Town of Norton, Massachusetts

Energy Reduction Plan

Prepared by the Southeastern Regional Planning and Economic Development District (SRPEDD) with support from the Town of Norton

In Fulfillment of the
Massachusetts Green Communities Grant Program
Criterion #3

December 2020

Table of Contents

I. Purpose and Acknowledgements

A. Letter from the General Government Verifying Adoption of the Energy Reduction Plan

Town of Norton

70 East Main Street

Norton, MA 02766

December 30, 2020

To Whom It May Concern,

As the Chief Executive Officer for the Town of Norton, please be advised that the of Town of Norton has adopted the Energy Reduction Plan for Criterion 3 as part of the Town's Green Communities Application for Designation.

Sincerely,

Michael Yunits

Town Manger

B. Letter from the School District Verifying Adoption/Approval of the Energy Reduction Plan

NORTON PUBLIC SCHOOLS

Joseph F. Baeta, Ed.D.
Superintendent of Schools

RE: Adopt the Energy Reduction Plan

December 22, 2020

To Whom It May Concern:

Please be advised that the Norton Public Schools of Norton, MA has adopted the Energy Reduction Plan as part of the town's Green Communities Application for Designation.

Sincerely,

Joseph F. Baeta, Ed.D
Superintendent of Schools

Cc: Matt Wells, School Business Manager
Wade Lizotte, Director of Facilities
Norton School Committee

C. List of Contributors

The collaborative efforts of the offices of Norton Town Manager Michael Yunits, Director of Planning and Economic Development Paul DiGiuseppe, and MA Department of Energy Resources Green Community Regional Coordinator Lisa Sullivan were all vital in the production this Plan.

Much of the information in this Plan was derived from energy audits performed by Energy Source, led by Christopher Collins. Additional technical assistance was provided by the Southeastern Regional Planning and Economic Development District (SRPEDD), the author of this Plan.

II. Executive Summary

A. Narrative Summary of the Town

The Town of Norton is in southeastern Massachusetts in northern Bristol County. It is located 30 miles south of Boston and 18 miles north of Providence, Rhode Island. The town has an approximate area of 29 square miles and is bordered by Mansfield on the north; Easton on the east; Taunton and Rehoboth on the south; and Attleboro and North Attleborough on the west. According to the 2010 U.S. Census, Norton had a population of 19,031, having experienced a 5.5% increase in population since 2000.

Norton was originally part of Taunton's North Purchase along with other surrounding towns. It incorporated as its own community in 1711. The town's earliest settlers consisted of iron workers who mined and forged bog iron and farmers. Other early industries in Norton included gristmills and lumbering. In the nineteenth century textile mills and jewelry manufacturing flourished. Norton remained a relatively pastoral community well into the 20th century. The construction of Interstate 495 in the latter half of the twentieth century attracted new industrial development near the highway and led to a dramatic increase in residential development. Between 1960 and 2000, the town's population almost tripled.

Despite the town's considerable increase in development over the past half century, the town has worked hard to inventory and protect its cultural, historical, and natural resources for its current and future residents.

B. Summary of Municipal Energy Uses

- Total Number of Municipal Buildings: 13
- Total Number of Municipal Vehicles: 92
- Total Number of Street Lights: 561
- Total Number of Traffic Lights: 4
- Water & Sewer: 6 drinking water pumping stations and 12 wastewater pumping stations. The town's drinking water treatment plant was not included in the baseline as it was just constructed within the past year. The regional wastewater treatment Norton shares with Foxborough and Mansfield was also not included in the baseline as it is a regional entity and not under the full control of the town.

Table 1: Municipal Energy Use Summary

	Number	Ownership
Buildings	**13**	
Natural Gas Heat	11	Municipality
Propane Heat	1	Municipality
Electricity	1	Municipality
Vehicles	**92**	
Non-Exempt	14	Municipality
Exempt	78	Municipality
Street Lights	**561**	Municipality
Traffic Lights	**4**	Municipality
Water & Sewer	**18**	Municipality
Drinking Water Pumping Stations	6	Municipality
Wastewater Pumping Station	12	Municipality

C. Summary of Energy Use Baseline and Plans for Reductions

This Energy Reduction Plan commits Norton to reduce energy use in municipal facilities by at least 20% compared to Fiscal Year 2019 over five years. In the baseline year, the town used 63,359 MMBTUs of energy, which means the town must reduce usage by at least 12,672 MMBTUs over the following five-year period.

Figure 1: Municipal Energy Use Baseline Dashboard from MEI (FY2019)

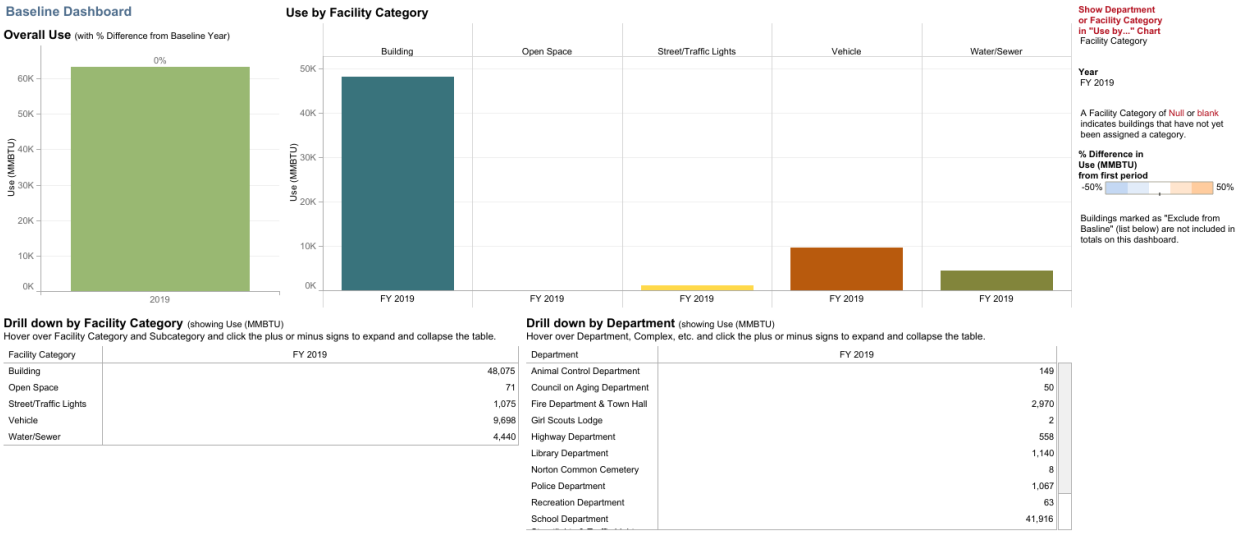


Table 2: Summary of Municipal Energy Use and Reductions

Facility Category	MMBTu in Baseline Year	% of Total MMBTu Baseline Energy Consumption	Projected Planned MMBTu Savings	Savings as % of Total MMBTu Bas
Buildings	48,075	75.9%	9,269	14.6%
Vehicles	9,698	15.3%	0	0.0%
Street/Traffic Lights	1,075	1.7%	591	0.9%
Water/Sewer/Pumping	4,440	7.0%	0	0.0%
Open Space	71	0.1%	0	0.0%
Total	**63,359**	**100%**	**9,860**	**15.5%**

III. Energy Use Baseline Inventory

A. Identification of the Inventory Tool Used: The Town of Norton used the Department of Energy Resources (DOER) MassEnergyInsight (MEI) web-based energy inventory and analysis tool.

B. Identification of the Baseline Year: Fiscal Year (FY) 2019 will serve as the baseline year. FY2019 ran from July 1, 2018 to June 30, 2019. This will give the Town until June 30, 2024 (FY2020 - FY2024) to reach its 20% energy reduction goal.

C. Municipal Energy Consumption for the Baseline Year (FY2019): In the baseline year, the town used 63,359 MMBTUs of energy. Tables 3a and 3b in the Appendix presents energy use for each municipal facility in MMBTUs and native units.

- Buildings: Norton's 13 buildings use 48,075 MMBTUs, approximately 75.9% of Norton's total municipal energy use. The buildings with the largest energy use are Norton High School (13,067 MMBTUs) and Norton Middle School (10,922 MMBTUs), as shown in Figure 2.

- Street/Traffic Lights: There are 561 streetlights and 4 traffic lights in Norton. These lights consume 1,075 MMBTUs, 1.7% of the Town's energy use.

- Vehicles: Norton's 92 municipal vehicles use 15.3% of the baseline total, or 9,698 MMBTUs.

- Water/Sewer Facilities: The Town of Norton is serviced for water and wastewater by Town's Water/Sewer Department. Water/Sewer facilities consume 4,440 MMBTUs, or 7.0% of the town's energy use.

Figure 2: MEIs Buildings to Target Dashboard

In Figure 2 below, the points further to the right have a higher energy use per square foot (i.e. less energy efficient), while the points higher up use more total energy. Norton High School, for example, uses the most energy of any building in Norton.

IV. Energy Reduction Plan

A. Narrative Summary

As shown below, the town has identified energy savings measures to reduce usage from FY2019 by 9,860 MMBTUs or 15.5%. These measures are included in Table 4: Energy Conservation Measures, located in Appendix C. It is important to note that the schedule below can be modified to accommodate the changing goals and priorities of the community and that projects outside the scope of this Energy Reduction Plan may be eligible for grant funding if they are in a building that is listed in this Plan.

1. Overview of Plan Goals Years 1-3:

- Town Hall/Fire Department
  - Weatherization Improvements
  - RTU Scheduling
- Animal Control Shelter & Kennels
  - Weatherization Improvements
- DPW Garage
  - Weatherization Improvements
- Police Department
  - Weatherization Improvements
  - RTU Scheduling
- Senior Center
  - Weatherization Improvements
  - Interior Lighting
- Public Library
  - Weatherization Improvements
- J.C. Solmonese Elementary School
  - Weatherization Improvements
  - Retrocommissioning*
- L.G. Nourse Elementary School
  - Weatherization Improvements
  - Retrocommissioning
- Henri A. Yelle Elementary School
  - Weatherization Improvements
  - Steam Trap Replacement
  - Retrocommissioning
- Noton Middle School
  - Weatherization Improvements

    - Retrocommissioning

- Norton High School
    - Weatherization Improvements
    - Exterior Lighting
    - Retrocommissioning

- Historical Society
    - Interior Lighting

- Wetherall Fire Station
    - Interior Lighting

- Building Operator Certification (BOC)**

2. Overview of Plan Goals Years 4-5:

- Town Hall/Fire Department
    - Hot Water Boiler Replacement
    - Retrocommissioning

- Police Deaprtment
    - Retrocommissioning

- J.C. Solmonese Elementary School
    - Installation of Digital Combustion Controls

- L.G. Nourse Elementary School
    - Installation of Digital Combustion Controls

- Noton Middle School
    - Hot Water Boiler Replacement
    - Installation of Digital Combustion Controls

- Fire Station H.Q.
    - Installation of Infrared Heaters

- Edith Reed Conservation Area
    - Exterior Lighting

Retrocommissioning: Provides an understanding of how closely a building comes to operating as intended. It helps to identify improper equipment performance, what equipment or systems need to be replaced, opportunities for saving energy and money, and strategies for improving performance of the various building systems.[1]

Building Operator Certification: The Town intends to have a staff person attend the Building Operator Certification (BOC) Program. Energy-savings evaluations show that an individual Certified Building Operator (CBO) can reduce energy use by more than one (1) percent of a building's building electricity demand.[2] *By certifying operators in building systems efficiency, the town will realize savings in energy use and related costs, improvements in comfort and safety, and may continue to experience these benefits for up to five (5) years following certification (based on program estimates)*[3]*.*

B. Path to 20% Energy Use Reduction by the end of Fiscal Year 2024

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

The Town Manager's Office, in collaboration with 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 Manager's Office will be responsible for the annual reporting requirements to maintain designation and eligibility for annual competitive grant funding.

2. General Vehicle Fuel Economy

Norton will assess opportunities for general fuel economy to help reduce fuel consumption without any additional cost or investment. According to the U.S. Department of Energy (DOE) website at fueleconomy.gov, no-cost measures include:

- Drive sensibly: Avoid aggressive driving (e.g., rapid acceleration/ braking) to reduce vehicle fuel use by five (5) to thirty-three (33) percent.
- Remove excess weight: Avoid storing unnecessary items in your vehicle. An extra 100 pounds could reduce mpg by up to two (2) percent, especially in smaller vehicles.
- Keep engine tuned: Fixing a vehicle that is out of tune or has failed an emissions test can improve gas mileage by an average of four (4) percent.
- Keep tires inflated: Improve gas mileage by up to 3.3 percent by inflating to proper pressure.
- Use recommended grade of oil. Improve gas mileage by one (1) to two (2) percent by using manufacturer's recommended grade of motor oil.

3. IdleRight Technology

Norton will assess the benefits of installing IdleRight devices in its police cruisers. The IdleRight system monitors vehicle batteries' conditions and automatically turns vehicles on to idle only when necessary. While idling at an emergency or construction scene, a typical police cruiser uses about 0.9 gallon of gasoline per hour. That same vehicle equipped with the IdleRight system uses only about 1/10th of a gallon of gasoline per hour- and never jeopardizes the charge in the battery needed for startup. The cost of implementing the IdleRight equipment is approximately $750 per vehicle. (IdleRight technology is available from Havis, Inc. and is described more completely at www.havis.com/idleright.htm).

[1] https://www.energystar.gov/sites/default/files/buildings/tools/EPA_BUM_CH5_RetroComm.pdf

[2] Energy Savings for the Building Operator Certification (BOC®) Program. http://www.theboc.info/wp-content/uploads/2017/02/BOC-EnergySavings-FAQ-2.0-web.pdf

[3] Building Operator Certification Program: https://www.theboc.info/certifications/

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

1. Municipal Buildings (including schools)

To better strategize for the long-term maintenance and management of municipal buildings, Norton will work with school and town staff as well as outside consultants, when necessary, to assess and document the condition of major municipal buildings on an annual basis. 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 after five years, and the Town will seek to explore even more efficient policies and tracking systems to enable more efficiency.

3. Perpetuating Energy Efficiency

Ongoing dialogue with Town and School staff can tap into the knowledge of the employees who use and maintain the buildings every day. It can 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. The use of a web-based application system like See Click Fix creates additional real-time opportunities for efficiencies in operation and maintenance.

The Town of Norton will grow its capacity to retrofit and build more efficient facilities, purchase more efficient vehicles, and illuminate the Town through more efficient lighting throughout the 5-year period. These practices will become more 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

Appendix A: Table 3A & 3B. Municipal Energy Consumption for Baseline Year

Appendix B: Table 4. Energy Conservation Measures

Appendix C: Building Energy Audits – Energy Conservation Inc. (ECI) Audits & MAPC Streetlight Audit

Appendix A: Table 3A & 3B. Municipal Energy Consumption for Baseline Year

ERP Guidance Table 3b - Municipal Energy Consumption for 2019 (MMBTU)

Please make sure that any data submitted to DOER contains complete Data!

		2019					
		Diesel	Electric	Gas	Gasoline	Propane	Total
Building	Animal Shelter		28			120	**149**
	Henri A. Yelle Elementary Sch..		1,313	8,874			**10,187**
	J.C. Solmonese Elementary S..		1,293	2,777			**4,070**
	L.G. Nourse Elementary School		547	3,022			**3,569**
	L.G. & Mildred Balfour M..		361	778			**1,140**
	Norton High School		5,576	7,491			**13,067**
	Norton Middle School		2,856	8,066			**10,922**
	Council on Aging		50				**50**
	Police Station		718	316			**1,035**
	Fire Station-Headquarters & T..		1,105	1,715			**2,821**
	DPW Garage			547			**547**
	Fire Station-Chartley		34	116			**150**
	School Shed		30	71			**100**
	Police Firing Shed		33				**33**
	Salt Shed		11				**11**
	Water Department Office		100				**100**
	Water Department Office-Wes..		123				**123**
	Radio Shed			0			**0**
	Girl Scout Lodge		2				**2**
	Total		**14,182**	**33,773**		**120**	**48,075**
Open Space	Norton Common Cemetery		8				**8**
	Everett Leonard Park		63				**63**
	Girl Scout Lodge Pool		0				**0**
	Total		**71**				**71**
Street/Traffic Lights	Streetlights		1,071				**1,071**
	Traffic Lights		4				**4**
	Total		**1,075**				**1,075**
Vehicle	Vehicles	2,890			6,807		**9,698**
	Total	**2,890**			**6,807**		**9,698**
Water/Sewer	Sewer Lift Station-Rumford R..		28				**28**
	Sewer Lift Station-Reservoir S..		275				**275**
	Pumping Station #4		945				**945**
	Pumping Station #5		533				**533**
	Pumping Station #6		823				**823**
	Water Tank		74				**74**
	Center Water Tank		22				**22**
	Sewer Lift Station-Kingsley Ro..		80	1			**81**
	Sewer Lift Station-Holly Road		18				**18**
	Pumping Station #3		622				**622**
	Sewer Lift Station-Bay Road		123				**123**
	Sewer Lift Station-Island Road		31	6			**37**
	Sewer Pump Station-Fillmore ..		84				**84**

ERP Guidance Table 3b - Municipal Energy Consumption for 2019 (MMBTU)

Please make sure that any data submitted to DOER contains complete Data!

