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December 9, 2009

Local Government Energy Program
Energy Audit Final Report

For

Public Library
Borough of Metuchen
Metuchen, NJ 08840

Project Number: LGEA18

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INTRODUCTION

On July 29th, 30th and 31st of 2009, Steven Winter Associates, Inc. (SWA) performed an energy audit and conditions assessment of the Borough of Metuchen Borough Hall, Public Library, Senior Center and Department of Public Works buildings located in Metuchen, NJ in Middlesex County. This assessment was conducted under the New Jersey Clean Energy Local Government Energy Audit Program. A separate report has been submitted for each of the buildings that were assessed. This document applies only to the Metuchen Public Library at 480 Middlesex Avenue.

Existing conditions and energy-related information were collected in order to analyze and facilitate the implementation of energy conservation measures for the building. Energy data collected in the field was imported into the eQUEST energy conservation software to generate a baseline model of the building. SWA simulated the installation of energy improvement measures on the baseline model of the building. Energy saving calculations and projected economics are automated and served as the basis for our conclusions.

The Metuchen Public Library, located at 480 Middlesex Avenue, was built in 1937 with a one-story addition built in 1971. The Public Library consists of 12,029 square feet of conditioned space. The original structure is a two-story wood frame building. The addition is a one-story concrete and brick building. There are 8 full time employees and operates approximately an average of 52 hours a week.

The goal of this energy audit is to provide sufficient information to make decisions regarding the implementation of the most appropriate and most cost effective energy conservation measures for the building.

EXECUTIVE SUMMARY

The document contains the Energy Audit Final Report and conditions assessment report for the Borough of Metuchen Public Library located at 480 Middlesex Avenue, Metuchen, NJ 08840. The Library has two sections, the original building built in 1937 is a two-story structure with attic and full basement; the addition, built in 1971 is a one-story with full basement. The building contains approximately 12,029 square feet of conditioned space.

Based on the inspections performed by Steven Winter Associates (SWA) staff on July 16th and between July 29-31, 2009, and the results of a comprehensive energy analysis, this report describes the site's current conditions and recommendations for improvements. Suggestions for measures related to energy and conservation and improved comfort are provided in the scope of work. Energy and resource savings are estimated for each measure that results in a reduction of heating, cooling and electric usage.

For the 12 months from April, 2008 through March 2009, the Metuchen Public Library consumed approximately 172,048 kilowatt hours (kWh) of electricity at a cost of $30,645.51 and 8,960 therms of natural gas at a cost of $10,439.38. Combined energy consumption (electricity and gas) for that period was 1,483.16 million Btu (MMBtu) at a total 12-month cost of $41,085 ($27.70 per MMBtu).

SWA benchmarked the energy performance of the Municipal building using the U.S. Environmental Protection Agency's (EPA) *Energy Star Portfolio Manager* Energy benchmarking system. Using 2008 as a baseline year, Portfolio Manager was used to evaluate the site energy use intensity of the building. The site energy use intensity for the Municipal building is 120 kBtu/sq.ft/year. The score, or rating, was 75. Future utility bills can be added to the Portfolio Manager and the site energy use intensity for different time periods can be compared to the year 2008 baseline to track changes in energy consumption over time. After energy efficiency improvements are made, Portfolio Manager can be used to evaluate the impact over time.

SWA recommends a total of four Energy Conservation Measures (ECMs) for the Library. The total investment cost for these ECMs is $**77,980.** The total investment cost for these ECMs if maximum incentives are achieved is about **$64,903.** SWA estimates a first year savings of **$9,752** with a simple payback of **8.3 years**.

There are various incentives for which the Borough of Metuchen could apply that could also help lower the cost of installing the ECMs. SWA recommends that the Township applies for the NJ SmartStart program through the New Jersey Office of Clean Energy. This incentive can help provide technical assistance for the building in the implementation phase of any energy conservation project. Currently, the New Jersey Office of Clean Energy offers a Renewable Energy Incentive program that would pay $5,000 for the installation of a 5 kW photovoltaic system. There is also an incentive that issues a Solar Renewable Energy Certificate for every 1000kWh (1MWh) of electricity generated that can be sold or traded for the current market rate of electricity. The total investment cost if all the incentives are attained at their maximum amount is $64,903.

The following table summarizes the proposed Energy Conservation Measures.

SCOPE OF WORK – SUMMARY TABLE

ECM#	ECM description	Installed Cost		1st year energy savings					SPP	LoM	lifecycle savings	Averaged ROI
		Estimated $	Source	usage	unit	demand	unit	$ savings				
1	Retro-Commissioning	$ 4,210	LBL,Lit.	38.4	MMBtu			$ 1,064	4.0	15	$12,698	13.4%
2	High Efficiency Lighting	$ 19,770	Estimate	13,846	kWh	4.83	Kw	$ 2,809	7.0	12	$27,961	3.5%
3	Demand Controlled Ventilation	$ 19,000	Estimate	112.7	MMBtu	NA		$ 3,122	6.1	12	$31,074	5.3%
4	5 KW Solar Photovoltaic System	$ 35,000	Similar	5,915	kWh	5	kW	$ 3,505	10.0	15	$41,842	1.3%
Total		$ 77,980						$ 9,436	8.3	13.5	$103,491	2.4%

Discount rate: 3.0% per DOE FEMP guidelines
Energy price escalation rate: 0% per DOE FEMP guidelines

1. HISTORIC ENERGY CONSUMPTION

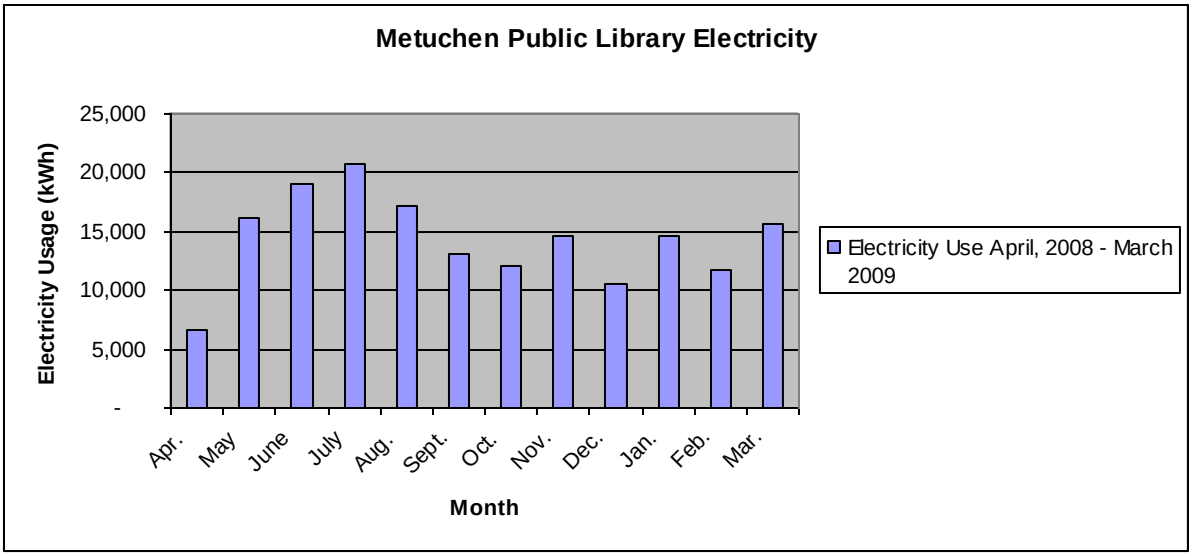
1.1. Energy usage and cost analysis

SWA analyzed utility bills provided by PSE&G and Elizabethtown Gas that showed consumption and cost for a fairly recent 12 month period.

