SHELTER ISLAND
MASHOMACK PRESERVE

SUSTAINABILITY STRATEGIES FOR RENOVATING IN A SENSITIVE ECOSYSTEM

CLIENT
The Nature Conservancy

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Mashomack Preserve, © Pam Pospisil

The Columbia University student team visiting Mashomack Preserve on February 4, 2012.

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The Mashomack Preserve Spring 2012 Capstone Team
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Mashomack Preserve, © TNC

Shelter Island Mashomack Preserve in the Fall

EXECUTIVE SUMMARY

Sustainable Renovations on the Mashomack Preserve

The Nature Conservancy (TNC) strives to protect the beautiful and diverse ecosystems that make up its Mashomack Preserve, located off the tip of Long Island on Shelter Island, New York. The roughly 2,000-acre Preserve is home to a unique ecosystem and eight buildings – most of which date to the late 19th Century – that are in need of renovation. The Manor House is the main structure and the focus of this report. Of the seven other buildings situated on the property, all but the Director's House and Visitor Center are used much less frequently than the Manor House. The Visitor Center has already been retrofitted to exhibit sustainable features, but the other buildings will benefit from upgrades that increase comfort and performance while reducing harm to the surrounding environment.

TNC's goals for the renovation of Mashomack's buildings are several. They aim to mitigate and plan for climate change while demonstrating their mission to preserve the planet's precious biodiversity. This goal operates in concert with planned efforts to increase fundraising activity, which will add to their already 25-30 thousand annual visitors.[1] Unless the buildings' current impacts are reduced, the resulting surge in their operational loads will place additional pressure on the Preserve's delicate ecology. This report identifies, evaluates and presents numerous opportunities for The Nature Conservancy to accomplish such objectives in the unique local setting of Shelter Island.

The Unique Ecology on Mashomack Preserve

Mashomack Preserve protects the unique and bustling ecosystems on one third of Shelter Island. The Preserve's varied landscape provides habitat for a diverse and interconnected web of plant and animal species. Nearly 80 species of resident birds, 20 species of mammals, 22 species of amphibians and reptiles, and countless other marine plants and animals reside on the Preserve.

Economists have long struggled to place a price on the value of nature. However, recent thought regarding the worth of various species and environmental features, especially related to the material benefit humans reap from these features and processes, has led to the development of the concept of ecosystem services. Although it would be exceedingly difficult to assign an explicit dollar value to the ecosystem services provided by and the intrinsic value of Mashomack Preserve, it is with these values in mind that this assessment for sustainably renovating the buildings on site has been undertaken. The actions proposed within this report will reduce human impact on the surrounding environment and prevent the loss of priceless ecosystems.

A Sustainable Solution for Mashomack Preserve

To address the challenge of reducing the Preserve buildings' footprints, this report suggests several strategies and technologies that aim to minimize impact on the environment and indeed to effect ecological enhancement where possible. Three main categories of sustainability strategies explored here were determined to have the highest potential to decrease resource use and pollution potential among the facilities. These are water conservation and wastewater management, energy efficiency, and renewable energy. These focus areas were determined to have the most potential to decrease resource use as well as reduce the environmental impact potential of the facilities. Within each of these broad categories are presented the best practices, state-of-the-art green building techniques, strategies, and technologies appropriate for the upgrade of the Preserve buildings.

Thirty-nine distinct opportunities have been identified with another ten that are sub-opportunities or those that we are not recommending; therefore, the report also presents a tool to prioritize the actions. Under the three analysis areas, opportunities are ordered in a progression from the most important to least important items to pursue. In all cases, it is vital to first establish baseline consumption to determine what the best next steps are. Additional graphics help illustrate how specific recommendations will address particular goals.

AREA 1: Water Conservation & Wastewater Management - Preserving the Natural Source

Water consumption patterns need to be critically considered for any building but especially for those located on islands. Mashomack's sole source of potable water is the local aquifer, which is cut off from mainland supplies. The geological constraints on the aquifer and threat of drought pose risks to the Preserve's ability to support the diverse range of species, habitats, and activities that it currently enjoys. Conservation and replenishment of groundwater supplies is of vital importance to this task. Of additional concern is wastewater treatment on the Preserve. Given the absence of municipal sewer services on Shelter Island, wastewater is treated on-site. Insufficient treatment of effluents by such systems can lead to harmful levels of nitrates polluting groundwater supplies. This is a particularly crucial issue for Long Island, and one that is being prioritized by the New York State Department of Environmental Protection (DEP).

Three key issues are explained and addressed in the water conservation and wastewater management section of this report. They are optimizing groundwater recharge, reducing water consumption, and minimizing nitrate emissions from the on-site wastewater treatment systems (OWTS). All of the opportunities within these categories will help the Preserve reduce its water footprint as well as the negative impacts that wastewater treatment practices may have on the surrounding environment.

AREA 2: Energy Efficiency - Reducing Mashomack's Energy Consumption

Scientists have attributed the increase in greenhouse gas (GHG) emissions observed since the Industrial Revolution to human activity. The Earth's atmosphere, which makes the planet habitable, is composed of these greenhouse gasses. Research shows that anthropogenic GHG emissions are the main driver of global climate change. Buildings are a major contributor to global GHG emissions, and the Intergovernmental Panel on Climate Change (IPCC) recommends the aggressive reduction of buildings' carbon footprints to mitigate future climate change.[2] While the effects of these emissions might not be felt directly at the site of consumption, the general increase of greenhouse gases in the atmosphere are observed everywhere and energy efficiency measures taken at Mashomack are a crucial step towards achieving Mashomack's future goals.

Fuel oil use for heating purposes, combined with a substandard building envelope, was identified as Mashomack's main energy efficiency obstacle. A lack of weatherization, such as inadequately sealed windows and doors, plus insufficient insulation in the exterior walls, roof and basement, demand that the Manor House consume more fuel oil than should be necessary. In addition to the excess GHG emissions produced by these inefficiencies, frequent re-filling of the underground fuel oil storage tank causes structural pressure that increases the chance of leakage into the surrounding soil and from there into groundwater supplies. The goal outlined in the energy efficiency section is for Mashomack to reduce the overall energy load in several stages. The phases are benchmarking, weatherization, passive conditioning, fuel-based efficiency, electric efficiency and general best practices. Taken as a whole or in parts, opportunities within each of the aforementioned categories will reduce the buildings' ecological impact on the Preserve.

AREA 3: Renewable Energy - Harnessing Nature's Power

Regardless of the energy efficiency measures that are implemented at Mashomack, some amount of energy will still be required, and the campus will remain tied to the electricity grid as provided by the Long Island Power Authority (LIPA). To further reduce this demand, Mashomack may install on-site renewable energy technologies that take advantage of the natural, regenerative energy sources available on site.

Four types of renewable energy were considered. They are wind, solar, hydropower, and biomass. The analysis of renewable energy in this report addresses the suitability of commercially available technologies and relates them directly to the Mashomack building energy needs. It is unlikely that renewable energy will be able to completely replace fossil fuel based sources, but it can supplement these requirements and facilitate the Preserve's eventual transition away from reliance on the grid. In collaboration with energy efficiency efforts, the application of renewable energy will have a substantial climate change mitigation impact.

Prioritization

Explanatory graphics and charts were developed to assist readers in navigating the various opportunities described herein. The following page features a comprehensive matrix that lists all of the identified opportunities and delineates which project goals opportunity satisfies (Figure 1). This visual is intended to assist the user in determining which of the recommended opportunities is most worth pursuing. Similarly, an Opportunity Feasibility Matrix is located at the conclusion of each of the three target area sections displays how the opportunities compare to one another with regard to relative environmental benefit and feasibility. Both frameworks lend further meaning and increased usefulness to this report.

Report Intent & Purpose

This report aims to facilitate conversation regarding a sustainably-minded upgrade of the buildings on the Preserve among The Nature Conservancy, Mashomack employees, and other Preserve stakeholders. While historic and alluring, the 1800s-era buildings are not beacons of energy and resource efficiency. The recommendations presented in this report do not dictate an implementation path. Rather, they should guide the decision-making process and help to prioritize the options for addressing TNC's goals. This report is also intended to facilitate communication with engineers, architects and contractors who will use their expertise to implement the recommendations to maximum effect given specific site conditions.

Mashomack Preserve is a unique property, especially considering its proximity to a major global metropolis. The beloved Preserve's beautiful and pristine ecosystems are a testament the preservation efforts of The Nature Conservancy and Shelter Island locals alike. This report strives to ensure that the Preserve's mission may continue even in the face of climate change and increased human impact. The strategies suggested to sustainably renovate the buildings on the Preserve will help to maintain, if not improve, their unique natural setting for years to come.

REFERENCES

1 Laspia, Michael, interview by Eileen Quigley, et al. Preserve Director (February 4, 2012).

2 "Climate Change 2007: Working Group III: Mitigation of Climate Change." IPCC Fourth Assessment Report: Climate Change 2007."Intergovernmental Panel on Climate Change, 2012. Web. 16 Apr 2012.

Opposite Page, Figure 1 -Comprehensive Opportunity Impact Matrix[18]

LEGEND

- P — Prerequisite: Should be addressed within the strategy area before other opportunities can be implemented to their fullest efficacy
- CO_2 — Air Quality: Will improve or maintain the air quality of the Preserve
- GHG emissions: Will reduce or maintain the level of greenhouse gases being emitted due to Preserve operations
- Water conservation: Will improve or maintain the amount of potable water that is stored in the aquifer
- Water quality: Will improve or maintain the integrity of the water that is stored in the aquifer
- Ecosystem: Will reduce the impact of the Preserve's operations on the local ecosystem
- Outreach: Will help address the Preserve's goals of fund raising, increasing occupancy, and educating visitors

Fig 1. COMPREHENSIVE OPPORTUNITY IMPACT MATRIX

OPPORTUNITIES		PREREQUISITES	AIR QUALITY	GHG EMISSIONS	WATER CONSERV.	WATER QUALITY	ECOSYSTEM	OUTREACH
Water Conservation Opportunities								
WCO 1	Measure and document - water audit; water meters	●						●
WCO 2	Implement water conserving behaviors				●	●	●	●
WCO 3	Install water conserving technologies - toilets; water fixtures; gardening				●		●	●
WCO 4	Institute best practices during construction	●			●		●	●
WCO 5	Collect and use rainwater - storage of water; toilet recharge; watering				●		●	●
WCO 6	Optimize groundwater recharge					●	●	●
WCO 7	Decomission unused water wells					●	●	●
WCO 8	Test well water	●				●	●	●
WCO 9	Consider desalination options			●	●		●	●
Wastewater Management Opportunities								
WMO 1	Modify or Replace OWTS - evaluate first; Nitrex system					●	●	●
Efficiency Evaluation								
EEO 1	Perform Energy Star benchmarking	●						
EEO 2	Perform blower door test	●						
Weatherization								
EEO 3	Seal the envelope		●	●			●	
EEO 4	Protect basement and attic		●	●			●	
EEO 5	Explore supplemental window insulation		●	●			●	
EEO 6	Install storm windows		●	●			●	
Passive Conditioning								
EEO 7	Create window shading through shutters		●	●			●	
EEO 8	Implement natural shading through planting		●	●			●	
EEO 9	Install outdoor entryway plantings		●	●			●	
EEO 10	Use natural wind breaks		●	●			●	
EEO 11	Utilize sun space		●	●			●	
EEO 12	Exploit stack effect for passive cooling		●	●			●	
Fuel Based Efficiency								
EEO 13A	Implement boiler upgrades			●				
EEO 13B	Forego boiler upgrades and replace existing			●				
EEO 13C	Explore supplemental heating upgrades		●				●	
EEO 14	Upgrade hot water heater insulation		●	●	●			
Electric Efficiency								
EEO 15	Upgrade indoor lighting			●				
EEO 16	Evaluate lighting automation			●				
EEO 17	Utilize natural light shelves			●				
EEO 18	Evaluate mechanical air conditioning			●				
EEO 19	Replace or remove walk-in refrigerator			●				
Best Practices								
EEO 20	Control plug load and computing			●				●
Renewable Energy								
REO 1	Solar thermal hot water generation		●	●			●	●
REO 2	Wind and solar-powered outdoor lighting						●	
REO 3	Solar electric energy			●			●	●
REO 4	Woody biomass energy			●			●	●
REO 5	Small wind turbine energy			●			●	●
REO 6	Tidal power energy		●	●				●
Sustainable Materials Selection								
	Paint and coating		●				●	
	Cleaning materials and process		●			●	●	

Mashomack Preserve, © Margo Weiss

One of the sandy beaches on Mashomack's pristine shoreline.

INTRODUCTION

Background

Nestled between the North and South Forks of the Long Island Sound is Shelter Island, here lies an ecological gem. The Mashomack Preserve, henceforth referred to as Mashomack or the Preserve, is an outstanding and mostly undeveloped marine coastal ecosystem – a rare find within driving distance of New York City, one of the most developed areas in the United States. The natural features and biodiversity on Mashomack make the ecosystem there especially vulnerable to human impact, including human-made climate change. The human drivers of climate change and the destabilization of the Earth's sensitive ecosystems include the conversion of land to agricultural use, increasing human population, urban sprawl, and natural resource harvesting and use. These lead to rising global temperatures, sea-level rise, changing weather patterns, which, along with localized pollution, cause fundamental shifts in ecosystem stability. As a result of these threats, beautiful and essential natural habitats such as those found on Mashomack are at risk of vanishing. Sea level rise is especially detrimental to island ecosystems like these.

From the early 1700s to the 1920s Mashomack was relatively sheltered from the aforementioned drivers of ecological instability. The Nicolls family once owned the land that makes up Mashomack today. During their tenure, the land was cleared for agricultural purposes but otherwise developed little. After the land left the Nicolls family possession, it passed through several owners before being leased to the Mashomack Fish and Game Club. During this period, interest in the property grew because at the time, Mashomack was the largest single land-holding on the Atlantic Coast between Boston and Washington, D.C. The Nature Conservancy (TNC), having taken notice of Mashomack's beautiful ecology, coastline estuaries, and sandy beaches, was one of the interested parties, and it embarked on a mission to preserve this valuable ecosystem and the flora and fauna that depend on it.