		2019					
		Diesel	Electric	Gas	Gasoline	Propane	Total
Water/Sewer	Pumping Station #1		478				**478**
	Sewer Lift Station-157 Mansfi..		10				**10**
	Water Pumping Station-Cotta..		183				**183**
	Sewer Lift Station-Mansfield A..		3				**3**
	Sewer Lift Station-Red Mill Vill..		55				**55**
	Sewer Lift Station-Codding Ro..			6			**6**
	Sewer Line Meter		0				**0**
	Sewer Department Generator			41			**41**
	Total		**4,385**	**54**			**4,440**
Grand Total		**2,890**	**19,713**	**33,827**	**6,807**	**120**	**63,359**

ERP Guidance Table 3a - Municipal Energy Consumption for 2019 (Native Fuel Units)

		2019				
		Electric (kWh)	Gas (therms)	Gasoline (gallons)	Diesel (gallons)	Propane (gallons)
Building	Animal Shelter	8,347				1,324
	Henri A. Yelle Elementary Sch..	384,787	88,742			
	J.C. Solmonese Elementary S..	379,079	27,769			
	L.G. Nourse Elementary School	160,364	30,220			
	L.G. & Mildred Balfour M..	105,840	7,784			
	Norton High School	1,634,292	74,906			
	Norton Middle School	837,139	80,660			
	Council on Aging	14,750				
	Police Station	210,560	3,163			
	Fire Station-Headquarters & T..	324,000	17,152			
	DPW Garage		5,471			
	Fire Station-Chartley	9,999	1,155			
	School Shed	8,707	705			
	Police Firing Shed	9,546				
	Salt Shed	3,215				
	Water Department Office	29,236				
	Water Department Office-Wes..	36,024				
	Radio Shed		1			
	Girl Scout Lodge	546				
	Total	**4,156,431**	**337,728**			**1,324**
Open Space	Norton Common Cemetery	2,302				
	Everett Leonard Park	18,560				
	Girl Scout Lodge Pool	3				
	Total	**20,865**				
Street/Traffic Lights	Streetlights	313,863				
	Traffic Lights	1,300				
	Total	**315,163**				
Vehicle	Vehicles			54,898	20,794	
	Total			**54,898**	**20,794**	
Water/Sewer	Sewer Lift Station-Rumford R..	8,113				
	Sewer Lift Station-Reservoir S..	80,500				
	Pumping Station #4	277,010				
	Pumping Station #5	156,107				
	Pumping Station #6	241,126				
	Water Tank	21,700				
	Center Water Tank	6,494				
	Sewer Lift Station-Kingsley Ro..	23,504	11			
	Sewer Lift Station-Holly Road	5,172				
	Pumping Station #3	182,194				
	Sewer Lift Station-Bay Road	35,946				
	Sewer Lift Station-Island Road	9,035	63			
	Sewer Pump Station-Fillmore ..	24,707				

ERP Guidance Table 3a - Municipal Energy Consumption for 2019 (Native Fuel Units)

		2019				
		Electric (kWh)	Gas (therms)	Gasoline (gallons)	Diesel (gallons)	Propane (gallons)
Water/Sewer	Pumping Station #1	140,080				
	Sewer Lift Station-157 Mansfi..	2,937				
	Water Pumping Station-Cotta..	53,561				
	Sewer Lift Station-Mansfield A..	793				
	Sewer Lift Station-Red Mill Vill..	16,222				
	Sewer Lift Station-Codding Ro..		60			
	Sewer Line Meter	0				
	Sewer Department Generator		410			
	Total	**1,285,201**	**544**			
Grand Total		**5,777,660**	**338,272**	**54,898**	**20,794**	**1,324**

Appendix B: Table 4. Energy Conservation Measures

Criterion 3 Step 4: Complete Table 4 - ECMs

Click here to view a sample version of this table

Table 4
Energy Conservation Measures Data

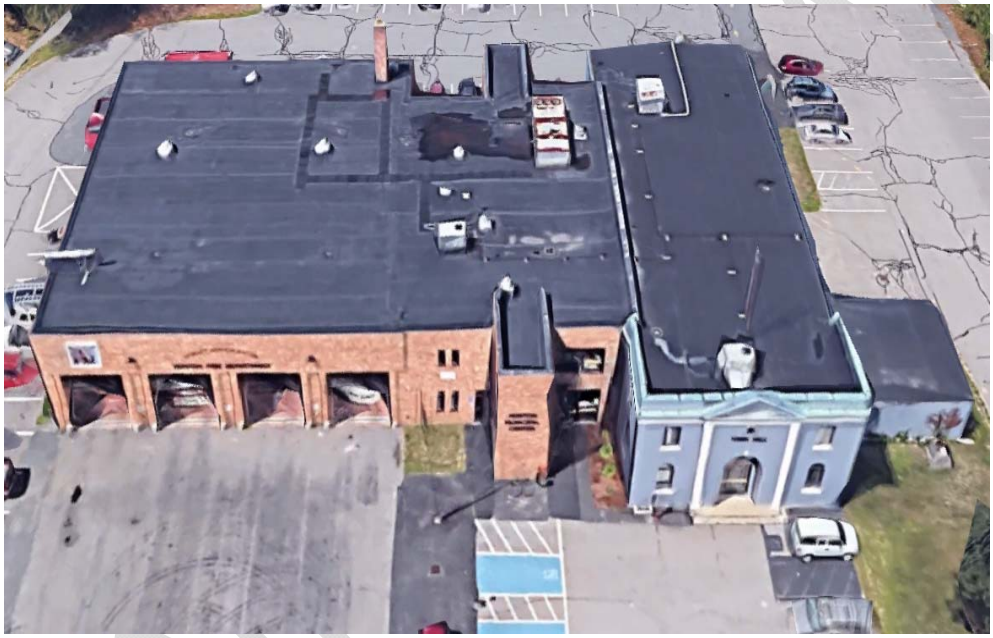
ECMs			Status		Energy Data						Financial Data					Reference Data	
Building/Site Name	Energy Conservation Measure Name	ECM Type (select one from drop-down)	Status (select one from drop-down)	Status Date (Completed with month/year or planned month/year)	Projected Annual Electricity Savings (kWh)	Projected Annual Natural Gas Savings (therms)	Projected Annual Oil Savings (gallons)	Projected Annual Propane Savings (gallons)	Projected Annual Gasoline Savings (gallons)	Projected Annual Diesel Savings (gallons)	Projected Annual Cost Savings ($)	Total Installed Cost ($)	Green Community Grant ($)	Utility Incentives ($)	Net Cost ($)	Funding Source(s) for Net Costs	Source for Projected Savings
Town Hall/Fire Department	Weatherization	Weatherization	Planned		1,272	1,905					$2,159	$33,973		$0	$33,973		*Energy Conservation, Inc.*
Town Hall/Fire Department	RTU Scheduling	HVAC	Planned		6,480	103					$826	$4,500		$300	$4,200		*Energy Conservation, Inc.*
Town Hall/Fire Department	Hot Water Boiler Replacement	Hot Water	Planned			590					$649	$75,900		$4,000	$71,900		*Energy Conservation, Inc.*
Town Hall/Fire Department	Retrocommissioning	Retrocommission	Planned		29,160	1,544											*www.energystar.gov*
Town Hall/Fire Department	Building Operater Certification (BOC)	Behav & Training	Planned		3,240	172											*www.theboc.info*
Animal Control Shelter	Weatherization	Weatherization	Planned		174			324			$767	$13,165		$0	$13,165		*Energy Conservation, Inc.*
Animal Control Kennels	Weatherization	Weatherization	Planned		43			107			$252	$16,123		$0	$16,123		*Energy Conservation, Inc.*
DPW Garage	Weatherization	Weatherization	Planned		335	711					$842	$14,712		$0	$14,712		*Energy Conservation, Inc.*
Police Department	Weatherization	Weatherization	Planned		1,066	1,512					$2,053	$30,342		$0	$30,342		*Energy Conservation, Inc.*
Police Department	RTU Scheduling	HVAC	Planned		8,422	190					$1,135	$7,880		$500	$7,380		*Energy Conservation, Inc.*
Police Department	Retrocommissioning	Retrocommission	Planned		18,950	285											*www.energystar.gov*
Police Department	Building Operater Certification (BOC)	Behav & Training	Planned		2,106	32											*www.theboc.info*
Senior Center	Weatherization	Weatherization	Planned		331	576					$634	$11,676		$0	$11,676		*Energy Conservation, Inc.*
Senior Center	Lighting	Interior Lighting	Planned		3,393						$646	$13,535		$2,890	$10,645		*Energy Conservation, Inc.*
Public Library	Weatherization	Weatherization	Planned		2,040	4,558					$5,122	$93,510		$0	$93,510		*Energy Conservation, Inc.*
J.C. Solmonese Elementary School	Weatherization	Weatherization	Planned		2,382	4,731					$4,999	$71,235		$0	$71,235		*Energy Conservation, Inc.*
J.C. Solmonese Elementary School	Digital Combustion Controls	Building Control	Planned		2,081	1,944					$2,471	$59,000		$0	$59,000		*Energy Conservation, Inc.*
J.C. Solmonese Elementary School	Retrocommissioning	Retrocommission	Planned		34,117	2,499											*www.energystar.gov*
J.C. Solmonese Elementary School	Building Operater Certification (BOC)	Behav & Training	Planned		3,791	278											*www.theboc.info*
L.G. Nourse Elementary School	Weatherization	Weatherization	Planned		507	1,029					$1,092	$15,817		$0	$15,817		*Energy Conservation, Inc.*
L.G. Nourse Elementary School	Digital Combustion Controls	Building Control	Planned		2,567	2,115					$2,738	$59,000		$0	$59,000		*Energy Conservation, Inc.*
L.G. Nourse Elementary School	Retrocommissioning	Retrocommission	Planned		14,433	2,720											*www.energystar.gov*
L.G. Nourse Elementary School	Building Operater Certification (BOC)	Behav & Training	Planned		1,604	302											*www.theboc.info*
Henri A. Yelle Elementary School	Weatherization	Weatherization	Planned		913	1,994					$2,005	$33,647		$0	$33,647		*Energy Conservation, Inc.*
Henri A. Yelle Elementary School	Steam Traps	Other	Planned			6,885					$7,573	$12,000		$6,000	$6,000		*Energy Conservation, Inc.*
Henri A. Yelle Elementary School	Retrocommissioning	Retrocommission	Planned		34,631	7,987											*www.energystar.gov*
Henri A. Yelle Elementary School	Building Operater Certification (BOC)	Behav & Training	Planned		3,848	887											*www.theboc.info*
Norton Middle School	Weatherization	Weatherization	Planned		2,081	4,331					$4,412	$56,580					*Energy Conservation, Inc.*
Norton Middle School	Hot Water Boiler Replacement	Hot Water	Planned			4,163					$4,579	$217,900		$15,000	$202,900		*Energy Conservation, Inc.*
Norton Middle School	Digital Combustion Controls	Building Control	Planned		3,238	4,517					$5,487	$70,000		$0	$70,000		*Energy Conservation, Inc.*
Norton Middle School	Retrocommissioning	Retrocommission	Planned		75,343	7,259											*www.energystar.gov*
Norton Middle School	Building Operater Certification (BOC)	Behav & Training	Planned		8,371	807											*www.theboc.info*
Norton High School	Weatherization	Weatherization	Planned		439	793					$789	$13,247		$0	$13,247		*Energy Conservation, Inc.*
Norton High School	Lighting	Exterior Lighting	Complete		16,070						$2,732	$19,839		$1,840	$17,999		*Energy Conservation, Inc.*
Norton High School	Lighting	Exterior Lighting	Planned		13,184						$2,254	$17,463		$1,200	$16,263		*Energy Conservation, Inc.*
Norton High School	Retrocommissioning	Retrocommission	Planned		147,086	6,742											*www.energystar.gov*
Norton High School	Building Operater Certification (BOC)	Behav & Training	Planned		16,343	749											*www.theboc.info*
Norton Fire Station HQ	Install Infrared Heaters	HVAC	Planned			1,372					$1,509	$52,300		$2,250	$50,050		*Energy Conservation, Inc.*
Edith Reed Conservation	Lighting	Exterior Lighting	Planned		355						$111	$4,346		$980	$3,366		*Energy Conservation, Inc.*
Historical Society	Lighting	Interior Lighting	Planned		7,994						$1,457	$6,746		$195	$6,551		*Energy Conservation, Inc.*
Wetherall Fire Station	Lighting	Interior Lighting	Planned		861						$209	$5,865		$1,010	$4,855		*Energy Conservation, Inc.*
Townwide	LED Streetlights	Exterior Lighting	Complete		173,367							$168,062		$38,466	$129,596		*Metropolitan Area Planning Council*
			TOTAL Projected Savings		**642,618**	**76,282**	**0**	**431**	**0**	**0**	**59,502**	**1,198,363**	**0**	**74,631**	**1,067,152**		
TOTAL MMBtu SAVINGS			**9,860**		**2192.612616**	**7628.2**	**0**	**39.221**	**0**	**0**							

Appendix C: Building Energy Audits – Energy Conservation Inc. (ECI) Audits & MAPC Streetlight Audit

Energy Conservation, Inc.
P.O. Box 726
Hanson, MA 02341
Telephone: 781-447-4474
ECI-NE.com

Town of Norton

Building Envelope Inspection Report



December 10, 2020

BUILDING ENCLOSURE RETROCOMMISSIONING

Retrofits to lower your maintenance, decrease operational costs, and increase comfort

PROPOSAL SYNOPSIS

TARGET: TO MAKE YOUR BUILDINGS PERFORM THE WAY THEY WERE DESIGNED – OR SHOULD HAVE BEEN.

- To eliminate drafts – to increase comfort, decrease complaints, and make people happier where they work
- Specifically, to warm up staff and visitors within the town buildings
- To decrease drafts and hot/cold spots; to improve humidity control and indoor air quality
- In particular, to improve occupant (student, teacher and staff) comfort within the school buildings
- To eliminate moisture sources that can lead to long-term damage and expensive repairs

The scientific understanding of how Energy Conservations and insulation impact building performance has increased dramatically in recent years. Yet, most people still do not know that many of their discomforts and maintenance headaches are due to a leaky building enclosure, a missing Energy Conservation, or poor insulation. When evaluating building envelope projects, they think first about saving energy and decreasing utility bills. But the real payoff is beyond energy. Uncontrolled airflow alters humidity and makes temperature control difficult, if not impossible. People are uncomfortable, and building components can be damaged, e.g., premature roof failure and rotting floor joists. It can lead to ice dams, as well as mold and mildew. Odors, noise, insects, and other pests also can pass through the gaps, cracks, and holes that most of us never notice. Each defect may be small, but they can add up to leaving a barn door open 24 hours a day, 7 days a week, 365 days a year.

Since 2006, Energy Conservation, Inc. has followed a systems approach to air sealing and insulation. We look from basement to rooftop for the keys to the puzzle of building performance and leave nothing on the table. We use cutting-edge testing technologies – e.g., ASTM E1186 infrared, tracer smoke, ultrasound, and hot-wire anemometer, and ASTM E779 multi-fan tests. Our officers bring 30+ years' experience to you and your project. Key staff sit on the ASTM E committee that sets the standards for testing, co-chair the Energy Conservation Association of America existing buildings committee, and were founding director of the Building Performance Institute (BPI). Our standard work specifications and proprietary quality assurance system helps us be on time, on budget, and defect-free. You will barely know we're there, other than experiencing the improvements in your building.

Standard operating procedure addresses the symptoms, not the cause. Ceiling tile and framing damage, odors, and discomfort will stop if the outside air and moisture can't come in - without expensive HVAC upgrades. Our scope will fix the root causes, and as a bonus, save on energy bills and decrease operational and maintenance costs.

FINANCIAL: The project is budgeted at $336,688.69, not including bond and/or QA/QC Our proposal is firm-fixed-price, with no change orders unless there is a mutually agreed scope change. Our work often qualifies for utility rebates or incentives. We can provide needed information to you and the utility. Unlike other capital improvements, fixing these defects will decrease utility and maintenance costs, paying for the work over time, freeing up funds for other budget items.

STATUS: Energy Conservation, Inc. has inspected the building(s) and is submitting a proposed scope of work to ECI-NE to be submitted to Norton, MA representatives, as part of the Green Communities Program. Upon receipt of a signed contract, we will order specialty materials, prepare the Quality Assurance Manuals, and arrange the work to fit your schedule.

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Town of Norton, Norton, MA

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PROJECT INFORMATION

Facilities Information			
Project:	**Town of Norton Norton, MA**		
Facilities:	**Town Hall & Fire Department Animal Control Shelter DPW Garage Police Department Senior Center Public Library J.C. Solmonese Elementary School L.G. Nourse Elementary School Henri A. Yelle Elementary School Norton Middle School Norton High School**		
Utility Information			
Heating Fuel(s):	**Natural Gas Propane**	**Cost:**	**$0.9280 - $1.2665/therm $2.30/gallon**
Other Energy:	**Electricity**	**Cost:**	**$0.1205 - $0.1526/kWh**
Inspection Information			
Inspector Name(s):	**Charley Casey**		
Inspection Date:	**October 22, 2020 - October 26, 2020**		

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Energy Conservation, Inc. Contact Information

Inquiries:	**Chris Collins** **Energy Conservation, Inc.** **P.O. Box 726** **Hanson, MA 02341** **617-504-6718** **Chris@ECI-NE.com**

EXECUTIVE SUMMARY

Inspection Performed

Building envelope inspections were performed on eleven (11) buildings located in Norton, MA. The facilities inspected are listed on the Project Information page. The inspector used infrared imagery, air flow measurement devices and smoke tracer tests in accordance with ASTM E-1186 to identify the location and severity of air leakage paths. Other inspection tools that may have been used include blower doors and duct blasters per ASTM E-779. Micro leakage detectors may have been used per ASTM E783. When necessary ultrasound detection is used per ASTM E-1186.

These air leakage paths are detailed in the scope of work. Areas inspected include roof-wall joints, elevation changes, soffit areas, roofs, walls, windows, doors, and other penetrations.

While it is never economically feasible to address all the penetrations in a building envelope, our work scope addresses the equivalent of a **119.88 square foot** hole, in total, across the buildings studied. The work can be done at a reasonable cost and will have a significant impact on future energy consumption and carbon emissions. In addition to energy impacts, the Significant Issues section outlines other benefits from the work.

Significant Issues

Repairing the Energy Conservations and/or insulation will help solve several significant problems that the client experiences. Below are some examples at specific sites, as well as some general issues that our inspector(s) encountered.

Senior Center (Ref #5)

The program Director, Beth, stated “there are major comfort issues here: specifically, there are cold and colder areas throughout the building. Often, the staff and seniors are freezing in here during the fall and winter seasons!”

Our inspection noted that there is no effective Energy Conservation between the conditioned spaces and attic, or between the sloped shed roof and conditioned offices and storage areas along the southwest elevation. There is merely R-19 batt insulation fitted into the ceiling joist framing above the suspended ceilings. There are a significant number of air leakage paths (e.g., framing chases, duct, pipe, light fixture, and conduit penetrations) that contribute to these uncomfortable conditions. Furthermore, due to the limited storage area in the conditioned space, the attic area is used for a variety of stored office items/equipment and houses some HVAC equipment. To establish and align

effective air and thermal barriers and bring the attic area “into the building envelope”, our scope of work proposes the underside of the roof deck and gable walls be air-sealed and insulated with 2-component, closed-cell, polyurethane spray foam and an intumescent barrier.

This will significantly improve occupant comfort and indoor air quality! Additionally, bringing the attic area into the building envelope will improve the energy performance of the HVAC equipment and eliminate damage to the stored office equipment and supplies; as they will not be subject to extremely high and low temperatures or excessive humidity and moisture levels. The structural integrity of the framing components and adjoining finished surfaces (i.e., on walls, ceilings, and floors) will be substantially improved as well, reducing maintenance, repair, and replacement costs.

Our scope of work also proposes installing an effective Energy Conservation along the underside of the insulated sloped “shed” roof section. Similarly, this will considerably improve the thermal performance of the preexisting batt insulation, structural integrity of the roof, wall, and ceiling systems, and will further improve occupant comfort in that section.

Public Library (Ref #7)

During our inspection, we noted that nearly half of the building has no effective Energy Conservation between the conditioned areas and large attic. The library Director noted that this was “intentional…after the fact,” with the intended goal to allow conditioned (heated) air to bypass the insulation at the attic floor, tempering the large attic area, and preventing the wet sprinkler system’s piping from freezing and bursting!

This model creates huge energy/heat losses, occupant comfort, indoor air quality (IAQ), and structural integrity penalties (attributed to ongoing moisture and outdoor pollutant intrusion and condensation on building framing components). Currently, we are recommending the Town convert the wet sprinkler system (within the attic) to a “dry” system, which would allow an effective Energy Conservation to be installed across the huge existing void in the barrier (approximately 54% of the total square footage) between the conditioned areas and large, vaulted, unconditioned attic space.

After further consultation between our inspectors, we believe we have an alternative strategy that will allow the wet system to remain. Our inspector will re-visit the site to gather the needed information for this alternative scope. We have left the original scope in as a place holder since the report deadline was before we could have our inspector re-visit the site.

J.C. Solmonese Elementary School (Ref #9)

The facilities director and head custodian both stated, “there are considerable comfort issues (i.e., hot and cold areas) throughout the building, and it is very cold near many of the building entrances, due to significant drafts.”

Our inspection identified construction framing details at several of the building entries. The exterior walls have large, 4’ H, openings at the top of the walls. These openings are across the width of the entries, 10’ – 12’ W, and are wide open to the leaky/vented canopies and outside. Overall, that represents approximately 260 square feet of openings in the exterior walls! Air-sealing and insulating these openings will have a huge impact on occupant comfort, IAQ, and the building’s energy performance. Along with installing new, effective weatherstrip on the exterior door systems, these measures will alleviate the drafts and “cold spots” that are creating occupant comfort complaints.

During our inspection, testing also indicates the roof-wall junctures are leaky. The proposed scope of work includes air-sealing the roof-wall junctures using 2-component, closed-cell, polyurethane spray foam. Sealing these junctures throughout the building will considerably tighten the building envelope. As a result, occupants would experience a reduction in drafts and moisture/outdoor pollutant infiltration and improvement in occupant comfort and IAQ. The structural integrity of the roof, wall, and ceiling framing systems and the adjoining finished surfaces would be improved, as well, resulting in fewer maintenance repairs and replacement costs.