Electricity – The Borough purchases electricity from Public Service Electric and Gas Co. (PSE&G) at **an average aggregated rate of $0.178 per kWh for the Public Library in 2008-2009.** The Library used **172,080 kWh at a cost of $30,645.51.** The data also reflected that demand charges and other fees (included in the above total) averaged approximately $217.10 monthly**.**

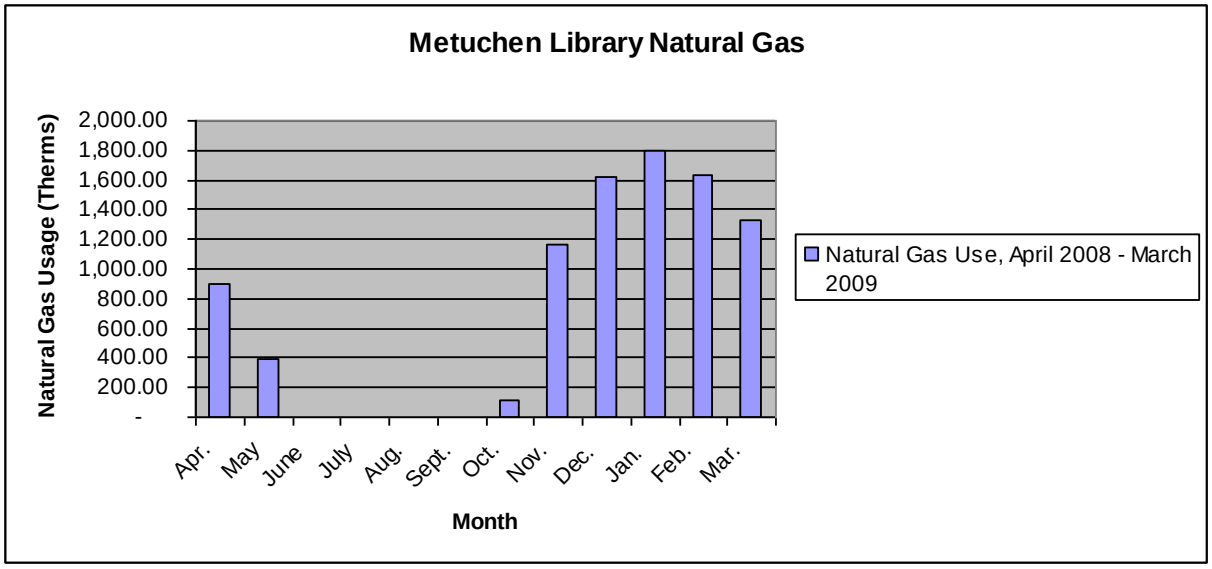
Natural Gas – The Library uses natural gas purchased form Elizabethtown Gas. **The average aggregated rate for natural gas in 2008-2009 was $1.17 per therm**. The building used **8,960 therms of gas costing $10,439.80.**

The following chart shows electricity usage for the Municipal complex based on utility bills for January 2008 through December 2008.



In the above chart, the electricity spikes upwards during the summer months reflect the cooling load as expected.

The following chart shows the natural gas usage for the Municipal complex based on utility bills for the year starting September 2007 through August 2008. The months have been arranged to reflect a calendar year.



In the above chart, the natural gas usage follows a heating trend as expected with no gas used through the late spring, summer and early fall.

1.2. Utility rate

The building purchases electricity from PSE&G at the MD rate. The Library uses Account #21 51 954 023 10 at service address 480 Middlesex Avenue, Metuchen, NJ 0884o. Natural Gas service is provided by Elizabethtown Gas, account number 5696632591. Electricity was billed at an average aggregated rate of **$0.178/kWh** and natural gas was billed at an average aggregated rate of **$1.17/therm**.

1.3. Energy benchmarking

The building information and utility data were entered into the U.S. Environmental Protection Agency's (EPA) *Energy Star Portfolio Manager* energy benchmarking system. A summary report of the Portfolio Manager results is provided on the following page. A rating of 75 was given to the building.

Per the LGEA program requirements, SWA has assisted the Township of Metuchen to create an *Energy Star Portfolio Manager* account and share the Metuchen Library facilities information to allow future data to be added and tracked using the benchmarking tool. SWA has shared this Portfolio Manager site information with TRC Energy Services, user name TRC-LGEA, as well as the Township of Metuchen with the following user name and password:

User name: "WEBoerth"
Password: "Metuchen"

OMB No. 2060-0347

STATEMENT OF ENERGY PERFORMANCE
Metuchen Public Library

Building ID: 1841533
For 12-month Period Ending: February 28, 2009[1]
Date SEP becomes ineligible: N/A
Date SEP Generated: September 07, 2009

Facility
Metuchen Public Library
480 Middlesex Avenue
Metuchen, NJ 08840

Facility Owner
Borough of Metuchen
500 Main Street
Metuchen, NJ 08840

Primary Contact for this Facility
Alan Tabachnikov
50 Washington Street
Norwalk, CT 07461

Year Built: 1937
Gross Floor Area (ft²): 12,029

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

Site Energy Use Summary[3]

Electricity - Grid Purchase(kBtu)	613,367
Natural Gas (kBtu)[4]	833,259
Total Energy (kBtu)	1,446,626

Energy Intensity[5]

Site (kBtu/ft²/yr)	120
Source (kBtu/ft²/yr)	243

Emissions (based on site energy use)

Greenhouse Gas Emissions ($MtCO_2e$/year)	138

Electric Distribution Utility
PSE&G - Public Service Elec & Gas Co

National Average Comparison

National Average Site EUI	104
National Average Source EUI	246
% Difference from National Average Source EUI	-1%
Building Type	Library

Stamp of Certifying Professional

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

Meets Industry Standards[6] **for Indoor Environmental Conditions:**

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

Certifying Professional
Alan Tabachnikov
50 Washington Street
Norwalk, CT 06854

Notes:
1. Application for the ENERGY STAR must be submitted to EPA within 4 months of the Period Ending date. Award of the ENERGY STAR is not final until approval is received from EPA.
2. The EPA Energy Performance Rating is based on total source energy. A rating of 75 is the minimum to be eligible for the ENERGY STAR.
3. Values represent energy consumption, annualized to a 12-month period.
4. Natural Gas values in units of volume (e.g. cubic feet) are converted to kBtu with adjustments made for elevation based on Facility zip code.
5. Values represent energy intensity, annualized to a 12-month period.
6. Based on Meeting ASHRAE Standard 62 for ventilation for acceptable indoor air quality, ASHRAE Standard 55 for thermal comfort, and IESNA Lighting Handbook for lighting quality.

EPA Form 5900-16

2. FACILITY AND SYSTEMS DESCRIPTION

2.1. Building Characteristics

The Metuchen Public Library was built in 1937, with an addition built in 1971. The original building is a two story wood frame building with an attic and full basement. The addition is a one story concrete and brick building. The entire library now has about 12,029 square feet of conditioned space.

2.2. Building occupancy profiles

There are only 8 full time employees at the Library. Due to the nature of the building's use and occupancy, the amount of people using the building at any given time is difficult to estimate.

2.3. Building Envelope

2.3.1. Exterior walls

The exterior walls of the original building consist of two withes of brick, a common brick structure with a red face brick facade. There was no evidence of any insulation in the original section walls and building maintenance staff confirmed that they had not seen any insulation. The addition walls are eight inch concrete block with a red façade matching the original section brick. The building plans for the addition specify two inches of insulation between the block and the brick but do not indicate what type of insulation. From the date of construction, 1971, the insulation is probably rigid board polystyrene, with an R-value of about 3.5 to 4 per inch, a total R-value of seven or eight when new. As rigid board foam insulation degrades slightly over time, the present R-value is probably closer to six.. Adding insulation to exterior walls is expensive and is not a cost-effective option.

2.3.2. Roof

The roof of the original section of the Library is a pitched wood frame with wood sheathing and slate shingles. The addition roof is flat/low slope, steel frame with a one and a half inch 20 gauge steel deck. There are about ten inches of fiberglass batt insulation in the attic of the old section. That reflects an R-value of about 30. For the newer section roof, once again, the building plans specify roof insulation under the built up roof and membrane but does not specify the material. The scale drawings show about 2 inches of insulation, which is probably an open-cell polyurethane or a polyurethane/perlite rigid foam board. The total r-value when installed was approximately 11 to 14 and would be closer to 9 to 12 now. It is not cost effective to add insulation to the flat roof section but at such time that the Borough decides to replace the roof membrane, three to four inches of polyisocyanurate rigid board insulation should be installed under the membrane.

2.3.3. Base

The building's base is 5" concrete slab-below-grade. There were no reported problems with water penetration or moisture. The building code in effect at the time of construction would not have required insulation either at the perimeter of the foundation walls or under the slab, and

the building plans do not show any insulation either. Again, excavation to install perimeter insulation is not a cost effective option.

2.3.4. Windows

The existing windows at both sections of the Library are single glazed with very little insulating qualities. Due to seasonal conditions at the time of the site visit, SWA could not review the actual performance of the windows during cold weather but single glazed windows are a poor performance energy option. New windows would be extremely expensive and cosmetically would actually detract from the appearance of the older section, which has large, very attractive old windows.