Founded in 1951, The Nature Conservancy is a leading international conservation organization dedicated to the preservation of biological diversity by identifying, protecting, and maintaining the best examples of rare and endangered species as well as their natural habitats. When faced with the issue of preserving Mashomack, TNC mounted the largest fundraising effort in its history and succeeded in buying the land.[1] TNC has owned and managed Mashomack since 1980 and promotes educational and recreational activities there, including scientific research and bird watching. Several buildings dating from the late 19th Century remain on site and serve as the main built facilities on the Preserve. They support the nine full time employees (FTEs) and eight part time or temporary employees who manage the Preserve and educate its 25-30,000 annual visitors. These visitors include donors, scientists, recreational hikers, nature enthusiasts and students. TNC plans to scale up efforts to expand awareness and fundraising for Mashomack. In their present state, the buildings will be insufficient to meet the needs of increased staff and visitors anticipated as a result of these efforts.[2]

As a flagship preserve of The Nature Conservancy, Mashomack is well positioned to influence conservation at a broader scale. Efforts to conserve it's terrestrial, freshwater, and marine resources using pioneering strategies will serve as models for replication that may become standards for conservation practitioners and will contribute to TNC's organization-wide global conservation goals. These goals include conserving critical lands, restoring the oceans and bays, securing fresh water, and reducing impacts of climate change.[3] Inefficient energy use creates a large carbon footprint, which has both local and global consequences. According to the draft 2012 Mashomack Conversation Plan, atmospheric deposition of nitrogen oxides, sulfur oxides, and mercury is a threat affecting all conservation targets at Mashomack Preserve and throughout the region.[4] Inadequate water stewardship may cause damage to the delicate local ecosystem. A guiding principle for the recommendations in this report is for humans and buildings to have a net-zero energy and water impact on Mashomack's environment. Net-zero doctrine dictates that energy usage is equal to or lower than energy generated on-site, and water independence is achieved by harvesting precipitation, managing storm water run-off, and the re-use of all household water. As a starting point, this ambitious sustainability principle demands the implementation of a program of water conservation and wastewater management strategies, energy efficiency measures, and renewable energy at Mashomack.

Objective and Methodology

This comprehensive feasibility report is provided to support TNC in their sustainability efforts at Mashomack. The negative impact of the Preserve's buildings on the sensitive local ecosystem must be recognized and mitigated, especially as demand on the buildings rises with increased use. This report identifies, evaluates and presents recommendations for best practices and/or state-of-the-art green building techniques, strategies, and technologies for the upgrade of Preserve buildings and the surrounding campus. It offers options to improve operations and conditions in the buildings both now and in the future. Post-implementation results will be high performance buildings with zero net ecological impact, particularly targeting net zero fossil fuel energy use. Recommendations are intended to help preserve and enhance natural habitats, improve hydrology on the site, and create an active and healthy environment that employees and visitors can be proud of. Moreover, this report furthers TNC's vision for the future of Mashomack by acknowledging it's educational, outreach, and fundraising missions.

The foci of this report are critical components of an overarching sustainability strategy. These foci are water conservation and wastewater management, energy efficiency, and renewable energy.[5]

The water section of this report covers areas of water use within the buildings and how to minimize impact on or even benefit the sensitive local water systems. The energy efficiency and renewable energy topics are related to the carbon footprint of the buildings on the surrounding environment as well as to the larger threat climate change poses to Mashomack. Reducing the energy load and generating carbon-free energy on-site is important for the long-term viability of the Preserve.

An initial survey of existing conditions was performed to put into context the current functionality, operational considerations, and environmental performance of the Manor House and surrounding buildings. The project methodology was then broken into phases: (1) data collection, (2) benchmarking, (3) analysis, and (4) recommendations.

The data collection phase involved gathering information in the following categories: environmental conditions, water and energy conservation technologies and strategies, wastewater management and energy use best practices, and renewable energy technologies. Data collection drew from building information supplied by the client, existing literature research, and interviews with experts, professionals, and other stakeholders. It focused on gathering information on current Mashomack facility issues and conditions, the ecosystem on Shelter Island, sustainable construction, and relevant case studies in order to understand the nature of the sensitive environment and make an educated evaluation of Mashomack.

The benchmarking phase included the development of energy, building, and climate profiles of the site. Other existing site conditions, including occupancy rates over the course of the year, were established from information discovered through site visits and client consultations.

During the analysis phase, each strategy was evaluated based on expected environmental impact and a net-zero doctrine. Based on this analysis, each strategy is presented along with highlighted advantages and disadvantages, environmental benefits and impacts, local viability of the technology, the approach's suitability for the specific conditions on the site, operational feasibility, and estimated cost. These strategies are guided by some potential technological synergies, ecosystem advantages or impacts, availability, and difficulty of implementation. While expense was not a deciding factor for recommending each opportunity, relative cost was included to help determine fundraising needs. Each strategy also accounts for the client's desire to retain the historical integrity of the existing buildings. Implicit in all evaluation criteria is the consideration of the action's environmental impact on the Preserve specifically as well as the global environment in general, in terms of air, soil, and water quality as well as any direct and/or indirect harm to flora and fauna. The strategies are presented in a progression from highest priority to least priority. This priority listing coincides with rising estimated costs and/or level of time and effort (T&E) involved in each. As such, recommendations may be implemented in the order presented. Finally, the report identifies suggested next steps to TNC.

Within each of the three strategy areas of Water Conservation & Wastewater Management, Energy Efficiency, and Renewable Energy, there is an Opportunity Feasibility Evaluation Matrix. They compare the opportunities within each section to each other based on environmental benefit and feasibility. Feasibility is situated on the vertical axis and shows that opportunities close to the top are more feasible than those on the bottom.

These matrices aim to guide decision making by identifying which of the many opportunities have hte highest environmental benefit while being relatively easy to implement. Opportunities that fall within the top right quadrant are both very beneficial to the environment and are highly feasible. It would be very favorable for Mashomack to pursue such opportunities.

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2 Ibid (Laspia 2012)

3 Kelley, Nancy, Mike Laspia, Mike Scheibel, Wayne Grothe, Joe Jannsen, and Jack Murrin. *Mashomack Preserve Conservation Plan – DRAFT.* Plan, The Nature Conservancy, 2012.

4 Ibid (Kelley, et al. 2012)

5 Ibid, (Laspia 2012)

Mashomack Preserve, © TNC

A view of the Manor House (looking west) during the Summer season, the busiest season at Mashomack Preserve.

GENERAL SITE CONDITIONS

To put the report's recommendations in context, a general summary of the ecology, climate conditions, and an overview of the buildings on the Preserve are discussed in this section. Unless otherwise noted, the information presented in this section was obtained from interviews conducted with Michael Laspia and Cynthia Belt of The Mashomack Preserve, as well as from Pamela Pospisil, the architect for Mashomack. Interviews occurred during a site visit on February 4, 2012. Additional information was obtained in correspondence throughout the course of the semester and as documented in the 2011 Property Condition Assessment Report performed by Schmitt Engineering.

Ecology

A walk through the Mashomack Preserve reveals a constantly changing landscape and a level of biodiversity uncommon for the region. There have been 22 species of amphibians and reptiles, nearly 80 species of resident birds, and 20 species of mammals documented on Mashomack. This remarkable count nonetheless excludes the plants and marine species on the Preserve as well as the countless migratory bird species that stop by the in their yearly journeys. They all find homes or temporary shelter among Mashomack's woodlands or uplands including wetlands; coastal areas including tidal creeks, salt ponds, dune, and beaches; and open fields. Each habitat is endowed with special living conditions, which make them attractive to particular plants, birds, or animals.

An area of particular note is the Pine Swamp Complex on the western edge of the Preserve. This wetland is the largest area of freshwater on Mashomack and has been designated by the New York State Department of Environmental Protection to be of "unique local importance."[1] A remarkable population of plant and animal species, four of which are unique to Mashomack, lives in the Pine Swamp Complex. The waters around Mashomack, famous for fish and shellfish, are particularly beautiful and serve important commercial and recreational functions. Fish from these waters comprise a main portion of the diet of resident harbor seals, mink, and osprey.

Much of Shelter Island's ecology was once similar to Mashomack's, however human settlement has reduced the pristine area to its current size. Even the Preserve itself is not untouched by humans. Forests were cleared in decades past to raise crops, create pasture, and plant orchards. Pigs were allowed to roam free, wreaking havoc on native vegetation. Invasive, non-native species introduced by humans remain a prominent conservation issue to this day and provide significant management challenges to TNC staff.[2] About 100 acres of land historically cleared for agriculture have been allowed to remain open as they provide habitat to native species that depend on the ecology of open fields.[3] Other areas have been restored to native forests.

Few of the previously mentioned human drivers that are damaging to the Earth's ecosystems exist on Shelter Island. Expansion of the built environment is limited and population has remained relatively steady. The island's economy is seasonal, however, and warmer months bring an influx of visitors that nearly quadruples its population to over 8,000 people. Many of these guests visit Mashomack and use its resources, especially water. In addition to local drivers of environmental harm, climate change may have a large impact on the Preserve's sensitive ecosystems in the future. Climate change is expected to increase the intensity and frequency of extreme weather events and to drive 25% of land animals and plants into extinction over the next 50 years.[4] By 2050, an estimated 1 million species will be lost. Climate change mitigation strategies are desperately needed in order to curb this loss. However, some level of change is expected regardless of future mitigation actions because of the GHGs already discharged into the atmosphere.[5]

Ecosystem Services

Biodiversity, the degree of variation of life within an area, holds incalculable value not just in a recreational or scientific sense, but also in an economic sense.[6] It embodies priceless worth through its role in providing or supporting various services we often take for granted such as clean air, clean water, pollination, and erosion prevention. Biodiversity allows for crop resistance to blight, provides plant-derived medicines, supplies raw materials for manufacturing, and enhances aesthetic experiences. It has even been shown that biodiversity has a positive correlation with ecosystem stability, resistance to extreme weather, and resilience from human exploitation.[7] Economists describe these benefits as ecosystem services and increasingly view them as integral to the smooth operation of human social and economic systems. Natural resources are vulnerable and finite, and the environmental impacts of human activities are becoming more apparent as population growth and rising consumption increase demand on ecosystems. The need to better consider long-term ecosystem health is urgent.

Climate Conditions/Geospatial Positioning

The Mashomack Preserve is located on the south-eastern tip of Shelter Island,[8] in the Long Island fork, surrounded by the Gardiner's and Peconic Bays. These conditions temper Mashomack's local climate compared to the severe climate of areas of nearby New England.[9] Despite relatively mild winters, cold winter weather and hot, humid summers remain building design concerns for the area. The average annual high and low temperatures on Shelter Island are 69.8°F (21°C) and 44.6°F (7°C), respectively. Shelter Island enjoys clear skies during more than 40% of day time hours, and average annual precipitation totals 45.9 inches evenly (monthly precipitation averages range from 8.10 to 1.67inches). Influential weather disturbances include high winds and hurricanes, and the annual wind velocity average is approximately 8 miles per hour.[10]

In addition to normal weather conditions, sustainable renovation strategies must consider the potential changing weather patterns due to climate change. To put these conditions into a local context, by the 2050s, the areas surrounding New York City are predicted to experience a 3-5 °F (1.67-2.22 ° C) rise in temperature, sea level rise between 7-12 inches, brief periods of intense precipitation, storm-related coastal flooding, and severe droughts.[11] New York State's "Sea Level Rise Task Force Report to the Legislature" echoed the sea level rise findings specifically for Long Island.[12] This set of potentially dangerous conditions must be considered when evaluating renovation strategies and is especially important in regard to water conservation and wastewater management.

Site and Existing Buildings

There are eight buildings on site, of which seven are located in the Manor House complex. These include: the Manor House, the Water Tower, the Keeper's Cottage, the Barn, the Firehouse, the Garage, and the Director's House. The Visitor Center is situated near the entrance to the Preserve.

Primary Building - The Manor House

The Manor House is the primary building used on the Preserve. Built in 1890, it has undergone several modernizing renovations through the years. While it does not house full-time residents, the Manor House is used by staff daily for administration, meetings, and minor food preparation. In addition, it hosts large groups of overnight guests and is the site of many annual events. The house is three stories tall and composed of wood frame on a brick and stone foundation. There are an oil-fired furnace and four large fireplaces inside the Manor House.[13] The primary facade of the building faces southwest, and the original portion of the house contains, on the main level, a large conference/dining room, a commercial kitchen, living room, study, parlor, and a half bathroom. The upper floors contain a combination of guest rooms with en suite bathrooms and an attic space.   The recent addition of an office wing includes a full attic that connects to the small attic space of the original building. The Manor House has a full basement that extends under the outside of the patio at the south corner and includes a crawl space under the addition.[14]

The house has a 2,000 gallon underground fuel storage tank that does not leak at this time, however, TNC is evaluating the possibility of removing the tank in favor a potentially less problematic above ground tank. Gasoline for vehicles and cooking propane are also stored on site.

The Manor House is used daily by staff, and seasonally by various visitors. These users' comfort and performance requirements, such as adequate light and comfortable indoor climate, are vital aspects of the site's current conditions. An analysis of past occupancy of the Manor House indicates that occupancy peaks during the summer months (June, July and August) as staff and volunteers prepare for, stage, and hold the Annual Benefit Dinner Dance.[15]

Secondary Buildings – The Water Tower, Keeper's Cottage, the Barn, the Garage, the Fire Station, the Director's House, and the Visitor Center[16]

Mashomack's remaining buildings are the Water Tower, Keeper's Cottage, Barn, Garage, Fire Station, Director's House, and Visitor Center.

The Water Tower is an L-shaped, three-story wood frame structure, which is used seasonally as dormitory-style guest quarters. The south leg of the "L" is an addition to the original structure. The building has a crawl space basement and an inaccessible crawl space attic. The Keeper's Cottage is used seasonally both as guest quarters and as a dormitory. It is a two-story wood frame building with a crawl space basement and a partial attic. Keeper's Cottage has a living room, dining room, kitchen and bath on the main floor; and two bedrooms and a bath on the second floor. The main period of use for both the Keeper's Cottage and Water Tower is from May to November. After the close of the peak season, both structures are winterized, which entails turning off electricity and water, closing all apertures, and securing the building against entry.

The Barn is the primary workshop for the Preserve, however, it is only partially insulated and heated, and it does not have a source of running water. The Barn has a second floor storage loft, which is accessible via an interior stair. The gasoline storage tank described in the previous section is located outside of the Barn.

The Garage is a detached wood structure which appears to have originally been built on locust post supports. A concrete footing has been built under the original walls.

The Fire Station building is a one-room wood frame structure with a full basement and is used for storage of scientific equipment.

The Director's House is occupied year-round. Because it was not included in the original tour of the property, for the purpose of this report, this building is only provisionally included in the evaluation where general recommendations could also be applied.

The Visitor Center, which underwent extensive renovation in 2004, is the most modern and sustainable building on Mashomack. TNC has been successful in installing and operating solar panels on the Visitor Center that supply one-third of the building's electricity. Other sustainable improvements include wood plastic composite lumber for the outdoor decks, carpets made from recycled soda bottles, high efficiency fluorescent and LED lighting, and low-e glass in new windows. Composting toilets dramatically reduce water use, and repurposed wood was used to renovate the interior. However, the strategies presented in this report are not intended to be applied to the Visitor Center; the focus is the improvement of the seven other buildings on site.[17]

Opposite Page, Figure 2 - Aerial view of the Manor House Complex[18]

Mashomack Preserve, © TNC

Utility Baseline

Current baseline energy consumption conditions at Mashomack had to be established in order to guide research and make effective recommendations. A utility baseline provides critical insight into the operation of a facility. Consumption evaluation can demonstrate weaknesses in the operation of a building, atypical consumption patterns, and may help the energy audit team identify "sicknesses" in a building, such as envelope issues or unproductive usage patterns.

Type two oil fuels a boiler that provides both hot water and heat in the Manor House. Monthly oil consumption data was not available and was estimated by proxy of refueling deliveries throughout the year. The Long Island Power Authority provides electricity to Mashomack. Electric consumption is shown as the sum of each monthly bill for calendar year 2011.[19] Both energy types are converted to kBtu (thousands British thermal units) to put consumption on a relative scale and evaluate the true uses of energy in the building. The tables below show calendar year 2011 summaries for consumption on-site and the average over the previous four years for both oil and electricity.

