The Town of Canton Energy Reduction Plan

Prepared by the Metropolitan Area Planning Council with support from the Town of Canton

In fulfillment of the
Massachusetts Green Communities Grant Program
Criterion 3

October 2017

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I. Purpose and Acknowledgements

A. Letters from Both General Government and School District Verifying Adoption of the ERP

B. List of Contributors:

The collaborative efforts of Town Administrator Charles Aspinwall, Town Planner Laura Smead, Administrative Secretary Jennifer Kemalian, and of the MA Department of Energy Resources' Green Communities Regional Coordinator Seth Pickering were vital to produce this plan.

Much of the information in this plan was derived from energy audits performed by Guardian Energy, led by William Harrow. Additional technical assistance was provided by the Metropolitan Area Planning Council (MAPC), the author of this plan.

II. Executive Summary

A. Narrative Summary of the Town

The Town of Canton is a Norfolk County community which was incorporated in 1797, situated inland about 15 miles southwest of Boston. It has an area of 19.6 square miles, and a population of 21,932 as of 2012. The Town is governed by an annual Town meeting, and run by a Town Administrator and a Board of Selectmen. The Town school district includes three elementary schools, one middle school, and one high school.

B. Summary of Municipal Energy Uses

- Total Number of Municipal Buildings: 27
  The Town owns a total of 27 municipal buildings. Of Canton's buildings, four of the schools are the largest individual energy users, with Canton High School using over 12,000 MMBTU per year. The least efficient building is the Senior Center, using 134 kBTU/sf, and 783 MMBTU per year.

- Total Number of Municipal Vehicles: 124
  Canton owns a total of 124 municipal vehicles, the majority of which belong to the DPW, police department, and fire department.

- Total Number of Street Lights and Traffic Lights: 1,996 streetlights and accounts for 29 traffic lights.

  In 2017, the Town undertook a retrofit project, in which it purchased all of the streetlights in the Town from Eversource (f.k.a NSTAR), and replaced the high pressure sodium bulbs with more energy efficient LED bulbs.

- Water and Sewer: 2 drinking water treatment plants, and 1 drinking water pumping station.

Table 1: Municipal Energy Use Summary	
	Number
Buildings	**27**
Oil Heat	2
Natural Gas Heat	13
Propane Heat	2
Biomass Heat	-
Other Heat Type	-
Electric or No heat	10
Vehicles	**124**
Gasoline or Diesel	124
Hybrid	-
Electric	-
Street Lights	1,996
Traffic Lights	29
Water and Sewer	**3**
Drinking Water Treatment Plant	2
Drinking Water Pumping Station	1
Wastewater Treatment Plant	0
Wastewater Pumping Station	0

C. Summary of Energy Use Baseline and Plans for Reduction

This Energy Reduction Plan commits Canton to reduce energy use in municipal facilities by at least 20% compared to Fiscal Year 2016 over five years. In the baseline year, the town used 63,553 MMBTUs of energy, which means the town must reduce usage by at least 12,710 MMBTUs over the following five year period.

As shown in **Figure 1**, buildings made up almost two-thirds (65.8%) of the usage by facility type (i.e. building, street/traffic light, vehicles and water/sewer). As shown in **Figure 2**, the School Department made up half (50.9%) of the usage by department (i.e. school, public works, police, and miscellaneous).

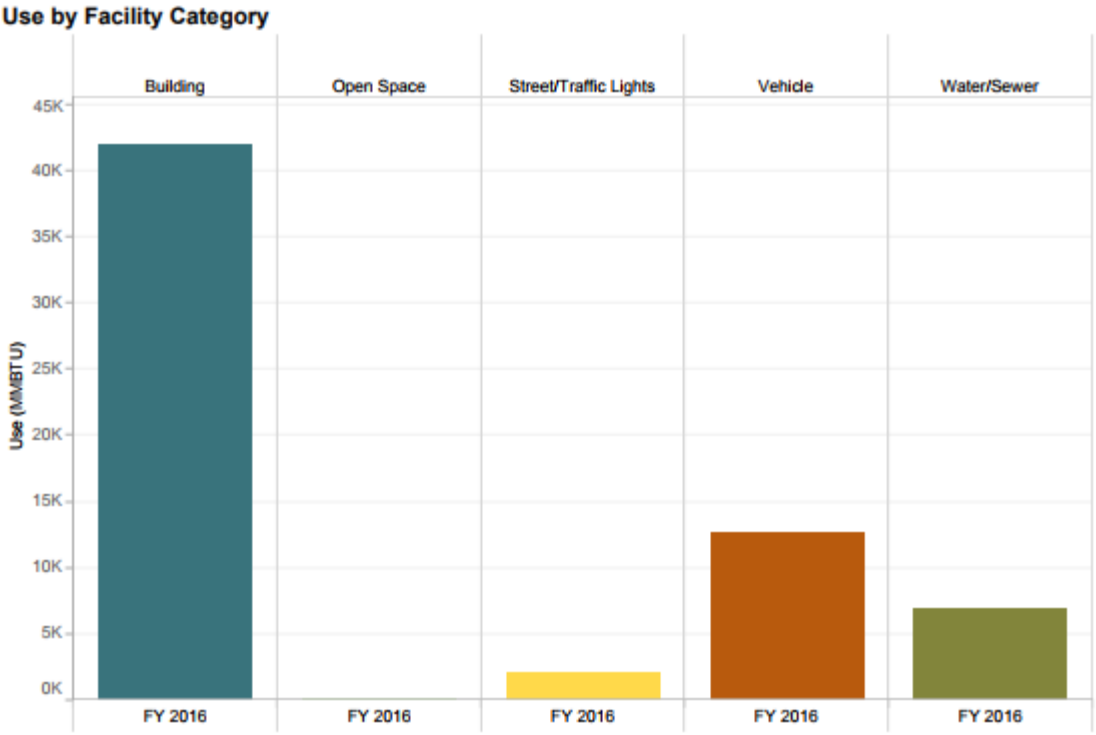

Figure 1. Municipal Energy Use Baseline Dashboard from MEI (FY 2016) by Facility Category.