Installation of new windows would not be economically viable. There are interior and exterior retrofit strategies that would provide increased comfort for building occupants and significant energy savings. One alternative may be the installation of an interior storm window system manufactured using two layers of high strength plastic film on an aluminum frame. This type of system has been shown to lower the u-value (u-value is a measure of transmission of heat through a material or assembly; lower numbers indicate better performance) of single pane windows from about .9 to .31, almost triple the insulating value. These systems have also been shown to reduce drafts and minimize radiation from cold surfaces. It is difficult to verify the rated energy performance of site-built assemblies, as a result, it is difficult to guarantee energy savings and any associated economic payback. Selection of the appropriate alternative should be made with consideration to comfort, durability, window functionality, and aesthetics as well as possible energy savings. Also the large windows at the southwest side of the addition should be equipped with a solar control film either applied directly to the existing glazing or as part of the storm window system. The solar gain from these windows can be felt at more than 25 feet away from the window and this kind of extra load causes the cooling system to labor, wasting electricity.

Addition Existing Windows

Original Building Existing Windows

The operable windows, especially the single hung windows in the older section, were extremely difficult to open if they could be opened at all. They were obviously covered with Plexiglas at one time and were not used at all for ventilation. Several of the larger windows in the newer section had small operable casement type panels framed into the glass and these did operate well. As a best practice, SWA recommends that all windows be inspected at least once a year. Any gaps, cracks, or damage to weather-stripping or caulking should be repaired or replaced, as needed, to minimize energy loss around those openings. Building staff should also verify that windows open and close properly and have them repaired, as needed.

2.3.5. Exterior doors

Some of the exterior doors are in satisfactory condition with much of the weather-stripping still intact. But some of the doors in the old section are older wood doors and the weather-stripping on these is failing and needs to be replaced. If not properly maintained, exterior doors can become major sources of heat loss and infiltration. As a best practice, SWA recommends checking the weather-stripping of each door on a regular basis and replacing any broken seals immediately. This will help optimize comfort and energy performance.

Daylight can be seen between two emergency egress doors at old section

2.3.6. Building air tightness

Based upon a visual inspection, the newer addition section appears to be fairly well sealed while the original section has some deficiencies; in addition to the aforementioned doors, the operable windows have not had the weather-stripping repaired or replaced for many years evidently and some of it is failing and should be replaced.

2.4. HVAC systems

2.4.1. Heating

The heating plant consists of two gas boilers: one generating steam and one hot water. The steam boiler in the older section is a Weil-McLain Model 780 with a Powerflame JR30A-10 burner, with an input capacity of 935,000 Btu per hour (935 MBtuh). The hydronic boiler in the newer addition is a cast iron sectional Weil-McLain Model LGB-5 with atmospheric burners with an input capacity of 520,000 Btu per hour (520 Mbtuh).

The steam boiler distribution system is known as one-pipe steam, meaning the steam supply and the condensate return use the same pipes. Radiators at the perimeter of the older section deliver the heat.

The hydronic boiler uses two circulator motors to move heating water to two zones. There is also a heat water coil in the air handling unit in the first floor mechanical room.
The boilers are relatively new having been installed in 2004 and 2005 and the rated efficiencies are in the range of 80%.

2.4.2. Cooling

The cooling equipment serving the Library is located on roof and in mechanical spaces in attic and ground floor.

Attic Mechanical Room

The mechanical room in attic houses two air handling units served by condensing units installed on roof.

Roof

The following equipment is installed on roof:

- Condensing unit CU-1
- Manufacturer: Trane
- Model: RAUCC30EBX03OOD

- Condensing unit CU-2
- Manufacturer: Goodman
- Model: GSC130603AC

- Condensing unit CU-3
- Manufacturer: Goodman
- Model: GSC140001AC

The 30 Ton Trane RAUC-C30 (CU-1) unit has a better than average rated Seasonal Energy Efficiency Ratio (SEER) of around 11.3 (The SEER rating is the Btu of cooling output during a typical cooling-season divided by the total electric energy input in watt-hours during the same period).

The Goodman condensing units CU-2 and CU-3 are only two years old and have a higher rated SEER of up to 13 and 14 respectively.

Ground floor mechanical room in newer part of the building

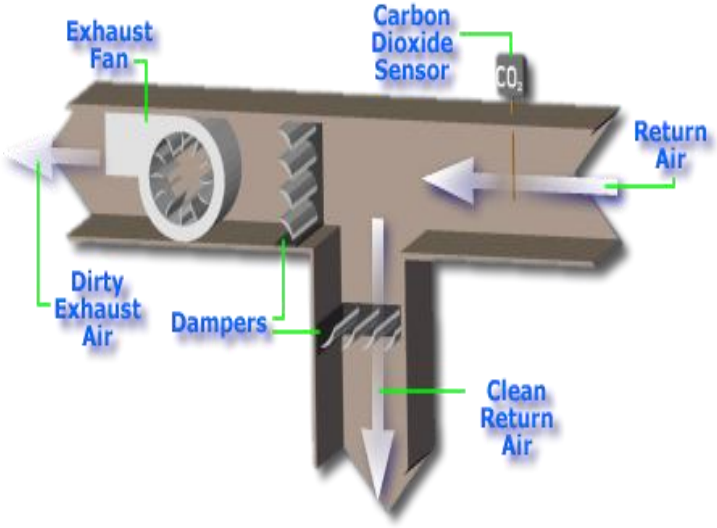
The basement mechanical room houses the following equipment:
- Air handling unit AHU-1
- Manufacturer: Trane
- Model: LPCAB21D1F0LC4
- The unit is provided with DX coil and hot water coil.

2.4.3. Ventilation

Fresh air is distributed by the air handling equipment.

ASHRAE Standard 62-99 identifies the outdoor air ventilation required for indoor air quality. Almost all municipal, state and federal jurisdictions use these guidelines as gospel in their building codes and bylaws. The traditional method of accomplishing the ventilation rates was to set the outdoor air quantity to maximum design occupancy. This can result in a tremendous waste of energy when the occupant load is not at maximum –almost always the situation in libraries - or intermittent use of the space. Carbon dioxide monitoring and control is an acceptable method of reducing ventilation rates when occupancy is below the design load. This ensures ASHRAE standards are being met and only expending the necessary amount of energy.

SWA recommends installation of CO2 based demand controlled ventilation (DCV). Instead of continuously ventilating the space at a constant rate designed to accommodate the maximum occupancy of the library, demand-controlled ventilation (DCV) will see that the amount of outside air drawn in for ventilation depends on the building's actual occupancy at any given time. This strategy results in energy savings because it reduces the amount of air that needs to be conditioned as well as the fan energy used to move that air. DCV primarily refers to when actual occupancies are approximated by measuring carbon dioxide (CO2) levels within a building with sensors. The following figure is an example of one of the ways that CO2 sensors are sometimes used:



2.5. Domestic Hot Water

Domestic Hot Water for the Library is provided by one electric Rheem Standard water heater with two 2 kW heating elements and a 30 gallon storage tank (located in the basement mechanical room) and one electric General Electric Profile Performance Model #5E40M12A with a 5.5 kW heating element and a 40 gallon storage tank (located in the ground floor mechanical room)

While there are several more efficient domestic water heating options, the amount of hot water demand at the Library is quite low and replacing the equipment at this time would not be a cost-effective measure.

SWA recommends the domestic hot water pipe runs be reviewed to ensure they were properly insulated. Repairing insulation and/or providing increased insulation levels, particularly where piping passes through semi- or un-conditioned spaces, will decrease the piping heat losses.

More efficient hot water fixtures and equipment will save energy through reduced energy consumption for water heating and additional money, through reducing water and sewer bills. Automatic water shut-off controls for the faucets should be considered to further decrease water consumption. SWA did not see any dishwashers or clothes washers. As a best practice, at such time as the Borough deems it necessary to replace fixtures, energy saving fixtures bearing the ENERGY STAR label should be selected to ensure efficient performance.

2.6. Electrical systems

2.6.1. Lighting

Interior Lighting – Most of the lighting in the original section has been updated and is comprised mostly of T8 fixtures that contain electronic ballasts, which are far more efficient than the older magnetic ballasts.
The lighting in the addition, however, contains mostly fixtures with magnetic ballasts and T12 (inch and a half diameter) lamps.

T12 Fluorescent Lamps in Processing Room

There are several types of lighting that are used in the building, the most prevalent being fluorescent.

The Library uses predominantly linear fluorescents but there are some incandescent lights and one or two screw-in type compact fluorescents.

The lighting for the Library is generally operating for approximately the 53 hours a week (average) that the Library is open.