	2011 CALENDAR YEAR TOTAL ENERGY USE	
	Energy Usage	**Converted to kBtu**
Oil	3,001 gallons[20]	416,174 kBtu[21]
Electric	24,880 kWh	84,915 kBtu[22]
Total		501,089 kBtu

Figure 3 - Total Oil and Electric Usage On-Site at the Manor House for 2011[23]

	AVERAGE TOTAL ANNUAL ENERGY USE	
	Energy Usage	**Converted to kBtu**
Oil[24]	3,084 gallons	427,722 kBtu
Electric[25]	24,880 kWh	84,915 kBtu
Total		512,637 kBtu

Figure 4 - Average Oil and Electric Usage On-Site at the Manor House (2008-2011)

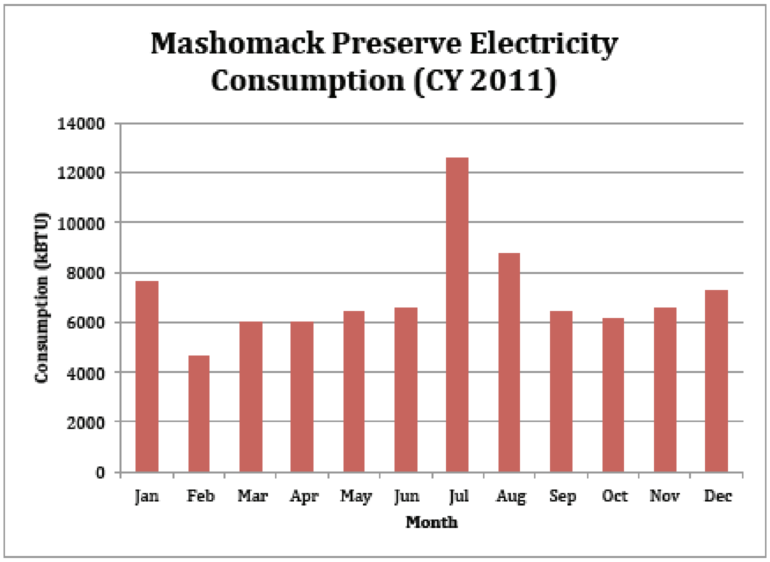

Figure 5 - Electricity (kBtu) Used Per Month for 2011

The following conclusions are based on this analysis and the fact that electricity is used for both cooling and domestic hot water. For calendar year 2011, the approximate monthly electric base load at the Manor House was 5,552 kBtu.[26] In January, when heating was most required,[27] electric usage climbed to 7,645 kBtus; inexplicably, even though it is not as intensely cold as February and March, electric use climbed in December to 7,235 kBtus. Electric usage peaked above 8,000 kBtus during the most intense cooling months of July and August.[28] The Manor House experienced its peak load at 12,560 kBtus in during the Mashomack Preserve Annual Benefit Dinner Dance in July, when a walk-in freezer was required.

One important measure that is used to determine when to mechanically adjust the indoor ambient temperature of a building is the concept of a degree day. This is a numerical value used to compare how temperatures on one day compare to those on another. For example, on a very hot August in the summer, there would be more cooling degree days than a mild month such as October, while in a very cold February; there would be more heating degree days than during a mild April. It is possible to have both heating and cooling degree days in a single month, particularly in shoulder months like April or October. Overall, heating and cooling degree days provide a benchmark to compare temperature performance. These degree days vary by day, month, year, and region.

Heating and cooling degree days are an indicator of energy consumption for space heating. The concept for heating degree day (HDD) is based off the assumption that on a 65°F day most buildings require heat to maintain a comfortable 70°F inside the building. For a cooling degree day (CDD) it would be the opposite. Essentially, a HDD or CDD is the average temperature difference per day as it relates to 65°F, so for each day of the year there can be multiple degree days.[29]

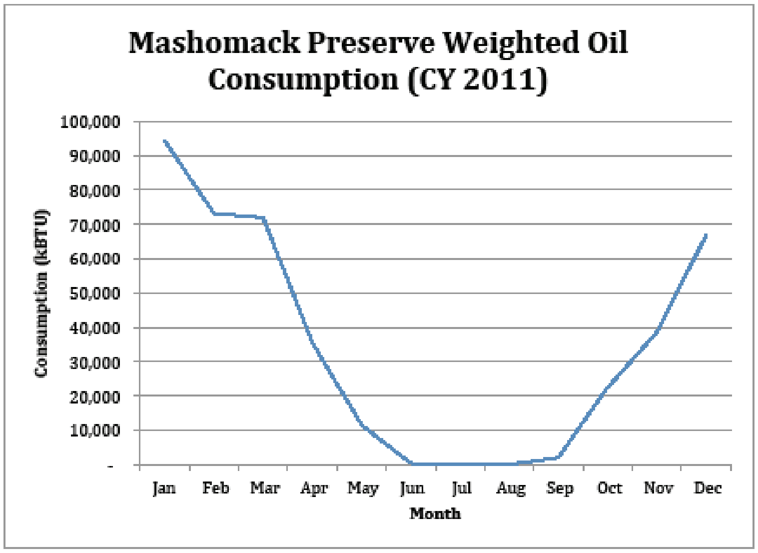

Figure 6 - Type 2 Oil Consumption (in kBtu) Per Month for 2011

Figure 6 demonstrates the weighted oil consumption determined from deliveries and heating/cooling degree-days for the Manor House. A weighted monthly average usage was calculated based upon the timing of oil deliveries and the proportional amount of heating degree-days during each month in which a single delivery was used. This curve shows a conventional heating trend, meaning that consumption is minimal in the summer and peaks during the coldest months. On average, the tank requires refill every 2,000th heating degree-day. The average consumption of oil per year is 338 gallons. This approximates to an average annual consumption of 431 million Btu.

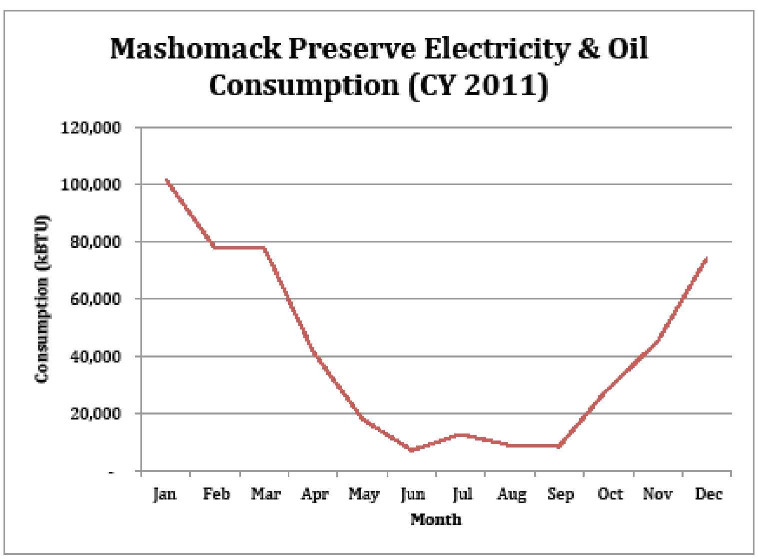

Figure 7 - Combined Electricity and Oil Consumption Used Per Month for 2011

Manor House Building Performance

In order to get a better idea of how Mashomack buildings perform throughout the year, it is important to compare utility usage to heating and cooling degree days.

Figure 8 below plots the 2011 combined utility consumption for Mashomack versus the corresponding heating or cooling degree days for a month.[30] The trends are typical of a house, but also show some interesting data. The red line indicates the heating degree days, i.e. when heating is needed to warm in the winter. As the heating degree-days increase, the consumption of oil increases linearly. This is expected for energy consumption; however, there are ways to decrease the slope of the line through weatherization and energy efficiency techniques such as those presented in this research. The blue line indicates the cooling degree-days, i.e. when air conditioning is needed to cool in the summer. While the higher number of cooling degree-days makes sense, those between 0 and 100 show an increase in energy consumption despite lower temperatures.

There are several hypotheses for these results, the most prominent of which is that higher occupancy of the building during the shoulder months and the resulting use of room air conditioners or occasional supplemental heating. Either way, it is important to note that electric loads are higher even when the temperature is lower. Energy efficiency measures, described later in the report may smooth consumption over the year.

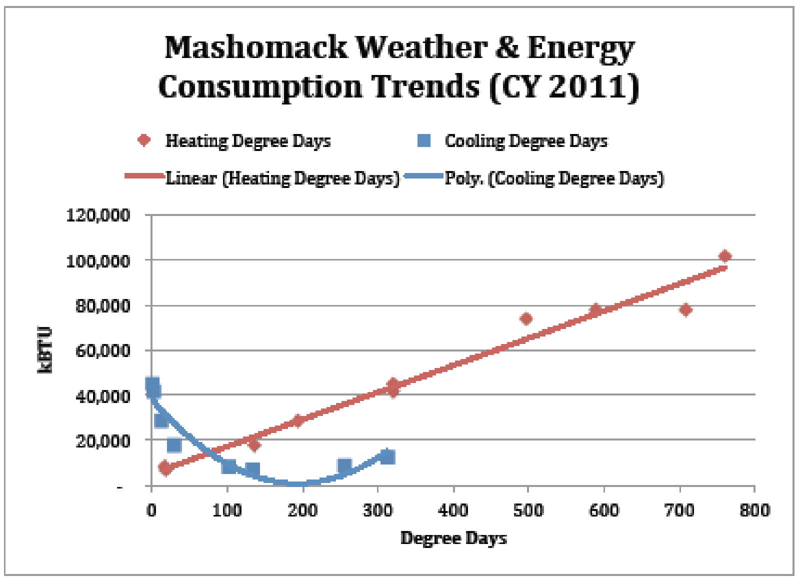

Figure 8 - Energy Consumption of Oil & Electricity Plotted against HDD and CDD for 2011[31,32]

Manor House Carbon Footprint

Carbon dioxide (CO_2) is emitted in a variety of ways including natural emissions from the carbon cycle and as a result of human activities such as fossil fuel burning. Although natural process such as photosynthesis remove carbon dioxide from the atmosphere, human activities such as deforestation and the burning of fossil fuels have emitted so much more that these natural processes can no longer maintain balance. In 2005, global atmospheric concentrations of carbon dioxide were 35% higher than they were prior to the Industrial Revolution.[33]

When fossilt fuels are burned, carbon dioxide is not the only greenhouse gas emitted. In order to represent all the gases released when burning a fossil fuel, the technical term of carbon dioxide equivalent (CO_2e)

was established. This term is a used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP).[34] Individual regions, districts, and even individual sites have their own carbon dioxide equivalent emissions depending upon the combination of fuels used to produce electricity and what other fuels are burned on-site. Because LIPA does not publish their emissions factor for electricity production, ConEdison's emission rate was used as a proxy for Mashomack, as the two utilities' production inputs tend to be very similar. The most recent published data, from 2010, gives a value of 692.2 pounds CO_2e for each megawatt-hour of electricity produced.[35] The standard CO_2e for #2 fuel oil is 22.5 lb. per gallon.[36]

In this case, the electric and oil consumption for the Manor House were used to establish a carbon footprint baseline for the site. When and if additional data become available, such as electric for the other houses or gasoline used in vehicles, a more complete picture for Mashomack's impact can be established.

Figure 9 and Figure 10 below show the Preserve's annual carbon footprint (in lb CO_2e), based on available information. As seen in Figure 10, the emissions for Mashomack Preserve are strongly correlated to oil use trends on the property. Since GHG emission reduction is a strategy for climate change mitigation and has a positive impact on the natural environment, this report will evaluate reduction of oil use on-site. Opportunities presented here will work toward a reduction in this overall footprint.

2011 Calendar Year Total Carbon Dioxide Equivalent	
Oil	67,498 lb. CO_2e
Electric	17,223 lb. CO_2e
Total	84,721 lb. CO_2e

Figure 9 - Mashomack Preserve Calendar Year 2011 Carbon Dioxide Equivalent Production for Oil and Electric

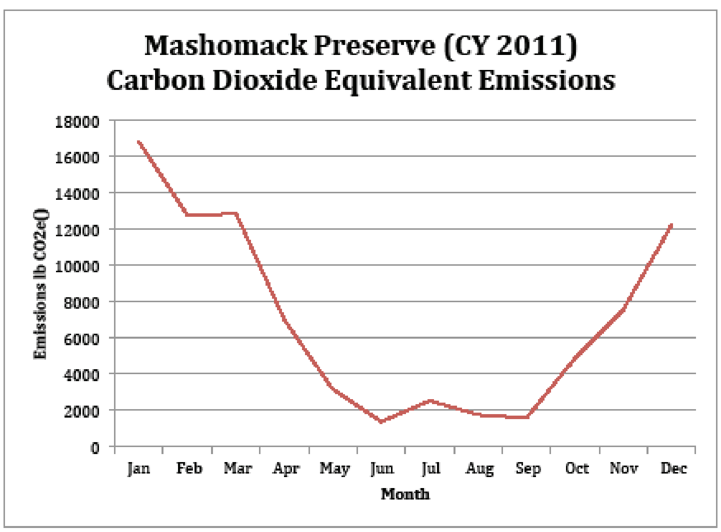

Figure 10 - Mashomack Preserve Calendar Year 2011 Monthly Carbon Dioxide Equivalent Emissions for Electricity and #2 Fuel Oil

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[1] Ibid (Weaver 1990)

[2] Ibid (Laspia 2012)

[3] Ibid (Weaver 1990)

[4] Brown, Paul. "An Unatural Disaster." The Guardian. London. 08 January 2004.

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[6] Costanza, Robert; D'arge, Ralph; De Groot, Rudolf; Farber, Stephen; Grasso, Monica; Hannon, Bruce; Limburg, Karin; Naeem, Shahid et al (1997). "The value of the world's ecosystem services and natural capital". Nature 387 (6630): 253–260.

[7] James Lovelock. The ages of Gaia: a biography of our living Earth. Oxford University Press. 2000. pp. 213–216

[8] Latitude: 41.06 N, Longitude: 72.33 W

[9] The U.S. Department of Energy (DOE) records important weather data for thousands of site locations to assist in understanding the micro-climate of the area. The nearest recorded weather data from DOE is the Westhampton-Suffolk County Air Port at Latitude: 40.85 N, Longitude: 72.63 W approximately 21.45 miles away.

[10] Abrams, Marc D., and Vanessa L.W. Hayes. "Impacts of contrasting land-use history on composition, soils, and development of mixed-oak, coastal plain forests on Shelter Island, New York." Journal of the Torrey Botanical Society, 2008: 37-52.

[11] "Climate Risk Information", New York City Panel on Climate Change, February 17, 2009, accessed 2.25.2012, http://www.nyc.gov/html/om/pdf/2009/NPCC_CRI.pdf

[12] "New York State Sea Level Rise Task Force Report to the Legislature", 12.31.2010, accessed 3.19.2012, http://www.dec.ny.gov/docs/administration_pdf/slrtffinalrep.pdf

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[14] Schmitt, Joseph. Mashomack Preserve-Manor House Property Condition Assessment. Print, Schmitt Engineering, Stony Brook: Schmitt Engineering, 2011.

