was analyzed and compared to typical usage rates for similar buildings.

The total annual cost of $1.16 per square foot is high for a family apartment building in Pennsylvania. The proportions attributable to each utility are shown below.

Utility	***Consumption***	***Cost***
Electricity	14,715 kWh	$ 2,427
Oil	3,171 gallons	$ 7,471
Natural Gas	3,407 ccf	$ 5,023
Water & Sewer	654,500 gallons	$ 5,146
TOTAL		**$ 20,066**

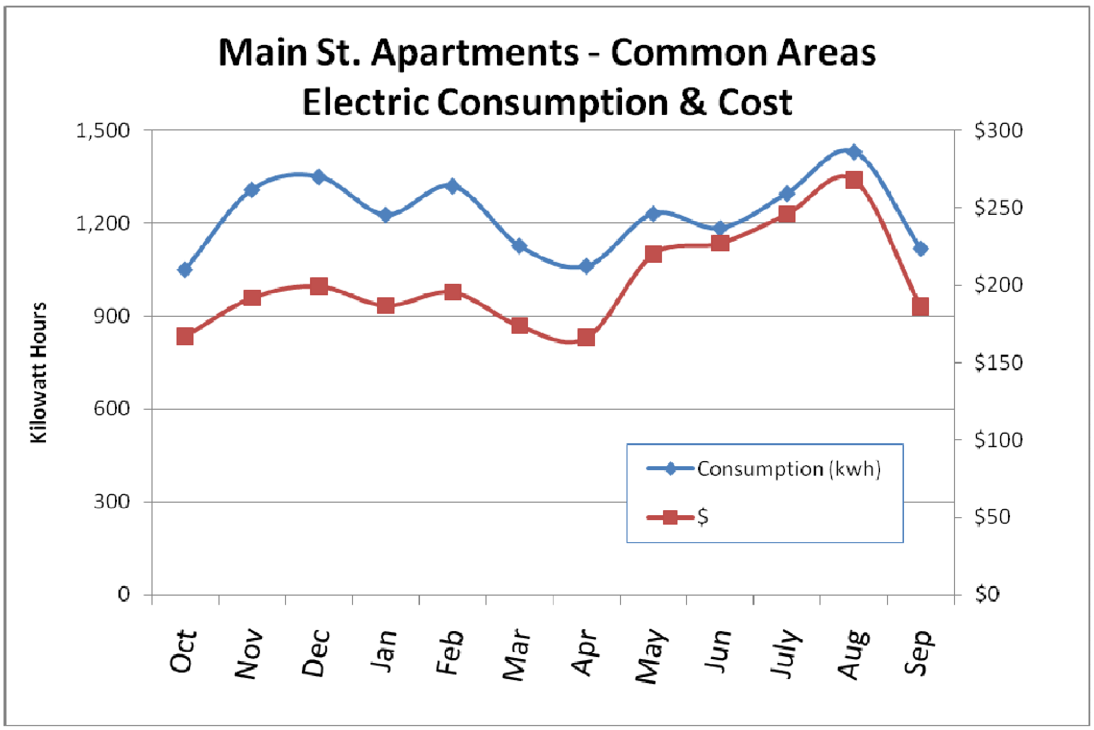


Electric Usage

Electric use data (actual utility bills) was provided for the common meters but not for individual apartments.

Seasonal consumption patterns are typical for a building using electricity for cooling, lights, and appliances.

- The lowest consumption occurs in the spring and fall, when there is no need for either heating or cooling. This corresponds to the "baseload" of lights and appliances.
- A small peak occurs during the winter months. This is attributable to increased lighting usage due to shorter days.
- No significant peak occurs in the summer because there are no cooling systems serving the common spaces in the building.