In accordance with requirements of the Local Government Energy Audit program, SWA, Inc. performed an investment grade lighting audit, which provides a comprehensive survey of existing lighting, and an extensive technical and financial analysis. It provides a dynamic simulation of the base building, calibrated against actual energy bills, as well as the proposed energy conservation measures.

Almost all the magnetic ballasted fixtures lighting in the newer section, as well as the few older technology fixtures in the original section should be retrofitted for electronic ballasts and T8 lamps with a reflective backing. The lighting in the stacks in the addition should be wired to accommodate bi-level illumination with the low level on whenever the Library is open and the high level controlled by occupancy sensors so that they are on only when someone is using the stack shelves. Occupancy sensors should also be used to control the lighting in all the rest rooms.

Refer to Appendix A for a table detailing the survey the existing lighting and a separate table indicating which specific fixtures in which areas of the building should be retrofitted or replaced.

Appliances and process

SWA performed a basic survey of appliances installed at the Library and does not think that it would be cost effective to replace any appliances at this time. Look for the Energy Star label when replacing appliances and equipment, including: refrigerators, printers, computers, copy machines, etc. More information can be found in the "Products" section of the Energy Star website at: http://www.energystar.gov.

2.6.2. Elevators

There is one hydraulic elevator in the Library. There are no cost-effective improvements presently available for hydraulic elevators.

3. EQUIPMENT LIST

Library

Building System	Description	Physical Location	Make / Model / Serial	Fuel	Space served	Date Installed	Estimated Remaining useful life %
Heating	One (1) cast iron hot water boiler Weil McLain boiler;Input capacity: 935 MBH, Output capacity: 753 MBH, Net IBR rating: 565 MBH, Thermal efficiency: 80% , 1/3 HP burner	Old Boiler Rm	Weil McLain80 / M#780, Power Therm Burner M# JR30A-10	Natural Gas	Community Rm & Children Rm	2004	80%
Heating	One (1) cast iron hot water boiler ;Input capacity: 520 MBH, Gross output capacity: 421 MBH, Net IBR rating: 366 MBH, Thermal efficiency: 80%	New Boiler Rom	Weil McLain / M#LGB-5 / S#CMA480-2	Natural Gas	1st Fl New Section	2005	80%
Cooling	Aircooled condensing unit;30 Tons, 208/3/60	Rooftop	Trane / M#RAUCC30EBX03OOD	Electric	1st Fl New Section	2007	80%
Cooling	Condensing unit Manufacturer: Goodman;	Rooftop	Goodman / M#GSC130603AC	Electric	Community Rm & Children Rm	2008	80%
Cooling	Condensing unit Manufacturer: Goodman;	Rooftop	Goodman / M#GSC140001AC	Electric	Community Rm & Children Rm	2008	80%
Domestic Hot water heater	One (1) domestic hot water heater;2kw, Storage capacity: 30 gal	Old Boiler Rm	Rheem / M#64-305 / S#781210316	Electric	Community Rm & Children Rm	1985	5%
Domestic Hot water heater	One (1) domestic hot water heater ;2 x 5.5 kw, Storage capacity: 40 gal	New Boiler Rm	GE / M#SC40M12A / S#0500C00130	Electric	1st Fl New Section	2001	10%
Heating/ cooling	Trane Air Handling Unit, Climate Changer;	New Boiler Rm	Trane / M#LPCAB21D1F0LC4	Electric	1st Fl New Section	2006	80%
Domestic Hot water	Bell & Gosset circulating pump, 1/3 HP;	New Boiler Rm	Bell & Gosset / M#ST06J49528	Electric	1st Fl New Section	2006	80%
Heating	Two (2),Bell & Gosset Hot water circulating pumps;1/3 HP, 1725 RPM	New Boiler Rm	Bell & Gosset / M#AQF56A17D58EP / S#P# 903580	Electric	1st Fl New Section	2006	80%
Cooling	Air Handling Unit, Goodman, working with rooftop condensers;	Attic above childrens rm	Goodman / M#ARUF486016BA / S#804152599	Electric	Community Rm	2008	90%
Cooling	Air Handling Unit, Goodman, working with rooftop condensers;	Attic above childrens rm	Goodman / M#AEPF426016C7 / S#805570412	Electric	Children's Rm	2008	90%
Elevator	Dover Elevator motor, oil leak found in motor pan;10 HP, 1730 RPM	Cellar closet	Dover / M#SKL213AK224	Hydraulic	Elevator	1990	30%

Note: The remaining useful life of a system (in %) is an estimate based on the system date of built and existing conditions derived from visual inspection.

4. ENERGY CONSERVATION MEASURES

Based on the assessment of this building, SWA has separated the investment opportunities into three categories of recommendations:

1. Capital Improvements – Upgrades not directly associated with energy savings
2. Operations and Maintenance – Low Cost/No Cost Measures
3. Energy Conservation Measures – Higher cost upgrades with associated energy savings

Category I Recommendations: Capital Improvements

- Replace fireproofing material above the boiler that was damaged during roof replacement.
- The existing single pane windows in both sections of the building do not provide effective heat loss resistance or air sealing. Installation of an air sealing interior storm panel system would increase both the resistance to heat loss through the glass and frame and the resistance to infiltration of outside unconditioned air. While the building simulation model SWA uses to estimate energy savings of certain energy conservation measures does not project significant savings for this measure, experience reflects that storm window systems provide a significant improvement in building occupant comfort that may produce additional savings by allowing the thermostat setpoints to be lowered somewhat in winter and raised in summer.

Category II Recommendations: Operations and Maintenance

- Weather Stripping/Air Sealing – As a best practice, exterior/overhead doors and vestibules should be observed annually for deficient weather-stripping and replaced as needed. The perimeter of all window frames should also be regularly inspected and any missing or deteriorated caulking should be re-caulked to provide an unbroken seal around the window frame. Building staff should also verify that windows open and close properly and repair, as needed. Any other accessible gaps or penetrations in the thermal envelope should also be sealed with caulk or spray foam. Particular attention should be paid to penetrations and doors connecting the main building to the garage to prevent transfer of combustion product.
- Pipe Insulation – All heat water, steam and DHW pipes should be inspected and any missing or deteriorated insulation should be replaced with new.
- Plug-In Timer Controls – For locally controlled equipment that the staff are currently responsible for turning off equipment when not in use. Plug-in timer controls can be utilized to ensure electrical equipment does not operate during unoccupied periods.
- Lighting Controls - Occupancy sensors and/or photocells, should also be considered. In applications where occupants tend to leave the lights running inadvertently, such as during fire response or other extended periods of absence, the occupancy sensors automatically shut-off the lights. Since operating hours vary, a survey of the building occupants can provide the most accurate feedback on lighting usage patterns within the facility to help determine the appropriateness of lighting controls.
- Energy Star Appliances - Consider Energy Star labeled equipment and appliances when replacement is necessary, including: refrigerators, printers, computers, copy machines, etc.
- Water Efficient Fixtures & Controls - Adding controlled on/off timers on all lavatory faucets is a cost-effect way to reduce domestic hot water demand and save water. Building staff can also easily install faucet aerators and/or low-flow fixtures to reduce water consumption. There are many retrofit options, which can be installed now or incorporated as equipment is replaced. Routine maintenance practices that identify and quickly address water leaks are a low-cost way to save water and energy. Retrofitting with more efficient water-consuming fixtures and

appliances will save both energy and money through reduced energy consumption for water heating, while also decreasing water and sewer bills.

Category III Recommendations: Energy Conservation Measures

Summary table

ECM#	Description
1	Retro-Commissioning of All HVAC Equipment
2	High Efficiency Lighting Retrofit
3	Demand Controlled Ventilation
4	Install 5kW Solar Photovoltaic System

ECM #1: *Retro-Commissioning of All HVAC Equipment*

Description:

Commissioning is the systematic and documented process of ensuring that a new building's systems are designed, installed, tested for full functionality, and capable of being operated and maintained according to the owner's operational needs. Retro-commissioning refers to that process being performed on an existing building as an after market measure.

Installation cost:
Estimated cost: $ 4,210

Source of cost estimate: Estimate based on Lawrence Berkeley National Laboratory studies[1]

Economics:

Installed Cost		1st year energy savings					SPP	LoM	Lifecycle Savings	ROI
Estimated $	Source	usage	unit	demand	unit	$ savings				
$ 4,210	LBL	38.4	mmbtu			$ 1,064	4.0	15	$12,698	13.4%

3.0% per DOE FEMP guidelines
0% per DOE FEMP guidelines

Assumptions: SWA estimated the cost and savings of the measure based on studies done by Lawrence Berkley National Laboratory (LBL), a U.S. Department of Energy laboratory operated by the University of California.