[15] Ibid (Laspia 2012)

[16] Ibid (Schmitt 2011)

[17] Ibid (Laspia 2012)

[18] Google Earth 41°02'43.17" N 72°17'40.70" W (Image taken 9/19/2010, accessed 3/23/2012)

[19] Ibid (Laspia 2012)

[20] The oil consumption is based upon oil delivery data provided converted to a weighted average based upon heating degree days for consumption.

[21] Gallons of oil are converted to kBtu by multiplying by 140gal/kBtu

[22] kWh of electricity are converted to kBtu by multiplying by 3,413 BTU/kWh and dividing by 1000 BTU/kBtu.

[23] Ibid (Laspia 2012)

[24] The Oil-Delivery average is based upon four (2008-2001) years of oil data provided converted to a weighted average based upon heating degree days for consumption; the Electric-Consumption average is based only on calendar year 2011 data.

[25] Only one year of electric consumption data was provided, so the same number was applied for the average.

[26] Based on average of the three lowest months (February, March, April)

[27] Based on Heating Degree Days per month

[28] Based on Cooling Degree Days per month

[29] To calculate HDD, take the average of a day's high and low temperatures and subtract from 65. For example, if the day's average temperature is 50o F, its HDD is 15. If every day in a 30-day month had an average temperature of 50o F, the month's HDD value would be 450 (15 x 30). If the number is negative, that is a CDD.

[30] Weather Underground. Weather History for East Hampton, Long Island. December 31, 2011. http://www.wunderground.com/history/airport/KHTO/2011/1/1/CustomHistory.html?dayend=1&monthend=1&yearend=2012&req_city=NA&req_state=NA&req_statename=NA (accessed March 4, 2012).

[31] Ibid, (Weather Underground 2011).

[32] Monthly heating and cooling degree days are calculated by taking the average temperature for a day and determining how many degrees it is off from the design day of 65F. This is done for each day in a month and then added up for all those days. If the temperature averaged very low for an extended period of time, this increases the number of heating degree days drastically. It is important to note, the degree day number is not an actual count of days, but a count of degree deviations from a design day added up over a period of time. Each point is representative of the monthly heating and/or cooling degree days for the relevant month. Because calendar year 2011 was so cold, the heating degree days (days requiring heat) are much more extreme per month than the cooling degree days.

[33] United States Environmental Protection Agency. Carbon Dioxide. April 14, 2011. (accessed March 21, 2012).

[34] OECD. Glossary of Statistical Terms. 04 July 2005. 21 March 2012.

[35] Dickinson, Jonathan and Rishi Desai. Inventory of New York City Greenhouse Gas Emissions, September 2010. New York: Mayor's Office of Long-Term Planning and Sustainability, 2010.

[36] Ibid, (Dickinson and Desai 2010).

SUSTAINABILITY STRATEGIES

In the following sections, opportunities for upgrades at Mashomack are outlined and explained in detail. As noted earlier, they fall underneath the general sustainability categories of water conservation & wastewater management, energy efficiency, and renewable energy. All of the information below carefully considers the existing conditions described above, so that each opportunity is specific to Mashomack.

WATER CONSERVATION & WASTEWATER MANAGEMENT

Introduction

On a global scale, there is as much water in the world today as there was thousands of years ago, however, approximately 97% of the world's water is salt or brackish water and 2% is locked in ice caps and glaciers. That leaves just 1% for consumption.[1] Compounding this scarcity issue is climate change and its associated environmental impacts. The potential consequences of these combined conditions are a reality that human kind must address.

The implications and potential consequences of drought conditions on the local water supply should not be unfamiliar to the Shelter Island (S.I.) community. Less than ten years ago, S.I. experienced a drought during which two of their primary drinking water wells ran dry. This situation necessitated that potable water to be trucked onto the island to meet the needs of S.I. residents. In addition, because of Shelter Island's geological features and the way the Earth's hydrological cycle functions, the area's water supply is particularly susceptible to salt water incursion.[2] The vulnerability of Shelter Island's water supply and ecosystems[3] is exacerbated by ambient temperature increases and sea level rise predicted to result from climate change.

There is a local, related threat to the water supply as well as the health of its surface waters and the surrounding marine environment. This threat is that the use of septic tanks and cesspools to manage commercial and residential wastewater throughout Suffolk County has been shown to be releasing harmful levels of nitrates into the ecosystem.[4] A 2003-2004 analysis by the Suffolk County Department of Health found a 73% increase in nitrate levels in developed parts of S.I. from 1980 to 2002. Similar studies have found comparable results throughout eastern Long Island.

Excessive levels of nitrates can cause methemoglobinemia and contribute to eutrophication. Methemoglobinemia is a condition where nitrates destroy the ability of red blood cells to carry oxygen.[5] Eutrophication is a term for nutrient overload in aquatic ecosystems, which can lead to exponential algal growth. Such growth reduces dissolved oxygen concentrations to the point where aquatic flora and fauna can no longer survive, a water condition referred to as hypoxia. This well-documented phenomenon is and an ongoing problem. [6] In fact, as a result of this nitrate pollution, several L.I. bodies of water are on New York State's list of Impaired Waters. [7,8]

Mashomack Preserve's location on S.I. leaves it equally vulnerable to the threats on the local water supply. The Preserve's use of an onsite wastewater treatment system (OWTS) makes it a potential contributor to nitrate pollution. As such, it is in the best interests of the Preserve as well as its host community to do all it can to reduce its water footprint and to eliminate its nitrate emissions. In doing so, the Preserve will help to ensure the health of S.I.'s environment. The material contained in the Compendium and Opportunities sections are the product of extensive research intended to provide Preserve staff the knowledge to fulfill these interests.

Methodology & Approach

The actions identified in the Opportunities section specifically seek to reduce the water footprint and improve the performance of the OWTS. Each action – which has been coined opportunities – has been evaluated on the criteria outlined in the general Methodology section. Methodological considerations specific to Water Conservation and Wastewater Management are detailed below.

Water is not paid for by the Preserve, and in the absence of a useful proxy price, a cost benefit analysis is not provided for any of the opportunities. It is therefore understood that many of the strategies will require upfront costs, some significant, that will never pay for themselves through cost savings. Implicit in all evaluation criteria is instead the consideration of the opportunity's environmental impact on the Preserve as well as the global environment in terms of air, soil, and water quality as well as any direct and/or indirect harm to flora and fauna.

This approach is in keeping with that fact that TNC does not explicitly seek financial benefits from implementing these recommendations as well as their mission to "conserve the lands and waters on which all life depends," and its vision to "leave a sustainable world for future generations."

Site Conditions

This section of the report describes the site conditions as they pertain to the Preserve's water supply, water use, water conservation practices, and the onsite wastewater treatment system (OWTS).

Water Supply: Water for the Manor House complex is supplied by two, recently installed, unmetered subterranean wells that are located in the immediate area. There is no monetary cost associated with this private, on-site water source. Both wells are entirely dependent on precipitation for groundwater recharge. In addition, the water is treated for an unspecified hardness condition by a mechanical and chemical filtration system located the basement of the Manor House.

The Preserve's reliance on precipitation to recharge groundwater for its water supply is a function of the hydrological cycle as well as the geological features of the area. [9] The hydrological cycle (Figure 11) is a multi-stage process by which water travels from the atmosphere in the form of precipitation to and through the ground, where a portion returns to the atmosphere via transpiration and another portion collects in an underground aquifer. Once in the aquifer, water flows to the sea before it returns to the atmosphere via evaporation. Although this cycle is constantly ongoing, it takes at least 15 years for precipitation that reaches the ground to percolate through the soil into the aquifer and then out to sea.[10] The considerable time lag before water becomes available for consumption after the area experiences precipitation is largely governed by the weather, soil composition, and the variety and characteristics of the flora that inhabit the soil.[11]

On Shelter Island, the portion of water that collects in the aquifer is what is available for human consumption. Because the water flows through the ground, it can become contaminated by pollutants in the soils. It is possible for these contaminants to be present in drinking water supplies as well as to be transmitted to surface waters and marine environments. In order to maintain a high quality supply of water and to help ensure the health of the surrounding water ecologies, it is incumbent upon the Preserve to ensure it does not negatively impact its soil quality.

Water Use: Because the wells are unmetered and water use has not been measured, exact water use figures could be provided. Given this limitation, only a general description of water use at the Preserve is possible. Research revealed that water is used on the Preserve for cooking, drinking, laundering, seasonal vegetable garden watering, household cleaning, and bathroom use including showering. Based on estimated occupancy data provided by Preserve staff and a generally accepted daily, per capita, indoor water consumption rate of approximately 70 gallons, [12] an estimated 100,000 gallons of water is used at the Preserve by full time residents per year. This volume does not account for water used by visitors, guests, or part time staff.

Water Conservation Practices: No water conserving behaviors and/or rules have been instituted at any of the buildings on the Preserve. Water conserving technologies in place include a front-loading washing machine and some low-flow fixtures in the bathrooms of the Manor House, and two composting toilets in the Visitor Center. There is an unused subsurface cistern located just outside of the Manor House.

Onsite Wastewater Treatment System (OWTS): The OWTS serving the Manor House was installed in 1968 and employs the conventional technology standard at that time. The system consists of a 2,000 gallon septic tank and three cesspools, each comprised of a drainage dome and two 4"- 6" sections embedded in an ample amount of sandy medium and covered with loam. The system functions without any flow or capacity issues, has never needed servicing, maintenance, or renovation, and is not expected to require it in the future.[13]

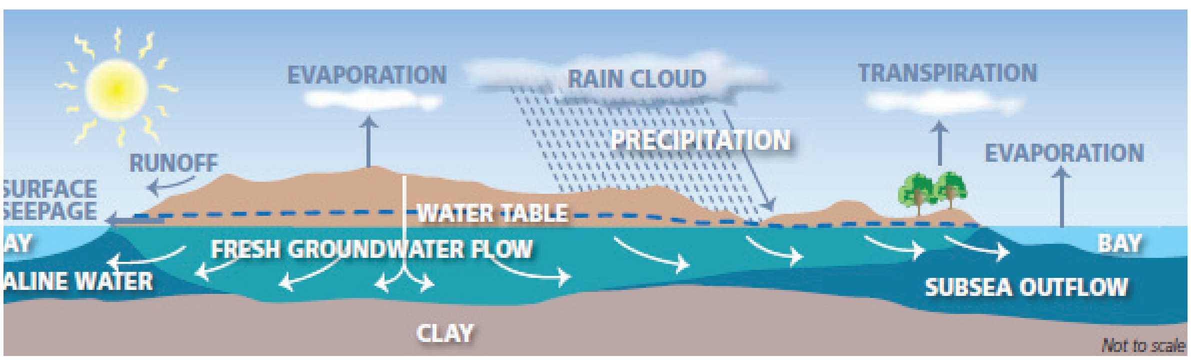


Figure 11 - Hydrological Cycle

Compendium

Under the headings of Water Conservation and Wastewater Management, the following list of opportunities addresses the three key issues of optimizing groundwater recharge, reducing water consumption, and reducing nitrate emissions from the OWTS. Each opportunity identifies a recommendation that involves the use of a technology- and/or behavior-based practice to minimize the Preserve's operational water footprint.

Water Conservation Opportunities (WCO):

WCO 1: Measure Water Use

WCO 1a: Conduct a Water Audit

WCO 1b: Install Water Meters

WCO 2: Implement Water Conserving Behaviors

WCO 3: Install Water Conserving Technologies

WCO 3a: Replace Toilets

WCO 3b: Replace Water Fixtures

WCO 3c: Practice Efficient Garden Watering

WCO 4: Ensure Construction is Conducted in an Environmentally Responsible Manner

WCO 4a: Ensure Contractor and Laborers Observe Anti-Erosion and Anti-Pollution Practices

WCO 4b: Conduct Tours of Preserve for Laborers & Contractors

WCO 5: Collect and Use Rainwater

WCO 5a: Implement On-Site Rainwater Collection & Storage Capability

WCO 5b: Use Harvested Rainwater to Supply Toilets

WCO 5c: Use Harvested Rainwater for Outdoor Watering Activities

WCO 6: Optimize Groundwater Recharge

WCO 7: Decommission Unused Water Wells

WCO 8: Test Well Water

WCO 9: Consider Desalination

Wastewater Management Opportunities (WMO):

WMO 1: Address Any Issues There May be With Existing OWTS

WMO 1a: Professionally Evaluate OWTS & Test Surrounding Soil for Contaminants

WMO 1b: Install a Nitrex System

Opportunities

Despite the Preserve's relatively low water footprint, undertaking all of the following recommendations will leverage synergies among them that will serve to maximize water efficiency. For example, installing water meters will enable water use measurements that the Preserve can use to focus behavioral water conservation efforts. To assist with the undertaking of these tasks, a matrix of the recommendations is provided in Appendix III.

Water Conservation Opportunities

WCO 1: MEASURE WATER USE

Issue:	No water measurement capabilities
Recommendation:	**WCO 1a** - Conduct a water audit, **WCO 1b -** Install water meters
Estimated Cost:	**WCO 1a** - Time & effort, **WCO 1b** - $60 plus labor

Issue and Recommendation: There is a lack of any metrics pertaining to the volume of fresh water used or the volume of gray and black water produced. This lack of knowledge prevents an accurate determination of the water foot-print of the buildings on the Preserve. This also hinders the Director's ability to set appropriate and objective goals with respect to reducing water use and prevents him from knowing where to concentrate water use reduction efforts.

In order to address this issue, it is recommended to conduct a water audit at all of the buildings in which water is used on the Preserve (WCO 1a) and to install water meters (WCO 1b) throughout the buildings on the Preserve as well as at each well-head, and begin monitoring and tracking water use.[14]

Existing Conditions: Water use is unmetered, and there is no other means of easily measuring or monitoring water use at any of the buildings on the Preserve.

Applicable To: All buildings

WCO 1a: Conduct a Water Audit

Advantages: Conducting a water audit will result in heightened awareness of the volume as well as how water is used. Combined with the knowledge of the limited and threatened nature of the Preserve's water resources, this awareness will lead to more conscientious use of water and thereby reduce total usage.

The data obtained will enable each building's as well as the entire Preserve's water usage to be benchmarked and for objective quantitative water conservation goals to be set. In addition, a water audit will help to identify the areas of high use that should receive further attention in the form of behavioral changes and/or technology based solutions. By implementing conservation measures, it is possible to reduce water usage by as much as 30%.[15] Finally, there is no upfront cost provided once one has the ordinary household items to perform the audit.[16]

Disadvantages: Drawbacks to conducting a water audit are few and inconsequential, especially in consideration of the limited and threatened nature of the Preserve's water resources. Time is required to prepare the materials needed for the audit and for the audit itself.

Estimated Cost: The time it takes to complete the audit and the cost of whatever materials are needed to perform the audit.

Comments: If this action is undertaken, it should be performed during a time of peak occupancy and water use, i.e. one of the summer months, as well as during an off-peak time. Performing two separate audits will ensure benchmarks are applicable and water conservation goals and objectives are feasible and realistic.