Average Rate: $ 0.165 / kWh

(Including Service Charges)

Discussion:

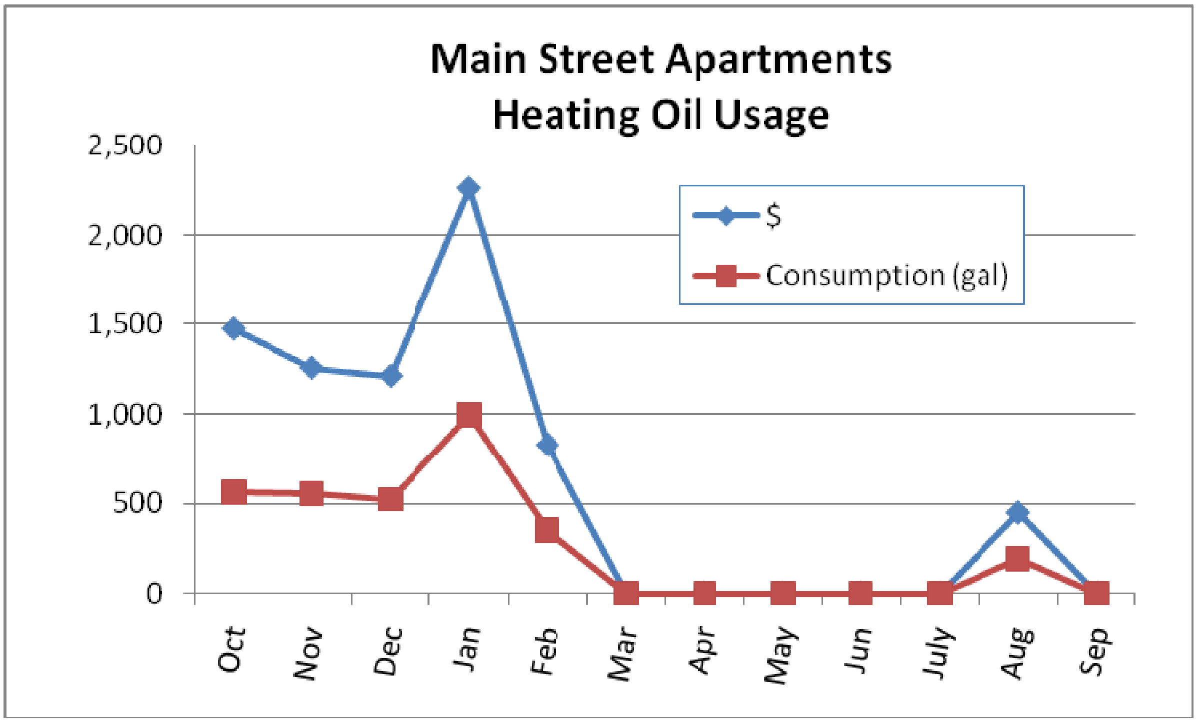
The overall electric cost, at $ 0.14 per square foot of floor area, is low for a multi-family building in Pennsylvania. The baseload accounts for most of the cost but it doesn't offer substantial opportunities for conservation measures, since the total building electric cost is only $ 2,400 per year.

It is assumed that the apartment electric usage is much higher than that of the common areas because each apartment includes lighting and appliances. Most apartments also use window or sleeve air conditioning units.

Oil Usage

Seasonal consumption patterns are typical for a building using oil for space heating. Consumption begins in October, peaks in January/February, and ends in April.

It should be noted that oil use data is based on delivery logs. It therefore doesn't show consumption directly. Deliveries tend to lag usage by several weeks and are grouped in large quantities of hundreds of gallons at a time. However, they are still useful in understanding general trends and total consumption.