Overall, the work we are proposing (repairing the Energy Conservations and insulation at the building entries and establishing a tight and effective building envelope) will address the comfort and IAQ problems. Weatherstripping the door systems and air-sealing the roof-wall junctures will stop air movement through gaps and cracks into the lobbies, hallways, classrooms, and offices. Stopping this air movement will even-out the temperatures in the building, and everyone will be more comfortable.

General Issues

Beyond these specific problem areas, we identified several significant building enclosure problems at many of the sites we inspected. The key leakage areas are:

- Exterior, roof-access, mechanical room, and overhead door systems
- Window systems
- Roof-wall joints

- Openings in exterior walls that connect to soffits/canopies
- Roof fans that connect the unconditioned mechanical rooms and outdoors directly to the conditioned spaces within the building envelopes
- Construction details causing voids in (or missing) Energy Conservations, between conditioned and unconditioned areas

The defects we found range from missing or defective Energy Conservations and insulation to misalignment of the building's thermal and Energy Conservations. The flaws are a result of a combination of design issues, poor construction implementation, and deterioration of materials over time.

Because of these, the buildings do not perform to their full potential. Addressing the deficiencies will reduce operational and maintenance costs; improve the comfort and indoor air quality of the building occupants; extend building component life by blocking the entry of moisture, which causes deterioration; mitigate noise, odor, and pest problems; and reduce energy usage.

"By Others"

We also identified a few problems that do not fall into one of our core competencies. We are mentioning them to bring them to the staff's attention, as they should be addressed.

These include:

All Sites

Reducing the heating and cooling loads should help the central HVAC system's performance, but we highly recommend that a full evaluation of the HVAC systems be performed (**by others**). Part of that evaluation should be to balance the systems after air-sealing retrofits are performed.

Senior Center (Ref #5)

The (bump-out) boiler room is only accessible via the exterior door. This door shows significant signs of age-deterioration along framing components. We highly recommend having the door replaced (**by others**) with a new Energy Star rated exterior door system.

Public Library (Ref #7)

As noted in the Significant Issues section (above), we recommend having the "wet" sprinkler system be replaced (**by others**) with a "dry" system. This will allow an effective Energy Conservation to be installed between the conditioned areas on the main floor and unconditioned attic area, improving the overall energy performance of the building and alleviating the occupant comfort and IAQ complaints.

Henri A. Yelle Elementary School (Ref #11)

During our inspection, we noted ceiling and/or wall sections with evidence of water intrusion. The custodial staffs noted there are some roof leaks within those areas, causing the water damage to the ceiling and wall systems and surfaces. We highly recommend having roof system inspections performed (**by others**) to identify the failing sections and develop plans to repair these roof sections, as needed.

Norton Middle School (Ref #12)

During our inspection, the custodian noted water intrusion through the entry doors at the east elevation of the A-Wing, causing water damage to the entry wall systems and surfaces and the door thresholds and framing, as well as causing condensation build-up on the tile floor within the entry hall. The staff representative noted a failure with the drains and poor grading (sloped toward the doors) as a root cause. We highly recommend having a comprehensive inspection performed on the drainage system (**by others**) to identify the failing components and develop plans to repair these systems, as needed.

Concerns and Future Work

Senior Center (Ref #5)

The work detailed below that initially included in our scope, but it was dropped due to high percentage baseline savings estimates. If comfort issues persist after the other retrofit measures are performed, the following would be advisable:

Roof Decks: Air-Seal and Insulate

The wood-framed sloped roof decks on the main section and rear bumpout lack insulation. There is no effective Energy Conservation between the conditioned spaces and attic areas, merely suspended ceilings with R-19 batt insulation fitted within the ceiling joist framing (10” above the suspended ceilings). The AHUs and the duct distribution system are in the main attic. A large portion of the main attic is used for storage. There are partially floored (for storage items) and open-beam sections, with a significant amount of framing chases, top plates, and penetrations, many of which are not easily accessible (if at all). To effectively tighten the building envelope and establish and align effective air and thermal barriers, the underside of the sloped roof decks and exposed gable walls (of the main and rear bump-out sections) should be air-sealed and insulated with 2-component, closed-cell, polyurethane spray foam and an intumescent barrier, bringing the attic areas (and the HVAC equipment) into the building envelope. Five (5) inches should be applied to the roof decks and three (3) inches should be applied to the three exposed gable walls.

The absence of effective air and thermal barriers in these two sections are considerable sources to the major occupant comfort and indoor air quality (IAQ) issues (noted by the Director and staff) and the deterioration of the stored files, office equipment, etc. stored in the attic.

The maximum working headroom height is 4’ at the bump-out and 7’ at the peak of the main attic, with a working headroom height of approximately 2’ along the eaves. Access to the main attic area is via a drop-stair. Access to the deck and gable wall in the rear bump-out is through the suspended ceiling. Each of the three gable walls have vents that need to be air-sealed as prep for insulating the walls. The eaves (soffits) are not vented. Air-seal and insulate the underside of the roof decks and gable walls, per the QAS manual and floor plan.

- In the main attic, insulate the underside of the sloped wood roof deck with 5” of 2-component, closed-cell, polyurethane spray foam insulation, **total 1,850 SF/9,350 BF**

- In the main attic, air-seal the two gable vents and insulate the two exposed gable walls with 3” of 2-component, closed-cell, polyurethane spray foam insulation, **total 297 SF/890 BF**

- In the rear (bump-out) attic, insulate the underside of the sloped wood roof deck with 5” of 2-component, closed-cell, polyurethane spray foam insulation, **total 216 SF/1,080 BF**

- In the rear (bump-out) attic, air-seal the gable vent and insulate the exposed gable wall with 3” of 2-component, closed-cell, polyurethane spray foam insulation, **total 27 SF/81 BF**

- Cover all installed spray foam at roof decks and gable walls using an intumescent paint at 14 mil wet film, **total 2,390 SF**

Doors

Right: Town Hall – tracer smoke testing along an exterior door. Note the smoke being blown back into the building, indicating the door system is very leaky, due to failing, deteriorated weatherstrip. Each of the exterior doors need to have new, effective weatherstrip installed.

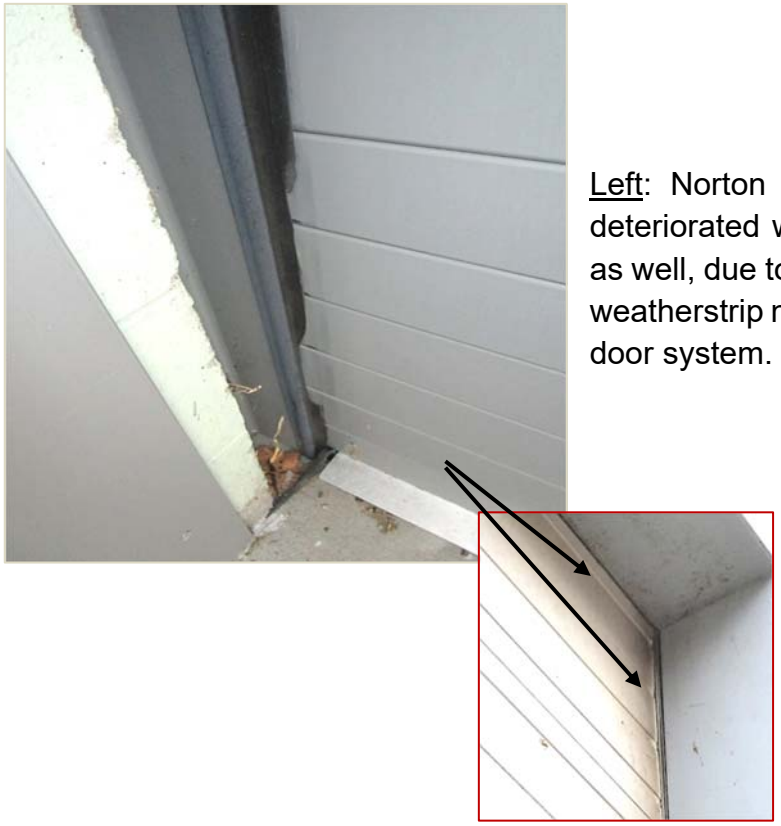
Left: High School – tracer smoke test being performed on exterior door system. The smoke being blown back into the building along the bottom of the door indicates the sweep weatherstrip is failing, allowing significant air, moisture, insect, and pollutant infiltration through the building envelope. The leakage along all sides of each exterior door is one source of the drafts and cold spots cited in occupant complaints. New weatherstrip needs to be installed.

Right: Nourse E.S. – note the smoke being blown back into the building. The weatherstrip on the exterior doors is failing, allowing infiltration and significant air, moisture, insect, and pollutant infiltration through the building envelope during heating season! The leakage along all sides of each exterior door is one source of the drafts and cold spots cited in occupant complaints. New weatherstrip needs to be installed to help alleviate heat losses and significant air and moisture Stopping the infiltration will help alleviate the deterioration of the doors and framing. This will make the lobby areas and hallways warmer, occupants more

comfortable, and improve the overall energy performance of the building.

Overhead Doors

Right: Nourse E.S. – photo shows large gaps along the perimeter of the sectional overhead door. Note the daylight between the door and frame/weatherstrip! The failing/deteriorated weatherstrip needs to be replaced with new, effective, and durable weatherstrip.



Left: Norton H.S. – photo shows the considerably deteriorated weatherstrip, with a large gap at the top as well, due to missing weatherstrip. New, appropriate weatherstrip needs to be installed along all sides of the door system.

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Right: Highway Dept – testing of the overhead doors in the heated high bay indicates a huge amount of air leakage, attributed to the lack of any effective weatherstrip on the door systems! Appropriate weatherstrip needs to be installed on each of the overhead doors within the heated high bay section to tighten the air leakage pathway through the building envelope, which will greatly improve the working environment for its occupants.

Windows

Right: Highway Dept. – the hopper and casement-type windows tested leaky along the sashes, attributed to the failure of the old, deteriorated weatherstrip. New, appropriate weatherstrip needs to be installed on each of the windows. Many of the windows also tested leaky along the framing and need to be air-sealed along the frame-wall junctures.

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Left: Library – each of the windows tested leaky along the frame-wall junctures, attributed to missing sealants. These junctures need to be air-sealed on all sides using non-foam sealants.

Right: Town Hall & Fire – most of the windows tested leaky along the sashes and glazing. The casement and awning windows need new, appropriate weatherstrip installed. Most of the units also need to be wet glazed, some along the interior and many along the exterior using non-foam sealants.

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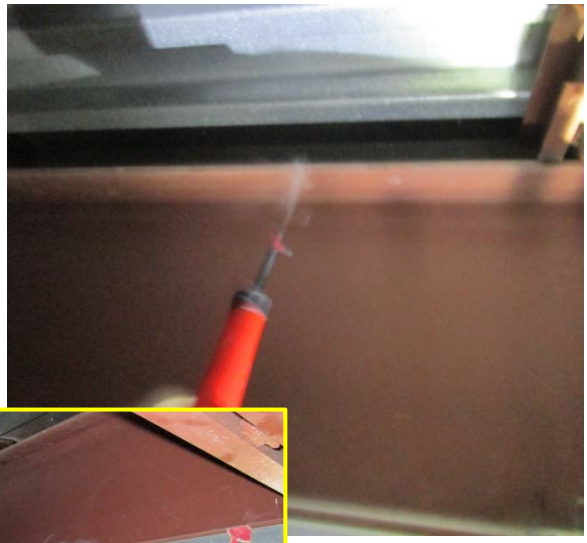
Roof-wall

Right: Town Hall & Fire – testing indicates the roof-wall junctures are leaky throughout the additions. These junctures need to be air-sealed using 2-component, closed-cell, polyurethane spray foam.



Left: Police Dept. – tracer smoke testing indicates the roof-wall junctures are very leaky. Additionally, the upper walls have batt insulation, but they lack an effective Energy Conservation, (insert); the roof-wall junctures need to be sealed with spray foam and the open framing needs to have an effective Energy Conservation material, (e.g.: rigid board insulation, with all seams sealed with 2-component, closed-cell polyurethane spray foam).

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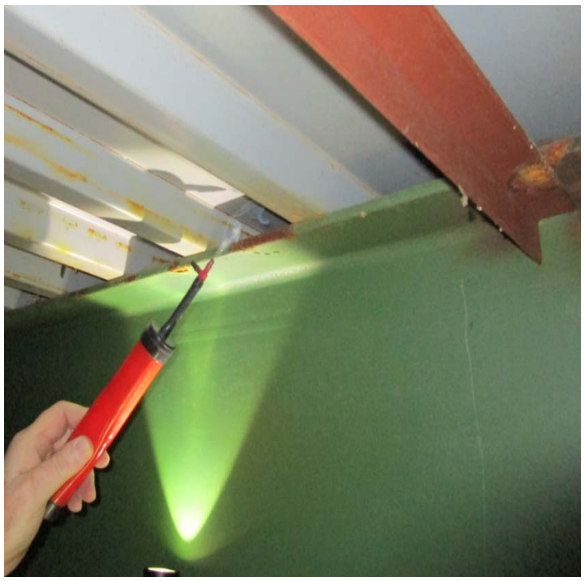

Right: Solmonese E.S. – tracer smoke testing indicates the roof-wall junctures are considerably leaky throughout both the one-story and two-story sections. Note the smoke being pulled through the junctures to the outdoors, i.e., ongoing heat loss along the entire perimeter of the school! These junctures need to be effectively air-sealed using 2-component, closed-cell, polyurethane spray foam.

Soffits

Right: Nourse E.S. – photo shows large openings in the upper walls (above the main entry), allowing for ongoing air leakage in/out of the building envelope directly to the outside; passing through the soffit/canopy. The large opening needs to be air-sealed and insulated to establish effective and aligned air and thermal barriers along the large building entry.

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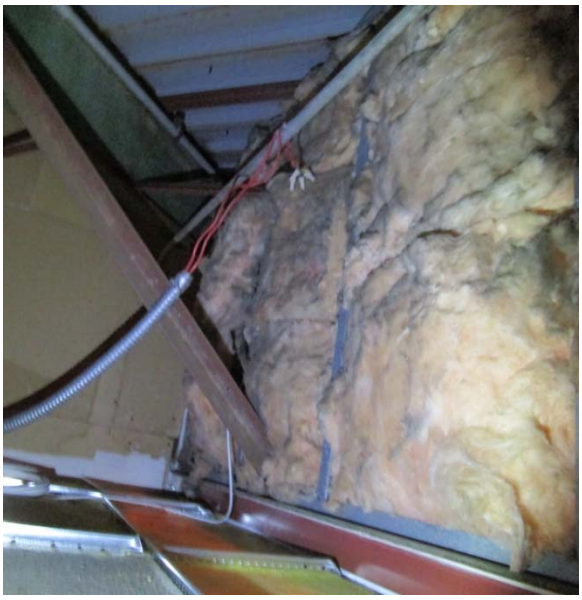
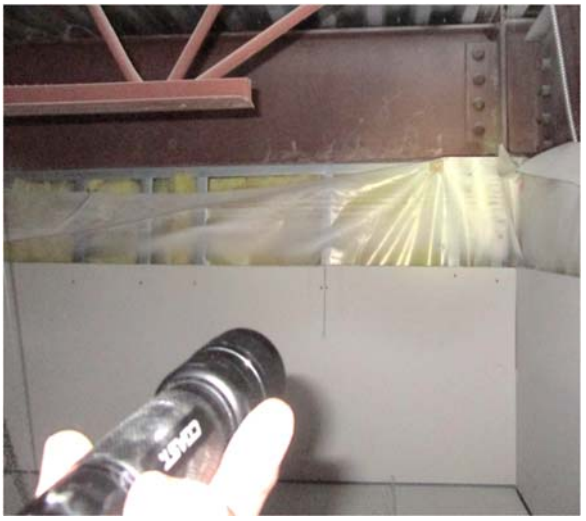


Left: Solmonese E.S. – photo shows deteriorated batt insulation "fitted" within the large opening in the exterior wall; 4' H across the 12' W entry door system. The ongoing air leakage in/out of the building bypasses this insulation, allowing considerable heat loss (heating season) and tremendous heat, moisture, and insects to enter the building through these opening(s) during the spring/summer seasons. These large openings represent approximately 260 square feet of voids in the exterior walls and building envelope! The openings need to be air-sealed and insulated.

Energy Conservations

Right: Police Dept. – throughout the upper level of the two-story section, there are 6" and 2' H voids in the Energy Conservation that need to have an effective Energy Conservation installed to assure a continuous and aligned air and thermal barrier along the top of the building envelope.



Right: Library – Across approximately 55% of the conditioned area of the main floor, there is no effective Energy Conservation in place between the conditioned spaces and attic area. In these sections, there is merely batt insulation fitted into the joist framing above the suspended ceilings. This was reported to be intentional, to temper the attic and keep the "wet" sprinkler piping from freezing. We recommend replacing the wet system with a "dry" system (in the attic) and having an effective Energy Conservation installed, affixed to the bottom of the joist framing.

Roof Deck: Spray

Left: Senior Center – the Energy Conservation between the conditioned spaces and attic is very leaky, with many framing chases, bypasses, and duct, pipe, top plate penetrations. Many of these are not accessible to air-seal. The attic houses HVAC equipment and the duct distribution system, and it is also used for storage of office supplies and equipment. To establish and align effective air and thermal barriers, the underside of the roof deck and the gable walls should be sealed and insulated with 2-component, closed-cell, polyurethane spray foam.

Attic: Air-seal and Insulate

Right: Animal Control – there are several (accessible) framing chases, top plates, pipe, conduit, and exhaust fan penetrations that allow communication between the conditioned spaces below and attic, causing poor comfort and energy performance. To tighten the building envelope and establish and align effective air and thermal barriers, these air leakage paths need to be effectively air-sealed, and 6" of cellulose insulation should be installed over these R-19 batts at the attic floor.

Rooftop Fans

Left: Town Hall & Fire – photo shows examples of the rooftop fans at the roof decks. The tops of the large, framed chases and frame-to-curb framing are leaky, allowing communication between the conditioned spaces below, mechanical rooms, and directly with the outdoors. This is leading to poor energy performance, poor occupant comfort and IAQ, and ongoing moisture intrusion into the building systems (e.g., roof, wall, and ceiling framing and the adjoining finished surfaces), causing deterioration of these building components. These air leakage pathways need to be air-sealed.

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Right: Solmonese E.S. – an example of the rooftop fans on the roof of the school. The framing along the chases and the frame-to-curb junctures need to be effectively air-sealed to tighten the building envelope, improving occupant comfort & IAQ, and improve the building's overall energy performance.

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Pricing

The total price of building envelope work scoped in this document is **$404,026.43** with estimated annual **savings of $25,125.86,** resulting in a combined **payback of 16.08** years **and a reduction of 2.99%** from the baseline energy consumption. Tables by building, and a summary tab, are provided in the savings calculation spreadsheets, as well as below. Similarly, unit savings by fuel unit and carbon emissions are provided in the spreadsheets and table below.