Rebates/financial incentives:

While there are no prescriptive incentives for retro-commissioning available from the New Jersey Clean Energy Program, an argument could be made that the energy savings deriving from this measure should qualify for the custom electric and custom gas savings available from the SmartStart Commercial Building Incentive Program. Applications for the custom electric and gas incentives are available by request or at the NJ Clean Energy website.

[1] Mills E et al. 2004. The cost-effectiveness of commercial buildings commissioning. Lawrence Berkeley National Laboratory. LBNL report #56637 (PDF 3.5 MB).

ECM #2: *High Efficiency Lighting Retrofit*

Description:

The lighting at the newer section of the Library is mostly comprised of older technologies. There are some incandescent lighting and some compact fluorescent lighting. The bulk of the lighting is provided by linear fluorescents using magnetic ballasts and T12 diameter lamps. Almost all of the linear fluorescent lighting should be replaced, or retrofitted where possible, with electronic ballasts and T8 diameter lamps.

Installation cost:
Estimated cost: $ 19,770

Source of cost estimate: Estimates; Similar Projects; Contractors

Economics:

Installed Cost		1st year energy savings					SPP	LoM		
Estimated $	Source	usage	unit	demand	unit	$ savings			Lifecycle Savings	ROI
$ 19,770	Contractor	13,846	kWh	4.83	kW	$ 2,809	7.0	12	$27,961	3.5%

3.0% per DOE FEMP guidelines
0% per DOE FEMP guidelines

Assumptions: SWA used estimates from contractors for other similar projects and derived unit costs for various types of lighting replacements and retrofits.

Rebates/financial incentives:
High efficiency lighting qualifies for incentives under the New Jersey Clean Energy SmartStart Commercial Building Incentive Program prescriptive measures. Incentives are available for retrofits and/or new fixtures with T8 and T5 lamps and electronic ballasts, hard-wired compact fluorescent lights, pulse start metal halide fixtures or retrofits and certain other types of lighting. SWA estimates that if our lighting recommendations are implemented, the measures would qualify for about $4,710 total incentives.

ECM #3: *Demand Controlled Ventilation*

Description:

Building codes require that a minimum amount of fresh air be provided to ensure adequate air quality. To comply, ventilation systems often operate at a fixed rate based on an assumed occupancy (e.g., 15 cfm per person multiplied by the maximum design occupancy). The result is there often is much more fresh air coming into buildings than is necessary, especially in buildings with long operating hours and occupancy that can be well below maximum for extended periods of time, like libraries. That air must be conditioned, resulting in higher energy consumption and costs than is necessary with appropriate ventilation. In humid climates, excess ventilation also can result in uncomfortable humidity and mold and mildew growth, making the indoor air quality (IAQ) worse rather than better.

Demand-controlled ventilation (DCV) using carbon dioxide (CO_2) sensing is a combination of two technologies: CO_2 sensors that monitor CO_2 levels in the air inside a building, and an air-handling system that uses data from the sensors to regulate the amount of ventilation air admitted.

Installation cost:
Estimated cost: $19,000

Source of cost estimate: Federal Energy management Program "Demand-Controlled Ventilation Using CO2 Sensors"; AirTest Energy Analysis Program for CO2 based demand contolled ventilation.

Economics:

Installed Cost		1st year energy savings					SPP	LoM	Lifecycle Savings	ROI
Estimated $	Source	usage	unit	demand	unit	$ savings				
$ 19,000	AirTest	112.7	mmbtu			$ 3,122	6.1	12	$31,074	5.3%

3.0% per DOE FEMP guidelines
0% per DOE FEMP guidelines

Assumptions: SWA estimated the cost and savings of the measure based on the AirTest Energy Analysis Program for CO2 based demand controlled ventilation. There are certain assumptions made within the program that are detailed in program calculations available as a separate document.

Rebates/financial incentives:

While there are no prescriptive incentives for retro-commissioning available from the New Jersey Clean Energy Program, an argument could be made that the energy savings deriving from this measure should qualify for the custom electric and custom gas savings available from the SmartStart Commercial Building Incentive Program. Applications for the custom electric and gas incentives are included in the Appendix B of this document.

ECM #4: *Install Solar Photovoltaic System*

Please see section 5: RENEWABLE AND DISTRIBUTED ENERGY MEASURE

5. RENEWABLE AND DISTRIBUTED ENERGY MEASURES

5.1. Existing systems

There are currently no existing renewable energy systems.

5.2. Solar Photovoltaic

ECM #4: *Install 5 Kilowatt Solar Photovoltaic System*

Description:

Currently, the complex does not utilize any renewable energy systems. Renewable energy systems such as solar photovoltaics can offset a certain amount of the electricity purchased by the Township. In addition, utility companies general bill for electricity in two ways – for usage and for demand. Usage is the actual amount of electricity consumed by the property in a given period (usually each month, measured in kilowatt hours). Demand is the mount of electrical power that the property requires at any given time to satisfy the building's electrical load. Peak demand is billed based on the largest amount of power required by the building at any given time during the billing period (measured in kilowatts). During the summer when demand is at its' highest due to the addition of air conditioning loads, the utility demand charges often rise to help the utility cover its' need for increased power capabilities. A photovoltaic system will not only offset the amount of electricity consumed, but will actually lower the peak demand, resulting in additional cost savings. SWA recommends installation of a small sized (5 kilowatt) solar system. As part of a concept known as net metering, when solar electricity production from the system is high and the building load is low, any excess power can be sold back to the utility. A solar photovoltaic system of this size will need approximately 1,200 square feet of roof area with a clear southern exposure.

Installation cost:

Estimated material cost:	$35,000
Rebate@$1 per watt:	$ 5,000
Total installed cost:	**$30,000**

Source of cost estimate: Similar Projects

Economics:

Installed Cost		1st year energy savings					SPP	LoM	Lifecycle Savings	ROI
Estimated $	Source	usage	unit	demand	unit	$ savings				
$ 35,000	RS Means	5,915	kWh	5	kW	$ 3,505	10.0	15	$41,842	1.3%

3.0% per DOE FEMP guidelines
0% per DOE FEMP guidelines

Assumptions: SWA estimated the cost and savings of the system based on past solar photovoltaic projects, the NREL online solar savings calculator and included the projected Solar Renewable Energy Credits in the savings estimate.

Rebates/financial incentives:

PSE&G Solar Loan Program, 15 year payback, paid with SRECs (Solar Renewable Energy Certificates) with a floor value of >$475.

Options for funding ECM:

This project may benefit from enrolling in the New Jersey SmartStart program to obtain Technical Assistance and offset a portion of the cost of implementation.
http://www.njcleanenergy.com/commercial-industrial/programs/nj-smartstart-buildings/nj-smartstart-buildings

5.3. Combined Heat and Power

Description:

SWA analyzed the feasibility of installing a combined heat and power system (also know as co-generation) for the Borough of Metuchen Library but believes that the expense of this type of system makes it economically unfeasible at this time

5.4. Geothermal

Description:

Geothermal is not applicable for the Municipal building because it would not be cost effective to change to a geothermal system.