WCO 1b: Install Water Meters

Advantages: Water meters enable total water usage as well as within each room that has water service to be accurately measured. The use of meters also facilitates leak detection and the performance of water audits. Finally, the measurements will enable baseline water usage metrics to be established and will facilitate any monitoring and tracking of water use at the Preserve.

Establishing baseline water usage metrics will enable a benchmark figure to be set, future water footprint reductions to be measured and performance goals to be set. Monitoring and tracking water use will generate data that will enable the original water usage benchmark to be adjusted to account for gradual reductions in water use as a result of conservation efforts. It will also make the identification of areas that need improvement possible, help promote the importance of engaging in water conserving behaviors, and provide justification for employing water conserving technologies.

Finally, given the threat of adverse water supply conditions and water quality issues, it is not unreasonable to speculate that at some point authorities may require water use to be measured and priced. Having a metering system in place prior to any such regulation(s) may mitigate or eliminate any effort required with respect to compliance and future costs.

Disadvantages: The only direct disadvantage is the monetary cost to purchase and install the meters, which may require hiring a professional plumber. In addition, there are workload considerations to be taken into account, since someone must regularly read and record measurements from the meters. The measurements will need to be recorded in a spreadsheet or similar application so that monitoring, tracking, and analysis can be performed. These activities will require an individual with a moderate degree of spreadsheet application skill.

Estimated Cost: The cost is approximately $60.00 per water meter plus labor. [17,18]

WCO 2: IMPLEMENT WATER CONSERVING BEHAVIORS

Issue:	No water conserving behaviors in place
Recommendation:	Institute the provided list of water conserving behaviors
Estimated Cost:	No monetary cost, there is a time & effort cost

Issue and Recommendation: There are no protocols pertaining to the use of water at any of the buildings on the Preserve. It is therefore safe to assume water is not being used as efficiently as possible. Behaviorally based water conservation practices have been shown to be successful in significantly reducing water consumption in residential settings. These practices seek to change water use habits so as to ensure water is used as efficiently as possible and to eliminate waste wherever possible. These practices can be applied both indoors and outdoors.

In order to address this issue, it is recommended to institute the below set of rules to govern the use of water at the Preserve. [19]

Note: The following pages outline practices intended to serve as a list of “dos” and “don’ts” regarding water use behaviors. As such, they can be recreated and communicated in a variety of ways, ranging from postings in the applicable room/area to email reminders.

KITCHEN

1. Run the dishwasher only when it is full.
2. If dishes are washed by hand, use a dishpan filled with water rather than running the water continuously.
3. Catch and save water used while peeling and rinsing vegetables to water flora.
4. Store drinking water in the refrigerator rather than letting the tap run every time you want a cool glass of water.
5. Defrost food overnight in the refrigerator or by using the defrost setting on your microwave rather than using water to thaw meat or other frozen foods.
6. Use the smallest amount of water necessary to cook foods such as vegetables, pasta, and stews.
7. Use tight-fitting lids on pots and pans while cooking and to boil water.
8. Use as few pots, pans, bowls, plates, utensils etc. as possible to prepare, cook, and serve meals.
9. Time foods during the cooking process to avoid over cooking and loss of liquids through evaporation.
10. Refrigerate leftover vegetable boiling water for later use in making soup, stock, stew, gravy, and/or watering flora.
11. Use leftover pasta boiling water to water flora.
12. Avoid unnecessary rinsing of dishes that go into the dishwasher, scrape with a spatula or other utensil if necessary.
13. When entertaining, only serve water by request.
14. Don't dispose of items in the sink that should be disposed of in the garbage, e.g. fat or grease of any kind, insects, refuse, etc.

BATHROOM

1. Don't run the water while brushing teeth or shaving.
2. Limit the time water is run while taking a shower to five minutes by turning of the water while soaping, shampooing, and conditioning.
3. Limit the time the water is run while washing hands by turning off the water while soaping.
4. Don't flush the toilet unnecessarily.
5. As you wait for shower water to heat up, collect the cold water in a bucket or pot to water flora or to cook with.
6. Don't dispose of items in the toilet that should be disposed of in the garbage, e.g. insects, pharmaceuticals, hair, refuse, etc.

LAUNDRY

1. Adjust water levels in the washing machine to match the size of the load.
2. If the washing machine does not have a variable load control, run the machine only when it is full.
3. If washing is done by hand, use laundry tubs to soak, wash, and rinse clothes and reuse the water as much as is practical.

OUTDOORS

1. Water the lawn and/or gardens early in the morning or late in the evening and on cooler days, when possible.
2. Group garden flora with high water requirements together to make efficient use of watering.
3. Allow grass to grow to three inches before mowing it.
4. Only grow plants that are indigenous to the area.
5. Wash vehicles at a commercial car wash that recycles water.
6. Turn the hose off between washes and/or rinses while cleaning vehicles.
7. Wash vehicles on a lawn or otherwise vegetated area.
8. Sweep sidewalks and driveways rather than hosing them down.
9. Regularly inspect irrigation systems and equipment to be sure they are operating properly.
10. When an activity is completed, turn the water off at the spigot or fixture rather than at the equipment or device.
11. Clean the leaders and roof gutters of all buildings regularly.

GENERAL

1. Never let water run down the drain when there may be another use for it such as watering flora or cleaning.
2. Regularly inspect all plumbing and water fixtures for leaks, drips, and/or corrosion. [20]
3. Fix all leaks, drips, and/or corrosion as soon as they are detected.
4. Ensure all equipment is properly installed and is functioning according to manufacturer's performance specifications.
5. Insulate hot and cold water pipes.
6. Use water from dehumidifiers for watering flora and/or cleaning.

Existing Conditions: Preserve staff stated that there are no behaviorally based water conservation measures in place. As such, it is assumed that a reduction of between 14 - 21 gallons per day per person can be achieved through the implementation of the practices listed in the following recommendation.[21]

Applicable To: All buildings

Advantages: These simple water conserving behaviors have been shown to save significant amounts of water. For example, fixing a one drop per second leak can reduce water losses by up to 220 gallons per month, and not running the water while shaving can save up to 300 gallons a month. Adopting these behaviors will serve to mitigate the risk of reduced and/or lack of water supply during drought conditions.

Moreover, reducing the volume of water used will decrease the amount of water feeding into the onsite wastewater treatment system (OWTS), which will ease the biological load imposed on the soils surrounding the cesspools. This will reduce the threat of nitrate contamination of ground and surface waters as well as the surrounding marine environments.

Finally, successfully implementing these rules may inspire adoption by Preserve staff and visitors in their lives outside of the Preserve. Expanding the use of the behaviors beyond the buildings of the Preserve engenders greater overall water savings and awareness of the need to conserve water.

Disadvantages: A downside to these rules is the extra mental and physical effort, inconvenience, and potential discomfort associated with observing and engaging in them.[22] These factors may result in resistance from employees, visitors, volunteers, and donors.

Another downside is the actual planning and implementation of the rules. Deciding which rules are most appropriate for the Preserve and how to best communicate them, whether through the use of pamphlets, information sessions, posters, etc., will require some consideration.[23] The importance of observing them to Preserve staff and visitors must also be communicated. Similarly, monitoring, rewarding, and/or enforcing compliance with these rules can be time consuming and typically involves a fair amount of trial and error to identify the most effective methods.

Estimated Cost: As the Preserve does not pay for water there are no financial savings to be realized. In fact, there will be upfront costs involved in implementing some of the suggestions. However, these costs are virtually all related to time and effort for the implementation, monitoring, and enforcement of the rules. The time and effort expended for each phase of the plan depends upon how elaborate the plan is.

WCO 3: INSTALL WATER CONSERVING TECHNOLOGIES

Issue:	Limited use of water conserving technologies
Recommendation:	**WCO 3a** - Replace toilets, **WCO 3b –** Replace fixtures, **WCO 3c -** Efficient garden watering
Estimated Cost:	**WCO 3a** – $200 - $300, **WCO 3b** - $20 - $30, **WCO 3c** - $20

Issue and Recommendation: Because the local water supply is fragile and finite, and because site conditions may allow for runoff, reducing opportunities for groundwater recharge, every effort should be made to reduce the Manor House campus' water consumption profile. Even when users are conscious of their water footprint, both behavioral and technological strategies are necessary to reduce the water-use footprint of any residential or commercial facility. Older buildings are especially prone to loss through leaks and inefficient fixtures.

It is recommended to replace standard toilets with low-flow, tank model dual-flush toilets (WCO 3a), replace standard shower heads with low-flow fixtures, replace aerators on faucets that have flow rates over 2.75 gallons per minute (gpm) and/or install aerators on standard faucets (WCO 3b), continue sound water conservation practices in the vegetable garden, and eliminate sprinkler use in favor of a soaker hose or drip irrigation system in the perennial flower garden and elsewhere. Hand watering and soaker hoses, in addition to spot-drip irrigation can also be used to care for new plantings (WCO 3c). The best practices described in WCO 2 regarding operation and maintenance of water-using appliances should suffice to reduce water used therein until such time as these appliances reach the end of their useful life. When replacing appliances, look for high-efficiency Energy Star models – these models usually incorporate water conservation technologies along with energy savings.

Existing Conditions: Although an awareness of the importance of water conservation is evident in the adoption of composting toilets in the Visitor's Center and the occasional application of low-flow shower heads in the Manor House, there has been no systematic effort to reduce water consumption campus-wide. Standard or early generation low-flow toilets are present throughout Manor House campus. Faucet aerators are early-model, where present. Residential-scale cooking, laundry, and cleaning are present year-round, and commercial-scale use occurs seasonally. The client reports generally sound water conservation practices in outdoor water use: the 400 ft^2 vegetable garden is hand-watered in the early morning, mulch is applied to reduce evaporation, and lawns and shrubs are not watered except in the case of new plantings. A perennial flower garden is watered with a sprinkler several times per season.[24]

WCO 3a: Replace Toilets

Advantages: Low flow toilets use a significantly lower volume of water than standard toilets, i.e. 1.1 or 1.6 gallons per flush (gpf) vs. 5 – 6 gpf for standard units. The tank model, which features buttons rather than a flush lever, draws attention to the flush choice and reduces user error (dual-flush toilets are usually designed with a push/pull flush feature, and user instinct is to automatically push down, negating the benefit of flush choice). They are easily retrofitted. Button-flush models (with tank) are aesthetically consistent with a residential-style application and are also ADA compliant.[25]

Figure 12 - Comparison of Toilet Water Use from 1980 to Present[26]

Disadvantages: At approximately $200.00 - $350.00 per unit plus installation fees, replacing all of the toilets on the Preserve represents a significant outlay of funds that will not pay back financially. Water savings are significant, however, and the Preserve's water supply is finite and somewhat precarious, so this expense is justified. Moreover, as toilets generally do not require replacement, this is a one-time expense.

Operationally speaking, low-flow toilets have an increased risk of clogging when used with older, cast-iron plumbing systems. If this is an issue at the Manor House, a standard flush toilet can be left in place "upstream" of low-flow units. The added volume of water form this unit will alleviate any potential clogging problems but reduce overall water savings.[27]

Applicable To: All buildings

Estimated Cost: The cost is approximately $200.00 - $350.00 per unit. Variation is due to toilet brand, features, and performance.

Comments: Inexpensive dual-flush conversion kits are commercially available for retro-fitting standard fixtures. These utilize the existing flush lever which, however, eliminates the two-button behavioral trigger and facilitates user-failure among untrained guests.

WCO 3b: Replace Water Fixtures

Advantages: Although research suggests replacing a typical shower head with a low-flow model results in longer showers, this technology nonetheless results in water and energy use reductions of around 25 gallons of water and 80 therms per person, per day.[28] Low-flow units are often less-expensive than their standard counterparts.[29] The newest low-flow shower heads reduce flow to about 1.5 gallons per minute (gpm) over first-generation technologies that perform at around 2.5 gpm. Significant performance gains will be realized by updating all showerheads to the newer fixtures.[30] The Huntington VA Medical Center, for example, reduced its annual water use by 11% through the introduction of low-flow fixtures.[31] New aerators can reduce water use through faucets by up to 50%.[32] Finally, there is the potential for some energy-cost savings realized through reduced hot water heating requirements.

Disadvantages: Conducting flow tests, fixture inventory, and installing retrofits requires time and some cost. Replaced fixtures require disposal. Research shows mixed user preference for low- versus standard-flow shower heads, however, the potential user preference for standard fixtures may be mitigated through education and acclimation to the new technology.[33]

Estimated Cost: $20 - $30 per shower head; $5 - $10 per faucet aerator;[34] standard repair and maintenance may require nominal investment in replacement hardware and/or labor. Appliance retrofit or replacement may require investment ranging from $25 for a high-efficiency pre-rinse spray valve, which lasts about five years, to several thousand dollars for new Energy Star appliances.[3]

CASE STUDY[36]

In 2007 the Huntington VA Medical Center in West Virginia implemented a water efficiency program that replaced 178 faucets and 33 shower heads to low flow models. The retrofits were performed by hospital staff, and each installation took about half an hour to perform. As part of the program, the staff also converted 87 toilets to a mix of low-flow, 1.6 gpf toilets and dual flush toilets with average use of 1.3 gpf.

The faucet and showerhead retrofits alone reaped nearly six times initial materials and labor expenditures in annual energy, water, and sewer costs. These efforts allowed Huntington to reduce its annual water use by 11 percent in 2008 over its 2006 baseline. The facility was awarded the Federal Energy Management Award for Water Management in 2008 for its dramatic success.

WCO 3c: Practice Efficient Garden Watering

Advantages: Most water applied by a sprinkler evaporates before it ever reaches plants. Watering is more targeted and efficient when applied near the plant base, as with soaker hoses and drip irrigation systems.[37] These systems are inexpensive and use much less water than sprinklers in similar applications. Both are easy to install and maintain, work well in areas where heavy mulch is applied, and can be fed from rainwater collected on-site in rain barrels or cisterns.[38]

Disadvantages: Replaced sprinklers and hoses must be stored or disposed of and new equipment must be purchased, installed, and maintained.

Applicable To: Vegetable and perennial gardens, new plantings, and other landscaping installations

Estimated Cost: A typical soaker hose can be found at most home garden centers for around $20.[39] Spot-drip systems for new plantings can be constructed from milk jugs and other common household materials for little to no cost.[40]

Comments: For optimal efficiency, soaker hoses should run in lengths less than 100 feet long, should be applied on relatively level ground and covered with mulch, and water flow should be set low for a slow flow.[41] Drip systems should also be used in conjunction with heavy mulch.