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Cost and Savings by Building/Site

Reference #	Building Name	Estimated Costs	Estimated Annual Savings	Simple Payback
	Heating			
1	Town Hall & Fire Department		$ 1,995.18	
2	Animal Control Shelter		$ 744.91	
2K	Animal Control - Kennels		$ 246.04	
3	DPW Garage		$ 798.73	
4	Police Department		$ 1,914.55	
5	Senior Center		$ 583.06	
6	Fire Department - w Town Hall			
7	Public Library		$ 4,844.00	
8	Water & Sewer Department - Drop			
9	J.C. Solmonese E.S.		$ 4,672.89	
10	L.G. Nourse Elementary School		$ 1,017.39	
11	Henri A. Yelle E.S.		$ 1,874.35	
12	Norton Middle School		$ 4,154.65	
13	Norton High School		$ 736.21	
	Cooling			
1	Town Hall & Fire Department		$ 164.08	
2	Animal Control Shelter		$ 22.20	
2K	Animal Control - Kennels		$ 5.45	
3	DPW Garage		$ 43.18	
4	Police Department		$ 138.43	
5	Senior Center		$ 50.58	
6	Fire Department - w Town Hall			
7	Public Library		$ 278.20	
8	Water & Sewer Department - Drop			
9	J.C. Solmonese E.S.		$ 326.38	
10	L.G. Nourse Elementary School		$ 74.63	
11	Henri A. Yelle E.S.		$ 130.81	
12	Norton Middle School		$ 257.08	
13	Norton High School		$ 52.89	
	Combined			
1	Town Hall & Fire Department	$ 33,972.99	$ 2,159.26	15.73
2	Animal Control Shelter	$ 13,164.56	$ 767.11	17.16
2K	Animal Control - Kennels	$ 16,122.79	$ 251.50	64.11
3	DPW Garage	$ 14,711.90	$ 841.91	17.47
4	Police Department	$ 30,342.05	$ 2,052.98	14.78
5	Senior Center	$ 11,675.82	$ 633.63	18.43
6	Fire Department - w Town Hall			
7	Public Library	$ 93,509.89	$ 5,122.20	18.26
8	Water & Sewer Department - Drop			
9	J.C. Solmonese E.S.	$ 71,235.08	$ 4,999.26	14.25
10	L.G. Nourse Elementary School	$ 15,817.14	$ 1,092.02	14.48
11	Henri A. Yelle E.S.	$ 33,646.89	$ 2,005.16	16.78
12	Norton Middle School	$ 56,580.12	$ 4,411.73	12.82
13	Norton High School	$ 13,247.21	$ 789.11	16.79
	Total	$ 404,026.43	$ 25,125.86	16.08

Summary Hole Size =	119.88	Square Feet
Facilities' Total Square Footage =	519,075	Square Feet

Pricing Assumptions and Terms

Energy Conservation, Inc. has conditioned its proposal on the following assumptions and terms. If wage, tax, insurance, or other requirements are different than these assumptions, a pricing adjustment may be needed.

- Pricing is good for 60 days from the date of this proposal.
- We priced labor using prevailing wages, specifically the Massachusetts State prevailing wage for the Town of Norton; Laborer – Laborers Zone 2 classification.
- We are not charging sales tax. A tax-exempt or resale certificate will be required before mobilization.
- No fire-rated foam, intumescent coating, or other fire-rated material is required, except where indicated in the work scope. If the local jurisdiction calls for such measures in other areas, pricing will need to be adjusted to cover the additional cost.
- Site access will allow (4) ten-hour shifts/week. If (5) eight-hour shifts are required, pricing will increase by 12%.
- Measurements and counts are approximate.
- Payment & performance bond is not included in the price above. If one is required, the price will increase by 3.09%. On bonded projects, any change orders will also incur the 3.09% bonding price.

Intellectual Property

All information, including, but not limited to, report language and format, shall remain CONFIDENTIAL AND PROPRIETARY to Energy Conservation, Inc. unless the Company grants prior written permission. Information may be shared, without written permission, with the organization(s), agency(s), municipality(s), etc. that would fund measures in the Detailed Scope of Work section.

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All Plans and Specifications and copies thereof furnished by or purchased are property of Energy Conservation, Inc. and are not to be used on other work. Except for one complete set, Client must return all documents upon contract completion. NO PORTION OF THIS DOCUMENT SHALL BE SHARED WITH ANY PARTY OTHER THAN THE CLIENT FOR WHICH IT IS PREPARED WITHOUT EXPRESS WRITTEN PERMISSION FROM ENERGY CONSERVATION, INC. This includes any direct or indirect reference to the scope, materials, or methodologies outlined in this report. Again, this **excludes** the organization(s), agency(s), municipality(s), etc. that would fund measures in the Detailed Scope of Work section.

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Energy Savings and Carbon Footprint

The proposed scope of work will decrease operational and maintenance costs, as well as utility bills. The table below outlines the energy savings that drive the utility savings. If a site uses two types of fuel for heating, there will be an entry for Heating Fuel Type 1 and Type 2. If there is only one heating fuel, Heating Fuel Type 2 will be blank. The table reports total carbon equivalent emission savings across all fuels. Carbon savings are derived from the USEPA Greenhouse Gas Equivalencies Calculator and its Calculations and References page. Values were also compared to the U.S. Energy Information Administration for the most recent year available.

Ref #	Building Name	Heating Fuel Type 1	Savings	Unit	Heating Fuel Type 2	Savings	Unit	Cooling Fuel Type	Savings	Unit	CO2e Savings (lbs)
1	Town Hall & Fire Department	Natural Gas	1,904.52	Therms	N/A	N/A	N/A	Electricity	1,271.09	kWh	24,316.65
2	Animal Control Shelter	Propane	323.87	Gallons	N/A	N/A	N/A	Electricity	173.54	kWh	4,283.96
2K	Animal Control - Kennels	Propane	106.98	Gallons	N/A	N/A	N/A	Electricity	42.61	kWh	1,391.47
3	DPW Garage	Natural Gas	711.39	Therms	N/A	N/A	N/A	Electricity	334.53	kWh	8,858.46
4	Police Department	Natural Gas	1,511.66	Therms	N/A	N/A	N/A	Electricity	1,065.74	kWh	19,391.63
5	Senior Center	Natural Gas	575.58	Therms	N/A	N/A	N/A	Electricity	331.46	kWh	7,264.56
6	Fire Department - w Town Hall	0	#DIV/0!	0	N/A	N/A	N/A	0	#N/A	0	-
7	Public Library	Natural Gas	4,557.51	Therms	N/A	N/A	N/A	Electricity	2,039.78	kWh	56,586.53

8	Water & Sewer Department - Drop	0	#DIV/0!	0	N/A	N/A	N/A	0	#N/A	0	-
9	J.C. Solmonese E.S.	Natural Gas	4,730.68	Therms	N/A	N/A	N/A	Electricity	2,381.71	kWh	59,159.69
10	L.G. Nourse Elementary School	Natural Gas	1,028.94	Therms	N/A	N/A	N/A	Electricity	506.64	kWh	12,849.23
11	Henri A. Yelle E.S.	Natural Gas	1,993.53	Therms	N/A	N/A	N/A	Electricity	912.88	kWh	24,784.96
12	Norton Middle School	Natural Gas	4,331.20	Therms	N/A	N/A	N/A	Electricity	2,081.09	kWh	54,004.80
13	Norton High School	Natural Gas	793.33	Therms	N/A	N/A	N/A	Electricity	439.00	kWh	9,984.31

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Modeling Assumptions: High Baseline Savings Percentage

Police Department (Ref #4)

A high percentage of baseline savings (44.86%) is estimated at the Police Department. We believe there may be missing baseline utility data that would explain this high percentage. The energy intensity index (EII), or Btus/square foot/heating degree day, is a 3.8, which is low compared to figures we're accustomed to seeing; usually around 10.0. For your consideration, were the Police Department's EII 10.0, the percent of baseline savings would be a more reasonable 17.08%.

Public Library (Ref #7)

The scope in the proposal is a placeholder until our inspector can re-visit the site and gather data for an alternate scope that will allow the wet sprinkler system to remain in place, without danger of freezing. The percentage of baseline savings at this building is very high. Because we plan to propose an alternate scope, we did not fully fit test this information. The alternate scope will have a lower percentage of savings and a lower cost.

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Town Hall & Police Station (Ref #1)

The Town Hall was initially built in 1910. In 1978, the adjoining two-story and high bay sections were constructed. The structure has steel and wood framing, brick/masonry wall systems, and both metal and concrete flat (insulated) roof systems with rubber membrane surfaces. It is in fair-to-good condition, with some building systems showing signs of age deterioration. However, the building is fairly well-maintained by staff, overall. The building envelope is moderately leaky, partly due to failing weatherstrip, failing/missing sealants, and construction framing details along the additions. The five (5) sectional-type glass overhead doors are to be replaced (**by Facilities Dept.**) by the end of the year.

Doors

The exterior and boiler room doors in the building are leaky and need to be weatherstripped; the boiler room doors should have appropriate fire-rated materials installed. The doors in the building are brown and grey. Mill-finished and brown door kits will be fine. Weatherstrip the doors, per the Quality Assurance System (QAS) manual and floor plan.

- Install new, appropriate weatherstrip on all the nonstandard-sized, 3’6” W x 7’ H, exterior doors, **total 9 doors**
- Install new, appropriate fire-rated weatherstrip on the nonstandard-sized, 3’6” W x 7’ H, boiler room doors, **total 2 doors**

Roof Access Hatch

The roof-access hatch measures 3’6” W x 3’6” L. The three (3) tiers of built-up framing tested leaky, and each of the (1/8” – 1/2") seams/gaps needs to be air-sealed, 4-lines (1 each tier and 1 at top), using appropriate sealants (e.g., backer rod and exterior caulk). Air-seal the built-up framing at the roof-access hatch, 4-lines, per the QAS manual and floor plan.

- At the 3’6” W x 3’6” L roof-access hatch, air-seal the seams/gaps at the three (3) tiers of built-up framing, 4-lines, **total 56 LF/1 hatch**

Windows

There are five (5) window assembly types (WATs). They are metal-framed, insulated single-pane units, with fixed-only, casement-only, and fixed-awning subunit configurations.

The WAT-1 units tested leaky along the casement-type sashes. Each of these units need new (vinyl-bulb) weatherstrip installed, 2-channels, all sides. The exterior seals are deteriorated; they need to be removed and replaced using exterior glazing sealants. There are five (5) WAT-1 units on the first floor and sixteen (16) units on the second. The work on the second floor carries a maximum work height of 20' H. A lift can be used to access these units. Weatherstrip and air-seal the windows, per the QAS manual and floor plan.

- Remove and replace the exterior glazing on the first floor WAT-1 units, **total 55 LF**
- Remove and replace exterior glazing on the second floor WAT-1 units, with a 20' H exterior work height (lift), **total 176 LF**
- Weatherstrip the casement-type sashes on the WAT-1 units, 2 channels, using vinyl-bulb, **total 462 LF**

The exterior seals are deteriorated on the WAT-2 unit. They need to be removed and replaced using exterior glazing sealants. This window is on the second floor, which carries a maximum height of 20' H. A lift can be used to access the window. Air-seal the window, per the QAS manual and floor plan.

- Remove and replace exterior glazing, on the second floor WAT-2 unit at 20' H exterior work height (lift), **total 11 LF**

The WAT-3 and WAT-4 assemblies tested leaky along the awning-type sashes. They need new vinyl-bulb weatherstrip installed, 2-channels, all sides. Additionally, the exterior seals are deteriorated. The exterior sealants need to be removed and replaced using exterior glazing sealants. The four (4) WAT-3 units are on the first floor, and the three (3) WAT-4 units are on the second floor. The maximum working height to the top of the second floor units is 20' H. A lift can be used to access these windows. Weatherstrip and air-seal the windows, per the QAS manual and floor plan.

- Remove and replace exterior glazing on the first floor WAT-3 units, **total 44 LF**

- Remove and replace exterior glazing on the second floor WAT-4 units at a 20' H exterior work height (lift), **total 33 LF**

- Weatherstrip the awning-type sashes on the WAT-3 and WAT-4 units (2 channels, all 4 sides) using vinyl-bulb materials, **total 154 LF**

The WAT-5 assembly is a large, 10' W x 7' H, fixed-only assembly. This tested leaky along the frame-wall junctures, and it needs to be air-sealed, 1-line, using non-foam sealants. Air-seal the window, per the QAS manual and floor plan.

- Air-seal the WAT-5 unit along the frame-wall junctures, 1-line, using non-foam sealants, **total 34 LF**

Roof-Wall

The roof-wall junctures are leaky throughout the addition. The junctures along the metal roof deck need to be air-sealed with 2-component, closed-cell, polyurethane spray foam. All flutes on steel decking must be punched and sealed. Air-seal the roof-wall junctures, per the QAS manual and floor plan.

- At the addition's two-story section, air-seal the roof-wall junctures, punching flutes and sealing framing penetrations, 1-line, at 13' working height, **total 405 LF**

- At the high bay, air-seal the roof-wall junctures, punching flutes and sealing framing penetrations, 1-line, at 24' working height with direct access (lift), **total 176 LF**

- At the stairwells, air-seal the roof-wall junctures, punching flutes and sealing framing penetrations, 1-line, at 24' working height (ladders), **total 94 LF**

Rooftop Fans

There are nine (9) fans on the roof that need to be air-sealed along the chases and framing details. Fans should be serviced annually. Inspect fan for proper operation. Inspect and clean dampers. Air-seal the roof fans, per the QAS manual.

- Inspect and air-seal the rooftop fans, **total 9 roof fans**

Animal Control Shelter (Ref #2)

The Animal Control Shelter was built in 2001. It has wood framing, wood-framed, insulated wall systems with vinyl siding and a sloped wood roof. It is in good condition and well-maintained by staff. The building envelope is quite leaky, partly due to failing weatherstrip as well as construction framing details (e.g., penetrations and chases) along the attic floor, creating voids in the Energy Conservation.

Doors

The exterior doors in the building are leaky and need to be weatherstripped. The boiler room houses sealed combustion equipment, thus no weatherstripping is required. The doors in the building are white. White door kits will be fine. Weatherstrip the doors, per the QAS manual and floor plan.

- Install new, appropriate weatherstrip on all standard-sized exterior doors, **total 3 doors**

Pull-down Stairs

The attic is accessed by pull-down stairs, located in the hallway (noted on floor plan). These stairs need to be (1) weatherstripped, (2) have a dam built/framed along the perimeter of the stair opening that is higher than the surrounding insulation and will hold a person's weight, and (3) have a removeable insulated cover installed (Therma-Dome/insulated cover or fabricated, with a counter-weight). Weatherstrip and insulate the pull-down stairs, per the QAS and floor plan.

- Install a Therma-Dome or custom-fabricated insulated, removeable cover (4" rigid foam board insulation) over the 2'6" W x 4'6" L pull-down stairs, with a counter-weight; weatherstrip the drop-stair frame and build a dam around it that is higher than the surrounding insulation and will hold a person's weight, **total 1 pull-down stair**

Attic: Air-Seal and Insulate

The sloped wood roof deck lacks insulation. There is R-19 batt insulation within the open-beam floor joist framing. The Energy Conservation between the conditioned spaces and attic is fairly leaky, with bath exhaust fan, pipe, light fixture, and conduit penetrations, along with top plates, that need to be air-sealed. Each of the housings on the four (4) bath-type exhaust fans measure approximately. There are 366 lineal feet of top plates to be air-sealed (206 LF interior, 160 LF exterior). Once air-sealing is complete, six (6)

inches of open-blow cellulose should be installed over the existing batt insulation. The maximum working headroom height is 7’ H at the peak and approximately 2’ H along the eaves. Access to the attic is via a drop-stair. Air-seal and insulate the attic floor, per the QAS manual and floor plan.

- Air-seal all interior top plates, **total 206 LF**
- Air-seal all exterior top plates, **total 160 LF**
- Air-seal all 12” W x 12” L bath exhaust fan housing penetrations, **total 4 fan penetrations**
- Air-seal all the pipe, light fixture, and conduit penetrations, **total 1/3 crew day**
- Install 8” of cellulose insulation, open-blow, into the attic floor joist framing, over the existing batt insulation, **total 1,536 SF**

Animal Control – Kennels (Ref #2K)

We have separated the work scope for the insulated kennel door installation due to its long payback that skews the energy savings of other retrofit measures at the Animal Control Shelter.

Dog Pen Guillotine Doors

The existing guillotine-type doors in the dog pens are deteriorated and leaky. The doors should be replaced with new insulated, weathertight, guillotine-type doors. Each of the doors measure 1’10” W x 2’10” H. Replace dog pen doors with new, insulated guillotine-type kennel doors, per the QAS manual and floor plan.

- Install new, weathertight, insulated kennel doors at each dog pen that opens to the outside, **total 12 insulated kennel doors**

DPW Garage (Ref #3)

The DPW Garage, also know as the Highway Department Office/Garage, was built in 1978 with steel and wood framing, CMU/masonry wall systems, and flat, wood roof systems. In 2000, a new rubber membrane surface (with 4" insulation) was installed. The structure is in fair condition (considering age and type-of-use) and fairly well-maintained by staff. The building envelope is moderately leaky, partly attributed to failing and missing weatherstrip and sealants along the exterior doors, overhead doors, and windows. The large (10-bay) section at the northeast side/elevation is completely unheated and merely used for vehicle and equipment storage.

Doors

The exterior doors in the building are leaky and need to be weatherstripped. The doors in the building are brown and grey. Brown, Black, and mill-finished door kits will be fine. Weatherstrip the doors, per the QAS manual and floor plan.

- Install new, appropriate weatherstrip on all the standard-sized exterior doors, **total 8 doors**
- Install new, appropriate weatherstrip on all the nonstandard-sized, 3'6" W x 7' H, exterior door, **total 1 door**

Overhead Doors

There are four (4) sectional-type overhead doors. The doors tested very leaky, lacking effective weatherstrip, and should have new, effective weatherstrip installed. Each of the doors measure 14'6" W x 14' H. Weatherstrip the overhead doors, per the QAS manual and floor plan.

- Weatherstrip the 14'6" W x 14' H sectional-type overhead doors, **total 4 doors**

Windows

There are six (6) window assembly types. The windows are metal-framed and single-pane. There are fixed-only, casement-only, hopper-only, fixed-awning-hopper, and fixed-A/C-casement subunit configurations.

WAT-1 are hopper-only units that tested leaky along the sashes. New vinyl-bulb weatherstrip needs to be installed on each hopper-type sash (1-channel, all sides). Weatherstrip the windows, per the QAS manual and floor plan.

- Weatherstrip the WAT-1 units, 1-channel, using vinyl-bulb materials, **total 66 LF**

The WAT-2 casement units need new weatherstrip installed (vinyl-bulb: 1-channel, all sides) on each casement subunit. These assembies have two casements adjoined. The frame-wall junctures at each unit need to be air-sealed, 1-line, using non-foam sealants. Weatherstrip and air-seal the windows, per the QAS manual and floor plan.

- Weatherstrip the WAT-2 units, 1-channel (all sides), using vinyl-bulb materials, **total 72 LF**

- Air-seal the WAT-2 units at the frame-wall junctures, 1-line, using non-foam sealants, **total 48 LF**

The WAT-3 units have a combination of a fixed (with A/C unit) and casement subunit adjoined. The casement subunits need new, appropriate weatherstrip installed (vinyl-bulb: 1-channel, all sides). These units need to be air-sealed along the frame-wall junctures, 1-line, using non-foam sealants. The fixed subunit and adjoined A/C unit need to be sealed shut along the framing, 1-line, using non-foam sealants. Weatherstrip and air-seal the windows, per the QAS manual and floor plan.

- Weatherstrip the casement subunits within the WAT-3 “combo” units using vinyl-bulb materials, 1-channel (all sides), **total 24 LF**

- Air-seal the WAT-3 units at the frame-wall junctures, 1-line, using non-foam sealants, **total 32 LF**

- On the WAT-3 units, seal the fixed sub-unit and adjoining A/C unit shut along the framing, 1-line, using non-foam sealants, **total 28 LF**

The WAT-4 unit is configured with two fixed sections: an awning and a hopper subunit adjoined. There is a duct passing through the hopper-type subunit at the bottom of the unit. The awning subunit needs cast-in-place (CIP) gasket weathertrip installed. This unit needs to have the frame-wall junctures air-sealed, 1-line, using non-foam sealants. The hopper subunit does not operate, due to the duct. The sash and duct penetration should be sealed shut, 1-line, using non-foam sealants. Weatherstrip and air-seal the window, per the QAS manual and floor plan.

- Within the WAT-4 unit, weatherstrip the awning-type subunit with CIP gasket,

total 14 LF

- Air-seal the WAT-4 unit at the frame-wall junctures, 1-line, using non-foam sealants, **total 23 LF**

- On the WAT-4 unit, seal the sash on the hopper-type sub-unit and duct penetration shut along the framing, 1-line, using non-foam sealants, **total 12 LF**

The WAT-5 unit is configured with two fixed sections: an awning and a hopper subunit adjoined. The awning and hopper subunits need to have CIP gasket weatherstrip installed. This unit needs to have the frame-wall junctures air-sealed, 1-line, using non-foam sealants. Weatherstrip and air-seal the window, per the QAS manual and floor plan.