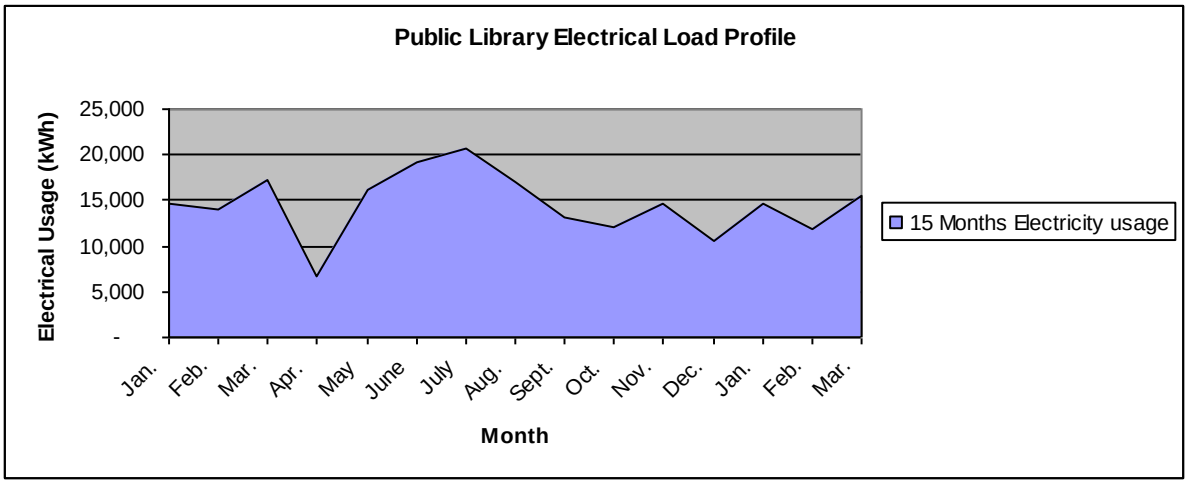
5.5. Wind

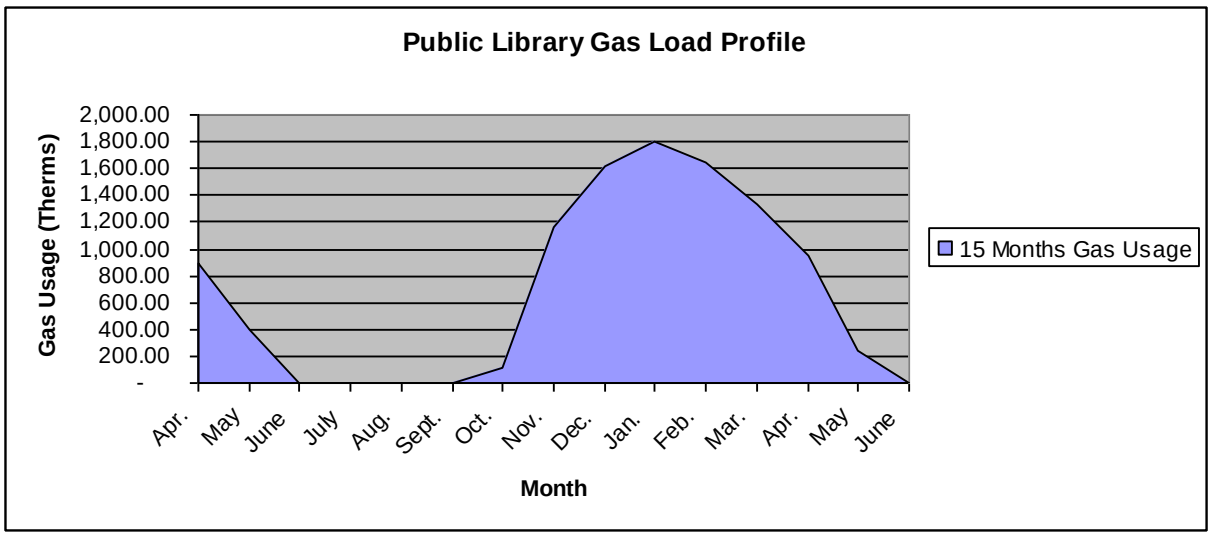
Description:

Wind power production is not appropriate for this location, because required land is not available for the wind turbine. Also available wind energy resource is very low.

6. ENERGY PURCHASING AND PROCUREMENT STRATEGIES

6.1. Load profiles





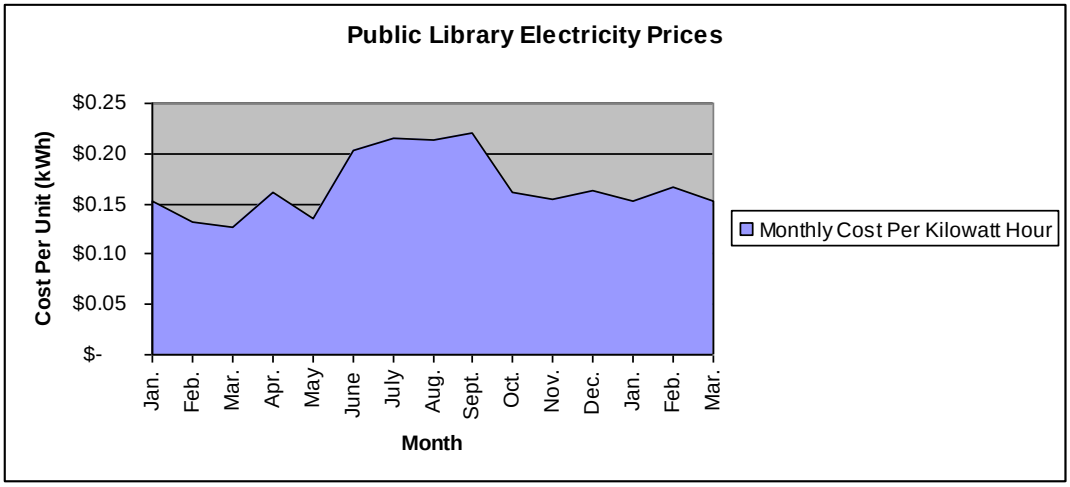
6.2. Tariff analysis

The Borough of Metuchen currently buys electricity and gas from Public Service Gas and Electric and Elizabethtown Gas respectively, on general service rates. The general service is a typical rate where customers pay for natural gas based on usage and for electricity based on consumption as well as peak electrical demand. The general service rate is the best option at this time.

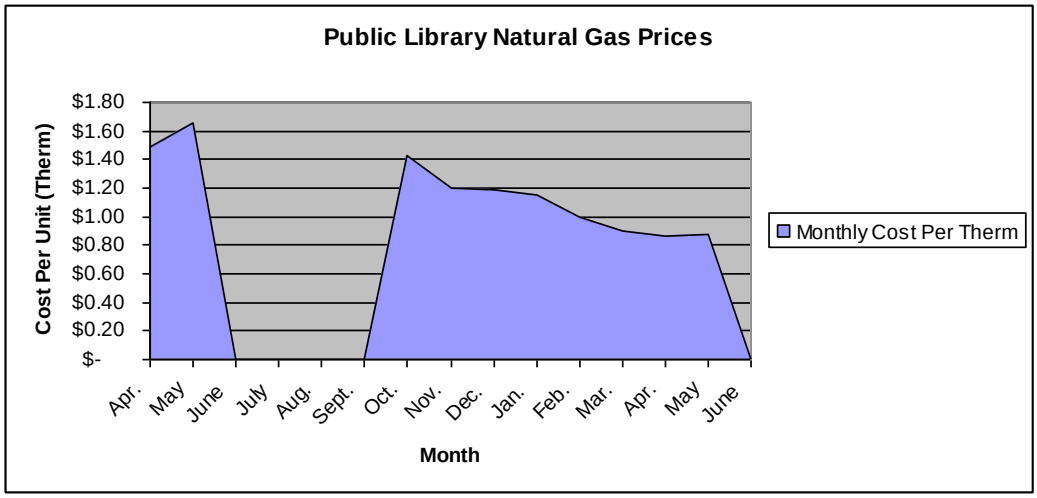
6.3. Energy Procurement Strategies

Bill analysis shows prices fluctuation of over 20% for both electricity and for natural gas over the course of January 2008 through March 2009 and April 2008 and June 2009 respectively.

Electric account



Natural Gas account



We recommend contacting the NJ Energy Choice program and deciding if a third party energy supplier for both the gas and the electricity would benefit the Township.

See http://www.state.nj.us/bpu/commercial/shopping.html.
The building would not be eligible for enrolling in a Demand Response Program because electric demand does not exceed 50kW, which is a typical threshold for considering this option.

7. METHOD OF ANALYSIS

7.1. Assumptions and tools

Energy modeling tool: eQUEST V3.6
Cost estimates: RS Means 2009 (Facilities Maintenance & Repair Cost Data)
RS Means 2009 (Building Construction Cost Data)
RS Means 2009 (Mechanical Cost Data)
Cost estimates also based on utility bill analysis and prior experience with similar projects.

7.2. Disclaimer

This engineering audit was prepared using the most current and accurate fuel consumption data available for the site. The estimates that it projects are intended to help guide the owner toward best energy choices. The costs and savings are subject to fluctuations in weather, variations in quality of maintenance, changes in prices of fuel, materials, and labor, and other factors. Although we cannot guarantee savings or costs, we suggest that you use this report for economic analysis of the building and as a means to estimate future cash flow.