Average Rate: $ 2.36 / gallon

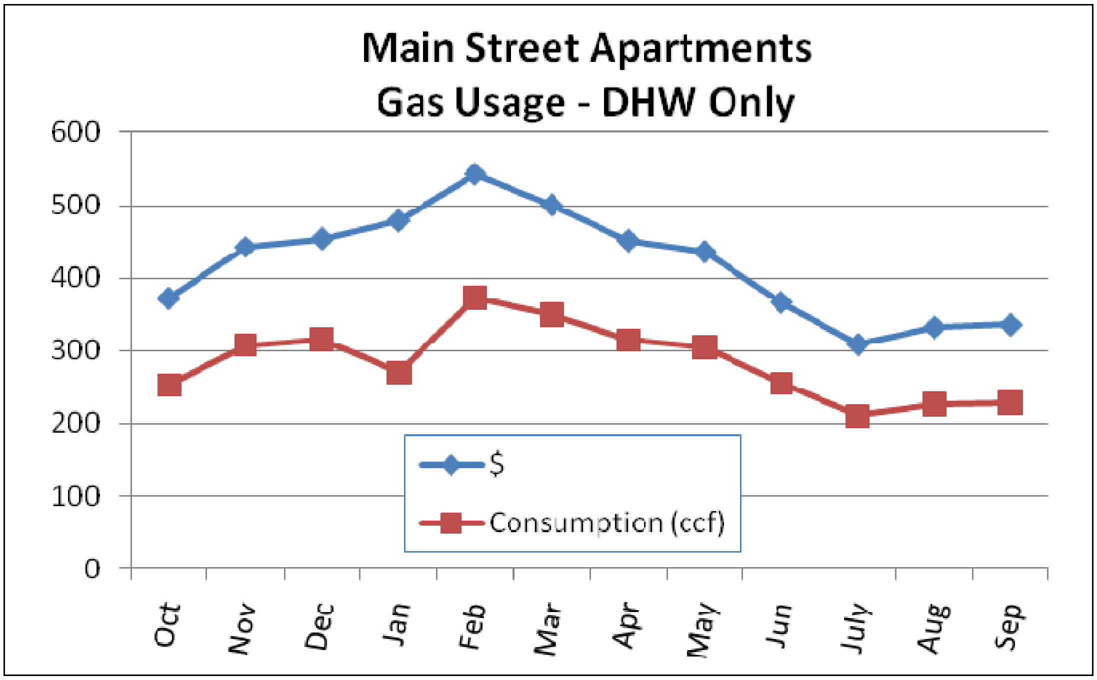
(No Service Charges)

Discussion:

The overall heating oil cost, at $ 0.43 per square foot of building area, is moderate-to-high for a building in Pennsylvania, indicating that there are significant savings opportunities.

Natural Gas Usage

Seasonal consumption patterns are typical for a building using natural gas for domestic hot water. It is steady, with a small peak in the winter, when the incoming water is colder and more heat loss occurs from pipes circulating water through the building.



Average Rate: $ 1.47 / ccf

(Including Service Charges)

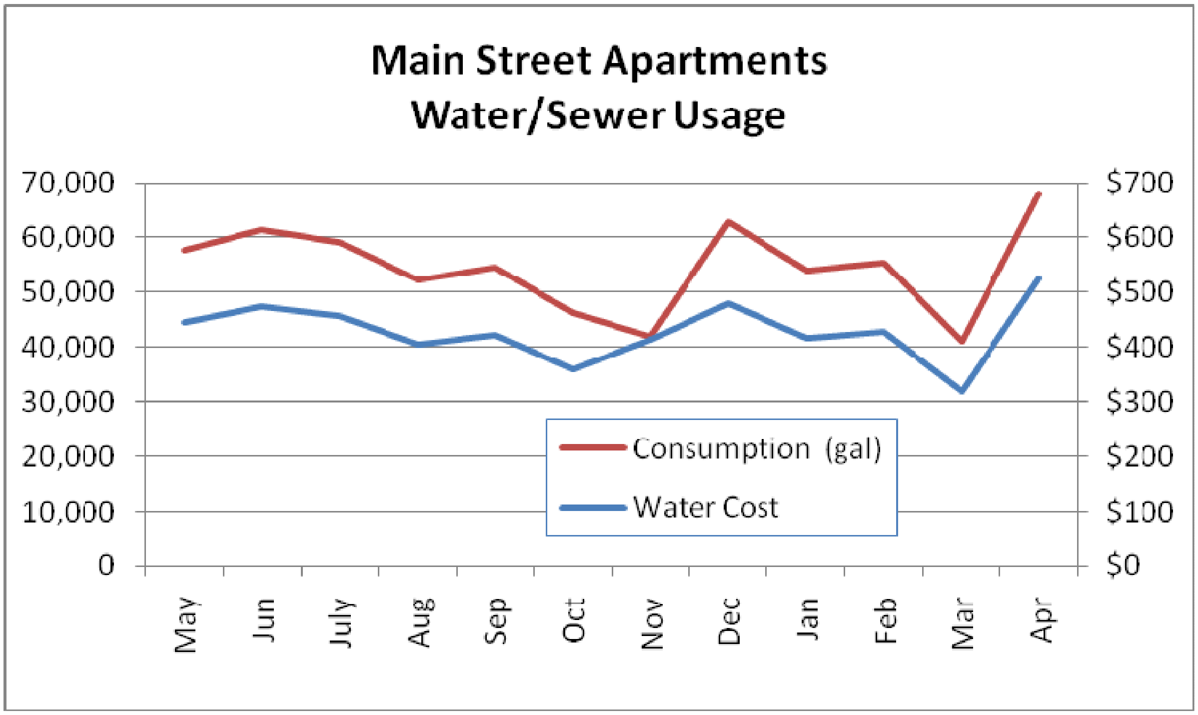
Discussion:

The overall water heating gas cost, at $ 0.29 per square foot of building area, is very high for a building in Pennsylvania, indicating that there are significant savings opportunities.

Additional gas is used by the apartments for cooking, but this is typically a relatively small quantity, in the range of 30-50 ccf per year per apartment.

Water & Sewer Usage

Seasonal consumption patterns are typical for a building with no irrigation. Consumption is fairly steady throughout the entire year.



Average Rate: $ 7.87 / thousand gallons
(Including Service Charges)

Discussion:

The overall water cost, at $ 0.30 per square foot of building area, is low-to-average for a family apartment building in Pennsylvania, but the consumption rate of 138 gallons per apartment per day is higher than expected. Reductions in water consumption and cost present a significant opportunity.

6 DISCLAIMER

The energy conservation opportunities contained in this report have been reviewed for technical accuracy. Savings estimates reflect experience with similar and/or past projects. However, because energy savings ultimately depend on the lifestyle of the residents, the weather, and many other factors that cannot be controlled, Bone Energy Services does not guarantee the savings estimated in this report. Bone Energy Services shall not, in any event or circumstance, be held liable should the actual energy savings vary from estimated savings.

The recommended modifications to building components and operation are intended as a starting point for the implementation of changes. Significant modifications to a building or its components should be reviewed and certified by a licensed architect or engineer. Compliance with all applicable national, state, and local codes and best practices is essential to realizing expected savings. Applicable codes supersede any recommendations in this report. Bone Energy Services may suggest certain contractors or products that will help attain the necessary energy savings. These entities and/or products are chosen based on experience and/or expertise, Bone Energy Services neither provides compensation, nor is it provided compensation, for any recommended products or services.

APPENDIX:

Detailed Descriptions of Recommended Energy Conservation Measures (ECM's)

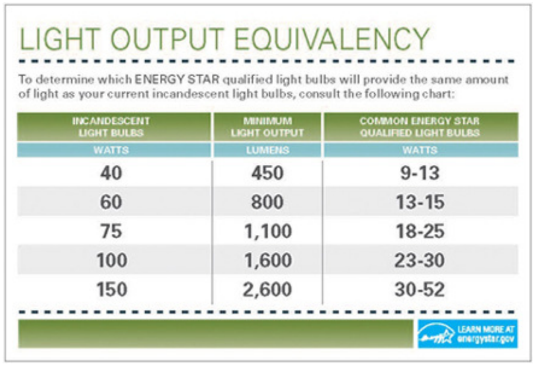
ECM #1	***Low Flow Showerheads and Faucet Aerators***
Rationale:	Much of the water used in a multifamily building flows through showerheads and faucet aerators. The current federal mandate for these devices is a maximum flow rate of 2.5 gallons per minute (gpm). Most of the faucet aerators in the building are 2.2 gpm models. Some of the showerheads have been replaced with 1.6 gpm models, but others are likely to be aging and use 3.0+ gpm. High efficiency models are available that can reduce this flow well below even the current federally mandated maximum levels. This will reduce both water consumption and water heating energy use.  
Proposed Implementation Method:	1. Replace all shower heads with 1.6 or 1.75 gpm versions. One suitable model is the Niagara Conservation Earth Massage N2917CH, which provides a variable spray pattern and reliable performance at a reasonable cost. 2. Replace all faucet aerators with 1.5 gpm versions.  
Estimated Implementation Cost:	$ 380
Estimated Annual Energy/Water Savings:	$ 1,659