- Within the WAT-5 unit, weatherstrip the awning and hopper-type subunits with CIP gasket, **total 25 LF**

- Air-seal the WAT-5 unit at the frame-wall junctures, 1-line, using non-foam sealants, **total 23 LF**

The WAT-6 units are fixed sidelights. There are four (4) sidelights adjoining the main entry door to the office section (2 stacked on the left and 2 on the right). The glazing/sealant along the interior of the sidelights is failing and/or missing. Each of the sidelights needs to be wet-glazed, from the interior, using glazing materials. Each sidelight measure 3’ W x 3’6” H. Wet-glaze the “sidelight” units, per the QAS manual and floor plan.

- Wet-glaze the WAT-6 sidelight units, from the interior, using glazing materials, **total 52 LF**

Rooftop Fans

There are two (2) fans on the roof that need to be air-sealed along the chases and framing details. Fans should be serviced annually. Inspect fan for proper operation. Inspect and clean dampers. Air-seal the roof fans, per the QAS manual.

- Inspect and air-seal the rooftop fans, **total 2 roof fans**

Police Department (Ref #4)

The Norton Police Department was built in 1999 with steel and metal framing, metal-stud wall systems with stucco exterior surfaces, and flat metal roof systems. It is in good condition and well-maintained by staff. The window systems (wood, double-pane) tested tight. However, the building envelope is quite leaky, partly due to failing weatherstrip and to missing sealants along construction framing details at the upper levels of the one-story and two-story sections.

Doors

The exterior and boiler room doors in the building are leaky and need to be weatherstripped. The boiler room doors should have appropriate fire-rated materials installed. The doors in the building are blue and white. White and mill-finished door kits will be fine. Weatherstrip the doors, per the QAS manual and floor plan.

- Install new, appropriate weatherstrip on all the standard-sized exterior and roof-access doors, **total 6 doors**
- Install new, appropriate fire-rated weatherstrip on the standard-sized boiler room door, **total 1 door**

Overhead Doors

There are four (4) sectional-type overhead doors. The doors tested leaky and should have new, effective weatherstrip materials installed. Each door measures 9’6” W x 8’ H. Weatherstrip the overhead doors, per the QAS manual and floor plan.

- Weatherstrip the 9’6” W x 8’ H sectional-type overhead doors, **total 4 doors**

Roof-Wall

The roof-wall junctures are leaky throughout the upper levels of the one-story and two-story sections. The junctures along the metal roof deck need to be air-sealed with 2-component, closed-cell, polyurethane spray foam. All flutes on steel decking must be punched and sealed. Air-seal the roof-wall junctures, per the QAS manual and floor plan.

- Air-seal the roof-wall junctures, the flutes, and any framing penetrations, 2-lines (1 at top of beam and 1 at bottom), at 14’ working height mostly above suspsended ceiling (with direct access along some 1-story sections), **total 632 LF**

Rooftop Fans

There are eight (8) fans on the roof that need to be air-sealed along the chases and framing details. Fans should be serviced annually. Inspect fan for proper operation. Inspect and clean dampers. Air-seal the roof fans, per the QAS manual.

- Inspect and air-seal the rooftop fans, **total 8 roof fans**

Penetrations: Air-Seal

Within the sally port, there are two large duct/vent penetrations that are connected directly to the outside. The two penetrations need to be air-sealed along the frame-wall junctures. The duct penetration measures 2' W x 2'6" H and the vent housing measures 2'6" W x 2'6" H. There is direct access to these penetrations, with standard working heights. Air-seal the duct and vent penetrations, per the QAS manual and floor plan.

- Air-seal the duct penetration at the frame-wall junctures, **total 9 LF**
- Air-seal the vent housing penetration at the frame-wall junctures, **total 10 LF**

Energy Conservations

The metal-framed exterior walls have batt insulation. Along the exterior walls of the main second level section, there is no effective Energy Conservation in place at the upper 6" of the wall sections. There is merely batt insulation fitted within the metal framing, lacking the sheetrock interior surface/barrier, with torn, missing, and deteriorated sections of the poly throughout. Along two of the exterior walls at the front "bump-out" section (Chief's and adjoining Admin Offices), there are 2' H openings that lack the sheetrock Energy Conservation. A rigid Energy Conservation needs to be installed along the (6" H and 2' H) open framing using 1" fire-rated board insulation, sealing all seams. Access to the openings is above the suspended ceilings. The working height is 14'. Install an Energy Conservation along the 6" and 2' high wall openings, per the QAS manual and floor plan.

- Install an effective Energy Conservation at the 6" H wall openings, affixing 1" fire-rated board insulation to the framing, sealing seams with 2-component, closed-cell, polyurethane spray foam, **total 316 LF**
- Install an effective Energy Conservation at the 2' H wall openings, affixing 1" fire-rated board insulation to the framing, sealing seams with 2-component, closed-cell, polyurethane spray foam, **total 55 LF**

Senior Center (Ref #5)

The Senior Center was built in 1987 with wood framing, framed (insulated) walls with clapboard exterior surfaces, and wood-framed, sloped rafter, and shed roof systems. It is in fair-to-good condition (considering age of some key building systems) and well-maintained by staff. The wood-framed windows tested tight. The AHUs and duct distribution system is in the attic areas. The building envelope is quite leaky, partly due to failing door weatherstrip, as well as lacking effective Energy Conservations between the conditioned areas and unconditioned attic spaces.

Doors

The exterior doors in the building are leaky and need to be weatherstripped. The doors in the building are white. White door kits will be fine. Weatherstrip the exterior doors, per the QAS manual and floor plan.

- Install new, appropriate weatherstrip on all the standard-sized exterior doors, **total 2 doors**

Install Energy Conservation

The wood (sloped shed-type) roof has R-30 batt insulation within the rafter framing. However, there is no effective Energy Conservation in place, merely the suspended ceiling below the deck. To establish an effective Energy Conservation and align the air and thermal barriers, a rigid Energy Conservation should be installed above the suspended ceiling, affixed to the bottom of the rafter framing, using 1” fire-rated board insulation and sealing all seams with an appropriate sealant (e.g., 2-component, closed-cell, polyurethane spray foam or Hilti mastic). The working height to the bottom of the rafter framing is 9 - 13 feet (3” spacing above the drop at the eave, 3’ spacing at the peak). At the underside of the sloped shed roof system, install an effective Energy Conservation, per the QAS manual and floor plan.

- Install an effective Energy Conservation above the suspended ceiling, affixing 1” fire-rated board insulation to the bottom of the rafter framing, sealing seams with an appropriate sealant, **total 880 SF**

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Fire Department (Ref #6)

The Fire Department is part of the same building envelope as the Town Hall (Ref #1). Please reference that site for work scoped at the Fire Department.

Public Library (Ref #7)

The Public Library was built in 1990 with steel framing, metal-framed and insulated wall systems with brick veneer, and a sloped wood roof system. It is in good condition and well-maintained by staff. The building envelope is quite leaky, partly attributed to failing weatherstrip and missing sealants, as well as to construction framing details; more specifically, 50% of the footprint lacks an effective Energy Conservation between conditioned areas and the attic area.

Doors

The exterior and mechanical room doors in the building are leaky and need to be weatherstripped. The mechanical room doors should have fire-rated materials installed. The doors in the building are black and white. Black and white door kits will be fine. Weatherstrip the doors, per the QAS manual and floor plan.

- Install new, appropriate weatherstrip on all the standard-sized exterior doors, **total 8 doors**
- Install new fire-rated weatherstrip on the standard-sized mechanical room (penthouse) doors, **total 3 doors**

Overhead Doors

There is one (1) sectional-type overhead door. The door tested leaky and should have new, effective weatherstrip materials installed. The door measures 8’ W x 7’ H. Weatherstrip the overhead door, per the QAS manual and floor plan.

- Weatherstrip the 8’ W x 7’ H sectional-type overhead door, **total 1 door**

Windows

There are three (3) window assembly types. They are metal-framed, single-pane units with fixed-only, double-hung, and fixed-adjoined subunit configurations.

The WAT-1 and WAT-3 units tested leaky along the frame-wall junctures. Each of these types need their frame-wall junctures air-sealed, 1-line, using non-foam sealants. The WAT-1 units are single, fixed-only configurations, whereas the WAT-3 units are configured with six (6) fixed subunits adjoined (2 wide x 3 high). Air-seal the windows along the frame-wall junctures, per the QAS manual and floor plan.

- Air-seal the WAT-1 and WAT-3 units along the frame-wall junctures, 1-line, using non-foam sealants, **total 284 LF**

The WAT-2 double-hung unit needs new fuzz weatherstrip installed, 2-channels, all sides of both sashes. It also needs to be air-sealed along the frame-wall junctures, 1-line, using non-foam sealants. The sash lock (center of meeting rail) needs to be replaced with a new, meeting-rail type sash lock, and two (2) side-mount sash locks need to be installed as well. Weatherstrip and air-seal the window, per the QAS manual and floor plan.

- Weatherstrip the WAT-2 units using fuzz materials, 2 channels (all sides of both sashes), **total 30 LF**

- Air-seal the WAT-2 unit along the frame-wall junctures, 1-line, using non-foam sealants, **total 15 LF**

- On the WAT-2 unit, replace the existing sash lock on the center of the meeting rail, **total 1 sash lock**

- On the WAT-2 unit, install two (2) side-mount sash locks, **total 2 sash locks**

Install Energy Conservation

The sloped wood roof has approximately 4” of exterior insulation. In five (5) sections of the main floor, there is no effective Energy Conservation in place, merely a suspended ceiling and batt insulation above, fitted within the ceiling joist framing. These sections represent approximately 50% of the overall footprint (i.e., conditioned area). Per the Library Director, this was done intentionally to allow heated air to bypass the insulation, temper the attic, and prevent the “wet” sprinkler system piping from freezing.

We recommend replacing the “wet” system within the attic (**by others**) with a “dry” sprinkler system. If a dry system is installed in the attic, we highly recommend moving forward with the installation of an effective Energy Conservation along those sections identified in our proposed work below. We have included in our scope by default and could provide a separate proposed scope without the Energy Conservation installation, if desired.

A rigid Energy Conservation should be installed above the suspended ceiling, affixed to the bottom of the joist framing, using 1” fire-rated board insulation and sealing all seams. The working height to the bottom of the joist framing is 18 feet (approximately 6” above

the suspended ceiling). Install an effective Energy Conservation, per the QAS manual and floor plan.

- Install an effective Energy Conservation above the suspended ceilings, affixing 1" fire-rated board insulation to the bottom of the ceiling joist framing, sealing seams with 2-component, closed-cell, polyurethane spray foam, **total 6,970 SF**

Water & Sewer Department (Ref #8)

This building was originally slated for an energy audit. However, it was discovered that it fulfilled a regional purpose, and is not included for retrofit consideration solely for the Town of Norton.

J.C. Solmonese Elementary School (Ref #9)

The Solmonese Elementary School was built in 1978. A recent renovation was performed that included exterior doors and window systems. The structure has steel framing, CMU/brick masonry wall systems, and flat metal roof systems. It is in good condition and well-maintained by staff. However, the building envelope is quite leaky, partly due to failing weatherstrip and missing sealants, as well as to construction framing details along several entries (walls open to soffits/canopies).

Doors

The exterior, roof access, and boiler/AHU room doors are leaky and need to be weatherstripped. The doors at the boiler and AHU rooms should have fire-rated materials installed. The doors in the building are red. Black or mill-finished door kits will be fine. Weatherstrip the doors, per the QAS manual and floor plan.

- Install new, appropriate weatherstrip on all the standard-sized exterior and roof-access doors, **total 21 doors**
- Install new, appropriate weatherstrip on all the nonstandard-sized, 4’ W x 7’ H, exterior door, **total 1 door**
- Install new, fire-rated weatherstrip on the standard-sized boiler and AHU room doors, **total 2 doors**

Miscellaneous Air-Sealing: I-beam

Within the cafeteria, the large, 64’ W x 1’6” H, I-beam needs to be air-sealed along all 4 sides, 1-line (1/2” gaps, picture frame), using appropriate sealants (e.g., backer rod and non-foam sealant). There is direct access to the beam at a maximum working height of 13 feet. Air-seal the I-beam, per the QAS manual and floor plan.

- Air-seal along all four (4) sides of the I-beam (picture-frame, 1/2” gaps) using clear sealants, **total 131 LF**

Roof-Wall

The roof-wall junctures tested leaky. The junctures need to be air-sealed with 2-component, closed-cell, polyurethane spray foam. All flutes on steel decking must be punched and sealed. In the cafeteria, the ceiling is perforated. Air-seal the roof-wall junctures, per the QAS manual and floor plan.

- Air-seal the roof-wall junctures above the perforated ceiling, 1-line at 14’ working height with direct access (punching perforated ceiling), **total 64 LF**

- Air-seal the roof-wall junctures and any framing penetrations, 2-lines (above and below the beam), at 14’ working height above suspended ceiling (first and second levels), **total 1,720 LF**

- In the gym, air-seal the roof-wall junctures and any framing penetrations, 2-lines, at 20’ working height with direct access to the junctures (lift), **total 294 LF**

Soffits

Along six (6) building entries, there are 4’ H openings at the exterior walls, wide open to the canopies and outside.

There is some batt insulation at a soffit that measures 10’ W x 4’ H and a second soffit that measures 12’ W x 4’ H, with pieces of blocking and metal framing. However, the blocking is deteriorated and very leaky. These two openings need to be air-sealed and insulated, affixing 2” rigid board insulation to block the opening, and seal seams with 2-component, closed-cell, polyurethane spray foam.

A third soffit measures 12’ W x 4’ H and has blocking, but it is very leaky along the edges. The large, 1/2” to 1”, gaps at the edges need to be air-sealed using 2-component, closed-cell, polyurethane spray foam.

The fourth, fifth, and sixth soffits each measure 10’ W x 4’ H and lack batt insulation or blocking. These need to be air-sealed and insulated, affixing 2” rigid board insulation and sealing seams with 2-component, closed-cell, polyurethane spray foam. Access to the soffit openings is above the suspended ceilings, at a working height of 14 feet. Air-seal and insulate the openings, per the QAS manual and floor plan.

- Air-seal and insulate 4’ H soffit openings, affixing 2” thick rigid board insulation along the opening and sealing seams with 2-component, closed-cell, polyurethane spray foam at 14’ working height, **total 52 LF**

- Air-seal the blocking in place at a 4’ H soffit opening, sealing the large gaps at the edges of the blocking (picture frame) with 2-component, closed-cell, polyurethane spray foam at 14’ working height, **total 12 LF**

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Rooftop Fans

There are sixteen (16) fans on the roof that need to be air-sealed along the chases and framing details. Fans should be serviced annually. Inspect fan for proper operation. Inspect and clean dampers. Air-seal the roof fans, per the QAS manual.

- Inspect and air-seal the rooftop fans, **total 16 roof fans**

L.G. Nourse Elementary School (Ref #10)

The Nourse Elementary School was built in 1960. In 2019, a substantial renovation project was performed, which included replacement of the windows and most of the exterior doors. The structure has steel framing, CMU/brick masonry wall systems, and and flat TECTUM roof systems, with rigid insulation and a rubber membrane surface installed in 2005. It is in fair-to-good condition (considering the age of several key building systems) and well-maintained by staff. The building envelope is somewhat leaky, partly due to failing and missing weatherstrip, as well as some construction framing details along the main entry and at the roof fans.

Doors

The exterior and boiler room doors in the building are leaky and need to be weatherstripped. The boiler room doors should have fire-rated materials installed. The doors in the building are red and grey. Black and mill-finished door kits will be fine. Weatherstrip the doors, per the QAS manual and floor plan.

- Install new, appropriate weatherstrip on all the standard-sized exterior doors, **total 11 doors**
- Install new, appropriate weatherstrip on all the nonstandard-sized, 3’6” W x 7’ H, exterior doors, **total 6 doors**
- Install new, appropriate weatherstrip on all the nonstandard-sized, 4’ W x 7’ H, exterior door, **total 1 door**
- Install new, appropriate fire-rated weatherstrip on the standard-sized boiler room door, **total 1 door**

Overhead Doors

There is (1) sectional-type overhead door that measures 7’ W x 7’ H. The door tested leaky and should have new, effective weatherstrip installed. Weatherstrip the overhead door, per the QAS manual and floor plan.

- Weatherstrip the 7’ W x 7’ H sectional-type overhead door, **total 1 door**

Soffits

Along the main building entry, there is a 1’6” high opening along the exterior wall, wide open to the canopy and outside. There is some wood framing in place. The opening needs

to be air-sealed and insulated, affixing 2" rigid board insulation to block the opening, sealing seams with 2-component, closed-cell, polyurethane spray foam. The soffit opening measures 10' W by 1'6" H. Access to the opening is above the suspended ceiling at a working height of 13 feet. Air-seal and insulate the soffit opening, per the QAS manual and floor plan.

- Air-seal and insulate the 1'6" H soffit opening at 13' H working height, with access above the suspended ceiling, **total 10 LF**

Rooftop Fans

There are seventeen (17) fans on the roof that need to be air-sealed along the chases and framing details. Fans should be serviced annually. Inspect fan for proper operation. Inspect and clean dampers. Air-seal the roof fans, per the QAS manual.

- Inspect and air-seal the rooftop fans, **total 17 roof fans**

Henri A. Yelle Elementary School (Ref #11)

The Yelle Elementary School was initially built in 1955, with a large addition constructed in 1975, extending southeast and southwest from the rear of the original building. In 2019, a substantial renovation was performed (included windows and doors). The structure has steel framing, brick/masonry and insulated brick-veneer wall systems, and multiple flat metal roof systems with rigid exterior insulation and rubber membranes. It is in fair-to-good condition (considering the age of some building systems) and well-maintained by staff. The building envelope is moderately leaky, partly attributed to failing weatherstrip and sealants, as well as construction framing details along the gymnasium section.

Doors

The exterior and boiler room doors in the building are leaky and need to be weatherstripped. The boiler room doors should have fire-rated materials installed. The doors in the building are red/orange and black. Black and mill-finished door kits will be fine. Weatherstrip the doors, per the QAS manual and floor plan.

- Install new, appropriate weatherstrip on all the standard-sized exterior doors, **total 25 doors**
- Install new, appropriate weatherstrip on all the nonstandard-sized, 4’ W x 7’ H, exterior doors, **total 10 doors**
- Install new, appropriate fire-rated weatherstrip on the standard-sized boiler room doors, **total 4 doors**

Windows

There is one (1) window assembly type that requires retrofit. The main window systems are metal-framed, double-pane units, installed in 2019. Each of these systems tested tight. The older, large, fixed windows along the upper stage wall (WAT-1) tested very leaky. The facility director and head custodian noted major drafts and comfort issues within this area.

The WAT-1 units tested leaky along the frame-wall junctures. Each of these windows need their frame-wall junctures air-sealed, 1-line, using non-foam sealants. To improve thermal performance and occupant comfort, the older WAT-1 single-pane units should have 2” rigid board insulation blocking affixed to the framing, sealing all seams. The maximum working height is 18 feet to the tops of the assemblies. Air-seal and insulate the windows, per the QAS manual and floor plan.

- Air-seal the WAT-1 units along the frame-wall junctures, 1-line, at 18’ maximum working height using non-foam sealants, **total 120 LF**

- Insulate the WAT-1 units, affixing 2” rigid board insulation ***with white finish*** at the framing, sealing all seams, **total 144 SF**

Roof-Wall
The roof-wall junctures are leaky within the gymnasium (stage has acoustic tile; no access). The junctures need to be air-sealed with 2-component, closed-cell, polyurethane spray foam. All flutes on steel decking must be punched and sealed. Air-seal the roof-wall junctures, per the QAS manual and floor plan.