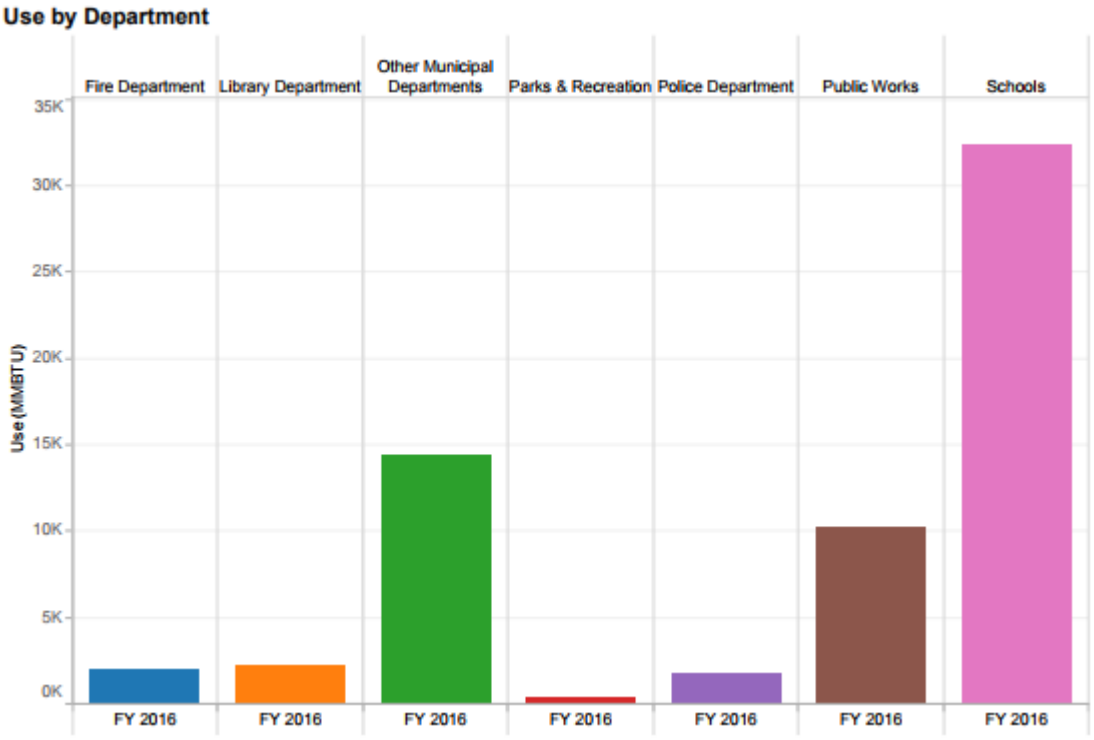

Figure 2. Municipal Energy Use Baseline Dashboard from MEI (FY 2016) by Department Category.

Canton has identified energy savings measures in each facility category to reduce energy use 20% based on the total baseline usage, as illustrated in **Table 2a**.

Table 2a: Summary of Municipal Energy Use & Reductions				
Facility Category	**MMBTU Used in Baseline Year**	**% of Total MMBTU Baseline Energy Consumption**	**Projected Planned MMBTU Savings**	**Savings as % of Total MMBTU Baseline Energy Consumption**
Non-Weather Normalized				
Buildings	41,942	66.00%	11,451	18.0%
Vehicles	12,598	19.82%	1,039	1.6%
Street/Traffic Lights	2,049	3.22%	916	1.4%
Open Space	72	0.11%	0	0.0%
Water/Sewer/Pumping	6,892	10.84%	325	0.5%
Total Non-Weather Normalized	**63,553**	100.00%	**13,731**	**21.61%**
***Savings are not weather normalized and can only be compared against other data that is not weather normalized.**				

III. Energy Use Baseline Inventory

A. Identification of the Inventory Tool Used – The Town of Canton used the Department of Energy Resources' (DOER) MassEnergyInsight (MEI) web-based energy inventory and analysis tool. Energy use is measured in British thermal units (MMBTUs), which allow all fuel types (e.g. electricity, natural gas, diesel, etc.) to be converted to a common unit.

B. Identification of the Baseline Year – Fiscal Year (FY) 2016 will serve as the baseline year. FY 2016 ran from July 1, 2015 to June 30, 2016. This will give the Town until June 30, 2021 (FY 2017 – FY 2021) to reach its 20% energy reduction goal.

C. Municipal Energy Consumption for the Baseline Year (FY 2016) – In the baseline year, the town used 63,553 MMBTUs of energy.

As shown in Figure 3, energy use from electricity and natural gas are the two largest categories, and together they account for over three-quarters (78%) of energy use.

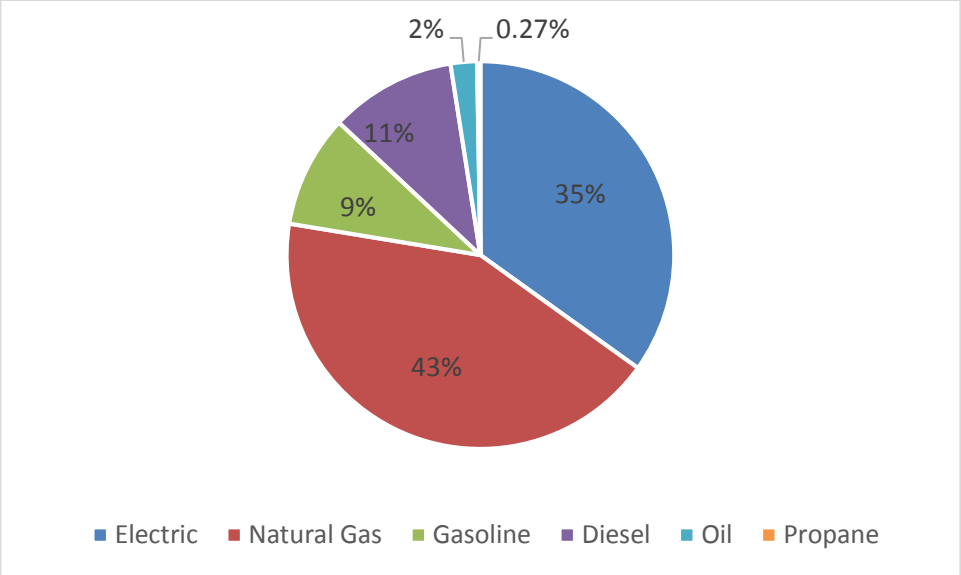

Figure 3. Energy Usage in FY2016 By Fuel Type

***Data is Weather Normalized.**

Table 2b shows that the top 10 largest energy users in town account for roughly 81% of all usage. The top user is the municipal and school vehicles, and half of the top ten users are school buildings. Two water treatment facilities are also included in the top 10, along with the library.

Table 2b. Top 10 Energy Consuming Facilities in Canton

Facility	MMBTUs	Percent of FY2016 Baseline
1. Municipal and School Vehicles	12,598	20%
2. Canton High School	12,061	19%
3. Galvin Middle School	5,043	8%
4. Luce Elementary School	4,466	7%
5. Hansen Elementary School	3,899	6%
6. Sullivan Water Treatment Facility	3,477	5%
7. Kennedy Elementary School	3,434	5%
8. Rodman Early Childhood Center	2,662	4%
9. Public Library	2,219	3%
10. James Moran Water Treatment Facility	1,863	3%
Total FY 2016 Usage for Top 10	**51,722**	**81%**
Total FY 2016 Usage Baseline	**63,553**	**100%**

Energy Use Intensity is a measure of the energy used per square foot, with lower EUIs indicating more efficient buildings. Buildings with a higher EUI generally have more opportunities for cost-effective energy efficiency upgrades.

The median EUI of all buildings in Canton is 52.1 kBTU per square foot. As shown in **Figure 4**, the largest user in town, Canton High School, has a EUI of 40.2.

Any buildings with high usage or above the median efficiency present the best opportunities for savings. These include the five schools, the Rodman building, the public library, police headquarters, fire stations, public works garage, and the senior center.

