



EXECUTIVE SUMMARY & ENERGY RETROFIT REPORT



Town of Needham Facilities

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A. EXECUTIVE SUMMARY & PROJECT SCOPE

EMG has been hired by the Town of Needham (hereafter referred to as Needham) in response to RFP 12-PFC-017G to conduct energy efficiency upgrade study of the town's municipal and school buildings including seven school buildings, public safety buildings and the library. The process started with the analysis of historical utility information and logging that information into EPA Energy Star Portfolio Manager to obtain a benchmark score for each building. EMG has performed a degree day regression analysis to establish the base year consumption and after review and discussion with Needham's officials, it has been decided to use July 2010 to June 2011 for the base year. Following the benchmarking study is the field assessment of the sites for energy saving opportunities.

The purpose of the energy audits is to identify the energy & cost savings opportunities related to HVAC systems, lighting, motors & pumps, building operations and building fenestration. The town has a central Energy Management & Control System (EMCS) that controls multiple buildings including the schools and library. Currently the Public Safety building and Fire Station 2 are not connected to the EMCS at time of audit but according to town's maintenance department, such integration is planned for in near future.

The overall condition and general maintenance practices of the facilities are found to be good. The newly constructed facilities are built with good energy conservation features in mind including high efficiency HVAC equipment, high efficiency lighting and controls, ASHRAE recommended levels of insulation in walls and roof, thermal performance windows, to mention a few. The Needham Public Library, originally constructed in 1915 and renovated and expanded in 2006 with many energy conservation features attained a LEED Silver rating. The existing facilities also received some energy conservation retrofits in recent years, including installation of occupancy sensors for class room lighting, installation of new chiller for Public Safety building and boiler for Fire Station 2 and new high performance roof for Pollard Middle School.

Though the buildings are generally performing well in terms of energy efficiency, during our energy audits EMG identified opportunities that if implemented could further reduce the energy consumption, improve occupant comfort and in turn reduce operating costs of the facilities through improvements to the building HVAC & lighting systems, controls and indoor air quality. The buildings are supplied electricity and natural gas from local utilities and are billed on monthly basis. No.2 fuel oil is supplied by local oil distributors.

EMG performed ASHRAE Level II equivalent energy audits on a total of 10 Needham sites and provided a detailed Energy Audit report for each site. ASHRAE Level II energy audits included detailed inspection and analysis of building envelope, lighting, HVAC and building operational patterns, HVAC controls and plumbing. Reports include detailed analysis and description of existing building systems and recommended energy conservation measures including capital cost of implementation, energy and water savings, cost savings, payback and life cycle savings.

For each site, the list of Energy Conservation Measures (ECMs) is broken into two categories based on the projected project cost:

No/Low Cost measures: These are the measures with projected project cost of \$1,000. Generally these include all maintenance related items and relative low investment i.e. standalone HAVC controls, temperature set-backs and lighting controls special areas.

Capital Cost measures: These generally include all other recommended projects with projected costs over \$1,000. They generally include building wide lighting retrofit, lighting controls for entire building or multiple area of the building, exterior lighting, upgrade/replacement of old HVAC system, installation of VFD, building retro-commissioning, envelope upgrade and insulation including new thermal windows and appliance replacement.

Each identified Energy Conservation Measure (ECM) is evaluated based on simple payback and other financial methods to see if a project is cost feasible for implementation. Simple payback, expressed in years, is the ratio of total investment needed for an upgrade to the annual cost savings resulting from such investment. Typically the payback is expected to be much less than the total expected life of a measure, without which the project is not feasible and not recommended. Though some projects with long payback periods are not economically feasible standing alone, they might be attractive in conjunction with other major capital projects. EMG has provided a list of such economically non-attractive projects in each report.

This Executive Summary focuses only on recommended projects for implementation.