- In the gym, air-seal the roof-wall junctures and any framing penetrations, 1-line at 25’ working height with direct access to the junctures (lift), **total 268 LF**

Rooftop Fans
There are twenty-five (25) fans on the roof that need to be air-sealed along the chases and framing details. Fans should be serviced annually. Inspect fan for proper operation. Inspect and clean dampers. Air-seal the roof fans, per the QAS manual.

- Inspect and air-seal the rooftop fans, **total 25 roof fans**

MUA Ducts/Vents
Along the rear wall of the stage, there are two (2) Make-Up Air (MUA) duct penetrations that tested leaky and need to be air-sealed along the 1/2” gaps at the frame-wall junctures on all sides. Each duct measures 5’ W x 5’ H. The working height is 18 feet to the tops of the ducts: extension ladders will be needed. Air-seal the MAU duct penetrations, per the QAS manual and floor plan.

- Air-seal the MAU duct penetrations using 2-component, closed-cell, polyurethane spray foam (or other appropriate sealant) at a maximum work height of 18’ H, **total 2 penetrations**

Norton Middle School (Ref #12)

The Middle School was built in 1998 with steel framing, brick/masonry and insulated metal-stud wall systems, and both flat and sloped (insulated) metal roof systems. It is in good condition and well-maintained by staff. The building envelope is moderately leaky, partly due to failing weatherstrip and sealants, as well as construction framing details where roof-wall junctures were accessible and tested leaky.

Doors

The exterior, roof-access, and boiler room doors in the building are leaky and need to be weatherstripped. The boiler room doors should have fire-rated materials installed. Two (2) sets of double-doors are leaky along the frame-trim details. These double-door systems need to be air-sealed along the door and transom framing/trim, 2-lines (at interior), using non-foam sealants. One of these double doors has ongoing water seepage, due in part to deteriorated exterior sealants. The existing sealants need to be removed and replaced. The doors in the building are white, grey, and brushed metal. Black and mill-finished door kits will be fine. Weatherstrip and air-seal the doors, per the QAS manual and floor plan.

- Install new, appropriate weatherstrip on all the standard-sized exterior and roof-access doors, **total 32 doors**
- Install new, appropriate weatherstrip on all the nonstandard-sized, 3’6” W x 7’ H, roof-access doors, **total 2 doors**
- Install new, appropriate weatherstrip on all the nonstandard-sized, 3’ W x 8’ H, exterior doors, **total 4 doors**
- Install new, appropriate fire-rated weatherstrip on the standard-sized mechanical room doors, **total 2 doors**
- Air-seal frame-trim at two (2) double-door systems, 2-lines, along the left, top (above transoms), and right framing, **total 100 LF**
- At one (1) double-door system, remove deteriorated exterior sealants and replace with new exterior sealants, 1-line, along the left, top (above transoms), and right framing, as well as the outer edge of the masonry threshold, **total 31 LF**

Overhead Doors
There is (1) rollup-type overhead door that measures 9' W x 9' H. The door tested leaky and should have new weatherstrip materials installed. Weatherstrip the overhead door, per the QAS manual and floor plan.

- Weatherstrip the 9' W x 9' H rollup-type overhead door, **total 1 door**

Roof-Wall
The roof-wall junctures are leaky in several locations on the first, second, and third levels. Other areas tested tight or have solid surface ceilings, prohibiting access to test and retrofit the junctures. The junctures identified as leaky need to be air-sealed, 2-lines (top/bottom of beam), with 2-component, closed-cell, polyurethane spray foam. All flutes on steel decking must be punched and sealed. Air-seal the roof-wall junctures, per the QAS manual and floor plan.

- Air-seal the roof-wall junctures and any framing penetrations, 2-lines (above and below the beam), at 16' working height above suspended ceiling, **total 1,094 LF**

Rooftop Fans
There are twenty-three (23) fans on the roof that need to be air-sealed along the chases and framing details, using appropriate sealants. Fans should be serviced annually. Inspect fan for proper operation. Inspect and clean dampers. Air-seal the roof fans, per the QAS manual.

- Inspect and air-seal the rooftop fans, **total 23 roof fans**

Windows: Air-seal and Insulate
There are three (3) window assembly types. Most of the window systems are metal-framed, double-pane units. These assemblies tested tight. The older fixed windows at the top of the large curtain wall are single-pane units. The top tiers of these windows are above the suspended ceilings. The units create a tremendous cold area along the conditioned areas near the exterior walls (i.e., "you can feel the cold air cascading down the walls, creating huge drafts"), which is a source of major complaints from the staff and students. These windows should be insulated with 2-component, closed-cell, polyurethane spray foam and an intumescent barrier.

The WAT-1 units consists of eight (8) fixed subunits (adjoined 2 high x 4 wide). The WAT-

2 unit consists of ten (10) fixed subunits (adjoined 2 high x 5 wide). The WAT-3 unit consists of sixteen (16) fixed subunits (adjoined 2 high x 8 wide). The WAT-1, WAT-2, and WAT-3 units should be insulated with 2" of 2-component, closed-cell, polyurethane spray foam and covered with an intumescent barrier paint.

Access to the WAT-1 through WAT-3 units is above the suspended ceilings and stepping through some metal truss framing components. The suspended ceiling's metal framing can accommodate a person's weight to stand on during spray foam installation, if needed. The suspended ceilings are at 10 feet. The maximum work height above the ceiling is 7 feet (to tops of window assemblies and metal roof deck). Air-seal and insulate the upper tier of the fixed windows, per the QAS manual and floor plan.

- Air-seal and insulate the WAT-1, WAT-2, and WAT-3 units with 2" of 2-component, closed-cell, polyurethane spray foam, **total 323 SF/646 BF**

- Cover all installed spray foam at window assemblies using an appropriate intumescent paint at 14 mil wet film, **total 323 SF**

Norton High School (Ref #13)

The Norton High School was initially built in 1972. In 2013, a substantial renovation project was performed (which included new windows). It has steel framing, insulated metal-stud and CMU/brick masonry wall systems, and both flat and sloped metal roof systems. The roof-wall junctures have been sealed with spray foam. It is in good condition and well-maintained by staff. The building envelope is somewhat leaky, partly due to failing and missing weatherstrip along the exterior and overhead door systems.

Doors

The exterior and boiler room doors in the building are leaky and need to be weatherstripped. The boiler room doors should have fire-rated materials installed. The doors in the building are grey, black, and brushed metal. Black and mill-finished door kits will be fine. Weatherstrip the doors, per the QAS manual and floor plan.

- Install new, appropriate weatherstrip on all the standard-sized exterior doors, **total 23 doors**
- Install new, appropriate weatherstrip on all the nonstandard-sized, 3’6” W x 7’ H, exterior doors, **total 2 doors**
- Install new, appropriate fire-rated weatherstrip on the standard-sized boiler room doors, **total 1 doors**

Overhead Doors

There are three (3) rollup-type overhead doors. The doors tested leaky, with deteriorated materials and some sections lacking effective weatherstrip. The rollup doors should have new, effective weatherstrip materials installed. One door measures 6’ W x 10’ H, a second door measures 8’6” W x 9’ H, and a third door measures 8’6” W x 10’ H. Weatherstrip the overhead doors, per the QAS manual and floor plan.

- Weatherstrip the 6’ W x 10’ H rollup-type overhead door, **total 1 door**
- Weatherstrip the 8’6” W x 9’ H rollup-type overhead door, **total 1 door**
- Weatherstrip the 8’6” W x 10’ H rollup-type overhead door, **total 1 door**

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APPENDIX 1 – BUILDING ENVELOPE OVERVIEW

Building envelope retrofits improve deficient areas of a building's thermal and/or air (pressure) boundaries. For thermal deficiencies, the R-value of building components is increased by either replacing components (e.g., single-pane to double-pain windows) and/or by installing insulation. For pressure-related deficiencies, the retrofit focuses on sealing up areas where unwanted air migration occurs.

Air movement across the building's pressure boundaries may be intentional – designed to introduce fresh air or to exhaust stale air – or unintentional. Intentional air movement is known as ventilation. Unintentional air movement is known as air leakage. Air leakage can result in conditioned air moving from inside the building to outside and/or unconditioned outside air moving into the conditioned building. Many times, intentional efforts at ventilation result in additional unintentional leakage via building junctures due to pressure imbalances acting on defects in the building enclosure.

The Effects of Pressure and Hole-Size on Air Flow in Buildings

A simple orifice calculation for airflow is:

$$\sqrt{\text{P}} \times \text{A in}^2 \times 1.07 = \text{flow in CFM}$$ (if the pressure is in pascals)

The two main factors impacting air leakage are pressure and hole size. Airflow increases by the square root of the pressure and linearly with hole size. When evaluating a building envelope for retrofit, we are constantly on the lookout for gaps, cracks, and holes that provide pathways to the exterior – the linear component.

Three driving forces move air across the pressure boundaries of a building:

- Stack Effect – pressure caused by the density difference between outside and interior air, due to temperature differentials
- Wind Effect – wind-driven pressures
- Mechanical Effect –either deliberate or inadvertent pressure imbalances created by the HVAC systems.

The potential for unintentional airflow exists in all buildings due to the presence of these three physical effects. This airflow can either be into the structure – infiltration; or out of it – exfiltration. The airflow itself is made possible by the flaws in the building envelope – gaps, cracks, and holes.

So, the two fundamental concerns are the continuity of the building's Energy Conservation and the pressures at which the building operates.

Savvy design engineers will attempt to balance a building's HVAC systems to reduce the effects of all three driving forces. Buildings so balanced perform much better from an airflow standpoint but are still regularly subjected to forces outside the range of intentional design parameters, and are susceptible to changes by occupants and staff.

A study on building commissioning recommended that buildings be reviewed every five years or so to determine if they are still in balance and make adjustments if needed. In the majority of the buildings we investigate for building envelope retrofits, we request that the building be "re-balanced' following the building envelope repairs.

The leakier the building, the more difficult it is to maintain that balance. The various pressure effects working on the building have larger swings with larger holes, and the energy penalty of keeping the desired pressure increases. Tightening the building envelope decreases energy use and increases the likelihood that the building will perform within design pressure parameters. Some physicists and engineers are beginning to speculate whether building pressurization is necessary with a tight building envelope.

How Leaky Are Buildings?

Many believe that institutional and commercial buildings are tight structures. Several pieces of research, as well as our direct observations in the field over many years, belie this assumption.

"It is often assumed that commercial and institutional buildings are fairly airtight and that envelope air leakage does not have a significant impact on energy consumption and indoor air quality in these buildings. Furthermore, it is also assumed that more recently constructed buildings are tighter than older buildings. The fact of the matter is that very few data are available on the airtightness of building envelopes in commercial and institutional buildings. The data that do exist show significant levels of air leakage in these buildings and do not support correlations of airtightness with building age, size, or construction." ***Airtightness of Commercial and Institutional Buildings: Blowing Holes in the Myth of Tight Buildings****, Andrew K. Persily, Ph.D., Thermal Envelopes VII Conference, 1999.*

"Many discussions in the popular press and the technical literature still refer to commercial and institutional buildings, and newer buildings in particular, as being airtight. 'Tight buildings' often are blamed for a host of indoor air quality problems, including high rates of health complaints and more serious illnesses among building occupants. Furthermore, discussions and analyses of energy consumption in commercial and institutional buildings frequently are based on the assumption that envelope air leakage is not a significant portion of the energy used for space conditioning. These statements are almost never supported by any test data or airflow analysis for the buildings in question." ***Airtightness of Commercial Buildings in the U.S.*** *Steven J. Emmerich and Andrew K. Persily, Building and Fire Research Laboratory, National Institute of Standards and Technology, Gaithersburg, MD, USA.*

Retrofitting a building's envelope generally involves sealing various gaps, cracks, and holes that, left alone, allow uncontrolled migration of air between the inside and the outside of the building. Building envelope retrofits provide wonderful opportunities for energy savings. There are many non-energy benefits associated with the work, and these, while sometimes challenging to monetize, can be as much or more important than energy savings. Occupants are more comfortable as drafts and airflow decrease. Indoor air quality improves as outside pollutants can no longer enter the building. Pressure differences from mechanical system imbalances are mitigated. Pest, odor, and water infiltration headaches are often taken care of by building envelope retrofit work. Desired humidity levels can be maintained. In many instances, repairing the building envelope can increase the time before structural issues manifest themselves, e.g., roof shingles and sheathing last longer if the attic is air-sealed, stopping moisture drive and condensation.

Common Air Sealing Needs

Lack of continuity in a building's Energy Conservation exists from basement to rooftop. Typical measures include roof-wall joint sealing, blocking of soffit openings, weatherstripping, applying sealants to windows and doors, and more

Doors: Doors are very cost-effective to weatherstrip. The proper weatherstrip should be ample, durable, and capable of transitioning between seasonal variations. It should be completely airtight at all times the door is closed. Many products have thin bulbs, which cannot accommodate seasonal variances. Others have brushes that close the hole down but do not entirely seal it. Frequently the "fuzz" product in a frame is worn or lacks a silicone or Teflon tab in the middle to completely block the flow. Carefully selected replacement weatherstrip products for windows and doors have been proven over time to be durable and effective.

Windows: Windows are also a common measure. Replacement windows generally have extremely long paybacks. Whenever possible, it is much more cost-effective to air seal and weatherstrip windows rather than replace them. Many times, new replacement windows still leak around the frames due to the installation procedures. These can be made airtight with appropriate sealants.

Roof-wall: Often, the juncture where the roof and the wall meet is not airtight. The usual approach is to seal this joint with 2-component, closed-cell polyurethane foam. This repair provides a durable, monolithic seal and stops leakage around the perimeter of the roof. Elevation changes – where second or third stories attach to lower structures – are sometimes areas of considerable leakage. In addition to 2-component foam, backer rods and caulks are occasionally appropriate for these junctures, or rock-wool and fire-rated mastic.

Soffits: Soffits are often areas of significant leakage. Some have openings several feet high, going around the entire perimeter of the building. The severity of the problem varies – we find them ranging from wide open to totally sealed. Fiberglass insulation may have been installed in the past in an attempt to block and insulate the hole, although often, it has fallen, leaving a gaping hole. Even with fiberglass still in place, it is not a good seal in and of itself. The rule of thumb is that if it does not hold water, then it will not stop airflow. Similarly, we see failures of polyethylene and other non-rigid materials used in attempts to air seal these junctures. These materials are not able to stand up to the building pressures they experience, are easily pierced and torn, and cannot be effectively fastened.

Penetrations: There are other miscellaneous penetrations throughout buildings, including utility chases, plumbing and electrical penetrations, HVAC duct penetrations and boots that are not sealed, rooftop fan curbs with gaps and cracks, and more. A well-trained inspector is needed to identify all the penetrations and what to do to fix them.

Insulation and Bypasses: Finally, we often see misalignment of the thermal and Energy Conservations of the building. When the Energy Conservation is not in direct contact with the thermal boundary, the insulation is bypassed and does not function at its rated values. Similarly, cold air can intrude behind the insulation and make direct contact with the Energy Conservation. This contact provides an opportunity for condensation on internal building surfaces. The condensation can lead to building degradation and/or mold problems. On occasion, buildings lack insulation in the walls or attic/roof deck, and insulation needs to be added.

APPENDIX 2 – TESTING METHODOLOGIES

There are three applicable standards for determining airflow in buildings. They are ASTM E1186, ASTM E779, and ASTM E783.

ASTM E1186

ASTM E1186 ***Standard Practices for Air Leakage Site Detection in Building Envelopes and Energy Conservation Systems*** cites several different methodologies for determining leakage locations. The pertinent ones for testing at this site are:

- Section 4.1.1 Combined building depressurization (or pressurization) and infrared scanning;
- Section 4.1.2 Building depressurization (or pressurization) and smoke tracers;
- Section 4.1.3 Building depressurization (or pressurization) and airflow measuring devices; and
- Section 4.1.4 Generated sound and sound detection.

We use a variety of tests depending on the local conditions. A popular methodology is section 4.1.1, the infrared (IR) approach. However, it has its flaws. Air leakage can be very difficult to detect using IR, and it is easy to misinterpret the data. If the building is cooled or heated, and the outside weather is sufficiently different, then this method may yield good results depending on cladding, cloud cover, etc. – and, most importantly, operator skill. Section 4.1.2, smoke tracer testing, is the gold standard within the retrofit industry as it is not subject to as many of the limitations as are the other methodologies. It can still show no leakage, despite holes, if there is no driving force moving air at the time of the test. Section 4.1.3, airflow measuring devices, works when there are sufficient pressure differentials across the building envelope. Section 4.1.4, generated sound, can help when conditions are benign, with limited pressure differentials. In this instance, the inspector deploys a noisemaker and listens for sound signals that come through any gaps, cracks, or holes in the building envelope. We can also use fan pressurization/depressurization to spur smoke movement, allowing the use of IR, and enabling anemometers to record flows. The other applicable standards are tracer gas testing and chamber tests in conjunction with pressure differentials.

ASTM E1186 is a strictly qualitative test standard. Its purpose is to locate the sources and pathways of air leakage. It does not quantify the extent of the leakage. When calculating potential savings, we base crackage estimates on direct observation by the inspector, our experience with measuring quantified leakage from conducting E779 and

E783 tests, and engineering estimates. We then check the assumptions against baseline consumption data for reasonableness during our fit-testing process.

To determine the actual amount of air leakage in a building requires different tests. There is a quantitative approach to determining the amount of air leakage. Buildings can be pressure tested in conformance with the ASTM E779 to quantify the airflow across the building envelope at various pressure differentials.

ASTM E779

ASTM E779 ***Standard Test Method Determining Air Leakage Rate by Fan Pressurization*** is the standard driving the U.S. Army Corp of Engineers' (USACE) test protocol for new construction projects. The same whole building tests are appropriate for testing existing structures. This standard is significant because the practices described under ASTM E1186 are qualitative, determining the air leakage *sites* rather than determining quantitative leakage *rates*. So, for Measurement and Verification (M&V), E779 testing can document and verify the actual reductions forecast in the initial site inspection.

The standard allows the technician to test buildings under pressurization or depressurization. A minimum of six measurements are required, but it is preferable to take ten. Readings must be in increments between 25 and 75 pascals. Baseline pressure measurements must be recorded before conducting the test and immediately following the test.

This type of testing can supplement the ASTM E1186 tests and quantify leakage rates. They may be included for M&V, to document actual reductions. Generally, we rely on pre- and post-tests using the E1186 tests only, due to the significant costs and inconvenience associated with multi-fan blower door testing.

ASTM E783

ASTM E783 ***Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors*** uses microleakage detection devices. Microleakage testing requires setting up to measure leakage at a specific opening, taking the measurement, tearing down the testing setup, installing the measure, then repeating the testing process. Each test takes approximately one hour for the pre-test and one hour for the post-test. During the testing, the window or door is not available for egress. Again, these tests are usually not necessary but are available if needed or desired.

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Town of Norton

Mechanical Measures

Norton Town Hall

The Norton Town Hall is a two-story building with a basement storage area. HW heating is provided by (4) non-condensing Utica boilers using natural gas. (3) .75HP HW pumps circulate HW throughout the buildings. A Tekmar controller is used to control the boilers and pumps. An OA reset schedule is being used to control HW supply temperature. (3) Roof Top Units also serve heating and cooling needs for the building.

ECM-1: Roof Top Unit Scheduling

Replacing existing T-Stats with new programmable Bacnet or WIFI T-Stats. These stats can be scheduled to reduce usage during unoccupied times and are equipped to be monitored remotely for easy viewing and schedule changes off-site. For the purpose of this estimate, a percentage of usage was used to calculate energy savings.