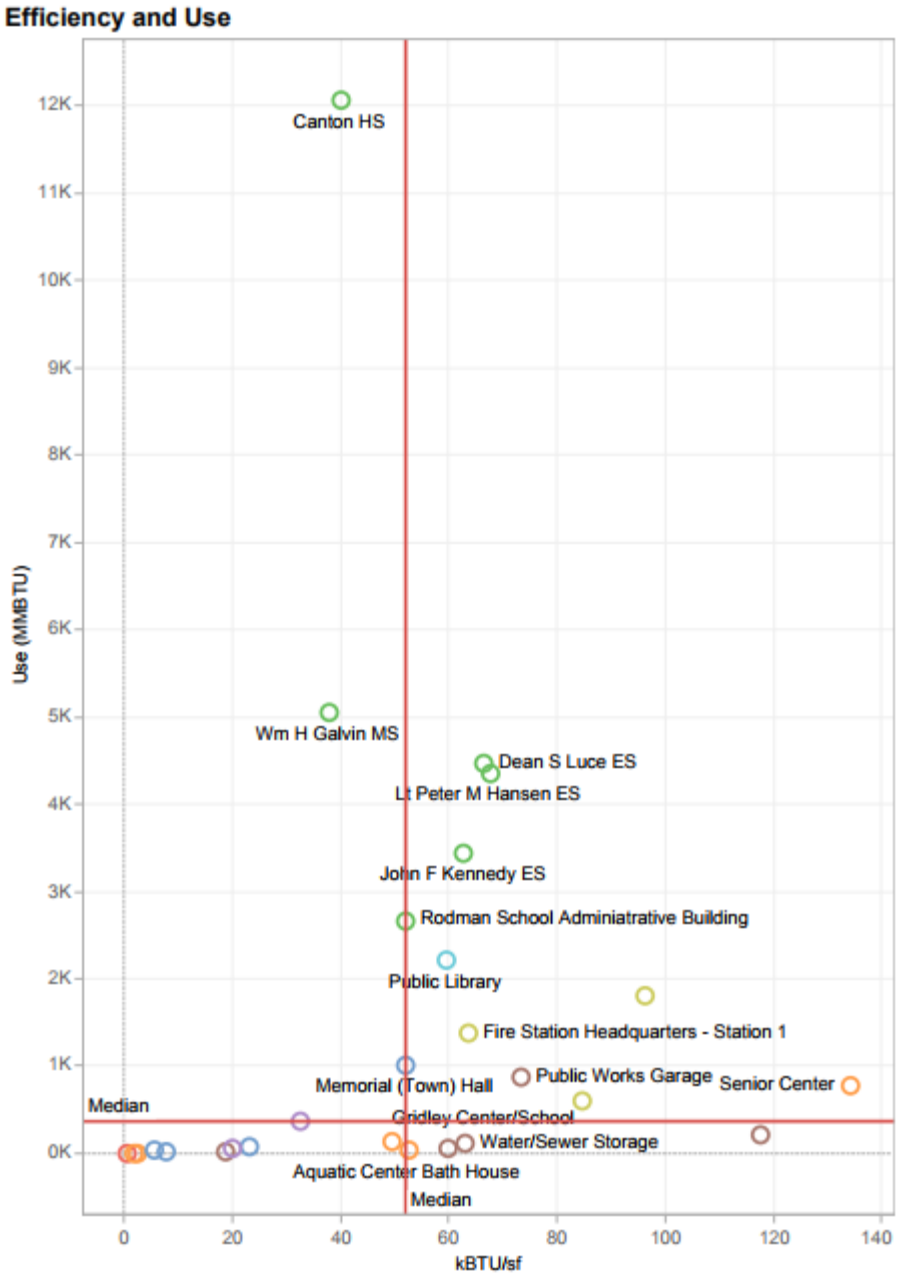

Figure 4. Energy Use Intensity (kBTU/sf) and Total Energy Use (MMBTU) for Buildings.

Points further to the right have a higher energy use per square foot (i.e. less energy efficient). Points higher up use more total energy. Canton High School, for example, uses the most energy of any building, and has slightly below average usage per square foot.

Red lines show the medians for the town's buildings.

Appendix A presents **Table 3a and 3b** showing energy use for each municipal facility in MMBTUs and native units in the Baseline year.

D. Energy Reduction Goal - Canton's 20% energy reduction goal will be measured against the baseline of 63,553 MMTBUs. Canton will reduce its energy consumption by at least 12,710 MMBTUs.

IV. Energy Reduction Plan

A. Narrative Summary

As shown in the summary table below, the town has identified energy savings measures to reduce usage from FY2016 by 13,731 MMBTUs or 21.61%.

Table 4. Summary of Identified Savings by Facility			
	Projected Planned MMBTU Savings	FY 2016 MMBTU usage	Top 10 Energy User
Buildings			
Canton High School	1,947	12,061	#2
Galvin Middle School	1,564	5,043	#3
Luce Elementary School	1,717	4,466	#4
Kennedy Elementary School	713	3,434	#7
Hansen Elementary School	1,329	3,899	#5
Rodman Early Childhood Center	305	2,717	#8
Memorial (Town) Hall	346	1,008	
Public Library	637	2,219	#9
Police	258	1,812	
Fire Headquarters	478	1,369	
Ponkapoag Fire Station - Fire Station 2	339	611	
Public Works Garage	24	864	
Senior Center	98	783	
William Armando Recreation Center	22	86	
Butch Pasquarosa Public Works Campus	52	212	
Gridley School	4	127	
Cemetery Office/Garage	4	60	
Parks and Recreation Garage	11	48	
Pequitside Carriage House	5	23	
Pequitside Main House	10	42	
Behavior-Based Programs at Schools	576	-	
Building Operator Certification	1,012	-	
Buildings Sub-Total (includes ALL buildings)	**11,451**	**41,942**	
Vehicles	1,039	**12,598**	#1
Streetlights / Traffic Lights	916	2,049	
Open Space	-	72	
Water/Sewer/Pumping			
Sullivan Water Treatment Center	208	3,477	#6
James Moran Water Treatment Facility	117	1,863	#10
Water/Sewer/Pumping Sub-Total (includes ALL facilities)	**325**	**6,892**	
Total	**13,731**	**63,553**	
Savings as Percent FY2016 Baseline	21.60%		

Overview of Goals[1]

YEAR 1: FY 2017

- Streetlights – Retrofit the Town's streetlights with LED fixtures.
    - The Town already successfully purchased and retrofit its streetlight fixtures with LED bulbs, and the project was completed in March 2017.

YEAR 2: FY 2018

- Retrofit Canton High School, including:
    - LED lighting and sensors/controls
    - Weatherization
    - Refrigeration Control
    - Energy Management System
- Pilot behavior-based energy savings programs in all schools.
    - Programs will include initial documentation of appropriate temperature set points and a quarterly documentation that those set points are being followed.
- Achieve Building Operator Certification for both School and Town facilities staff.
- Incorporate a switch to 100% synthetic oil for all municipal vehicles' oil replacement.
- Closely monitor vehicle tire air pressure to maintain vehicle fuel efficiency.

YEAR 3: FY2019

- Schools – Perform retrofits of Galvin Middle School[2], Luce Elementary School, Kennedy Elementary School, and Hansen Elementary School, which include:

[1] This is a non-binding sample timeline which prioritizes interventions that are expected to have the most energy reduction impacts (e.g. buildings that are high energy users and/or least efficient). The specific implementation of these goals is expected to change based on existing capital plans, need, and funding availability.