ECM #2	***Lighting Upgrade Package***
Rationale:	Much of the common area lighting at Main Street Apartments has been upgraded to improve energy efficiency. In the apartments, however, most of the fixtures are fitted with inefficient incandescent lamps that consume more electricity than necessary. Replacing them with compact fluorescent lamps (CFL's) will dramatically lower the electricity consumption of the building while providing comparable light levels and quality.

1. 75+% of the observed fixtures in the visited apartments use incandescent lamps.

2. Three fixtures on the exterior of the building use incandescent lamps. (In flood fixtures and at the entry to the manager's apartment.)

3. The light fixtures serving the laundry room are controlled by manual switches. Therefore, these lights are often left on when this space is unoccupied.

Proposed Implementation Method:	1. Replace all of the incandescent lamps in the exterior and hard-wired apartment fixtures with compact fluorescent lamps (CFL's). 13-15W lamps will be adequate for all locations except kitchens and bathrooms, which are often lit to low levels. 23W lamps should be installed in these locations.   2. Install 3-way, switch-mounted occupancy sensors to control the lights in the laundry room. 

LIGHT OUTPUT EQUIVALENCY

To determine which ENERGY STAR qualified light bulbs will provide the same amount of light as your current incandescent light bulbs, consult the following chart:

INCANDESCENT LIGHT BULBS	MINIMUM LIGHT OUTPUT	COMMON ENERGY STAR QUALIFIED LIGHT BULBS
WATTS	LUMENS	WATTS
40	450	9-13
60	800	13-15
75	1,100	18-25
100	1,600	23-30
150	2,600	30-52

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Estimated Implementation Cost:	$ 578
Estimated Annual Energy Savings:	$ 663 (Most savings accrue to the tenants)

<table>
<tr><th>ECM #3</th><th>Air Sealing Package</th></tr>
<tr><td>Rationale:</td><td>Air leaking through openings in the building shell can be one of the largest sources of heat loss in a building. Several significant air leakage pathways were identified.

• The doors leading to the roof at the top of the stairwells have large gaps that allow a significant amount of air to exit the building.

• Caps are fitted to the peaks of the skylights that illuminate the top of the stairwells. These caps appear to be open at all times, possibly to provide corridor ventilation. However, they are a significant source of winter heat loss.

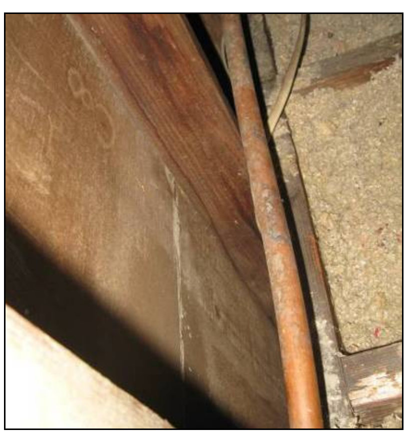
 </td></tr>
</table>

	• The two side entry doors lack weather strips and effective sweeps. They allow a significant amount of outdoor air to enter the building. • Window air conditioners appear to remain installed during the heating season, allowing a significant amount of air to move between the building and outdoors.  • The weather strip and astragal seals on the main entry doors are worn and in need or replacement.  • The boiler room is highly vented to the exterior to provide combustion air to the boilers. Therefore, it should be well isolated from the rest of the building. However, the door to the laundry room lacks a weather strip and the walls to the adjacent rooms are not well sealed. 

- Four abandoned dumbwaiter shafts run from the basement up through the roof. They have been penetrated in numerous locations to facilitate wiring changes. These shafts act like chimneys, allowing cool basement air to flow in, absorb heat from the building, and exit into the attic or at the poorly sealed caps above the roof level. One shaft is wide open above the roof level, and one is used to vent a dryer in Apartment 12.