Norton Town Hall RTU Unoccupied Set Point Scheduling

Natural Gas Usage and Savings	
3,430	Est. Therms for usage with Roof Tops
3%	Estimated % of Therm Usage Saved
102.912	Estimated Therm Saving
$1.10	Estimated Cost per Therm
$113.20	Estimated Therm Cost Savings

Electric Usage and Savings	
324,000	Building KWH Usage
2%	Estimated % of KWH Usage Saved
6,480	Estimated KWH Saving
$0.11	Cost per KWH
$712.80	Estimated KWH Cost Savings

Project Cost and Details	
$4,500.00	Total Project Cost
$300.00	Incentive
$4,200.00	Cost to the Town
$826.00	Cost Savings
5.08	Simple Payback (years)

17,152	Total Building Usage
20%	Percent of Total Building Usage

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Town of Norton

Mechanical Measures

Norton Town Hall (cont.)

ECM-2: HW Boiler Replacement

The existing boilers are non-condensing, gas-fired units. Recent advances in technology have contributed to boiler systems that are able to extract previously wasted heat from the exhaust stack. The result is an increase in efficiency from approx. 85% to up to 95% at times. An estimated average efficiency of 93% was used for this calculation.

Norton Town Hall				
Replacement of Existing Boilers with a New Condensing Boiler System				
Norton Town Hall	Cost/Therm		**Estimates**	Norton Town Hall
Existing Boiler	$1.10		Total Project Cost	$75,900.00
Eff	85.0%		Incentive	$4,000.00
Boiler Usage Therms	6,861		Cost to the Town	$71,900.00
Total BTU Input	686,080		Annual Savings	$649.19
Total BTU Output	583,168		Simple Payback (yrs)	110.75
Total Cost/Year	$7,546.88		Therms Saved	590
New Boiler		$1,000.00	Incentive per 300MBH Boiler	
Eff	93%	$4,000.00	Total Estimated Incentive	
Usage Therms	6271			
BTU Input	627,062	40%	Percent of Total Building Usage	
BTU Output	583,168	17,152	Total Building Usage	
Total Cost/Year	$6,897.69	590	Therm Savings	
		9%	Percent Savings	
Savings	**$649.19**			

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Town of Norton

Mechanical Measures

Norton Town Hall (cont'd)

ECM-3: HVAC Evaluation and RCx

The systems in the basement of the town hall have been abandoned. These spaces previously served as the Police Station. Now the space is used mostly for storage. It appears that some of the air systems have been put of service however I noticed the baseboard HW heating was on and that the door to the former Police Station lobby was wedged open. It would appear this was done to ensure the domestic water piping in the lobby area does not freeze. This space would require a further evaluation for commissioning or de-commissioning of the units as necessary to determine the potential for savings. To estimate the potential for savings we can compare the space's Kbtus/Sqft to known averages for electricity and heating fuel for similar building usage and type. This Energy Usage Index can be used to determine the building's savings potential overall.

EUI Reduction Analysis to Establish Total Potential Savings Opportunity

Norton Town Hall

Standard Data				Cost / Kbtu	Facility Type	Average EUI for Selected Facility Type	
Cost per KWH	$0.11	KWH	Bldg Sqft	$0.03223916	Town Hall	Electric	Other Heating Fuel
Cost Per Heating Fuel	$1.10	Therm	22,458	$0.01100000		35	45

Building Specific Usage Data

Electrical				Other Heating Fuel			
Kwh	Usage	EUI	Kbtu's	Unit	Usage	EUI	Kbtu's
KWH	324,000	49.22468608	1,105,488.00	Therm	15,500	69.02	1,550,000

Comparision of the Building vs Other Similar Local Facility Types (Deviation from the Average)

EUI Dev (Elec)	Elec Dev %	Elec Dev KBTU Usage	Cost Dev Elec	EUI DEV (Htg)	Htg Dev %	Htg Dev KBTU Usage	Cost Dev Htg
14.22	29%	319,458	**$10,299.06**	24.02	35%	539,390	**$5,933.29**

Summary of Outcomes and Potential Savings from Deviation	
Potential KBTU Savings	858,848
Potential KBTU Savings %	32.34%
Potential Therm Savings	5,394
Potential Therm Savings %	34.80%
Potential KWH Savings	93,628
Potential KWH Savings %	28.90%
Potential Cost Savings	$16,232.35
Potential Cost Savings %	30.81%

Summary of Potential Total Project Cost and Savings Estimates	
Estimated Total Project Cost	$64,177.00
Estimated Project Incentive	$0.00
Estimated Net Cost	$64,177.00
Total Potential Savings	$16,232.35
Simple Payback (years)	3.95

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Town of Norton

Mechanical Measures

Norton Fire Station

The Norton Fire Station has (6) Blower Heaters. Fans blow air across HW coils to the heat the air in the space. There is a high ceiling in the bay, with plenty of clearance relative to the trucks parked below.

ECM-1: Install Infrared Heaters

Heating a garage space with large garage doors and marginal insulation/weatherstripping is a challenge. One way to combat this is to install IR gas heating units. The IR heating units work to heat the floors, walls, and equipment within the building as opposed to only heating the air. This results in a space that feels warmer even when the air temperature is lower. The space will also recover much faster after a door is opened, as the heated air will escape, but the latent heat in the surrounding material will not. Savings from the use of these units is estimated to be about 20-30%. A 20% reduction was used to calculate therm savings.

Infrared Heating Saving Calculations

Norton Fire Station

Input Information	
Proposed Measure	IR Heating
Estimated Therm Usage	6,861
Existing Cost	$7,546.88
Assumed Savings %	20%
Proposed Therm Usage	5,489
Proposed Cost	$6,037.50

Therm Savings	1,372.16
$/Therm	$1.10
Total Cost Savings	$1,509.38

Proposed Usage and Cost Calculation	
Total Project Cost	$52,300.00
Incentive	$2,250.00
Net Cost	$50,050.00
Therm Savings	1,372
Cost Savings	$1,509.38
Simple Payback (Yrs)	33.16
*Incentive assumes (3) IR Heaters @ $750/Unit	

Total Bldg Therm Usage	17,152
Estimated FS Bay Usage	40%

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Town of Norton

Mechanical Measures

Norton Police Station

The Norton Police Station (7) RTUs that serve heating and cooling to most areas. (2) of the units have connect t-stats with scheduled setback programming capability, however it was not enabled. The remaining t-stats did not have the ability to program a setback schedule. The sally port has a 7.5kw electric heater that is used often.

ECM-1: Roof Top Unit Scheduling

Replacing (5) existing T-Stats with new programmable Bacnet or WIFI T-Stats. These stats can be scheduled in some office and conference areas that are not used at night to reduce energy usage. They are equipped to be monitored remotely for easy viewing and scheduling changes off-site. For the purpose of this estimate, a percentage of usage was used to calculate energy savings.

Norton Police Station RTU Unoccupied Setback Scheduling				
Natural Gas Usage and Savings			*Electric Usage and Savings*	
3,163	Est. Therms for usage with Roof Tops		210,560	Building KWH Usage
6%	Estimated % of Therm Usage Saved		4%	Estimated % of KWH Usage Saved
189.78	Estimated Therm Saving		8,422	Estimated KWH Saving
$1.10	Estimated Cost per Therm		$0.11	Cost per KWH
$208.76	Estimated Therm Cost Savings		$926.46	Estimated KWH Cost Savings
Project Cost and Details				
$7,880.00	Total Project Cost			
$500.00	Incentive	*Incentive based on 5 new stats @ $100/stat		
$7,380.00	Cost to the Town			
$1,135.22	Cost Savings			
6.50	Simple Payback (years)			

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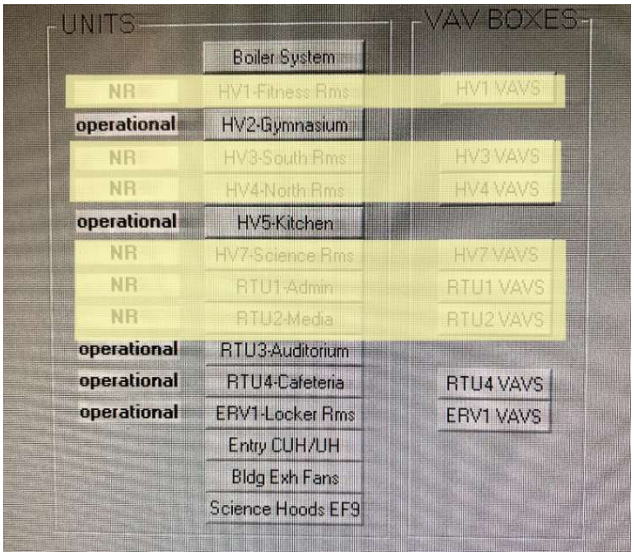
Town of Norton

Mechanical Measures

Norton High School

ECM-1: Advanced Energy Study

The High School building management system is no longer communicating with many of the air units throughout the school. Because of this, site and facility staff do not have control over the units. The following picture highlights the units that are no longer communicating with the BMS.



Of the units that were communicating with the BMS, the following schedules were recorded at the time of the audit.

Unit	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total Weekly Run	Estimated Yearly Run
RTU-4	5am-11pm	4am-12am	4am-11am	4am-11am	4am-12am			96	4992
HV-7	4am-5pm	1am-11pm	3am-5pm	6am-9pm	6am-6pm			76	3952
RTU-3	12am-12pm	12am-12pm	12am-12pm	12am-12pm	12am-12pm	12am-12pm	12am-12pm	168	8400
HV-2	4am-8pm	4am-8pm	4am-8pm	4am-8pm	4am-8pm	4am-8pm	4am-8pm	112	5824

Due to the complexity of the system and lack of information at the BMS, we recommend a more advanced study using paths laid out by either the state green communities' program or the utilities ESPO program. The results of the study can be used to determine the scope of work and benefit to cost ratio of any energy saving measures identified. The savings and cost estimates on the following page can be used to determine the potential savings that could be identified as a result of a more advanced study.

EUI Reduction Analysis to Establish Total Potential Savings Opportunity

Norton High School

Standard Data				Cost / Kbtu	Facility Type	Target EUI for Selected Facility Type	
Cost per KWH	$0.10	KWH	Bldg Sqft	$0.02930832	High/Middle School	Electric	Other Heating Fuel
Cost Per Heating Fuel	$1.10	Therm	126,500	$0.01100000		30	50

Building Specific Usage Data

Electrical				Other Heating Fuel			
Kwh	Usage	EUI	Kbtu's	Unit	Usage	EUI	Kbtu's
KWH	1,628,400	43.92	5,556,100.80	Therm	74,506	58.90	7,450,600

Comparision of the Building vs Other Similar Local Facility Types (Deviation from the Average)

EUI Dev (Elec)	Elec Dev %	Elec Dev KBTU Usage	Cost Dev Elec	EUI DEV (Htg)	Htg Dev %	Htg Dev KBTU Usage	Cost Dev Htg
13.92	32%	1,761,101	**$51,614.91**	8.90	15%	1,125,600	**$12,381.60**

Summary of Outcomes and Potential Savings from Deviation	
Potential KBTU Savings	2,886,701
Potential KBTU Savings %	22.19%
Potential Therm Savings	11,256
Potential Therm Savings %	15.11%
Potential KWH Savings	516,149
Potential KWH Savings %	31.70%
Potential Cost Savings	$63,996.51
Potential Cost Savings %	26.14%

Summary of Potential Total Project Cost and Savings Estimates	
Estimated Total Project Cost	$310,000.00
Estimated Project Incentive	TBD
Estimated Net Cost	$310,000.00
Total Potential Savings	$63,996.51
Simple Payback (years)	4.84

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Town of Norton

Mechanical Measures

Norton Middle School

The Middle School has (4) Burnham boiler providing HW to the building using (4) HW pumps to distribute HW to the spaces. PVI heaters are used to heat DHW. The building management system is an old Johnson Metasys System. The system is antiquated and past its useful life.

ECM-1: HW Boiler Replacement

The existing boilers are non-condensing, gas-fired units. Recent advances in technology have contributed to boiler systems that are able to extract previously wasted heat from the exhaust stack. The result is an increase in efficiency from approx. 87% to up to 95% at times. An estimated average efficiency of 93% was used for this calculation. We recommend the replacement of (2) boiler leaving the other (2) for backup.

Norton Middle School					
Replacement of Existing Boilers with a New Condensing Boiler System					
Norton Middle School	Cost/Therm			**Estimates**	Norton Middle School
Existing Boiler	$1.10			Total Project Cost	$217,900.00
Eff	87.0%			Incentive	$15,000.00
Boiler Usage Therms	64,528			Cost to the Town	$202,900.00
Total BTU Input	6,452,800			Annual Savings	$4,579.41
Total BTU Output	5,613,936			Simple Payback (yrs)	44.31
Total Cost/Year	$70,980.80			Therms Saved	4,163
New Boiler		1,143	MBH/Boiler		
Eff	93%	$15,000.00	Total Estimated Incentive		
Usage Therms	60365				
BTU Input	6,036,490	80%	Percent of Total Building Usage		
BTU Output	5,613,936	80,660	Total Building Usage		
Total Cost/Year	$66,401.39	4,163	Therms		
		6%	Percent Savings		
Savings	**$4,579.41**				

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Town of Norton
Mechanical Measures

Norton Middle School (cont)

ECM-2: Install High Efficiency Digital Burner Controls on Existing Boilers

The purpose of the burner is to mix molecules of fuel with molecules of air. A boiler will run only as well as the burner performs. Burners are designed to maximize combustion efficiency while minimizing the release of emissions. A power burner mechanically mixes fuel and combustion air and injects the mixture into the combustion chamber. All power burners essentially provide complete combustion while maintaining flame stabilization over a range of firing rates. Different burners, however, require different amounts of excess air and have different turndown ratios. An efficient natural gas burner requires only 2% to 3% excess oxygen, or 10% to 15% excess air in the flue gas, to burn fuel without forming excessive carbon monoxide. Most gas burners exhibit turndown ratios of 10:1 or 12:1 with little or no loss in combustion efficiency. Some burners offer turndowns of 20:1 on oil and up to 35:1 on gas. A higher turndown ratio reduces burner starts, provides better load control, saves wear and tear on the burner, reduces refractory wear, reduces purge-air requirements, and provides fuel savings.

7% is the average estimated savings associated with these units and was used the calculation shown below.

Savings Evaluation for Digital Combustion Controls

Norton Middle School

Input Information			Proposed Usage and Cost Calculation	
Proposed Measure	BLR Controls		Total Project Cost	$70,000.00
Existing Therm Usage	64,528		Incentive	$0.00
Existing Cost	$70,980.80		Net Cost	$70,000.00
Assumed Savings %	7%		Therm Savings	4,517
Proposed Therm Usage	60,011		kWh Savings	3,238
Proposed Cost	$66,012.14		Total Cost Savings	$5,486.74
			Simple Payback (Yrs)	12.76
Therm Savings	4,516.96		80%	Percent of Total Building Usage
kWh Savings from VFD	3,238.00			
$/Therm	$1.10		80,660	Total Usage
$/kWh	$0.16			
Therm Cost Savings	$4,968.66	Install (2) units, leave the other (2) for backup		
kWh Cost Savings	$518.08			

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Town of Norton

Mechanical Measures

Norton L.G. Nourse School

ECM-1: Install High Efficiency Digital Burner Controls on Existing Boilers

The purpose of the burner is to mix molecules of fuel with molecules of air. A boiler will run only as well as the burner performs. Burners are designed to maximize combustion efficiency while minimizing the release of emissions. A power burner mechanically mixes fuel and combustion air and injects the mixture into the combustion chamber. All power burners essentially provide complete combustion while maintaining flame stabilization over a range of firing rates. Different burners, however, require different amounts of excess air and have different turndown ratios. An efficient natural gas burner requires only 2% to 3% excess oxygen, or 10% to 15% excess air in the flue gas, to burn fuel without forming excessive carbon monoxide. Most gas burners exhibit turndown ratios of 10:1 or 12:1 with little or no loss in combustion efficiency. Some burners offer turndowns of 20:1 on oil and up to 35:1 on gas. A higher turndown ratio reduces burner starts, provides better load control, saves wear and tear on the burner, reduces refractory wear, reduces purge-air requirements, and provides fuel savings.

Savings Evaluation for Digital Combustion Controls				
L.G. Nourse School				
Input Information			**Proposed Usage and Cost Calculation**	
Proposed Measure	BLR Controls		Total Project Cost	$59,000.00
Existing Therm Usage	30,220		Incentive	$0.00
Existing Cost	$33,242.00		Net Cost	$59,000.00
Assumed Savings %	7%		Therm Savings	2,115
Proposed Therm Usage	28,105		kWh Savings	2,567
Proposed Cost	$30,915.06		Total Cost Savings	$2,737.66
			Simple Payback (Yrs)	21.55
Therm Savings	2,115.40		100%	Percent of Total Building Usage
kWh Savings from VFD	2,567.00		30,220	Total Usage
$/Therm	$1.10			
$/kWh	$0.16			
Therm Cost Savings	$2,326.94		Install (2) units, one on each boiler	
kWh Cost Savings	$410.72			

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Mechanical Measures

Norton Solmonese School

ECM-1: Install High Efficiency Digital Burner Controls on Existing Boilers

The purpose of the burner is to mix molecules of fuel with molecules of air. A boiler will run only as well as the burner performs. Burners are designed to maximize combustion efficiency while minimizing the release of emissions. A power burner mechanically mixes fuel and combustion air and injects the mixture into the combustion chamber. All power burners essentially provide complete combustion while maintaining flame stabilization over a range of firing rates. Different burners, however, require different amounts of excess air and have different turndown ratios. An efficient natural gas burner requires only 2% to 3% excess oxygen, or 10% to 15% excess air in the flue gas, to burn fuel without forming excessive carbon monoxide. Most gas burners exhibit turndown ratios of 10:1 or 12:1 with little or no loss in combustion efficiency. Some burners offer turndowns of 20:1 on oil and up to 35:1 on gas. A higher turndown ratio reduces burner starts, provides better load control, saves wear and tear on the burner, reduces refractory wear, reduces purge-air requirements, and provides fuel savings.

Savings Evaluation for Digital Combustion Controls				
Solmonese School				
Input Information			**Proposed Usage and Cost Calculation**	
Proposed Measure	BLR Controls		Total Project Cost	$59,000.00
Existing Therm Usage	27,769		Incentive	$0.00
Existing Cost	$30,545.90		Net Cost	$59,000.00
Assumed Savings %	7%		Therm Savings	1,944
Proposed Therm Usage	25,825		kWh Savings	2,081
Proposed Cost	$28,407.69		Total Cost Savings	$2,471.17
			Simple Payback (Yrs)	23.88
Therm Savings	1,943.83		100%	Percent of Total Building Usage
kWh Savings from VFD	2,081.00		27,769	Total Usage
$/Therm	$1.10			
$/kWh	$0.16			
Therm Cost Savings	$2,138.21		Install (2) units, one on each boiler	
kWh Cost Savings	$332.96			

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Town of Norton

Mechanical Measures

Norton Yelle School

ECM-1: Replace defective steam traps

The Yelle School has an old steam system that operates steam heat in the original section of the building. The steam is also used in conjunction with a heat exchanger to create hot water for a section of the building that was renovated in the 50s. The system is very old and past its useful life. According to onsite staff the steam traps have not been evaluated since approx. 2005. Steam traps should be evaluated annually to ensure proper operation.

A steam system is designed to transport energy from a central location - the boiler - to remote locations in the plant, building, or operating complex. A properly designed and maintained system can lower energy, maintenance and operational costs by promoting system efficiency. To accomplish this efficiency demands that the condensate be removed from the piping as soon as it forms. Water moving along the bottom of the pipe can be effectively discharged with an automatic valve called a steam trap. An efficient steam trap must do more than just remove condensate. It must minimize steam loss, have a long and dependable service life, resist corrosion, vent air and CO2 which can form corrosive carbonic acid, operate even in the presence of dirt and scale, and operate against the system's back pressure.

The steam system will need to be evaluated to determine the level of failure. Using average failure rates, we can estimate the level of failure and saving shown below.