Following is a summary of sites that received energy audits and potential energy and cost savings with implementation cost:

Site Name	Base Year (July-10 to June-11) Energy Cost	Base Year (July-10 to June-11) Energy Consumption(MMBtu)	Estimated Annual Energy Savings (MMBtu)	Estimated Annual Cost Savings	% Energy Reduction Vs Base Year	Total Projected Implementation Cost	Simple Payback (Yrs)
Broadmeadow School	\$203,629	6,269	908	\$28,495	14%	\$74,035	2.60
Eliot Elementary School	\$153,150	5,730	634	\$11,005	11%	\$43,039	3.91
Hillside Elementary School*	\$142,848	5,160	33	\$1,228	1%	\$4,129	3.36
Mitchell Elementary School*	\$134,448	5,598	556	\$11,612	10%	\$19,740	1.70
High Rock Sixth Grade Center	\$131,777	3,340	32	\$2,164	1%	\$10,205	4.72
Pollard Middle School	\$298,058	10,783	2,414	\$45,814	22%	\$594,345	12.97
Needham High School	\$582,887	19,884	195	\$11,375	1%	\$73,191	6.43
Police Station/Fire Station #1	\$73,376	2,603	313	\$9,138	12%	\$146,351	16.02
Fire Station #2	\$18,500	941	79	\$2,417	8%	\$18,934	7.83
Needham Free Public Library	\$128,049	3,086	18	\$975	1%	\$2,407	2.47
Total	\$1,866,722	63,394	5,182	\$124,222	8%	\$986,376	7.94

**projects with payback period of less than 5 years only*

Based on the above summary, if all the recommended Energy Conservation Measures (ECM) are implemented across the 10 sites, **Needham could save \$124,000** (rounded to nearest \$1000) **annually with a one-time investment of \$986,000, yielding a payback in the order of 7 to 8 years.** This could also reduce the town’s baseline energy consumption by an estimated **8%** annually.

B. ENERGY & COST SAVINGS SUMMARY

Following is a summary of initial investment and estimated annual energy and cost savings if all projects are implemented. We have increased the projected project costs by 15% to cover the costs of engineering, design and contingency expenses for capital projects and discounted the savings by 10% to compensate for interactive effects among ECMs.

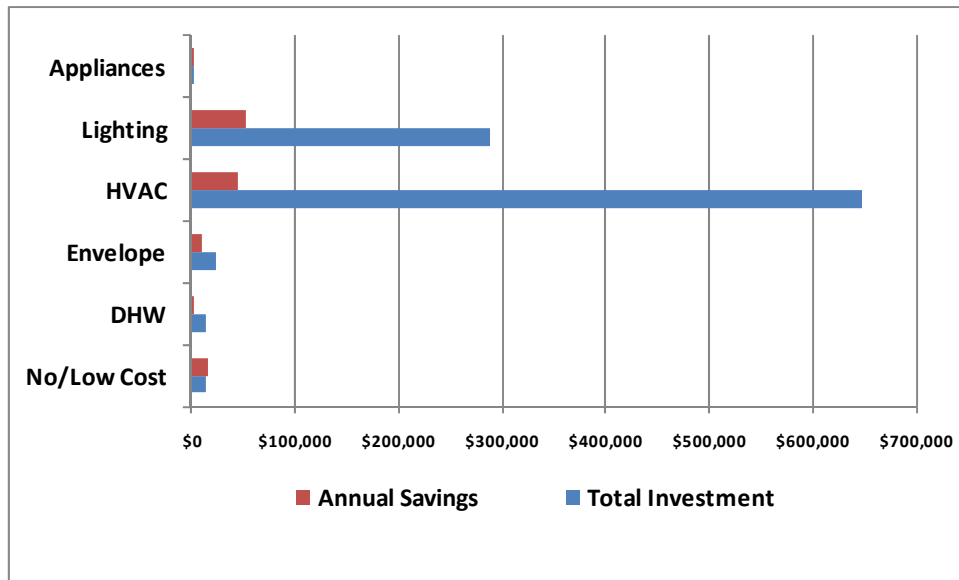
Total estimated capital cost of implementing all projects: (The above cost includes 15% mark up for Engineering, Design and Contingency expenses)	\$986,376
Total estimated annual cost savings (if all projects are implemented): (The above savings include 10% discount for interactive effects)	\$124,222
Simple Payback period:	7.94 years
Total annual Energy savings in MMBtu (w/10% discount):	5,182 MMBtu
Energy Savings compared to Baseline consumption:	8% annually