- The attic has been insulated but not air-sealed. Numerous air leakage points exist, particularly between the brick structure and wall framing at the exterior perimeter and around the stairwells. Additional leakage points exist at the tops of partition walls and around the chimney and dumbwaiter chases.

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- An attic hatch is located at the top of each stairwell. Neither is insulated or sealed with weather strip. They allow a substantial amount of air to move between the attics and stairwells.

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<tr><td>Proposed Implementation Method:</td><td>

1. Install heavy duty weather strips and sweeps on the side entry doors and the roof access doors. Alternatively, replace these un-insulated wood doors with insulated, pre-hung units.
2. Seal the skylight cap vents with backer rod and caulk.
3. Assist the residents in removing all window air conditioning units for the heating season.
4. Install new weather strips and center astragal seals on the main entry doors.
5. Seal all penetrations from the boiler room into the adjacent spaces. This includes installing a weather strip on the door and sealing all gaps in and above the walls with spray foam.
6. Seal the dumbwaiter shafts at the top floor ceiling level (if possible) and at the basement ceiling level with Thermax rigid sheet insulation and spray foam. Appropriate steps must be taken to deal with dryer exhaust that enters one of these shafts from a top floor apartment.
7. Have a BPI certified air sealing contractor seal all penetrations through the top floor ceiling plane, including the entire perimeter, partition wall top plates, and any plumbing or chimney chases.
8. Install insulation and weather stripping on each attic hatch.

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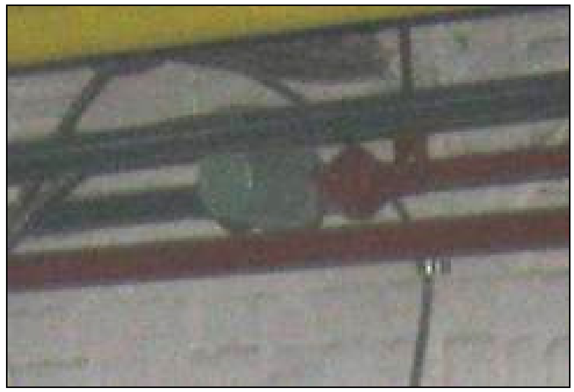
Estimated Implementation Cost:	$ 3,965
Estimated Annual Energy Savings:	$ 2,332

<table>
<tr><td>ECM #4</td><td colspan="2">Install Temperature Control on Hot Water Recirculation Pump</td></tr>
<tr><td>Rationale:</td><td colspan="2">A Taco 1/25 hp pump re-circulates domestic hot water through the building to maintain the loop temperature and keep hot water close to each apartment. This pump runs at all times.