    - LED lighting and sensors/controls (All)
    - Weatherization (All but Galvin)
    - Refrigeration Control (All except Luce)
    - Energy Management System (All except Kennedy)
    - Pneumatic System Retrocommission (All except Canton High)
    - Boiler Controls (Kennedy and Hansen)
    - Boilers (Luce only)
    - Generator Heat Pump (Galvin only)
    - Mechanical Insulation (Galvin only)
    - Summer Boilers (Kennedy and Hansen)
- Rodman Early Childhood Center –
    - LED lighting and sensors/controls
    - Weatherization
    - Generator Heat Pump
- Continue pilot behavior-based energy savings programs in all schools
- Continue synthetic oil & tire air pressure monitoring

YEAR 4: FY2020

- Public Library –
    - LED lighting and sensors/controls
    - Boiler replacement
    - Energy Management System
- Memorial Town Hall
    - LED lighting sensors and controls
    - Weatherization
    - Energy Management System
    - Zone Control
- Police Headquarters –
    - LED lighting and sensors/controls
    - Mechanical Insulation

[2] The Town may choose to delay Galvin Middle School retrofits to later fiscal years, or to only selectively implement them in FY18 to align with the Schools Master Plan (2017)

- Continue synthetic oil & tire air pressure monitoring
- Build on pilot behavior-based energy reduction programs to create a permanent program in schools
- Anti-idling policy for non-police vehicles

YEAR 5: FY2021

- Fire Headquarters –
    - LED lighting and sensors/controls
    - Boilers
    - Weatherization
- Ponkapoag Fire Station (Fire Station 2) –
    - LED lighting and sensors/controls
    - Boiler
    - Domestic Hot Water
    - Infrared Heating
- Senior Center –
    - LED lighting and sensors/controls
    - Re-heating
    - Retrocommissioning
- Sullivan Water Treatment Center, James Moran Water Treatment Facility, Public Works Garage, William Armando Recreation Center, Butch Pasquarosa Public Works Campus, Gridley School, Cemetery Office/Garage, Parks and Recreation Garage, Pequitside Carriage House and Pequitside Main House–
    - LED lighting and sensors/controls
- Continue synthetic oil & tire air pressure monitoring
- Build on pilot behavior-based energy reduction programs to create a permanent program in schools
- Continue anti-idling policy for non-police vehicles

Sample Summary Plan by Year with Estimated Costs[3]				
	Fiscal Year (FY) Planned	Final Cost to Town Sum	Green Communities Grant	Town Capital or General Fund
Year 1				
Streetlights / Traffic Lights	FY17	Completed	Completed	Completed
Years 2-5				
Behavior-Based Programs at Schools[4]	FY18-FY21	$20,500	$0	$20,500
Vehicles (synthetic oil; tire pressure)	FY18-FY21	$0	$0	$0
Year 2				
Canton High School Retrofits	FY18	$1,006,353	$160,000	$846,353
Building Operator Certification	FY18	$3,660	$0	$3,660
FY18 Total		**$1,010,013**	**$160,000**	**$850,013**
Year 3				
Galvin Middle School	FY19	$695,748	$0	$695,748
Luce Elementary School	FY19	$419,158	$0	$419,158
Kennedy Elementary School	FY19	$233,818	$0	$233,818
Hansen Elementary School	FY19	$376,587	146$250,000	$126,587
Rodman Early Childhood Center	FY19	$207,874	$0	$207,874
FY19 Total		**$1,933,184**	**$250,000**	**$1,683,184**
Year 4				
Memorial (Town) Hall	FY20	$271,615	$0	$271,615
Public Library	FY20	$456,203	$250,000	$206,203
Police	FY20	$159,124	$0	$159,124
Anti-idling policy	FY20	$0	$0	$0
FY20 Total		**$886,942**	**$250,000**	**$636,942**
Year 5				
Fire Headquarters	FY21	$172,651	$0	$172,651
Ponkapoag Fire Station - Fire Station 2	FY21	$148,929	$103,331	$45,598
Public Works Garage	FY21	$18,762	$0	$18,762
Senior Center	FY21	$178,481	$0	$178,481

[3] This is an example plan, for discussion purposes only, to show how energy conservation measures may be structured and paid for. It is non-binding and expected to change based upon further discussion. See Appendix B for a full breakdown of energy conservation measures, estimated costs, and payback years.
[4] $20,000 for a one-time consultant cost; $500-$1000 continues each year for educational materials.

William Armando Recreation Center	FY21	$13,501	$0	$13,501
Butch Pasquarosa Public Works Campus	FY21	$35,994	$0	$35,994
Gridley School	FY21	$2,467	$0	$2,467
Cemetery Office/Garage	FY21	$2,240	$0	$2,240
Parks and Recreation Garage	FY21	$7,769	$0	$7,769
Pequitside Carriage House	FY21	$3,617	$0	$3,617
Pequitside Main House	FY21	$7,218	$0	$7,218
Sullivan Water Treatment Center	FY21	$146,669	$146,669	$0
James Moran Water Treatment Facility	FY21	$82,146	$0	$82,146
FY21 Total		**$820,442**	**$250,000**	**$570,442**
Grand Total		**$4,650,581**	**$910,000**	**$3,750,581**

1. Energy Efficiency Identification Measures: Fuel

    - The town will continue to utilize MEI to review data and identify if year over year trends are occurring as expected. Unexpected increases or the failure of some categories to decrease despite known interventions/retrofits will prompt further inquiry.

    - Use MEI's building "Buildings to Target" tab to identify underperforming and/or wasteful buildings based on Energy Use Intensity (see Figure 4 above).

    - Conduct research and talk with experts such as energy auditors, DOER, MAPC, Massachusetts Clean Energy Center and others to find out if new technologies have come to market that could provide new savings in existing facilities.

B. Path to 20% Energy Use Reduction by the end of Fiscal Year 2021

1. Program Management Plan for Implementation, Monitoring, and Oversight

    - The Town Administrator's office, in collaboration with the Planning Department and the School Department, will be responsible both for oversight of the Energy Reduction Plan and for implementation of energy conservation measures within the Town. The Town Administrator's office

and Town Planner's office will coordinate with the School Department's Director of Facilities, and the Town's Facilities and Grounds Division to complete the annual reporting requirements to DOER to maintain designation and eligibility for annual competitive grant funding.

- Hiring a full- or part-time energy manager has been shown to be an effective way to ensure projects get planned and executed, annual reporting occurs, the town secures Green Communities and other grant funding, and the town stays on track to meet its 20% energy reduction goal. The town intends to evaluate hiring an energy manager, which could be shared with a nearby town to reduce costs.

- The School Department's Director of Facilities and the Town's Facilities division, working with the Town Administrator and Town Planner, will agree to thermostat set point and set back schedules for the largest energy users in town, including the five schools, the Public Library, Police Headquarters, and Memorial Hall (Town Hall).

    - Set points refer to the temperatures that thermostats are set at during normal usage hours. Set backs would occur during off-hours, such as evenings and weekends in most municipal facilities, when buildings do not need to be heated or cooled to the same levels.

    - The desired set points and schedules may differ by season, and will be documented in writing. The parties will then agree to a schedule for updates, at which the appropriate Facilities staff will provide written confirmation that the buildings are operating with the agreed upon set points and set backs. **This process is intended to minimize the chance that set points and set backs get overridden or forgotten. In some communities, this type of set point change has gone unnoticed for months, causing excessive spikes in energy use.**

- The set point reporting will be included as part of a behavior-based energy reduction program, recommended for Canton's schools.