As shown above, EMG identified several energy conservation projects across the 10 sites audited for a total investment of \$986,000 (including Eng/Design and contingency of 15%) which when implemented could yield an estimated annual savings of \$124,000 with a payback period of 7-8 years.

For proper project management and implementation, EMG has broken all projects across all sites into different project categories i.e. No/Low Cost Projects, Domestic Hot Water (DHW), Envelope, HVAC, Lighting and Appliances to be implemented over a multi-year phasing plan.

Following is a summary of breakdown of individual project costs by category, related annual energy cost savings, payback periods and recommend year of implementation:

Project Category	Total Investment	Annual Cost Savings	Simple Payback (Years)	% of Total Cost	Recommended Year of Implementation	Recommended Construction Method
No/Low Cost	\$13,538	\$14,588	0.93	1.4%	2012-2014	In-house
DHW	\$13,443	\$977	13.76	1.4%	2017	HVAC Vendor
Envelope	\$23,290	\$10,610	2.20	2.4%	2013-2014	General Contractor
HVAC	\$646,741	\$44,647	14.49	65.6%	2012-2016	HVAC Vendor
Lighting	\$287,524	\$53,170	5.41	29.1%	2013-2017	Lighting Contractor
Appliances	\$1,840	\$229	8.04	0.2%	2016	In-house
Total	\$986,376	\$124,222	7.94	100%		



The projects are further broken down into the following sub categories:

Vending Machine Controls: This measure recommends installing vending miser controls that automatically reduce the compressor and lighting run time for vending machines based on motion sensing.

Low Flow water fixtures: This measure recommends installing low flow water fixtures and faucet aerators where applicable.

DHW upgrades/set points: This measure recommends reducing the domestic water heater set points in storage tanks and retrofit of water heater itself where necessary.

HVAC Controls upgrade: This measure recommends installing digital HVAC controls i.e. temperature reset controls for boilers and chillers that reduce run time based on load.

Envelope & General Weather stripping improvements: This measure recommends installing new windows, upgrading building insulation and regular maintenance related caulking and weather stripping upgrades.

High Efficiency Fluorescent Lighting/Induction Lighting: This measure recommends installing high efficiency lighting including Super T8s for interior space and Induction replacements for exterior and high bay applications. Though Elliot, High Rock, Library and Fire Station 2 have Metal halide exterior and parking lot fixtures, they would not cost justify replacement due to the relative lower wattage of the fixture, which is less than 175W. Typically induction replacements justify for fixture wattages over 200W.

Automatic Lighting Controls: This measure recommends installing photo and occupancy sensors to optimally control lighting.

New High Efficiency Chillers: This measure recommends installing high efficiency chillers with kW/ton ration of less than 0.45 to replace older cooling systems.

New Unitary Air Conditioners: This measure recommends installing older unitary split and window AC systems with high SEER AC units.

High Efficiency Condensing Boilers: This measure recommends adding a new high efficiency (98%) condensing boiler and using it as primary heating boiler for both pools and space heating. These boilers have high turn down ratio and advanced load following capability.

Install NEMA Premium Efficiency Motors: This measure recommends upgrading/replacing existing motors with NEMA premium rated motors to permanently reduce electric demand and usage during operational hours. Further where a VFD is recommended, these motors should be of inverter based type.

Retro/Re-Commissioning (RCx): This measure recommends re commissioning all building HAVC and air distribution systems after all improvements are made and systems properly commissioned by the contractor. This will tune up all building components to ensure all building systems are operating to new design intent. It is generally recommended that buildings with complex HVAC systems be retro/re commissioned every 3 to 5 years.