The Northeast Organic Farming Association (NOFA) publishes comprehensive guidance on the design and care of ecological landscapes, Standards for Organic Lawn Care.[42]

WCO 4: ENSURE CONSTRUCTION IS CONDUCTED IN AN ENVIRONMENTALLY RESPONSIBLE MANNER

Issue:	Pollution and erosion due to construction activities
Recommendation:	**WCO 4a** - Ensure contractors and laborers observe anti-pollution and anti-erosion rules **WCO 4b –** Conduct tours of the Preserve
Estimated Cost:	**WCO 4a** - Time & effort, **WCO 4b** - Time & effort

Issue and Recommendation: The projects described in this report may require excavation and disruption of the landscape, which can significantly alter natural drainage processes. A typical construction site can erode at a rate as high as 100 - 500 tons/acre/year and introduce pollutants into storm water runoff.[43,44] Accelerated erosion results in the washing away of soil and vegetation that support local ecosystems, leaving them vulnerable to decline and eventual collapse. Polluted storm water runoff has been identified as a source of water and soil pollution that jeopardizes the quality of surface and ground waters as well as the health of marine ecosystems.[45]

In order to address this issue, it is recommended to ensure the provided list of Anti-Pollution/Waste Management and Anti-Erosion Best Management Practices (BMP) are practiced by contractors and laborers while working on the Preserve (WCO 4a) and to conduct a tour of the Preserve for contractors and laborers before work commences on any major construction projects (WCO 4b).[46]

Existing Conditions: The Preserve expects to conduct a series of construction projects as well as a significant modification to or replacement of the OWTS. Steps should be taken to preserve the relatively favorable conditions that now exist for groundwater recharge and to prevent any erosion or pollution that may occur as a result of said projects.

In addition, the slope and grading of the landscape surrounding the residential buildings on the Preserve has been identified as in need of build-up and contouring so as to ensure the ground surface slopes away from the buildings on all sides for a distance of at least four feet.[47] The reason for this modification is to eliminate the continued seepage of water into the basement of the buildings.[48] This ground contouring condition is counterproductive to groundwater recharge, and the effect may be exacerbated by the aforementioned effects of improperly managed construction site storm water runoff.[49]

WCO 4a: Ensure Contractor & Laborers Observe Anti-Erosion & Anti-Pollution Practices

The following pages describe practices intended to serve as checklists to be used for vetting contractors and ensuring they and related laborers observe the practices while working on the Preserve.

POLLUTION CONTROL/WASTE MANAGEMENT MEASURES

Material Transport & Storage:

1. Access to and from the site is limited to authorized vehicles.
2. Deliveries and trips to and from the site are minimized through carpooling and proper planning and scheduling.
3. Only the materials that are needed to finish the project are kept onsite.
4. Materials and equipment are not stored near storm drain inlets and/or watercourses.
5. Stockpiles and construction materials are protected from winds and rain by storing them under a roof, secured impermeable tarp, or plastic sheeting.

Dumpsters & Debris:

1. Open dumpsters are covered with secured tarps or plastic sheeting.
2. Dumpsters are never cleaned out by washing down with water on the construction site.
3. A debris disposal schedule is established and kept to ensure dumpsters do not overflow.

Spills & Clean-up:

1. The site is kept clean by conducting regular, frequent sweepings as well as removing trash, debris, and other waste.
2. Spills are cleaned-up immediately using dry clean-up methods for liquid spills (absorbent materials such as cat litter, sand, and/or rags) and by sweeping or vacuuming for dry spills such as cement, mortar, or fertilizer. Contaminated soil and/or absorbent material(s) are disposed of properly.
3. Where applicable, construction materials and wastes, including solvents, water-based paint, vehicle fluids, broken asphalt and concrete, wood, and cleared vegetation are recycled or otherwise disposed of properly.
4. Specific areas that employ the use of tarps or heavy plastic drop cloths are designated for mixing concrete as well as washing out concrete mixers to prevent soil contamination.

Vehicles:

1. Vehicle maintenance and repair is never conducted on site.
2. Entrance and exit points to the site are stabilized to minimize the track out of dirt and mud onto adjacent streets.
3. Vehicles and equipment are clean and maintained in good working condition, reducing the risk they will leak any harmful substances on the Preserve.

ANTI-EROSION MEASURES

1. Existing vegetation is removed only as needed.
2. Sediment from onsite runoff is removed before it leaves the site.
3. Steps are taken to reduce the velocity of the runoff traveling across the site.
4. Off-site runoff is prevented from traveling through any part of the construction site.
5. Erodible soils and sloped areas are covered with mulch, vegetation, matting, or riprap.
6. Grading and excavation operations are phased to limit disturbed areas and duration of exposure.
7. Excavation, grading, and paving operations are scheduled for dry weather periods, when possible.
8. All storm drain inlets and water courses near the site are protected to prevent sediment-laden water from entering.
9. Construction activities are adjusted to accommodate natural site features, e.g. topography, soils, waterways, and natural vegetation.
10. Areas that are disturbed and will not be re-disturbed for a long period are stabilized with temporary seeding, mulching or matting.
11. Grade changes are minimized on the site to decrease the amount of disturbed soil and the amount of erosion that can occur.
12. Sediment control devices remain in place until permanent vegetation has been established or the site is otherwise stabilized.
13. The amount of surface runoff at the site is controlled by impeding internally generated flows and employing means to directing incoming offsite flows around the site.
14. Routine checks are conducted to ensure that all control measures are working properly for the duration of the project.

Advantages: Observance of the above listed BMP will significantly reduce erosion rates and pollutant discharges from any construction site(s) on the Preserve. Implementation of these BMP will mitigate the risks associated with polluting the surface and ground waters as well as the marine ecosystems on and surrounding the area as a result of undertaking construction projects on the Preserve.

Disadvantages: It will be more difficult to identify contractors willing to comply with these rules or who have adopted a sufficiently similar set or rules than to identify a contractor who has not done so, which may prolong the search for a contractor. In addition, contractors who have implemented these BMP may demand a price premium, thus raising the cost of the project. Finally, ensuring these BMP are actually performed will require, at a minimum, some initial observation to be conducted by Preserve staff.

Estimated Cost: Time required to practice due diligence in selecting a contractor that employs the appropriate and applicable methods of construction site pollution and erosion prevention.

WCO 4b: Conduct Tours of the Preserve for Laborers and Contractors

Advantages: Contractors and laborers will be made aware of the ecosystems on the Preserve and the importance of conserving them. In addition, the potential for damage to occur to the area as a result of their work can be identified and explained, thereby making the connection between their work and the sensitivity of the area clear. Using the natural beauty of the Preserve's grounds as a backdrop to this educational session will make this connection explicit by reinforcing the verbal messages with visual impact. Moreover, in providing this deeper level of understanding, the contractors and laborers will have been provided with reasons for the rules, making them potentially easier to accept and follow. Finally, they will have been made amply aware of their pollution and erosion prevention responsibilities while working on the Preserve.

Disadvantages: The drawbacks of this gesture are that it will require time and effort to develop the curriculum of the tour as well as to plan, schedule, and coordinate each tour. Multiple tours per day may be required depending on crew size the availability of Preserve vehicles to transport them. In addition, there will be expenses in the form of fuel costs as well as the added wear and tear on the vehicles used to conduct the tours. There is also the potential for resistance from contractors and workers to take part in the tour. Finally, the participants may be uninterested in the subject matter, confounding the intention of the tour and wasting time and effort.

Estimated Cost: The time it takes to develop a curriculum and to conduct the tours, and the mileage on the vehicles used to transport the contractors and workers around the Preserve.

Comments: These recommendations could be incorporated into work contracts and become standard operating procedure for any major construction projects that take place on the Preserve.

WCO 5: COLLECT AND USE RAINWATER

Issue:	Use of rainwater
Recommendation:	**WCO 5a** - Capture and store rainwater, **WCO 5b -** Use rainwater for toilets, **WCO 5c -** Use rainwater for outdoor watering activities
Estimated Cost:	**WCO 5a** - $200 - $10,000, **WCO 5b** - $0 **WCO 5c** - $0

Issue and Recommendation: It is imperative to reduce stress on the aquifer that feeds the on-site wells.[50] In addition to standard water conservation practices, using harvested and stored rainwater instead of groundwater for toilet flushing and outdoor use can reduce pressure on the fragile aquifer.

In order to address this issue, it is recommended to implement rainwater collection and storage capability on site (WCO 5a), supply toilet fixtures with harvested rainwater (WCO 5b), and use harvested rainwater to water gardens, shrubs, and other landscaping (WCO 5c).

Existing Conditions: All indoor and outdoor plumbed water is drawn from on-site wells fed by the island's aquifer. Evidence of past rainwater harvesting and storage is present in the existing but presently unused cistern.

WCO 5a: Implement On-Site Rainwater Collection and Storage Capability

Advantages: Using collected rainwater for non-potable water applications reduces stress on the island's potable water source. Stored rainwater can serve as a backup during especially dry weather or other water supply disruptions. The technology is flexible and can adapt to nearly any building site where rain falls. For example, depending on its condition, the existing cistern can likely be rehabilitated with readily available latex sealant, new hatches, and new piping for very low cost. Prefabricated rain barrels and necessary accessories such as an overflow kit, rain diverter, soaker hose, linking kit, spigot, and additional guttering are an inexpensive and relatively simple retrofit. Prefabricated, above-ground cisterns are available in a choice of sizes (500 gallons < > 10,000+ gallons) and materials (fiberglass, steel, composite) to suit a variety of capacity requirements and budgets; or a custom, in-ground cistern can be built by hand for relatively low cost. Regardless of the capture and storage method selected, operation costs are low.[51] Visible rain barrel or cistern installations also provide excellent demonstration and education opportunities for Preserve visitors. Calculations for sizing this system are shown in a model exercise in Appendix III.

Disadvantages: Any of the rainwater harvesting and storage options detailed above will require time, labor, and capital investment to retrofit guttering and indoor/outdoor plumbing supply.

Applicable To: All buildings

Estimated Cost: Costs range from around $200 for a pre-fabricated rain barrel and related accessories to more than $10,000 for a new, custom high-capacity steel cistern. Rehabilitation of the existing cistern can probably be achieved for less than $200.[52]

WCO 5b: Use Harvested Rainwater to Supply Toilets

Advantages: It is unnecessary to flush toilets with potable water. Flushing toilets with rainwater collected via the methods described in WCO 5a reduces pressure on the local aquifer and, in times of water stress, leaves more potable water available for human consumption. Water supplied by rain may look different from water supplied by the well, which presents an excellent demonstration and education opportunity for Preserve visitors. Because this strategy merely switches the external supply of water, there should not be negative implications for application in an historic house, provided indoor plumbing is in good working order. The rainwater pipe feeds into the same header tank that the main water pipe currently fills. A relatively simple switch can be installed by site staff or a professional plumber to alternate water sources as needed.
Disadvantages: Collected rainwater may have undesirable aesthetic consequences in indoor plumbing applications, as the water may not appear "clean." This can be mitigated through user education (see advantages, above).[53] In a simple system where the toilets are below the rain barrel, a splitter can be installed at each toilet's intake to switch between sources. Because the toilets in the Manor House will be above, or "upstream" of, the rain barrel or cistern, a pump will take the water from the rainwater source to a header tank that supplies the toilets (and not the rest of the plumbing in the house). In that case, the splitter goes between the well pipe and the header tank. A professional plumber will need to assess, assist in selecting, and install an appropriate pump and the other required plumbing retrofits. Pumps have energy requirements that may be inadvisable with respect to energy-efficiency recommendations.

Applicable To: All buildings

Estimated Cost: The elements necessary to implement rainwater toilet flushing are included in the costs for WCO 5a. Additional costs may be incurred if a professional plumber is engaged to apply the retrofits. This should require less than one day of professional labor.

HOW A RAIN-FED TOILET FLUSH SYSTEM WORKS:

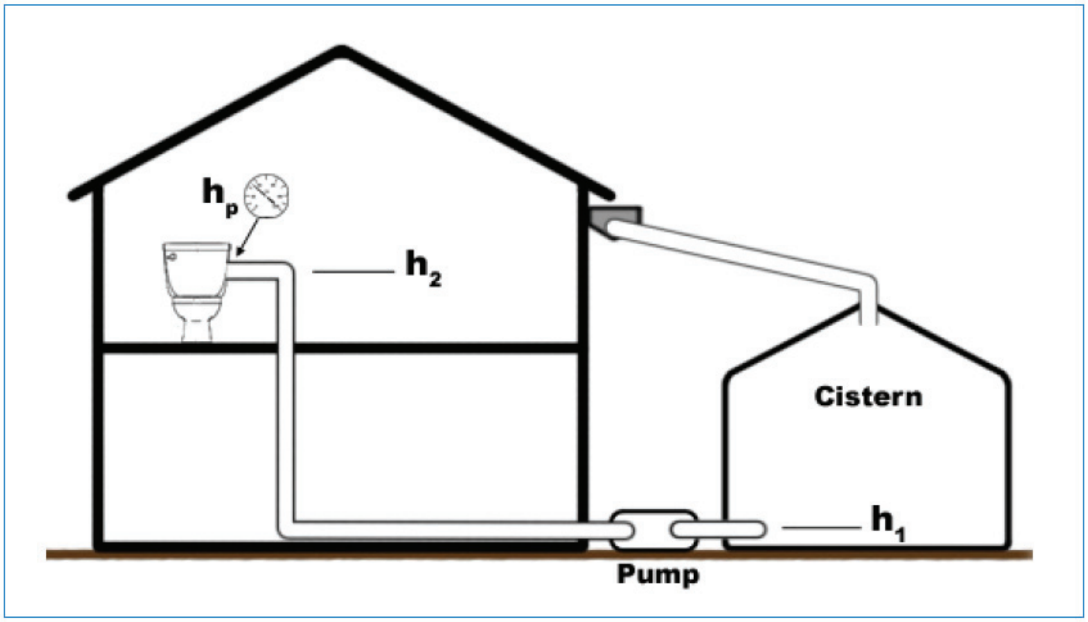


Figure 13 - Complete rainwater toilet flushing system[54]

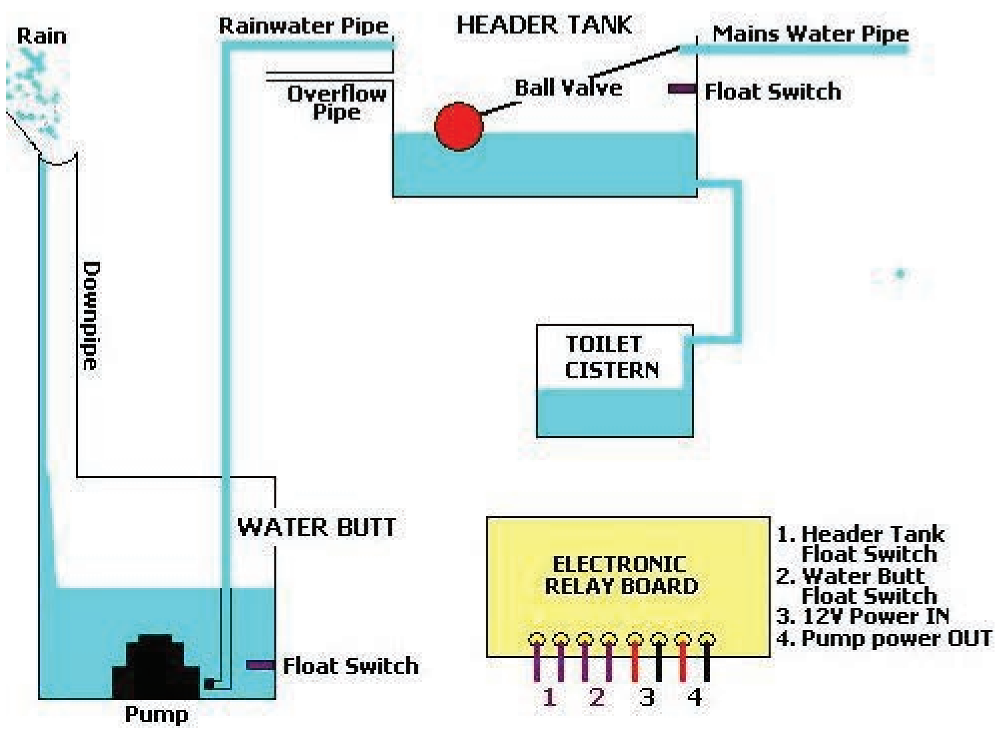


Figure 14 - Rainwater Toilet Flushing System-Schematic View[55]

WCO 5c: Use Harvested Rainwater for Outdoor Watering Activities

Advantages: Because outdoor water needs are naturally met by rain, it is again absolutely unnecessary to use drinking-quality water for outdoor watering and irrigation. As in WCO 5b, supplemental landscape watering with collected rainwater reduces pressure on the local aquifer and, in times of water stress, leaves more potable water available for human consumption. Operational requirements are minimal.