- The Town Planner (or other designee chosen by the Town Administrator), in collaboration with the School and Municipal Facilities divisions, will provide an annual update to the Board of Selectmen and the School Committee by the end of January following the submission of the Annual Report to DOER. The presentation will include:
  - The trend for town-wide **weather-normalized** energy usage
    - Show the baseline, current year and any years in between
  - The trend for energy usage in at least the largest energy using buildings identified above – the five schools, the Public Library, Police Headquarters, and Memorial Hall (Town Hall).
    - Show the baseline, current year and any years in between
  - A summary of the major efficiency measures implemented over the past year
  - An explanation or hypothesis of the cause of the trends town-wide and in the largest buildings
  - Update on Green Communities competitive grant applications

2. Summary of Energy Audit(s) or Other Sources for Projected Energy Savings

- Building audits were provided by Guardian Energy in 2017 and provide 16.0% energy savings[5]. The Guardian Energy Audit is included in Appendix B.

  MAPC developed estimates for energy savings through behavior-based energy programs in schools, based on published research from the report Powering Down from the US Green Building Council's Center for Green Schools (see Appendix D). These measures contribute 0.91% savings.

[5] Table 4 from the audit has been augmented to include all proposed savings measures. Measures for specific buildings were identified by Guardian's audit, totaling 16.0% energy savings.

Additionally, Building Operator Certification initiatives will provide 1.6% savings.

- Streetlight savings calculations from MAPC's calculator, based on Town's previous inventory (see Appendix E) provide an additional 1.4% savings. (Calculated separately but also included in the audit chart)

- Vehicle measures targeting overall vehicle usage will provide another 1.6% savings. MAPC developed estimates using available data for:
    - Tire pressure and synthetic oil policies for all vehicles
    - Anti-idling policies for non-police vehicles

  Vehicle measures are available in Appendix C.

3. Energy Conservation Measures

Table 4 lists recommended energy conservation measures. References for each measure is included in the table and these references are included as appendices to the Energy Reduction Plan. Projected annual MMBTU savings for each category (buildings, street and traffic lights, water and sewer) are subtotaled to arrive at a municipal grand total. Table 4 includes both hard measures (identified by Guardian), as well as behavior-based measures.

Table 4: Estimated Energy Savings in Canton Municipal Facilities

ECMs			Status		Energy Data					
Category (select one from drop-down)	Site/Building Name	ECM Type	Status (select one from drop-down)	Status Date (Completed or planned)	Projected Annual Electric Savings [kWh]	Projected Annual NG Savings [therms]	Projected Annual Oil Savings [gal]	Projected Annual Propane Savings [gal]	Projected Annual Gasoline Savings [gal]	Projected Annual Diesel Savings [gal]
Building	Canton High School	Lighting	planned	FY 2018	360,895	0	0	0	0	0
		Refrigeration Control	planned	FY 2018	9,310	0	0	0	0	0
		Weatherization	planned	FY 2018	0	2,010	0	0	0	0
		Energy Management System +	planned	FY 2018	70,487	2,420	0	0	0	0
Building	Galvin Middle School	Lighting	planned	FY 2019	189,653	0	0	0	0	0
		Refrigeration Control	planned	FY 2019	4,655	0	0	0	0	0
		Mechancial Insulation	planned	FY 2019	0	320	0	0	0	0
		Energy Mangemement System	planned	FY 2019	8,335	5,529	0	0	0	0
		Pneumatic System Retrocomm	planned	FY 2019	37,487	1,053	0	0	0	0
		Generator Heat Pump	planned	FY 2019	15,929	0	0	0	0	0
Building	Luce Elementary School	Lighting	planned	FY 2019	64,185	0	0	0	0	0
		Weatherization	planned	FY 2019	0	870	0	0	0	0
		Pneumatic System Retrocomm	planned	FY 2019	12,536	1,358	0	0	0	0
		Energy Management System	planned	FY 2019	2,821	7,132	0	0	0	0
		Boilers	planned	FY 2019	2,700	5,004	0	0	0	0
Building	Kennedy Elementary School	Lighting	planned	FY 2019	56,382	0	0	0	0	0
		Refrigeration Control	planned	FY 2019	4,655	0	0	0	0	0
		Weatherization	planned	FY 2019	0	360	0	0	0	0
		Pneumatic System Retrocomm	planned	FY 2019	23,956	997	0	0	0	0
		Boiler Controls	planned	FY 2019	0	1,871	0	0	0	0
		Summer Boiler	planned	FY 2019	0	998	0	0	0	0
Building	Hansen Elementary School	Lighting	planned	FY 2019	66,272	0	0	0	0	0
		Refrigeration Control	planned	FY 2019	4,655	0	0	0	0	0
		Weatherization	planned	FY 2019	0	240	0	0	0	0
		Pneumatic System Retrocomm	planned	FY 2019	1,303	1,117	0	0	0	0
		Energy Management System	planned	FY 2019	3,236	6,148	0	0	0	0
		Boiler Controls	planned	FY 2019	0	2,096	0	0	0	0
		Summer Boiler	planned	FY 2019	0	1,118	0	0	0	0
Building	Rodman Early Childhood Center	Lighting	planned	FY 2019	72,486	0	0	0	0	0
		Weatherization	planned	FY 2019	0	250	0	0	0	0
		Generator Heat Pump	planned	FY 2019	9,436	0	0	0	0	0
Building	Memorial (Town) Hall	Lighting	planned	FY 2020	41,902	0	0	0	0	0
		Weatherization	planned	FY 2020	0	1,420	0	0	0	0
		Energy Management System	planned	FY 2020	9,093	194	0	0	0	0
		Zone Control	planned	FY 2020	1,819	39	0	0	0	0
Building	Public Library	Lighting	planned	FY 2020	94,310	0	0	0	0	0
		Boilers	planned	FY 2020	3,691	1,918	0	0	0	0
		Energy Management System	planned	FY 2020	18,546	480	0	0	0	0
Building	Police	Lighting	planned	FY 2020	67,375	0	0	0	0	0
		Mechancial Insulation	planned	FY 2020	0	280	0	0	0	0
Building	Fire Headquarters	Lighting	planned	FY 2021	35,800	0	0	0	0	0
		Boilers	planned	FY 2021	490	-3,345	4,170	0	0	0
		Weatherization	planned	FY 2021	0	0	787	0	0	0
Water/Sewer	Sullivan Water Treatment	Lighting	planned	FY 2021	61,112	0	0	0	0	0
Building	Ponkapoag Fire Station - Fire Station 2	Lighting	planned	FY 2021	11,726	0	0	0	0	0
		Boiler	planned	FY 2021	490	-3,345	4,170	0	0	0
		Domestic Hot Water	planned	FY 2021	13,202	-434	0	0	0	0
		Infrared Heating	planned	FY 2021	389	-667	834	0	0	0
Building	Public Works Garage	Lighting	planned	FY 2021	7,107	0	0	0	0	0
Building	Senior Center	Lighting	planned	FY 2021	13,841	0	0	0	0	0
		Re-Heat	planned	FY 2021	8,123	0	0	0	0	0
		Retrocommissioning	planned	FY 2021	2,166	156	0	0	0	0
Building	William Armando Recreation	Lighting	planned	FY 2021	6,494	0	0	0	0	0
Water/Sewer	James Moran Water Treatment	Lighting	planned	FY 2021	34,227	0	0	0	0	0
Building	Butch Pasquarosa Public Works	Lighting	planned	FY 2021	15,187	0	0	0	0	0
Building	Gridley School	Lighting	planned	FY 2021	1,068	0	0	0	0	0
Building	Cemetery Office/Garage	Lighting	planned	FY 2021	1,039	0	0	0	0	0
Building	Parks and Recreation Garage	Lighting	planned	FY 2021	3,278	0	0	0	0	0
Building	Pequitside Carriage House	Lighting	planned	FY 2021	1,526	0	0	0	0	0
Building	Pequitside Main House	Lighting	planned	FY 2021	2,929	0	0	0	0	0
Street/traffic	Street Lights	Street Light Retrofit	complete	FY 2017	268,543	0	0	0	0	0
Building	All Schools	Behavior-based program	planned	FY 2018	169,046	0	0	0	0	0
Building	All Buildings	Building operator certification	planned	FY 2018	122,162	5,947	0	0	0	0
Vehicles	All municipal vehicles	Various	planned	FY 2018	0	0	0	0	5,217	2,877
		Total Projected Savings			**2,038,055**	**43,534**	**9,961**	**0**	**5,217**	**2,877**
		MMBTU Savings	**13,739**		**6,954**	**4,353**	**1,385**	**0**	**647**	**400**