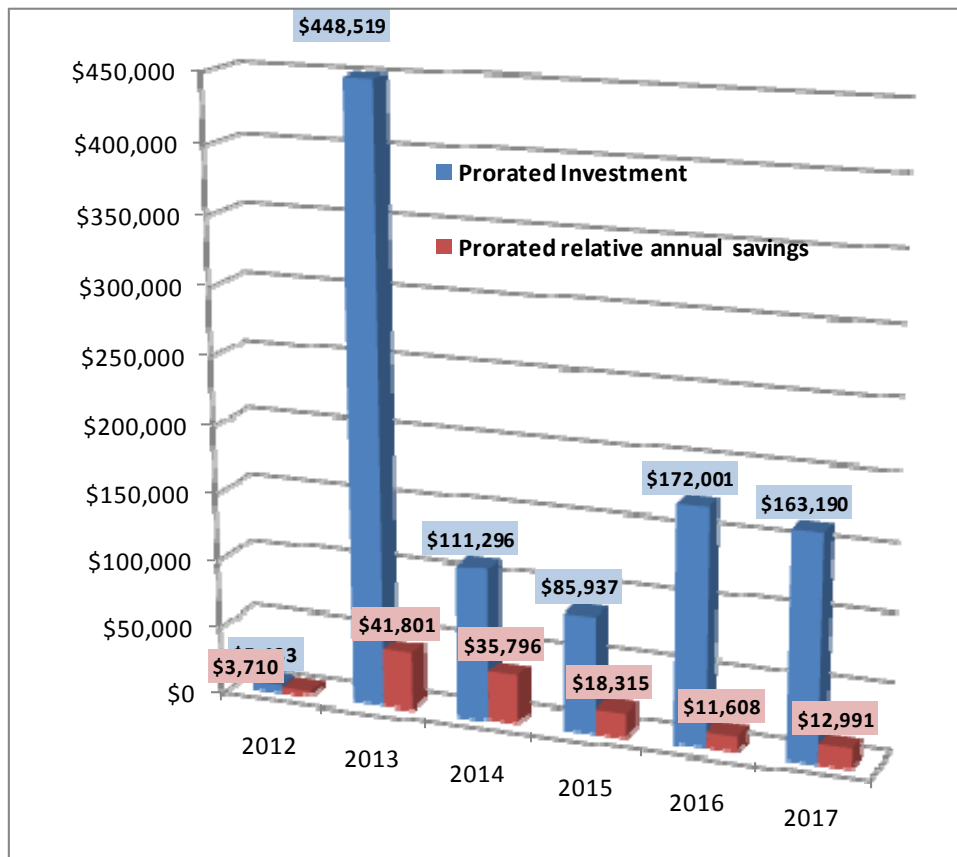
EMG has recommended the following construction methods commonly followed in the industry for implementation of the recommended projects:

- **In-house:** low/no cost projects and general maintenance items that can be implemented by in-house engineering and maintenance staff
- **General Contractor (GC):** GC is recommended for all insulation upgrade projects related to attic insulation, window replacement/upgrade and other envelope related projects not covered by maintenance
- **Lighting Contractor:** A Lighting contractor is recommended for all lighting upgrade projects including lamp, ballast & fixture retrofits for both interior and exterior lighting as well as automatic lighting controls including installation of photo and occupancy sensors; may require RFP procurement
- **HVAC Vendor:** HAVC contractor is recommended for all new boiler and chiller replacement/upgrade projects as well as VFD installation projects; may require RFP procurement

C. PROJECT IMPLEMENTATION BY YEAR

EMG proposes a multi-year phased implementation plan per below schedule for construction and implementation of all proposed projects and following table shows prorated total annual investment needed and prorated relative annual savings resulting from the projects. Utility rate escalation and other financial discount factors are not considered for this analysis.