THE RECOMMENDATIONS PRESENTED IN THIS REPORT ARE BASED ON THE RESULTS OF ANALYSIS, INSPECTION, AND PERFORMANCE TESTING OF A SAMPLE OF COMPONENTS OF THE BUILDING SITE. ALTHOUGH CODE-RELATED ISSUES MAY BE NOTED, SWA STAFF HAVE NOT COMPLETED A COMPREHENSIVE EVALUATION FOR CODE-COMPLIANCE OR HEALTH AND SAFETY ISSUES. THE OWNER(S) AND MANAGER(S) OF THE BUILDING(S) CONTAINED IN THIS REPORT ARE REMINDED THAT ANY IMPROVEMENTS SUGGESTED IN THIS SCOPE OF WORK MUST BE PERFORMED IN ACCORDANCE WITH ALL LOCAL, STATE, AND FEDERAL LAWS AND REGULATIONS THAT APPLY TO SAID WORK. PARTICULAR ATTENTION MUST BE PAID TO ANY WORK WHICH INVOLVES HEATING AND AIR MOVEMENT SYSTEMS, AND ANY WORK WHICH WILL INVOLVE THE DISTURBANCE OF PRODUCTS CONTAINING MOLD, ASBESTOS, OR LEAD.

THIS DOCUMENT IS MEANT TO BE USED TO ANALYZE HOW THE BUILDING USES ENERGY AND HOW VARIOUS ENERGY CONSERVATION MEASURES MIGHT AFFECT FUTURE ENERGY AND OPERATING COSTS. IT IS NOT MEANT TO BE USED AS A DESIGN TOOL OR FOR EQUIPMENT SPECIFICATIONS.

Appendix A: Lighting Survey

Public Library

Level/Floor	Location in Building	Measured Lighting Level in Footcandles	Fixture Type	Ballast Type	No. of Fixtures	No. of Lamps	Watts/Lamp	Hrs/Day	Energy Use (Watt hours/day)	Controls	Daylighting possible?
1	Entry Vestibule - Lib.Pl.		1Inc75PAR		1	1	75	7.5	562.5	Manual	Yes
1	Other Vestibule		1Inc75PAR		1	1	75	7.5	562.5	Manual	Yes
1	Newer Building Main	27-30-49	4F34T12	M	88	4	34	7.5	89760	Manual	Yes
1	Newer Building Stacks	11-18	1F32T8	E	40	1	32	7.5	9600	Dimmer	No
1	New Bldg. Ofcs,Counter	29	6F20T12	M	21	6	20	7.5	18900	Manual	No
1	Melody Office	63	4F34T12	M	2	4	34	7.5	2040	Manual	Yes!!
1	New Bldg. Stairs	14	6F20T12	M	4	6	20	7.5	3600	Manual	No
1	Lg. Conference Room	33	4F34T12	M	9	4	34	7.5	9180	Manual	Yes
1	Older Bldg. Main	31-36, 167	2F32T8	E	30	2	32	7.5	14400	Manual	Yes
1	Old Bldg. Office		2F32T8	E	1	2	32	7.5	480	Manual	No
1	Old Bldg. Office		6F20T12	M	1	6	20	7.5	900	Dimmer	No
1	Old Bldg. Vestibule		1CF20		1	1	20	7.5	150	Manual	Yes
1	Old Bldg. Stairwell – Top		2F32T8	E	1	2	32	7.5	480	Manual	No
Bsmt.	Processing Room	58	2F96T12	M	7	2	80	7.5	8400	Manual	No
Bsmt.	Processing Room	34-54	4F20T12	M	2	4	20	7.5	1200	Manual	No
Bsmt.	Boiler Room		1INC75	NA	1	1	75	2	150	Manual	No
Bsmt.	Grimstead Room		2F34T12	M	1	2	34	0.5	34	Manual	No
Bsmt.	Employee Break Room		2F34T12	M	1	2	34	4	272	Manual	No
Bsmt.	Halls		2F34T12	M	2	2	34	7.5	1020	Manual	No
Bsmt.	Activities Room		2F34T12	M	4	2	34	7.5	2040	Manual	No
Bsmt.	Historical Soc. Storage		1INC40PAR	NA	20	1	40	0.5	400	Manual	No
Bsmt.	Hall Outside Historical		1INC40Rec.	NA	1	1	40	7.5	300	Manual	No
Bsmt.	Employee Rest Room		3F13CF		1	3	13	4	156	Manual	No

1	Boiler Room	2F34T12	M	1	2	34	4	272	Manual	No
1	Boiler Room	1INC60	NA	7	1	60	4	1680	Manual	No
1	Boiler Room	1CF20		1	1	20	4	80	Manual	No
1	Storage Room	1F34T12	M	15	1	34	4	2040	Manual	No
1	Ladies Room	3F34T12	M	3	3	34	4	1224	Manual	No
1	Ladies Room	1INC60	NA	2	1	60	4	480	Manual	No
1	Men's Room	1F34T12	M	1	1	34	4	136	Manual	No
1	Men's Room	1INC60	NA	2	1	60	4	480	Manual	No
Exterior	Poles	1HPS150	NA	2	1	150	12	3600	Manual	No
Exterior	Entry Door	1INC150PR	NA	1	1	150	12	1800	Manual	No
Exterior	Entry Door	1INC150PR	NA	1	1	150	12	1800	Manual	No
Exterior	At Flag	1INC150PR	NA	1	1	150	12	1800	Manual	No
Exterior	Small Sconce-Boiler	1INC60	NA	1	1	60	12	720	Manual	No
Exterior	Arched Windows	1INC75PR	NA	2	1	75	12	1800	Manual	No
Exterior	Large Sconces	1MH100	M	2	1	100	12	2400	Manual	No
Exterior	Corners	2INC150PR	NA	2	2	150	12	7200	Manual	No