Disadvantages: Using collected rainwater for any application requires start-up investments of time, labor, and materials as detailed in WCO 5a.

Applicable To: All outdoor watering requirements

Estimated Cost: Once WCO 5a is executed, there is no additional cost to supply outdoor spaces with collected rainwater.

WCO 6: OPTIMIZE GROUNDWATER RECHARGE

Issue:	Groundwater recharge
Recommendation:	Install a rain garden(s)
Estimated Cost:	$200 - $300

Issue and Recommendation: The Preserve's supply of water is threatened by the effects of climate change as well as expected increases in future water consumption arising from The Nature Conservancy's plans to hold more fundraising functions at the Preserve.[56] Coupled with the fact that S.I.'s drinking water supply is dependent upon the hydrological cycle, prudent practice dictates that groundwater recharge is optimized to mitigate these expected future conditions.

In order to address this issue, it is recommended to install a rain garden(s) (see Figure 15 below[57]) containing native plants adjacent to buildings selected by the Preserve.[58]

Existing Conditions: The area directly around the Manor House consists of lawn grasses, including different types of native fescues, native oaks, maples, beeches, and other tree species. The lawn grasses are drought tolerant and require less water compared to other types of grasses typically used for lawns. Because the lawn requires mowing every seven to ten days, it is relatively low maintenance. Another benefit of the lawn is that it does not require fertilizer, which eliminates the threat of fertilizer-based nitrates infiltrating the ground or surface waters. The trees contribute to these favorable groundwater recharge conditions as well. By capturing water through their leaves and roots, they help to stabilize the soil and ultimately contribute to cleaner water and less runoff.[59] Similarly, the trees growing near the shoreline help keep stormwater runoff from flowing into the surrounding marine environments.

As there is no readily apparent evidence of erosion or runoff, it is safe to assume the water not consumed by the grasses and trees is efficiently infiltrating the soil, entering the aquifer, and is contributing to the supply of drinking water available to the Preserve.

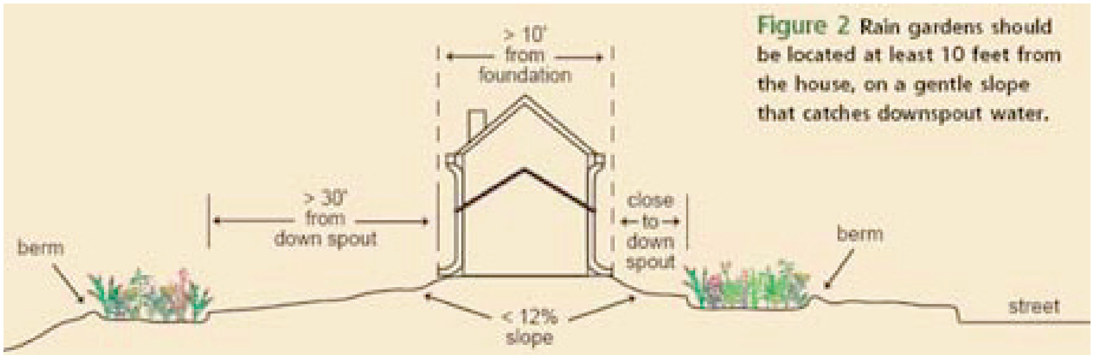


Figure 15 - Rain Garden

Despite these productive conditions, according to the 2011 Property Assessment Report, there are areas where water pools around the foundation of the Water Tower, Fire House, Caretaker's Cottage, and Barn / Garage. The report recommends having the area properly graded and for gutters to be installed. Once this sub-optimal condition is rectified through these recommendations, a rain garden can be installed to further maximize ground water recharge.

Advantages: Research has demonstrated the effectiveness of rain gardens in recharging groundwater and, when planted with native vegetation, will withstand a range of adverse weather conditions. [60, 61]

Rain gardens are inexpensive to install and maintain and make efficient use of roof run-off.[62] Because rain gardens provide decorative landscaping, birds and butterflies that are attracted to the flora will enhance visitors' experience of the Preserve.[63, 64] Furthermore, a rain garden is an attractive and practical means to contribute to the goal of increasing the amount of native vegetation on the Preserve.

Additional support for rain gardens comes from accounts by local Shelter Island residents who testify to their effectiveness. For example, after estimating that approximately 24,000 gallons of water pours from their roof each year, a couple in S.I. installed a rain garden planted with wetland wildflowers and irrigated by rainwater from their roof. Strategic placement of the rain garden with respect to sunlight and ample irrigation has contributed to its success. [65]

Finally, in keeping with the Preserve's educational work, staff can present rain gardens to visitors as an inexpensive, viable option for Long Island residents to prevent residential storm water runoff and make efficient use of rainwater.

Disadvantages: A new rain garden requires time and expense to install. Additional time and effort is required to maintain the garden until it reaches a point when it is self-sufficient. Finally, rain gardens that do not drain properly can serve as a breeding ground for mosquitoes.[66]

Estimated Cost: Approximately $200.00 - $300.00, if installed by TNC staff. This covers the cost of peat moss, native vegetation, crushed stone, and a roof gutter downspout extension.

Comments: See Appendix for general installation requirements and further recommendations.

WCO 7: DECOMMISSION UNUSED WATER WELLS

Issue:	Potential safety hazard and aquifer contamination
Recommendation:	Properly decommission the wells not in use
Estimated Cost:	$300- $1,500

Issue and Recommendation: Abandoned wells that are not properly decommissioned pose a safety hazard to children and small animals and/or may lead to groundwater contamination.[67]

In order to address this issue, it is recommended to properly decommission the abandoned wells as per Department of Environmental Conservation guidelines.

Existing Conditions: One of the two unused wells is in the basement of the Keeper's Cottage, and the other well is on the grounds immediately surrounding the Manor House. The former is an old drilled/pounded well from which the pump has been removed. It currently acts as a ground for the building's electric system. As part of a renovation project, the Preserve intends to decommission this well by filling it in with sand. The other well's pump was removed and the well is capped. The Preserve's plan is to keep this well as an emergency water source, not decommission it.[68]

Wells that have not been properly decommissioned pose a contamination threat to the aquifer by surface water directly entering the aquifer and by bacterial contamination from decomposition of animal bodies and waste products.[69]

Advantages: Properly decommissioning a well that is no longer in use eliminates a threat to S.I.'s aquifer, small animals, and humans. It also prevents any potential legal liability if someone were to injure themselves on an improperly abandoned well.

Disadvantages: Although properly abandoning the well will eliminate a potential emergency water supply source, there are other ways to get water during adverse conditions, e.g. bottled water. Finally, although there is a cost involved, it is outweighed by the benefits of avoiding the potential hazards.

Estimated Cost: The cost depends on well accessibility, construction technique, and materials. The cost ranges from $300.00 for a small-diameter shallow well to over $1,500.00 for a deep, large-diameter well.[70]

Comments: Please see Appendix for the steps to be taken to properly decommission a well as per the New York State Department of Environmental Conservation.[71]

WCO 8: TEST WELL WATER

Issue:	Potential for private water well contamination
Recommendation:	Test the water supply annually
Estimated Cost:	$25 - $300

Issue and Recommendation: The Onsite Wastewater Treatment System is installed in the same general area as the wells. Although this is standard procedure on S.I. and on L.I. in general, contamination of drinking water wells is possible if the OWTS malfunctions and/or the aquifer is somehow infiltrated with toxins. The Suffolk County Department of Health Services (SCDHS) recommends annual testing of private wells. [72]

In order to address this issue, it is recommended to have the Preserve's well-water tested annually.[73]

Existing conditions: The Preserve's wells have passed SCDHS's required water quality tests; however, staff noticed a film on pots and pans after water was boiled soon after the wells were activated. To fix this aesthetic issue, Krieger Well and Pump Co. installed a Chandler CU100N-20 filtration system to treat what they determined to be a water hardness condition. This filtration system is sufficient to remove taste, odor, color, sediment, iron, and to resolve low pH issues, however, it does not disinfect water or remove other toxins.[74] As SCDHS has determined the water is safe, further treatment is not required.

Advantages: Regular testing is an effective and recommended method to ensure potable water is being drawn from the wells. It also ensures Preserve residents, staff, and visitors will not suffer from any water borne illnesses while on the Preserve. In addition, through annual re-verification of the safety of the well-water, the Preserve can be relatively certain of the health of the soils and that the OWTS is functioning properly.

Disadvantages: In addition to the time and effort involved in the water testing procedure and waiting for results, there are annual costs involved in this action. The safety of the Preserve's water supply and thereby its staff's, residents', and visitors' health, however, far outweighs these relatively minor disadvantages.

Applicable To: All buildings

Estimated Cost: Testing is relatively inexpensive, ranging from $25.00 for basic bacterial tests to around $300 for comprehensive spectrum testing.[75] Should the water supply become contaminated and require further treatment, costs vary widely. Simple ultra-violet light sterilization units cost as little as $300.00, while costs associated with finding an alternative water supply would be extremely high.

Comments: With regular maintenance, the current water filtration system is sufficient to resolve water quality issues that do not threaten human health. If safety issues are identified through testing, SCDHS or the EPA can recommend an appropriate treatment solution based on the issue detected.

WCO 9: CONSIDER DESALINATION

Issue:	Potential for severely limited or no onsite water supply
Recommendation:	Install a desalination system
Estimated Cost:	$5.40/1,000 gallons

Issue and Recommendation: The effects of climate change can cause droughts and salt water incursion to such a degree that the existing water supply would be severely negatively impacted. Thus, the Preserve faces a long-term risk of no onsite water supply.

In order to address this issue, it is recommended to install a small wind-powered Reverse Osmosis Water Desalination system (see Case Study) to eliminate the risk of lack of water supply during periods of drought conditions or in the event the water supply is otherwise compromised.

Existing conditions: The Preserve's water supply is presently adequate. However, during a drought in 2002, two Shelter Island (S.I.) wells ran dry, which necessitated trucking in drinking water. As a result, Suffolk County officials considered constructing a desalination plant on Long Island.[76] Other regional bodies, including Marine Park Golf Course in Brooklyn, New York and the town of Cape May, N.J., have recognized the same concerns with respect to their water supply and have considered and constructed desalination systems. [77]

Advantages: Water desalination ensures freshwater during periods of drought or in case the Preserve's water supply was to become contaminated. Wind-powered reverse osmosis is preferable to other alternative emergency water supplies such as trucking in bottled water, as it does not emit any CO_2 or GHGs, contribute to landfill, unnecessarily consume energy, or have any of the other negative effects associated with bottled water.

These systems can produce freshwater on a large (128,000 m3/day) or very small (0.1 m3/day) scale and can be designed to accommodate Preserve's current freshwater requirements of between 1,000 gallons/day and 10,000 gallons/day (see 12.1.4 for a basic description of how the system works). Finally, the salt byproduct may be useful to local businesses engaged in the production of salt for consumption.

CASE STUDY

In 2009, the Water Resources Research Center in Hawaii developed a simple and cost-effective desalination system for the Pacific Islands and other coastal communities where freshwater and electricity was in short supply.[78] The research was conducted on a 28 acre island that has limited access to freshwater and is surrounded by a sensitive coral reef ecosystem where utilizing renewable energy is a priority. The desalination system operates on wind and solar power. The island's average wind speed of 2- 8 m/s drives a windmill that provides power to operate the reverse osmosis process, while photovoltaic cells power the instruments needed to control the system and provide data readings.[79]

Disadvantages: In addition to the disadvantages associated with employing wind power described in 6.5.1.5, constructing and operating a desalination system requires a significant capital expenditure as well as ongoing operation and maintenance costs. Moreover, specialized training is required to run the system, and any repairs may have to be performed by specialists. Furthermore, the system may detract from the aesthetic appeal of Preserve's grounds. There is also potential for harm to be done to marine life from the deposition of salt generated by the desalination process on the sea floor. Finally, permitting requirements do not exist for desalination on Shelter Island aside from causeway zones. These causeway standards, referenced in the Shelter Island Town Code (code # 129-4.1), could be eventually extend to other areas on Shelter Island.[80] Prior to construction, the Suffolk County Health Department should be contacted for the most current permitting requirements for the construction and operation of a desalination system.

Estimated Cost: The figure $5.40 per 1,000 gallons accounts for system construction, including three months' salary for a technician, equipment (windmill/pump, pressure stabilizer, reverse osmosis membrane module, data logger, sensors, miscellaneous), and operational costs for 20-years of operation.

Comments: See the Renewable Energy section for wind turbine permitting issues and an extended discussion of the tradeoffs between employing renewable energy technologies for human benefit and the impact they inflict upon the environment.

Wastewater Management Opportunities

WMO 1: ADDRESS ANY ISSUES THERE MAY BE WITH THE OWTS

Issue:	Possibility of high nitrate emissions and saltwater incursion
Recommendation:	**WMO 1a** - Evaluate the OWTS and test surrounding soil, **WMO 1b -** Install a Nitrex System
Estimated Cost:	**WMO 1a** - $1,500 & $2,000 -/+, **WMO 1b** - $160,000 +

Issue and Recommendation: The leaching process relied upon by the Onsite Wastewater Treatment System (OWTS) may be inadequate to reduce the septic fluid's nitrate levels to an acceptable level given the sensitivity of ecosystems that characterize the Preserve. This deficiency could result in the contamination of surface waters, groundwater supply, and the surrounding marine environments.

The Preserve wishes to employ the precautionary principle by replacing or modifying the existing OWTS so as to ensure nitrate emission levels are as low as possible. [81] The Preserve hopes to achieve two goals. The first goal is to reduce the nitrate emission levels of its OWTS as much as possible. The second goal is for the selected solution to serve as a model case in the hope that it will be adopted by the residential and business community of S.I. and L.I. If the latter is achieved, it has the potential make a significant contribution towards the restoration of the health of S.I's and L.I.'s surface waters, groundwater supply, and marine environments.

In order to address this issue, it is recommended to test the OWTS for salt water incursion and any potential groundwater contaminants (WMO 1a). If the tests reveal a problem sufficient to warrant it, install a Nitrex System (WMO 1b).