End of Year (EOY)	Total Investment	Resulting Annual Cost Savings	Prorated Total Investment	Prorated Annual Savings
2012	\$5,433	\$3,710	1%	3%
2013	\$448,519	\$41,801	45%	34%
2014	\$111,296	\$35,796	11%	29%
2015	\$85,937	\$18,315	9%	15%
2016	\$172,001	\$11,608	17%	9%
2017	\$163,190	\$12,991	17%	10%
Total	\$986,376	\$124,222	100%	100%



The following table shows a summary of No/Low Cost Projects. Please refer to the energy audit reports provided for each site for individual listing of projects.

Project category	Site	Projected Investment w/15% mark-up	Estimated Annual Cost Savings	Simple Payback (Yrs)	Recommended Year of Implementation
Total No/Low Cost Projects	all sites	\$13,538	\$14,588	0.93	2012-2014

The following table shows a summary of Domestic Hot Water (DHW) Projects:

Project	Site	Projected Investment w/15% mark-up	Estimated Annual Cost Savings	Simple Payback (Yrs)	Recommended Year of Implementation
Details: Replace Old Gas Fired Water Heater	Pollard	\$13,443	\$977	13.76	2017

The following table shows a summary of Envelope upgrade Projects:

Project	Site	Projected Investment w/15% mark-up	Estimated Annual Cost Savings	Simple Payback (Yrs)	Recommended Year of Implementation
Details: Install Insulation in Attic	Michelle	\$12,174	\$10,025	1.21	2013
Details: Replace All External Windows On The Second Floor	Fire #2	\$11,116	\$585	19.00	2014
Total		\$23,290	\$10,610	2.20	

The following table shows a summary of HVAC Projects:

Project	Site	Projected Investment w/15% mark-up	Estimated Annual Cost Savings	Simple Payback (Yrs)	Recommended Year of Implementation
Retro-Commission The Building HVAC & Control System	Broadmeadow	\$35,247	\$5,704	6.18	2014
Re-Commission The Building & Its Control Systems	Elliot	\$23,817	\$5,683	4.19	2015
Install On-Demand Ventilation on Air Handlers in Mechanical Room	Elliot	\$2,347	\$259	9.06	2016
Replace Existing Air Conditioners with Energy Star Air Conditioners	Pollard	\$18,849	\$3,057	6.17	2015
Replace Inefficient heating plant	Pollard	\$421,467	\$21,570	19.54	2013

	HW boilers					
Re-Commission The Building HVAC Controls	Details: Relocate the DP Sensor And Re-Program the Set point on the Sensor	Needham HS	\$6,153	\$1,939	3.17	2016
Install DDC and add building to BMS	Details: Install DDC and add building to BMS	Police/Fire #1	\$138,863	\$6,435	21.58	2016
	Total		\$646,741	\$44,647	14.49	

The following table shows a summary of Lighting Projects:

Project	Site	Projected Investment w/15% mark-up	Estimated Annual Cost Savings	Simple Payback (Yrs)	Recommended Year of Implementation
Replace High Intensity Discharge Lamp (HID) with Induction Lighting	Broadmeadow	\$11,252	\$3,840	2.93	2014
Install Automatic Lighting Controls	Broadmeadow	\$25,437	\$11,844	2.15	2014
Install Automatic Lighting Controls	Elliot	\$1,877	\$2,064	0.91	2014
Replace High Intensity Discharge Lamp (HID) with Induction Lighting	Elliot	\$13,710	\$2,248	6.10	2015
Replace High Intensity Discharge Lamp (HID) with Induction Lighting	Hillside	\$1,708	\$285	5.99	2013
Replace High Intensity Discharge Lamp (HID) with Induction Lighting	Michelle	\$6,578	\$970	6.78	2013
Replace High Intensity Discharge Lamp (HID) with Induction Lighting	High Rock	\$4,169	\$448	9.30	2016
Install Bi-Level Lighting System In Hallways	High Rock	\$4,825	\$607	7.95	2016
Replace High Intensity Discharge Lamp (HID) with Induction Lighting	Pollard	\$20,799	\$5,506	3.78	2015
Install Tandem Lighting System In Hallways	Pollard	\$20,902	\$7,545	2.77	2014
Delamp Fixtures In Individual Rooms And Install Lighting Controls	Pollard	\$98,169	\$6,775	14.49	2017
Install Automatic Lighting Controls	Needham HS	\$3,952	\$2,287	1.73	2014
Replace High Intensity Discharge Lamp (HID) with Induction Lighting	Needham HS	\$11,048	\$1,270	8.70	2016
Replace High Intensity Discharge Lamp (HID) with Induction Lighting	Needham HS	\$51,578	\$5,239	9.84	2017
Install Automatic Lighting Controls	Police/Fire #1	\$1,599	\$410	3.90	2015
Replace High Intensity Discharge Lamp (HID) with Induction Lighting	Police/Fire #1	\$2,757	\$421	6.55	2016
Replace Lamps In Individual Rooms And Install Lighting Controls	Fire #2	\$7,164	\$1,411	5.08	2015
	Total	\$287,524	\$53,170	5.41	

The following table shows a summary of Appliance replacement Projects:

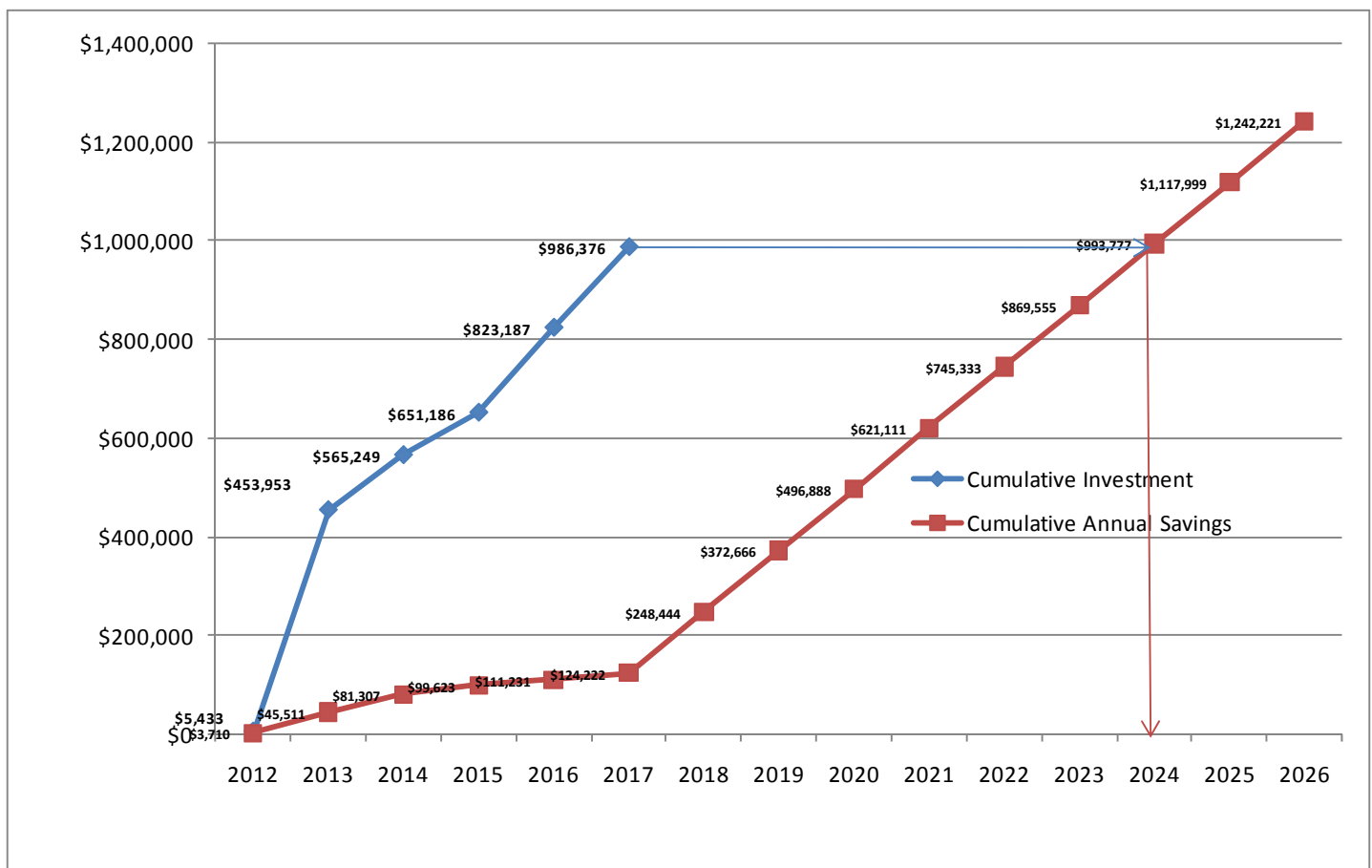
Project	Site	Projected Investment w/15% mark-up	Estimated Annual Cost Savings	Simple Payback (Yrs)	Recommended Year of Implementation
Details: Replace Refrigerators in Police Department with Energy Star Units	Police/Fire #1	\$1,840	\$229	8.04	2016
Total		\$1,840	\$229	8.04	