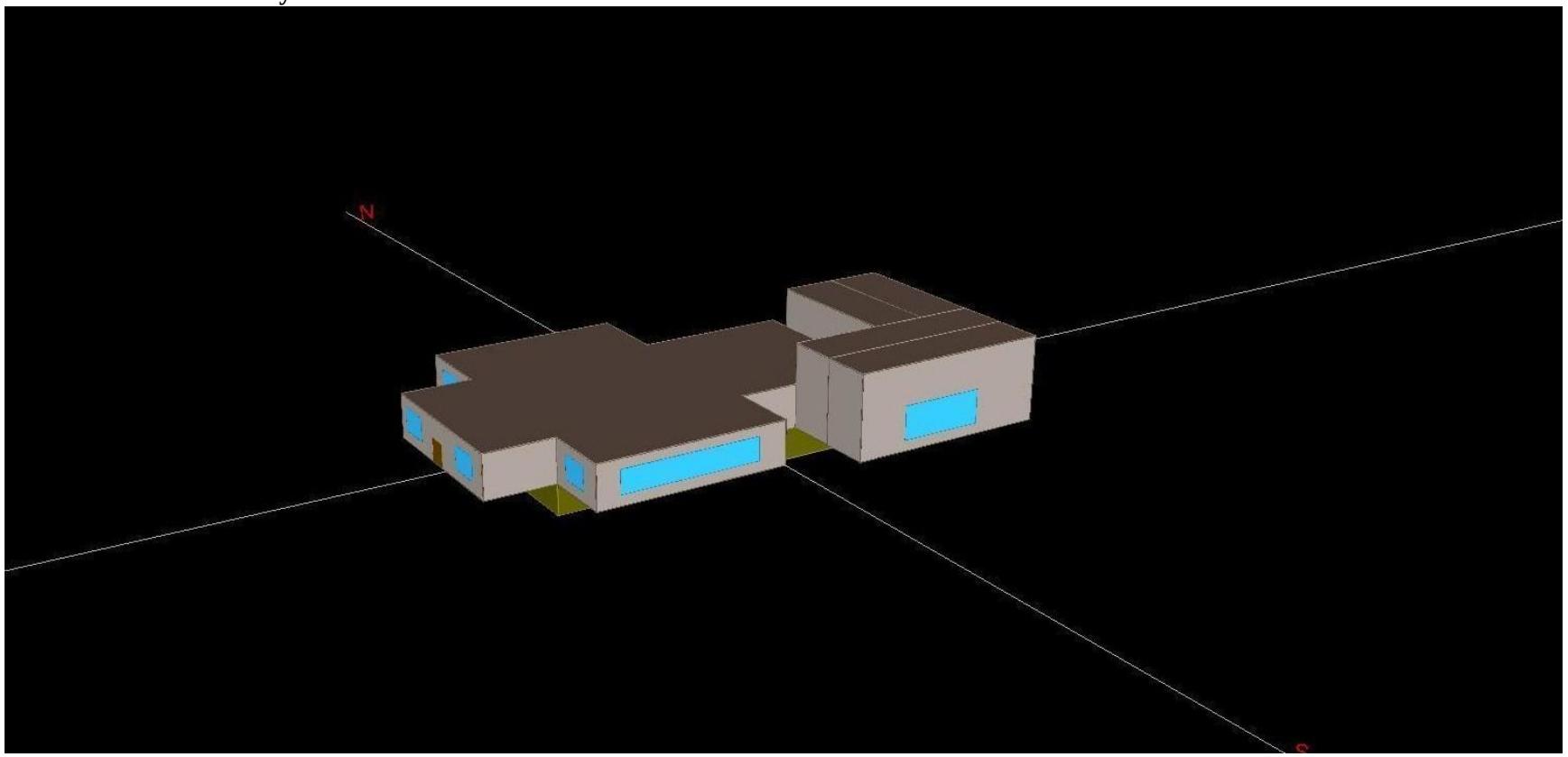
BOROUGH OF METUCHEN LIBRARY LIGHTING IMPROVEMENT TABLE

EXISTING								RETROFIT			
Level/Floor	Location in Building	Fixture Type	No. of Fixtures	No. of Lamps	Watts/Lamp	Hrs/Day	Energy Use (Watt hours/day)	New Fixture	Hrs/Day	Watts/Lamp	Energy Use
1	Storage Room	1F34T12	15	1	34	4	2040	1F28T8	2	28	840
1	Men's Room	1F34T12	1	1	34	6	204	1F28T8	4	28	112
Bsmt.	Historical Soc. Storage	1INC40PAR	20	1	40	0.5	400	1CF17	0.5	17	170
Bsmt.	Hall Outside Historical	1INC40Rec.	1	1	40	7.5	300	1CF17	7.5	17	127.5
1	Boiler Room	1INC60	7	1	60	4	1680	1CF20	4	20	560
1	Ladies Room	1INC60	2	1	60	6	720	1CF20	4	20	160
1	Men's Room	1INC60	2	1	60	6	720	1CF20	4	20	160
Bsmt.	Boiler Room	1INC75	1	1	75	2	150	1CF20	2	20	40
1	Entry Vestibule -Lib.Pl.	1Inc75PAR	1	1	75	7.5	562.5	1CF22PAR	7.5	22	165
1	Other Vestibule	1Inc75PAR	1	1	75	7.5	562.5	1CF22PAR	7.5	22	165

Bsmt.	Grimstead Room	2F34T12	1	2	34	0.5	34	2F28T8	0.5	28	28
Bsmt.	Employee Break Room	2F34T12	1	2	34	4	272	2F28T8	4	28	224
Bsmt.	Halls	2F34T12	2	2	34	7.5	1020	2F28T8	7.5	28	840
Bsmt.	Activities Room	2F34T12	4	2	34	7.5	2040	2F28T8	7.5	28	1680
1	Boiler Room	2F34T12	1	2	34	4	272	2F28T8	7.5	28	420
Bsmt.	Processing Room	2F96T12	7	2	80	7.5	8400	2F28T8	7.5	28	5880
Bsmt.	Employee Rest Room	3F13CF	1	3	13	4	156	1FC12HO	4	12	48
1	Ladies Room	3F34T12	3	3	34	6	1836	3F28T8	4	28	1008
Bsmt.	Processing Room	4F20T12	2	4	20	7.5	1200	4F17T8	7.5	17	1020
1	New er Building Main	4F34T12	88	4	34	7.5	89760	4F28T8	7.5	28	73920
1	Melody Office	4F34T12	2	4	34	7.5	2040	4F28T8	7.5	28	1680
1	Lg. Conference Room	4F34T12	9	4	34	7.5	9180	4F28T8	7.5	28	7560
1	New Bldg. Ofcs,Counter	6F20T12	21	6	20	7.5	18900	6F17T8	7.5	17	16065
1	New Bldg. Stairs	6F20T12	4	6	20	7.5	3600	6F17T8	7.5	17	3060
1	Old Bldg. Office	6F20T12	1	6	20	7.5	900	6F17T8	7.5	17	765
Exterior	Poles	1HPS150	2	1	150	12	3600	1MH90V	12	90	2160
Exterior	Entry Door	1INC150PR	1	1	150	12	1800	1CF43Par	12	43	516
Exterior	Entry Door	1INC150PR	1	1	150	12	1800	1CF43Par	12	43	516
Exterior	At Flag	1INC150PR	1	1	150	12	1800	1CF43Par	12	43	516
Exterior	Small Sconce-Boiler	1INC60	1	1	60	12	720	1CF20	12	20	240
Exterior	Arched Windows	1INC75PR	2	1	75	12	1800	1CF23PAR	12	23	552
Exterior	Large Sconces	1MH100	2	1	100	12	2400	1MH90V	12	90	2160
Exterior	Corners	2INC150PR	2	2	150	12	7200	2CF43PAR	12	43	2064

Appendix B: eQUEST model

Metuchen Public Library



Annual Costs

		Annual Utility Cost					Incentives		LCC
		Electric kWh($)	Electric kW($)	Electric Total($)	Nat Gas Total($)	Total ($)	Owner ($)	Design Team ($)	Total (PV$)
Annual COST									
0	Base Design	$ 27,715	--	$ 27,715	$ 10,184	$ 37,899			$ 212,007
1	0+Improve Window Glazing	$ 27,378	--	$ 27,378	$ 10,288	$ 37,666			$ 210,669
2	1+Improve Lighting	$ 25,986	--	$ 25,986	$ 10,473	$ 36,459			$ 203,810
3	2+Demand Control Ventilation	$ 25,966	--	$ 25,966	$ 10,006	$ 35,972			$ 201,156
Incremental SAVINGS	(values are relative to previous measure (% savings are relative to base case cost), negative entries indicate increased cost)								
1	0+Improve Window Glazing	$ 337	--	$ 337	$ -104	$ 233			$ 1,338
2	1+Improve Lighting	$ 1,392	--	$ 1,392	$ -185	$ 1,207			$ 6,859
3	2+Demand Control Ventilation	$ 20	--	$ 20	$ 467	$ 487			$ 2,654
Cumulative SAVINGS	(values (and % savings) are relative to the Base Case, negative entries indicate increased cost)								
1	0+Improve Window Glazing	$ 337	--	$ 337	$ -104	$ 233			$ 1,338
2	1+Improve Lighting	$ 1,729	--	$ 1,729	$ -289	$ 1,440			$ 8,197
3	2+Demand Control Ventilation	$ 1,749	--	$ 1,749	$ 178	$ 1,927			$ 10,851

Annual Energy and Demand

		Ann. TDV Energy		Annual Site Energy		Lighting	HVAC Energy			Peak	
		TDV-Mbtu	EUI TDV-kBtu/sf/yr	Elect kWh	Nat Gas Therms	Electric kWh	Electric kWh	Nat Gas Therms	Total Mbtu	Elect kW	Cooling Tons
Annual Energy USE or DEMAND											
0	Base Design	2,540	148.36	163,028	8,705	82,182	30,341	8,496	953	92	40
1	0+Improve Window Glazing	2,528	147.69	161,050	8,793	82,182	28,363	8,585	955	90	38
2	1+Improve Lighting	2,460	143.72	152,860	8,951	74,786	27,569	8,743	968	87	37
3	2+Demand Control Ventilation	2,419	141.31	152,739	8,552	74,786	27,448	8,343	928	86	37
Incremental SAVINGS	(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)										
1	0+Improve Window Glazing	11	0.67 (0%)	1,978 (1%)	-89 (-1%)	0 (0%)	1,978 (7%)	-89 (-1%)	-2 (-0%)	2 (2%)	2 (4%)
2	1+Improve Lighting	68	3.97 (3%)	8,190 (5%)	-158 (-2%)	7,396 (9%)	793 (3%)	-158 (-2%)	-13 (-1%)	3 (4%)	1 (2%)
3	2+Demand Control Ventilation	41	2.41 (2%)	121 (0%)	399 (5%)	0 (0%)	121 (0%)	399 (5%)	40 (4%)	1 (1%)	1 (2%)
Cumulative SAVINGS	(values (and % savings) are relative to the Base Case, negative entries indicate increased use)										
1	0+Improve Window Glazing	11	0.67 (0%)	1,978 (1%)	-89 (-1%)	0 (0%)	1,978 (7%)	-89 (-1%)	-2 (-0%)	2 (2%)	2 (4%)
2	1+Improve Lighting	79	4.64 (3%)	10,168 (6%)	-247 (-3%)	7,396 (9%)	2,771 (9%)	-247 (-3%)	-15 (-2%)	6 (6%)	2 (6%)
3	2+Demand Control Ventilation	121	7.05 (5%)	10,289 (6%)	153 (2%)	7,396 (9%)	2,893 (10%)	153 (2%)	25 (3%)	6 (7%)	3 (8%)