Table 4: Estimated Energy Savings in Canton Municipal Facilities (continued)

Financial Analysis					Reference Data	
Projected Annual Cost Savings [$]	Total Installed Cost [$]	Green Community Grant [$]	Utility Incentive [$]	Net Cost [$]	Funding Source(s) for Net Costs	Source for Projected Savings
$84,379	$1,082,684	$160,000	$216,537	**$706,147**	Capital fund	Guardian audit, 2017
$2,102	$19,204		$2,328	**$16,876**	Capital fund	Guardian audit, 2017
$2,211	$27,595		$3,015	**$24,580**	Capital fund	Guardian audit, 2017
$16,759	$98,750		$0	**$98,750**	Capital fund	Guardian audit, 2017
$47,511	$568,960		$113,792	**$455,168**	Capital fund	Guardian audit, 2017
$1,056	$6,554		$1,164	**$5,390**	Capital fund	Guardian audit, 2017
$352	$10,998		$220	**$10,778**	Capital fund	Guardian audit, 2017
$8,949	$174,827		$9,600	**$165,227**	Capital fund	Guardian audit, 2017
$9,256	$39,945		$0	**$39,945**	Capital fund	Guardian audit, 2017
$3,526	$21,630		$2,390	**$19,240**	Capital fund	Guardian audit, 2017
$18,999	$205,391		$47,240	**$158,151**	Capital fund	Guardian audit, 2017
$957	$13,424		$1,305	**$12,119**	Capital fund	Guardian audit, 2017
$4,601	$20,168		$0	**$20,168**	Capital fund	Guardian audit, 2017
$9,229	$129,192		$3,600	**$125,592**	Capital fund	Guardian audit, 2017
$6,594	$115,128		$12,000	**$103,128**	Capital fund	Guardian audit, 2017
$16,351	$157,870		$28,417	**$129,454**	Capital fund	Guardian audit, 2017
$1,056	$6,554		$1,164	**$5,390**	Capital fund	Guardian audit, 2017
$396	$5,956		$540	**$5,416**	Capital fund	Guardian audit, 2017
$6,488	$16,440		$0	**$16,440**	Capital fund	Guardian audit, 2017
$2,058	$16,371		$1,871	**$14,500**	Capital fund	Guardian audit, 2017
$1,218	$66,618		$4,000	**$62,618**	Capital fund	Guardian audit, 2017
$18,623	$178,936	$140,000	$30,419	**$8,517**	Capital fund	Guardian audit, 2017
$1,056	$6,554		$1,164	**$5,390**	Capital fund	Guardian audit, 2017
$264	$4,399		$360	**$4,039**	Capital fund	Guardian audit, 2017
$1,989	$19,200		$0	**$19,200**	Capital fund	Guardian audit, 2017
$8,280	$126,148	$110,000	$3,600	**$12,548**	Capital fund	Guardian audit, 2017
$2,306	$16,371		$2,096	**$14,275**	Capital fund	Guardian audit, 2017
$1,380	$66,618		$4,000	**$62,618**	Capital fund	Guardian audit, 2017
$21,673	$239,202		$57,409	**$181,794**	Capital fund	Guardian audit, 2017
$275	$6,240		$375	**$5,865**	Capital fund	Guardian audit, 2017
$2,207	$21,630		$1,415	**$20,215**	Capital fund	Guardian audit, 2017
$12,277	$129,897		$29,876	**$100,021**	Capital fund	Guardian audit, 2017
$1,562	$80,876		$0	**$80,876**	Capital fund	Guardian audit, 2017
$2,272	$77,300		$6,000	**$71,300**	Capital fund	Guardian audit, 2017
$507	$19,418		$0	**$19,418**	Capital fund	Guardian audit, 2017
$28,765	$330,086	$250,000	$82,521	**-$2,436**	Capital fund	Guardian audit, 2017
$3,217	$134,749		$8,000	**$126,749**	Capital fund	Guardian audit, 2017
$4,467	$99,890		$18,000	**$81,890**	Capital fund	Guardian audit, 2017
$19,539	$202,124		$46,489	**$155,636**	Capital fund	Guardian audit, 2017
$308	$3,908		$420	**$3,488**	Capital fund	Guardian audit, 2017
$10,597	$114,559		$24,057	**$90,501**	Capital fund	Guardian audit, 2017
$3,880	$72,821		$3,000	**$69,821**	Capital fund	Guardian audit, 2017
$1,322	$12,329		$0	**$12,329**	Capital fund	Guardian audit, 2017
$17,722	$183,336	$146,669	$36,667	**$0**	Capital fund	Guardian audit, 2017
$3,471	$37,523		$7,880	**$29,643**	Capital fund	Guardian audit, 2017
$3,880	$72,821	$69,821	$3,000	**$0**	Capital fund	Guardian audit, 2017
$2,220	$11,133		$0	**$11,133**	Capital fund	Guardian audit, 2017
$891	$40,582	$33,510	$2,250	**$4,822**	Capital fund	Guardian audit, 2017
$2,125	$23,452		$4,690	**$18,762**	Capital fund	Guardian audit, 2017
$3,931	$38,755		$8,914	**$29,841**	Capital fund	Guardian audit, 2017
$1,625	$99,750		$0	**$99,750**	Capital fund	Guardian audit, 2017
$955	$48,890		$0	**$48,890**	Capital fund	Guardian audit, 2017
$1,825	$17,533		$4,033	**$13,501**	Capital fund	Guardian audit, 2017
$7,371	$102,682		$20,536	**$82,146**	Capital fund	Guardian audit, 2017
$4,404	$45,562		$9,568	**$35,994**	Capital fund	Guardian audit, 2017
$310	$3,204		$737	**$2,467**	Capital fund	Guardian audit, 2017
$295	$2,909		$669	**$2,240**	Capital fund	Guardian audit, 2017
$951	$9,834		$2,065	**$7,769**	Capital fund	Guardian audit, 2017
$443	$4,578		$961	**$3,617**	Capital fund	Guardian audit, 2017
$867	$9,374		$2,156	**$7,218**	Capital fund	Guardian audit, 2017
$53,709	N/A		$0	**N/A**	N/A	MAPC Streetlight calcul
$33,809	$20,500		$0	**$20,500**	Capital fund	USGBC's Center for Gre
$30,974	$3,660		$0	**$3,660**	Capital fund	Building Operator Certif
N/A	N/A		$0	**N/A**	Capital fund	FuelEconomy.gov
$562,590	**$5,543,590**	**$910,000**	**$872,509**	**$3,761,081**		