The project schedule has been developed in conjunction with and feedback from Needham. The selection of projects for a particular year is based on project needs, budget availability, relative energy efficiency gains and cost savings. It can be noted that 46% of total project cost i.e. \$453,953 is projected for Y2012 & 2013. This includes the new boiler replacement project for Pollard Middle School which is expected to take place during Y2013 for an estimated cost of over \$421,000.

The following chart shows cumulative annual investment for each year and cumulative annual savings over period of 15 years. Simple payback period of 7.94 years assumes that all projects are fully implemented and full savings will start yielding in the first year alone. Since the actual implementation and construction schedule is spread over six (6) years, the actual time to recover full investment costs based on present dollar values is 13 years which is more than the simple payback period of 7.94 years, based on the projected construction schedule.

The following table and chart provides a quick summary of investment by year and cumulative annual cost savings and total recovery period:

End of Year (EOY)	Total Investment	Resulting Annual Cost Savings	Cumulative Investment	Prorated Annual Savings	Cumulative Annual Savings
2012	\$5,433	\$3,710	\$5,433	\$3,710	\$3,710
2013	\$448,519	\$41,801	\$453,953	\$45,511	\$45,511
2014	\$111,296	\$35,796	\$565,249	\$81,307	\$81,307
2015	\$85,937	\$18,315	\$651,186	\$99,623	\$99,623
2016	\$172,001	\$11,608	\$823,187	\$111,231	\$111,231
2017	\$163,190	\$12,991	\$986,376	\$124,222	\$124,222
2018				\$124,222	\$248,444
2019				\$124,222	\$372,666
2020				\$124,222	\$496,888
2021				\$124,222	\$621,111
2022				\$124,222	\$745,333
2023				\$124,222	\$869,555
2024				\$124,222	\$993,777
2025				\$124,222	\$1,117,999
2026				\$124,222	\$1,242,221
Year 11	\$986,376				



It can be clearly seen that according to the project phasing and construction schedule of six (6) years, total recovery of initial investment is projected to happen during the year 13 or during Y2024, based on present value method.

Further, EMG strongly recommends that all HVAC and Lighting related capital projects be installed and commissioned by a reputable contractor and a detailed commissioning report be provided to Needham upon completion of each project.

We also strongly recommend that a proper Measurement & Verification (M&V) program be budgeted and incorporated for all lighting and HVAC projects administered by a reputable third party M&V company. This will ensure if the anticipated energy savings are achieved and ascertained to meet the overall energy and cost reduction goal.