A thermostat can be installed to shut this pump off until the water cools enough to require recirculation. This will save pump energy and heat loss from the circulating water, particularly at night when demand is negligible. Studies have shown that a set point of 110°F is optimal for most buildings, minimizing energy usage while maintaining water at an adequate temperature in the loop.</td></tr>
<tr><td>Proposed Implementation Method:</td><td colspan="2">1. Install an aquastat to control the operation of the pump based on the temperature of the return line.
2. Adjust the thermostat so the domestic hot water recirculation pump shuts down when the loop temperature is above 110°F.
3. Fine tune the set point based on tenant feedback to ensure hot water is adequately maintained in the loop.</td></tr>
<tr><td colspan="2">Estimated Implementation Cost:</td><td>$ 642</td></tr>
<tr><td colspan="2">Estimated Annual Energy Savings:</td><td>$ 352</td></tr>
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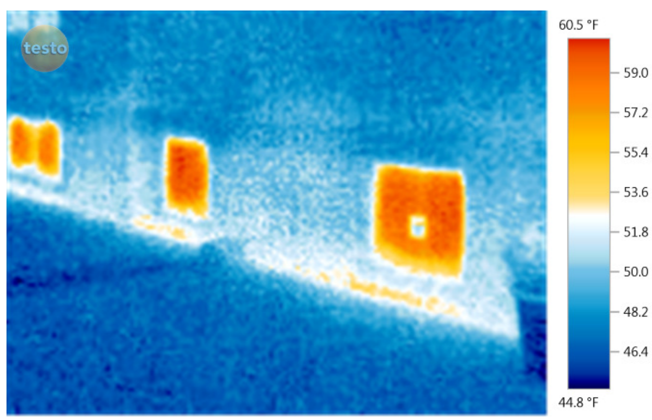
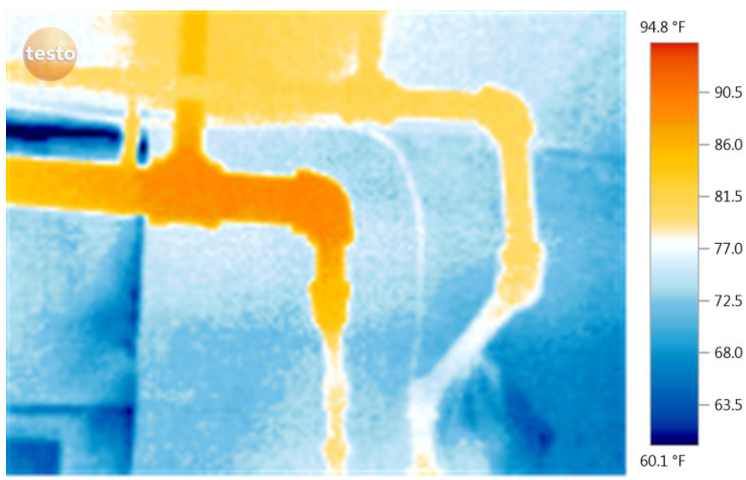
ECM #5	***Control Domestic Hot Water Boiler & Pump Based on Tank Temperature***
Rationale:	Domestic hot water is heated in a storage tank by a dedicated boiler. A pump continuously circulates water between the boiler and the tank and the boiler fires when the return temperature is below 140°F. Because room air is always flowing through the boiler and up the chimney, this operational strategy results in continuous standby losses as heat flows from the hot water through the boiler heat exchanger and up the chimney. 
Proposed Implementation Method:	1. Install an aquastat in the port specifically intended for this purpose on the storage tank. 2. Set the aquastat to 130°F, and wire it so the boiler and circulator pump only run when the temperature in the tank falls below the set point. 
Estimated Implementation Cost:	$ 855
Estimated Annual Energy Savings:	$ 451

ECM #6	Flush Boiler
Rationale:	Visual inspection at the boiler sight glass indicates that a significant amount of sediment has accumulated in the boiler. This sediment can slow heat transfer through the heat exchanger and plug valves or air vents. 
Proposed Implementation Method:	Thorougly flush the boiler whenever the water in the boiler sight glass is either cloudy or significantly discolored.
Estimated Implementation Cost:	$ 204
Estimated Annual Energy Savings:	$ 50

ECM #7	***Insulate Boarded Basement Windows***
Rationale:	Based on thermal imaging, the boarded windows in the basement laundry room are a large source of heat loss. They can be insulated with relative ease.  
Proposed Implementation Method:	Install 1-2" thick rigid foam insulation on the interior of the boarded windows and seal the perimeter of the foam to the window frames with caulk.
Estimated Implementation Cost:	$ 246
Estimated Annual Energy Savings:	$ 54

ECM #8	***Insulate Steam Pipes in Boiler Room***
Rationale:	None of the steam pipes in the boiler room are insulated. These pipes are very hot and lose a significant amount of heat to the surrounding space. The boiler room is intentionally vented to provide combustion air to the boilers. Therefore, much of the heat from the steam pipes is wasted warming air that flows into the room, through the boilers, up the chimney, and out of the building.  
Proposed Implementation Method:	Install R-5 fiberglass insulation on all steam lines in the boiler room. It should cover all straight sections, elbows, and tees. Both steam lines and condensate return lines should be insulated where practical.
Estimated Implementation Cost:	$ 1305
Estimated Annual Energy Savings	$ 119