C. Summary of Long-Term Energy Reduction Goals – Beyond 5 Years

1. Buildings (including schools)

To better strategize for the long-term maintenance and management of municipal buildings, Canton will work with internal school and Town staff as well as outside consultants, when necessary, to assess and document the condition of major municipal buildings. The Town will consult the School Department's Master Plan to coordinate efforts related to school buildings. In addition to exposing continuing opportunities for energy use reductions, this effort will provide the Town with a clear, long-term asset management strategy for the effective budgeting and maintenance of buildings.

2. Vehicles (including schools)

The Fuel-Efficient Vehicle policy will have become engrained within municipal purchasing practices in the first 5 years, and the Town will seek to explore even more efficient policies and tracking systems to enable additional efficiency gains.

- Explore options to purchase electric vehicles and install electric vehicle charging stations
- Explore options to retrofit senior transport vans with hybrid conversion technology
- Explore anti-idling technologies for police vehicles

3. Street and Traffic Lighting

As the Town has already had all streetlights retrofitted with LED bulbs within the 5 year period, the Town will next look to include wireless controls that can dim to drive further savings.

4. Perpetuating Energy Efficiency

An annual municipal audit by Town and Schools staff will tap into the knowledge of the employees who use and maintain the building every day. It will empower building staff to develop a detailed repair and management schedule and collect data

on problems and inefficiencies that may be missed by traditional third party audits. Web-based application systems such as See Click Fix will be considered to create additional real-time opportunities for efficiencies in operation and maintenance.

The Town of Canton will grow its capacity to retrofit and build more efficient facilities, purchase more efficient vehicles, and illuminate the Town with more efficient lighting throughout the 5-year period. These practices will become engrained in the culture of the Town and will provide opportunities to instill the ethos into additional policies and programs for more dedicated long-term funding streams and strategies.

V. Appendix A.: Municipal Energy Consumption for FY 2016 – Native Units and MMBTUs

Table 3a. Baseline in Native Units:

		2016					
		Electric (kWh)	Gas (therms)	Oil (gallons)	Gasoline (gallons)	Diesel (gallons)	Propane (gallons)
Building	Lt Peter M Hansen ES	323,596	32,532				
	Wm H Galvin MS	706,441	26,330				
	John F Kennedy ES	275,304	24,994				
	Canton HS	1,762,181	60,481				
	Dean S Luce ES	313,402	33,963				
	Rodman School Adminiatrativ..	219,600	19,126				
	Memorial (Town) Hall	181,868	3,875				
	Senior Center	54,151	5,987				
	Police Headquarters	267,360	8,993				
	Butch Pasquarosa Public Wor..	62,040					
	Pequitside Main House	12,308					
	Aquatic Center Bath House	12,583					
	Gridley Center/School	4,623	1,117				
	Messenger Field House	212					
	Ponkapoag Field House	84					
	William Armando Recreation ..	25,155					
	Public Works Garage	43,589	7,774				
	Fire Station Headquarters - St..	164,520		5,809			
	Public Library	377,840	9,592				
	Ponkapoag Fire Station - Fire ..	53,887		3,073			
	Pequitside Carriage House	6,699					
	Ponkapoag School	2,570					
	Water/Sewer Storage						1,215
	Parks and Recreation Garage	14,178					
	Cemetery Office/Garage	5,092					461
	North Street Garage	16,920	3,198				
	Yard waste and recycling facili..	5,537					
	Total	**4,911,740**	**237,962**	**8,882**			**1,676**

Table 3a. Native Units (Continued)

Open Space	Devoll Field	246					
	Duggan Field	156					
	Galvin Athletic Fields (upper a..	3,068					
	Fallon Field (behind baseball ..	186					
	Memorial Field	826					
	Dedham Street Fields (Crawfo..	16,619					
	Total	**21,101**					
Street/Traffic Lights	Street Lights	483,080					
	Traffic Signals/Lights	117,475					
	Total	**600,555**					
Vehicle	Municipal and School Vehicles				47,862	47,939	
	Total				**47,862**	**47,939**	
Water/Sewer	Edward Sullivan Water Treat..	873,032	4,978				
	Pump stations and water	455,112					
	James Moran Water Treatme..	488,960	1,946				
	Total	**1,817,104**	**6,924**				
Grand Total		**7,350,500**	**244,886**	**8,882**	**47,862**	**47,939**	**1,676**

Table 3b. Baseline in MMBTUs

		2016						
		Diesel	Electric	Gas	Gasoline	Oil	Propane	Total
Building	Lt Peter M Hansen ES		1,104	3,253				**4,357**
	Wm H Galvin MS		2,410	2,633				**5,043**
	John F Kennedy ES		939	2,499				**3,439**
	Canton HS		6,013	6,048				**12,061**
	Dean S Luce ES		1,069	3,396				**4,466**
	Rodman School Adminiatrativ..		749	1,913				**2,662**
	Memorial (Town) Hall		621	388				**1,008**
	Senior Center		185	599				**783**
	Police Headquarters		912	899				**1,812**
	Butch Pasquarosa Public Wor..		212					**212**
	Pequitside Main House		42					**42**
	Aquatic Center Bath House		43					**43**
	Gridley Center/School		16	112				**127**
	Messenger Field House		1					**1**
	Ponkapoag Field House		0					**0**
	William Armando Recreation ..		86					**86**
	Public Works Garage		149	777				**926**
	Fire Station Headquarters - St..		561			807		**1,369**
	Public Library		1,289	959				**2,248**
	Ponkapoag Fire Station - Fire ..		184			427		**611**
	Pequitside Carriage House		23					**23**
	Ponkapoag School		9					**9**
	Water/Sewer Storage						111	**111**
	Parks and Recreation Garage		48					**48**
	Cemetery Office/Garage		17				42	**59**
	North Street Garage		58	320				**378**
	Yard waste and recycling facili..		19					**19**
	Total		**16,759**	**23,796**		**1,235**	**153**	**41,942**

Table 3b. MMBTUs (Continued)