Steam Trap Replacement Saving Calculations

Input Information	
Equipment	Steam Traps
Estimated Total Traps	50
Steam Cost ($/1000 lbs)	10
Steam Pressure (lbs)	5.00
Average Oriface Size (Inches)	0.25
Annual Run Hours	1,700
Estimated Rate of Failure	30%
Daily Steam Loss/Trap (lbs)	138.31
Annual Losses/Trap	$504.85
Total Estimated Savings	$7,573.00

Proposed Usage and Cost Calculation	
Total Project Cost	**$12,000.00**
Incentive	**$6,000.00**
Net Cost	**$6,000.00**
Therm Savings	**6,885**
Cost Savings	**$7,573.00**
Simple Payback (Yrs)	**0.79**

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Town of Norton

Mechanical Measures

Norton Yelle School

ECM-2: Advanced Energy Study

The Yelle School building was built during the 1950s. The last renovation occurred in 2005. Most of the mechanical systems are over 30 years old. They are antiquated and well past their useful life. It may be difficult to retrofit or adjust mechanical equipment with energy saving technologies and strategies due to the equipment's age. Large scale, system wide replacements would be necessary. A more advanced study of the mechanical system would be needed to determine potential savings strategies. However, by comparing the building to similar type buildings we can estimate the buildings potential for energy savings.

To estimate the potential for savings we can compare the space's Kbtus/Sqft to known averages for electricity and heating fuel for similar building usage and type. This Energy Usage Index can be used to determine the building's savings potential overall.

EUI Reduction Analysis to Establish Total Potential Savings Opportunity

Norton Yelle Elementary School

Standard Data				Cost / Kbtu	Facility Type	Average EUI for Selected Facility Type	
Cost per KWH	$0.11	KWH	Bldg Sqft	$0.03223916	Elementary School	Electric	Other Heating Fuel
Cost Per Heating Fuel	$1.10	Therm	82,946	$0.01100000		35	50

Building Specific Usage Data

Electrical			
Kwh	Usage	EUI	Kbtu's
KWH	0	0	-

Other Heating Fuel			
Unit	Usage	EUI	Kbtu's
Therm	88,742	106.99	8,874,200

Comparision of the Building vs Other Similar Local Facility Types (Deviation from the Average)

EUI Dev (Elec)	Elec Dev %	Elec Dev KBTU Usage	Cost Dev Elec
0.00	#DIV/0!	0	**$0.00**

EUI DEV (Htg)	Htg Dev %	Htg Dev KBTU Usage	Cost Dev Htg
56.99	53%	4,726,900	**$51,995.90**

Summary of Outcomes and Potential Savings from Deviation	
Potential KBTU Savings	4,726,900
Potential KBTU Savings %	53.27%
Potential Therm Savings	47,269
Potential Therm Savings %	53.27%
Potential KWH Savings	#DIV/0!
Potential KWH Savings %	#DIV/0!
Potential Cost Savings	$51,995.90
Potential Cost Savings %	53.27%

Summary of Potential Total Project Cost and Savings Estimates	
Estimated Total Project Cost	$98,000.00
Estimated Project Incentive	$0.00
Estimated Net Cost	$98,000.00
Total Potential Savings	$51,995.90
Simple Payback (years)	1.88

nationalgrid Project Expediter

Energy Conservation, Inc.
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Hanson, MA 02341
ECI-NE.com

Energy Saving Lighting Improvements for:

Town of Norton Council on Aging

Norton Council on Aging
55 W. Main St
Norton, MA 02766

Line Number	Space Description	Existing system description	Existing Quantity	Proposed Retrofit - New system description	Proposed Quantity	Total kWh Savings
1	Common Area	2 x 4 Recessed Troffer	15	New 2x4 Recessed Troffer W/Sensor	15	1,082
2	Kitchen	2 x 4 Recessed Troffer	1	New 2x4 Recessed Troffer W/Sensor	1	72
3	Kitchen	2' Strip Fixture	1	Retrofit Remphos Linear Transformer 2' 1-Lamp	1	51
4	Hallway	2 x 2 Recessed Troffer	1	New 2x2 Recessed Troffer W/Sensor	1	152
5	Storage	4' Strip Fixture	1	Retrofit 4' Strip 15w 2059lm 4000k	1	82
6	Restroom	2 x 4 Recessed Troffer	2	New 2x4 Recessed Troffer W/Sensor	2	144
7	Hallway	2 x 4 Recessed Troffer	3	New 2x4 Recessed Troffer W/Sensor	3	216
8	Office	2 x 4 Recessed Troffer	2	New 2x4 Recessed Troffer W/Sensor	2	144
9	Common Area	2 x 4 Recessed Troffer	1	New 2x4 Recessed Troffer W/Sensor	1	127
10	Storage	2 x 4 Recessed Troffer	1	New 2x4 Recessed Troffer W/Sensor	1	322
11	Exterior	A-Lamp	4	Retrofit Philips A19 Screw In	4	421
12	Exterior	Flood Light	1	New Flood 27w Trunion	1	177
705	Switching & Controls	Wall Switch	0	63A Integral Fixture Mounted Dual Sensors and Controllers	26	403
			33		**59**	**3,393**

Total Project Cost	**$13,535**
Estimated National Grid Incentive	**$2,890**
Norton Council on Aging Net Cost	**$10,645**
Annual Electric Cost Savings	**$580**
Annual Fixture Maintenance Savings	**$66**
Annual Cost Savings	**$646**
Simple Payback in years	**16.47**

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Energy Saving Lighting Improvements for:

Norton Wetherell Fire Station

Town of Norton
25 South Worcester St
Norton, MA 02766

Line Number	Space Description	Existing system description	Existing Quantity	Proposed Retrofit - New system description	Proposed Quantity	Total kWh Savings
1	Garage	8' Strip Fixture	8	Retrofit BarkitJ-MO 4' 2-Lamp 30w	16	212
2	Locker Room	8' Wide Wrap Fixture	2	New Wide Wrap 8ft. Wrap 29w	2	85
3	Dormitory	8' Wide Wrap Fixture	1	New Wide Wrap 8ft. Wrap 29w	1	162
4	Stairwell	8' Wide Wrap Fixture	1	New Wide Wrap 8ft. Wrap 29w	1	42
5	Kitchen	8' Wide Wrap Fixture	1	New Wide Wrap 8ft. Wrap 29w	1	42
6	Kitchen	A-Lamp	2	A19 Lamp 11w	2	50
7	Kitchen	4' Wrap Fixture	1	New Wide Wrap 4ft. Wrap 16w	1	22
8	Common Area	4' Strip Fixture	3	New RAB 2x4 Flat Panel 30w	3	46
9	Restroom	4' Strip Fixture	1	Retrofit BarkitJ-MO 4' 1-Lamp 15w	1	23
10	Mechanical Room	A-Lamp	1	Retrofit Downlight 7in 10w	1	25
11	Exterior	Flood Light	2	New 2 Head Flood with Motion	1	64
12	Exterior	Flood Light	1	New Flood 27w	1	87
			24		**31**	**861**

Total Project Cost	**$5,865**
Estimated National Grid Incentive	**$1,010**
Town of Norton Net Cost	**$4,855**
Annual Electric Cost Savings	**$147**
Annual Fixture Maintenance Savings	**$62**
Annual Cost Savings	**$209**
Simple Payback in years	**23.20**

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Energy Saving Lighting Improvements for:

Norton Historical Society

Town of Norton Ma
18 W Main St.
Norton, MA 02766

Line Number	Space Description	Existing system description	Existing Quantity	Proposed Retrofit - New system description	Proposed Quantity	Total kWh Savings
1	Exterior	Flood Light	11	New 2 Head Flood with Motion	4	1,461
2	Common Area	A-Lamp	6	Retrofit Downlight 7in 10w	6	601
3	Common Area	2' Strip Fixture	1	Retrofit BarkitJ 2' 1-Lamp 10w	1	44
4	Restroom	A-Lamp	1	Retrofit Downlight 7in 10w	1	100
5	Restroom	A-Lamp	2	A19 Lamp 11w	2	196
6	Storage	8' Strip Fixture	9	Retrofit BarkitJ-MO 4' 2-Lamp 30w	9	2,580
7	Storage	A-Lamp	2	Retrofit Downlight 7in 10w	2	200
8	Corridor	6 Inch Recessed Downlight	1	Retrofit 6in Downlight 14w	1	92
9	Common Area	12" Square Recessed Downlight	16	A21 Lamp 16w	16	2,373
10	Common Area	6 Inch Recessed Downlight	1	Retrofit 6in Downlight 14w	1	92
11	Exterior	Flood Light	2	BR40 Lamp 12w	2	253
			52		**45**	**7,994**

Total Project Cost	**$6,746**
Estimated National Grid Incentive	**$195**
Town of Norton Ma Net Cost	**$6,551**
Annual Electric Cost Savings	**$1,367**
Annual Fixture Maintenance Savings	**$90**
Annual Cost Savings	**$1,457**
Simple Payback in years	**4.50**

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Energy Saving Lighting Improvements for:

Edith Reed Conservation

Town of Norton

79 N Worcester Street

Norton, MA 02766

Line Number	Space Description	Existing system description	Existing Quantity	Proposed Retrofit - New system description	Proposed Quantity	Total kWh Savings
1	Common Area	1 x 4 Wraparound Fixture	8	New ASD 4' Premium Strip Light 24w	8	144
2	Common Area	2 x 4 Wraparound Fixture	2	New ASD 4' Premium Strip Light 24w	4	64
3	Restroom	Ceiling Surface Mount	3	Retrofit A19 Lamp 11w	3	26
4	Medical Room	1 x 4 Wraparound Fixture	1	New ASD 4' Premium Strip Light 24w	1	18
5	Exterior	Ceiling Surface Mount	2	Retrofit PAR38 Lamp 12w	1	69
6	Restroom	1 x 4 Wraparound Fixture	1	New ASD 4' Premium Strip Light 24w	1	18
7	Exterior	Wall Pack - Exterior	4	New Wall Pack 20w	4	16
			21		**22**	**355**

Total Project Cost	**$4,346**
Estimated National Grid Incentive	**$980**
Town of Norton Net Cost	**$3,366**
Annual Electric Cost Savings	**$67**
Annual Fixture Maintenance Savings	**$44**
Annual Cost Savings	**$111**
Simple Payback in years	**30.22**

Upon project completion, complete the following table ***BLUE CELLS*** *, with a row for every unique combination of variables in the table. Send to MAPC as an Excel file, along with backup invoices for material and labor costs and documentation of the utility incentive. If utility incentive covered both cobra and non-cobrahead lights, submit a breakdown of the kWh savings associated with each. MAPC will review and discuss any changes with you and the town. When all parties agree it is complete and accurate, print it out and the Chief Executive of the municipality sign the form below.*

v.2/21/2019

Table 2A. Data for Final Standard MAPC-DOER Incentive

Municipality:	**Town of Norton**	**CEO Title:**	**Town Manager**	**CEO Name:**	**Michael Yunits**	**CEO Signature & Date:**	
Savings Calculated on Utility Documentation for Cobraheads (kWH):	**173,367**	**Reported Utility Incentive for Cobraheads, if Known (dollars):**	**$38,446.25**	**Installer:**	**Dagle Electric**	**Utility:**	**National Grid**
Total Cobreahs Retrofitted	**561**	**Total Material Costs**	**#REF!**	**Total Labor Costs**			**#REF!**

LED Brand	LED Model #	LED Wattage	Existing Light Wattage (nominal)	Existing Light Type (MV, HPS, Incandescent)	Advanced Control Installed (Motion Sensor, Timer, or Wireless Control)	Total Fixtures Replaced	LED Lumen Output	Existing Light Lumen Output	LED Color Temperature (Kelvin)	Existing Light Color Temperature (Kelvin)	Cobrahead Installation Cost (install, fusing, 3-15ft re-wiring)	Cobrahead Material Cost (luminaire, standard photocell, fuses) Do not include wireless controls costs.
Acuity Brands	118W_ATBM P30 MVOLT R2 3K MP NL P7	118	250	HPS	None	2	14637		3000K		$173.77	$227.93
Acuity Brands	118W_ATBM P30 MVOLT R2 3K MP NL P7	118	400	HPS	None	3	14637		3000K		$173.77	$227.93
Acuity Brands	23W_ATBX P30 MVOLT R2 3K MP NL P7	23	100	HPS	None	64	2455		3000K		$173.77	$120.87
Acuity Brands	23W_ATBX P30 MVOLT R2 3K MP NL P7	23	250	HPS	None	1	2455		3000K		$173.77	$120.87
Acuity Brands	23W_ATBX P30 MVOLT R2 3K MP NL P7	23	50	HPS	None	316	2455		3000K		$173.77	$120.87
Acuity Brands	23W_ATBX P30 MVOLT R2 3K MP NL P7	23	70	HPS	None	1	2455		3000K		$173.77	$120.87
Acuity Brands	28W_ATBX P40 MVOLT R2 3K MP NL P7	28	100	HPS	None	14	3603		3000K		$173.77	$120.87
Acuity Brands	28W_ATBX P40 MVOLT R2 3K MP NL P7	28	150	HPS	None	7	3603		3000K		$173.77	$120.87
Acuity Brands	28W_ATBX P40 MVOLT R2 3K MP NL P7	28	50	HPS	None	92	3603		3000K		$173.77	$120.87
Acuity Brands	40W_ATBS P10 MVOLT R2 3K MP NL P7	40	100	HPS	None	9	5360		3000K		$173.77	$148.41
Acuity Brands	40W_ATBS P10 MVOLT R2 3K MP NL P7	40	250	HPS	None	4	5360		3000K		$173.77	$148.41
Acuity Brands	40W_ATBS P10 MVOLT R2 3K MP NL P7	40	50	HPS	None	20	5360		3000K		$173.77	$148.41
Acuity Brands	50W_ATBS P20 MVOLT R2 3K MP NL P7	50	100	HPS	None	3	6707		3000K		$173.77	$167.18
Acuity Brands	50W_ATBS P20 MVOLT R2 3K MP NL P7	50	150	HPS	None	1	6707		3000K		$173.77	$167.18
Acuity Brands	50W_ATBS P20 MVOLT R2 3K MP NL P7	50	250	HPS	None	22	6707		3000K		$173.77	$167.18
Acuity Brands	50W_ATBS P20 MVOLT R2 3K MP NL P7	50	400	HPS	None	1	6707		3000K		$173.77	$167.18
Acuity Brands	68W_ATBM P05 MVOLT R2 3K MP NL P7	68	250	HPS	None	1	9396		3000K		$173.77	$194.80

Final Standard Grant							
M&L Total:	#REF!	**Utility Incentive** (Uses reported incentive. If not yet reported, uses MAPC estimate. We will not finalize grant until there is a reported incentive)	$ 38,446	**Net M&L After Subtracting Utility Incentive:**	#REF!	**Standard Grant: 30% of Net**	**#REF!**

Final Total Grant		Municipality Name
Standard Grant + Wireless Controls Grant	**#REF!**	Town of Norton

v.7/26/2018

Calculation of Total Costs and Utility Incentives (*Totals at bottom)*							
Calcualted Costs from T2		**Calculation of Savings & Utility Based on Pre and Post Wattages in T2**					
Total: Material Cost	**Total: Labor Cost**	**Per Light: Annual kWh Pre-Retrofit**	**Per Light: Annual kWh Post-Retrofit**	**Per Light: Annual kWh Savings**	**Per Standard Control: Annual kWh Savings**	**Total: Annual kWh Savings**	**Total: Utility Incentive @ 0.25/kWh**
$ 456	$ 348	1232	493	739	0	1,478	$ 369
$ 684	$ 521	1921	493	1428	0	4,284	$ 1,071
$ 7,736	$ 11,121	543	96	447	0	28,590	$ 7,148
$ 121	$ 174	1232	96	1136	0	1,136	$ 284
$ 38,195	$ 54,912	271	96	175	0	55,411	$ 13,853
$ 121	$ 174	376	96	280	0	280	$ 70
$ 1,692	$ 2,433	543	117	426	0	5,962	$ 1,490
$ 846	$ 1,216	793	117	676	0	4,734	$ 1,184
$ 11,120	$ 15,987	271	117	154	0	14,212	$ 3,553
$ 1,336	$ 1,564	543	167	376	0	3,382	$ 845
$ 594	$ 695	1232	167	1065	0	4,259	$ 1,065
$ 2,968	$ 3,475	271	167	104	0	2,088	$ 522
$ 502	$ 521	543	209	334	0	1,002	$ 251
$ 167	$ 174	793	209	585	0	585	$ 146
$ 3,678	$ 3,823	1232	209	1023	0	22,503	$ 5,626
$ 167	$ 174	1921	209	1712	0	1,712	$ 428
$ 195	$ 174	1232	284	948	0	948	$ 237
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Totals Below							
#REF!	**#REF!**					**#REF!**	**#REF!**

Quantities

	Table 2 - data from N.Grid	Invoices	Net	Individual Invoices				
Installed Lights	561	561	0	561				
Installed Fuses	561	683	122	683				
Photocells	561	686	125	122	564			
Gateways		0	0					
Fuses	561	683	122	683				
Neutral	561	683	122	683				
Holder	561	683	122	683				
Model Breakout	**561**	**575**	14					
23 W	382	390	8	6	384			
28 W	113	116	3	3	113			
40 W	33	34	1	33	1			
50 W	27	28	1	27	1			
68 W	1	2	1	2				
118 W	5	5	0	5				
		0	0					

Material Cost

	Table 2 Material Cost	Invoices						Net	
		Luminare	Photocell	Fusing	Labels	Extra Fusing for Re	Total		
23 W	$120.90	$105.00	$14.89		$0.98		$120.87	($0.03)	adjusted in final table 2
28 W	$120.90	$105.00	$14.89		$0.98		$120.87	($0.03)	
40 W	$148.44	$132.54	$14.89		$0.98		$148.41	($0.03)	
50 W	$167.21	$151.31	$14.89		$0.98		$167.18	($0.03)	
68 W	$194.83	$178.93	$14.89		$0.98		$194.80	($0.03)	
118 W	$227.96	$212.06	$14.89		$0.98		$227.93	($0.03)	

Install Cost							
	Table 2 Install Cost	**Cobrahead**	**Fuse**	**High Voltage Cl**	**Re-Wiring**	**Total**	**Net**
Cobrahead	173.77	$ 89.00	$ 81.00		$ 3.77	**$ 173.77**	$ (0.00)

Utility Incentive	$ 38,446.25
Total Savings	173,367
Non-Cobra Savings	-
Percent Cobra Savings	1
Utility Incentive to Apply	$ 38,446.25

		National Grid Custom Lighting Tool		Eversource DPRS Sheet		
	Nominal Wattage	Actual Wattage	Annual Billed kWh	Annual Billed kWh	Actual Wattage - Eversource	
MV Rdw	175	205	856	894.60	213	*haven't verified this one
HPS Rdw	50	65	271	243.60	58	
HPS Rdw	70	90	376	361.20	86	
HPS Rdw	100	130	543	491.40	117	
HPS Rdw	150	190	793	735	175	
HPS Rdw	250	295	1,232	1239	295	
HPS Rdw	400	460	1,921	1974	470	

Burn-Time Hours	
National Grid	Eversource
4175	4200

	Standard Controls Savings (% of Annual kWh)
National Grid	0%

Make a selection

#1. I commit that the municipality has implemented a dimming or On/Off schedule such that the combined energy of the LED streetlight and the wireless control node is lower, on an annual basis, than the LED alone (i.e. net energy reduction). I further committ that my municipality intends to continue using wireless controls to achieve a net energy reduction as long as they are installed.
#2. The municipality is currently experimenting with appropriate dimming schedules and levels for wireless controls. I committ that within three months, the municipality WILL implement a dimming or On/Off schedule such that the combined energy of the LED streetlight and the wireless control node WILL BE lower, on an annual basis, than the LED alone (i.e. net energy reduction). I further committ that my municipality intends to continue using wireless controls to achieve a net energy reduction as long as they are installed.

Cellular
Radio-Frequency