Open Space	Devoll Field		1					1
	Duggan Field		1					1
	Galvin Athletic Fields (upper a..		10					10
	Fallon Field (behind baseball ..		1					1
	Memorial Field		3					3
	Dedham Street Fields (Crawfo..		57					57
	Total		72					72
Street/Traffic Lights	Street Lights		1,648					1,648
	Traffic Signals/Lights		401					401
	Total		2,049					2,049
Vehicle	Municipal and School Vehicles	6,664			5,935			12,598
	Total	6,664			5,935			12,598
Water/Sewer	Edward Sullivan Water Treat..		2,979	498				3,477
	Pump stations and water		1,553					1,553
	James Moran Water Treatme..		1,668	195				1,863
	Total		6,200	692				6,892
Grand Total		6,664	25,080	24,489	5,935	1,235	153	63,554

VII. Appendix B: Building Energy Audits – Guardian Energy

[Please see attached report]

VIII. Appendix C: Vehicle Calculations

Policies that Affect Fleet Gas and Diesel Usage

Anti-Idling Policy**		
Non-Police FY 2016 Gas Usage (Gallons)	23,457	
Percent Savings	10%	Idling vehicles contribute significantly to air pollution and waste fuel, increasing fleet management costs. Municipalities across the commonwealth and the nation have seen significant cost and greenhouse gas emission reductions since implementing Town-wide "no idling" policies for municipal vehicles.*
Gallons Gasoline Saved per Year	2,346	
MMBTUs Saved per Year	**283**	
Closely Monitor Tire Air Pressure and Use Fuel Efficient Tires		
All FY 2016 Gasoline Usage (Gallons)	47,862	
All FY 2016 Diesel Usage (Gallons)	47,939	
Percent Savings	4%	Maintaining appropriate air pressure in vehicle tires can decrease that vehicles fuel consumption by as much as 4%.*
Gallons Gasoline Saved per Year	1,914	
Gallons Diesel Saved per Year	1,918	
MMBTUs Saved per Year	**504**	
Use 100% Synthetic Oil		
Percent Savings	2%	The use of 100% synthetic oils reduces fuel consumption, the number of annual oil change and labor costs.*
Gallons Gasoline Saved per Year	957	
Gallons Diesel Saved per Year	959	
MMBTUs Saved per Year	**252**	
Total MMBTUs Saved	**1,039**	
*http://www.fueleconomy.gov/feg/pdfs/OwnerRelatedFuelEconomyImprovements.pdf		
**Applies to all gasoline-using cars other than Police.		

IX. Appendix D: Behavior-Based Energy Savings

School Behavior-Based Savings Program

A School Behavior-Based Energy Use Reduction Program will allow Canton communities to not only better understand the inefficiencies in their school building operations, but will also help them implement programs that will work synergistically with their existing investments in energy infrastructure in school buildings. Further, this program can support or expand school curriculum by using "buildings as a teaching tool" for students.

While behavior-based energy reduction strategies have been difficult to measure or evaluate in the past, this is no longer the case. The Acton-Boxborough School District has been recognized by both DOER and the U.S. Department of Education as a national leader in implementing behavior-based energy programs that result in significant measured energy savings. Moreover, schools with established behavior-based energy programs have reduced their energy use by 20 to 37% as a direct result to the behavior-based initiatives.

More information can be found in the Powering Down report the US Green Building Council's Center for Green Schools at http://centerforgreenschools.org/sites/default/files/resource-files/Behavior-based-Efficiency.pdf.

In 2016, four MAPC communities (Hamilton, Wenham, Salem and Swampscott), hired a consultant to oversee the implementation of a behavior-based energy reduction program in one school in each school district. The programs used a faculty lead to work with students that developed programs to ensure everyday energy savings – such as lights being turned off – as well as larger weekly savings, such as powering down all applicable electronics by end of day Friday. The programs also connected students to the facilities staff. In this way, students became an extension of the facilities staff to help monitor issues and check up on set points, etc.

Hiring a consultant is not necessary, but is highly recommended for the first year of implementation. Based on MAPC's program with the four schools above, MAPC

would recommend budgeting about $15,000 to $20,000 for a consultant. Also, each school would want to set aside about $500 to $1000 per year to pay for materials the students may need to implement their behavioral awareness programs.

For Canton, MAPC assumed a conservative 5% savings per year for electricity in five schools.

School	kWh Electricity FY 2016	MMBTU Electricity FY 2016	Reduction from Program	MMBTU Saved Electricity (Annual)	kWh Saved Electricity (Annual)	Cost Savings Electricity (Annual)
Canton High School	1,762,181	6,008	5%	300.41	88,109	$17,622
Galvin Middle School	706,441	2,409	5%	120.43	35,322	$7,064
Luce Elementary School	313,402	1,069	5%	53.43	15,670	$3,134
Kennedy Elementary School	275,304	939	5%	46.93	13,765	$2,753
Hansen Elementary School	323,596	1,103	5%	55.17	16,180	$3,236
Total	**3,380,924**	**11,527**	**5%**	**576**	**169,046**	**$33,809**

Building Operator Certification

The Building Operator Certification suggests that based on evaluated programs, the certification will have an average savings of 2.5% of kWh and therms, which translates to:

- 122,162 kWh per year (417 MMBTU)
- 5,947 therms per year (595 MMBTU)

This adds to **1,012 MMBTUs** per year. The cost of the program is $1,695 for the first person, and $1,395 for each additional person, plus $285 for the certification exam. Assuming that one school staff person and one municipal staff person are certified, the total cost will be $3,660.

Source: http://www.theboc.info/wp-content/uploads/2017/02/BOC-Energy-Savings-FAQ-2.0-web.pdf

X. Appendix E: Streetlight Savings Calculations

LED Retrofit Energy Savings					
Existing Type	**Nominal Wattage**	**Quantity**	**Replacement LED Wattage**	**Annual Savings (kWh)**	**Annual Savings (MMBTU)**
Roadway					
HPS Rdw	50	1,962	34	246,781	841
HPS Rdw	100	9	54	2,859	10
HPS Rdw	150	36	54	18,026	61
MV Rdw	100	2	54	877	3
Total				**268,543**	**916**

XI. Appendix F: MMBTU Conversion Chart – DOER

MMBTU Conversion Chart[6]

Fuel Energy Content of Common Fossil Fuels per DOE/EIA

BTU Content of Common Energy Units – (1 million BTU equals 1 MMBTU)

- 1 kilowatt hour of electricity = 0.003412 MMBTU
- 1 therm = 0.1 MMBTU
- 1 ccf (100 cubic foot) of natural gas = 0.1028 MMBTU (based on U.S. consumption, 2007)
- 1 gallon of heating oil = 0.139 MMBTU
- 1 gallon of propane = 0.091 MMBTU
- 1 cord of wood = 20 MMBTU
- 1 gallon of gasoline = 0.124 MMBTU (based on U.S. consumption, 2007)
- 1 gallon of E100 ethanol = 0.084 MMBTU
- 1 gallon of E85 ethanol = 0.095 MMBTU
- 1 gallon of diesel fuel = 0.139 MMBTU
- 1 gallon of B100 biodiesel = 0.129 MMBTU
- 1 gallon of B20 biodiesel = 0.136 MMBTU[7]
- 1 gallon of B10 biodiesel = 0.137 MMBTU[7]
- 1 gallon of B5 biodiesel = 0.138 MMBTU[7]
- 1 barrel of residual fuel oil = 6.287 MMBTU

[6] If a conversion factor for a fuel you use is not provided, please contact DOER.

[7] Calculated Values from those of diesel and B100 biodiesel