Existing Conditions: The OWTS serving the Manor House, which employs the conventional technology standard of 1968, the year it was installed, consists of a 2,000 gallon septic tank and three cesspools, each comprised of a drainage dome and two 4'- 6" sections embedded in an ample amount of sandy medium and covered with loam (see Figure 16 for a depiction of how the Preserve's OWTS functions.)

The Director of the Preserve suspects that the system is faulty, that saltwater has incurred upon the cesspools, and that they are emitting toxic levels of nitrates. The system has not been tested for either suspected condition and any suspected faults in the system remain unsubstantiated.

According to the 2011 Property Condition Assessment Report, the OWTS, "generally appeared to be in good condition and to be operating properly . . . with no evidence of any back-up or blockage." In addition, "a dye test was performed and the results were negative for any leaks or surface seepage." The report goes on to say, "there is a low probability of well water contamination at this location." It is worthy to note that the findings of this evaluation are in keeping with the minimum life expectancy of a residential septic system of approximately 20 – 30 years depending on usage and soil conditions.[82] Also worthy of note is U.S. Environmental Protection Agency recommendation that residential septic systems be professionally inspected

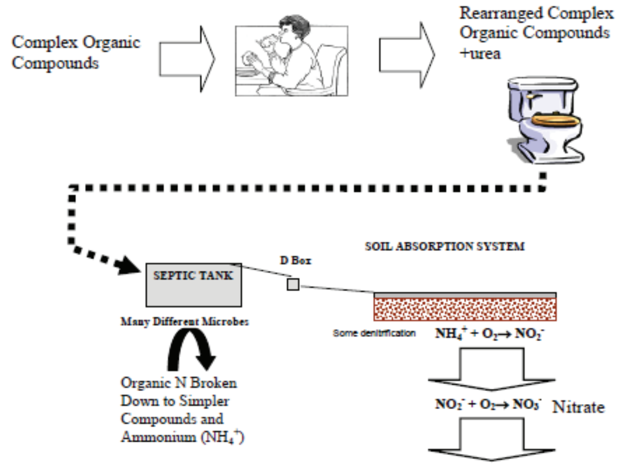


Figure 16 - Onsite Wastewater Treatment System (OWTS)

at least every 3 years and that the septic tank is pumped as recommended by the inspector, generally every 3-5 years.[83]

Applicable to: All buildings

WMO 1a: Professionally Evaluate OWTS and Test Surrounding Soil for Contaminants

Advantages: This preliminary action will dispel any doubt regarding the performance of the existing system arising from the conflict between the suspicion of the Director of the Preserve and the professional opinion of the installer of the OWTS as well as the observations of Schmitt Engineering, the latter two of which are in agreement. This action will verify whether or not any further action(s) *need* to be taken with respect to the performance of the OWTS at the Preserve.

If it is found that further actions do need to be taken, knowledge of the contaminant levels of the OWTS will be documented, enabling the effectiveness of any fix to be measured through subsequent monitoring of its performance. Moreover, this data may prove useful in any promotion of the system's replacement subsequent to the verification of its performance. Finally, if either suspected condition is discovered, the viability of WMO 1b and WMO 1c may be affected. It is prudent practice to accurately gauge the scope of work that will be involved when considering a costly, time consuming, and disruptive project.

Disadvantages: A complete evaluation of the septic system can only be done by exposing the cesspools and through soil testing, both of which must be performed by licensed professionals. The former involves an extensive excavation and refill process. Both procedures involve upfront costs.

Estimated Costs: Soil testing: approximately $1,500.00 (includes two 20ft. borings and lab testing fees) plus additional costs if the soil tests reveal the presence of excessive levels of nitrates: [84]

Septic tank pump-out $350.00 for a 2,000 gallon tank[85]

Visual inspection of the cesspools: $145.00 per foot of excavated soil[86]

Cesspool pump-out: $175.00 per 1,000 gallons of septic fluid removed[87]

Comments: If soil tests reveal that there is neither saltwater incursion nor excessive levels of nitrates and thus 1) no long-term threat to the surface waters, ground waters, or surrounding marine environments and 2) that the existing OWTS is not in need of servicing or is only in need of pump-out and/or cleaning, WMO 1b is *not recommended*. This determination was made based on the idea that the significant financial resources necessary to implement WMO 1c would be more effectively allocated to other Opportunities that directly address a problem area. In addition, replacing an OWTS that does not require it would represent a waste of resources and subject the property surrounding the facilities to unwarranted disruption and pollution.

WMO 1b: Install a Nitrex System

A Nitrex System is a small pump and a filter box that employs advanced nitrate converting media technology to convert nitrates in sewage into harmless nitrogen gas. The system can be integrated into the existing OWTS through a retrofit process.

Advantages: Nitrex is a state-of-the-art OWTS technology, proven to reduce influent septic fluid nitrate emission levels from between 14 and 75 parts per million (ppm) to between 1.6 and 6.9 (ppm). [88] Mean and median statistics for effluent were 3.4 ppm and 3.7 ppm respectively. In addition to this best-in-class performance, the system requires very little maintenance. Nitrex is one of the three systems approved for use by the Suffolk County Depart of Health Services (SCDHS).[89]

Currently, 10 Nitrex systems have been successfully installed, and are operating within the aforementioned performance expectations, in residential applications across the U.S., including one at the Scully Estate located in East Islip, L.I., New York, home of The Suffolk County Environmental Center U.S. (see case study). [90,91] There have also been several successful installations in Canada.

Finally, because SCDHS is considering the technology for residential use, the Preserve's objective of using the system as an advertisement of sorts to promote its effectiveness in reducing OWTS nitrate emissions is justified and reasonable. [92]

Disadvantages: There is a considerable implementation cost of $160,000.00. SCDHS will require periodic testing of the system to monitor its performance, the Preserve may need to apply to SCDHS for a code variance to meet the 1,000 gallon per day requirement to install the system, and the system requires electricity to run an underground pump.

The installation and reconfiguration of the existing OWTS is labor intensive and requires a large excavation and refill procedure, and the buildings will experience limited water use during certain phases of the project. These points apply to any modification to the existing OWTS, thus are "considerations" rather than disadvantages.

Estimated Costs:[93]
Estimated Initial Cost: $160,000.00
Two years of maintenance: $12,000.00
Electricity to run the pump: $50.00/year
Pump replacement (approximately every ten years): $1,200.00

Comments: Acting on his aforementioned suspicion, the Director has engaged the services of an environmental engineering and consulting firm, Lombardo Associates, Inc., to initiate the installation of a Nitrex System.

CASE STUDY

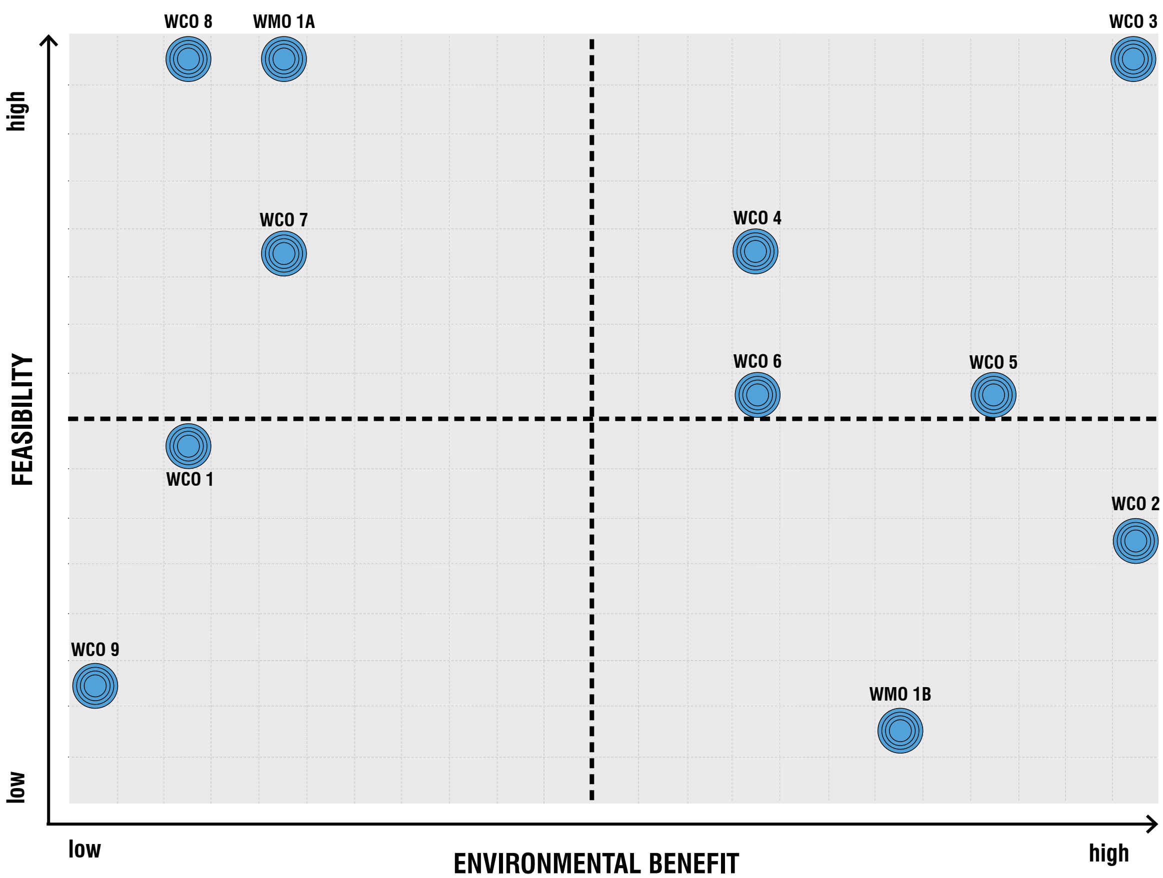
Located on South Bay Avenue in Bay Shore, L.I., The Scully Estate is a 1917 Normandy-style Chateau that sits amid the Suffolk County Environmental Center (SCEC), a 70 acre public nature center near the shores of the Great South Bay. Similar to Mashomack, the nature center features a system of trails that provide visitors access to a diverse mix of habitats, including extensive salt marsh, freshwater wetlands, and mature upland forest. Likewise, SCEC's buildings are adjacent to the Seatuck National Wildlife Refuge and the Islip Town Beach.

Between 2006 and 2010 The Estate underwent an extensive renovation project. In recognition of the Estate's proximity to these ecologically sensitive areas as well as a desire to comply with Leadership in Energy and Environmental Design (LEED) standards for enhanced wastewater treatment, Suffolk County sought out the best technology to reduce the nitrate emission levels of the OWTS employed to serve the SCES's buildings.

After learning of the performance of the Nitrex System and receiving approval from the County's Department of Health Services, a Nitrex system was installed at the facility in 2008. The system, designed to accommodate 1,300 GPD flow rate, consists of an OWTS enhanced with Nitrex filtering technology. Using this technology, influent septic fluid nitrate levels of 70.4 ppm are reduced to 1.64 ppm, which represents a reduction of 97.7%. In this way, the SCEC has successfully reduced the level nitrate emissions emitted by its OWTS to levels that will not pose a threat to groundwater sources, surface waters, or the surrounding marine environments.

OPPORTUNITY FEASIBILITY EVALUATION MATRIX

The Opportunity Feasibility Evaluation Matrix evaluates the Water Conservation and Wastewater Management opportunities based on **environmental benefit** and **feasibility**. Environmental benefit is measured along the horizontal access and increases from left to right. Feasibility is situated on the vertical axis and shows that opportunities close to the top are more feasible than those on the bottom. This matrix aim to guide decision making by identifying which opportunities have the highest environmental benefit while being relatively easy to implement. Opportunities that fall within the top right quadrant are both very beneficial to the environment and are highly feasible. It would be very favorable for Mashomack to pursue such opportunities.



Water Conservation Opportunities (WCO):

WCO 1: Measure Water Use

WCO 2: Implement Water Conserving Behaviors

WCO 3: Install Water Conserving Technologies

WCO 4: Ensure Construction is Conducted in an Environmentally Responsible Manner

WCO 5: Collect and Use Rainwater

WCO 6: Optimize Groundwater Recharge

WCO 7: Decommission Unused Water Wells

WCO 8: Test Well Water

WCO 9: Consider Desalination

Wastewater Management Opportunities (WMO):

WMO 1a: Professionally Evaluate OWTS & Test Surrounding Soil for Contaminants

WMO 1b: Install a Nitrex System

Conclusion: Water Conservation and Wastewater Management

The recommendations in this section have been made based on the objectives of optimizing groundwater recharge, reducing water use, and minimizing the environmental impact of the OWTS. These objectives were determined by the factors known to have an effect on the Preserve's water supply. Foremost among these factors is the Preserve's dependence on groundwater recharge through precipitation for its sole water supply and the Preserve's dedication to environmental conservation. Secondary, yet related, considerations included the drought of 2002, which may be seen as a harbinger of future water scarcity as a result of the effects of predicted future climate change, as well as the Preserve's role to educate the public on the importance of environmental conservation.

The operations of the Preserve is not actively doing harm either through excessive use of water or knowingly or inadvertently contributing to pollution., Additionally, while it is true that at present the Preserve's water footprint is relatively small, there is no concerted effort to minimize it. As such, there is room for improvement as explained in the WCOs in the previous section.

The recommendations that hold the greatest potential to reduce the Preserve's water use include the implementation of water conserving technologies such as low-flow toilets and faucet aerators, and the institution of water conservation behaviors. Safety and prevention opportunities include properly abandoning unused wells and ensuring contractors and laborers adhere to anti-erosion and anti-pollution BMPs. Risk reduction opportunities include the installation of a desalination system and verifying the proper functioning of the OWTS prior to undertaking a large-scale replacement project.

In keeping with the Preserve's stated lack of budgetary limitations with respect to its ability to implement any of these recommendations, it is our general recommendation that all of the opportunities identified and explained in the previous section be implemented as prioritized in the opportunity matrix found in Appendix III.

These improvements are in keeping with TNC's mission to "conserve the lands and waters on which all life depends," as well as its vision to "leave a sustainable world for future generations," as they will help to ensure visitors, staff, donors, and volunteers have to opportunity to fully experience and enjoy the flora and fauna inhabiting the Preserve for many generations to come.

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[69] Allan, Terrance. Proper Private Water System Abandonment. Cuyahoga County Board of Health. Web. http://www.clevelandwater.com/system_overview/backflow_documents/pdf/Abandoned%20well%20OCR%20_2_.pdf

[70] Skipton, S., et al. University of Nebraska – Lincoln Extension, Institute of Agriculture and Natural Resources. Decommissioning Water Wells to Protect Water Quality and Human Health. http://www.ianrpubs.unl.edu/pages/publicationD.jsp?publicationId=1050 (accessed Mar 24, 2012)

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http://www.suffolkcountyny.gov/Departments/HealthServices/EnvironmentalQuality/WaterResources/PrivateWellWaterTestingProgram.aspx

[73] Additional tests should be conducted under the following conditions: changes in water color, taste, odor or clarity; if the water begins leaving stains on fixtures, dishes, or clothes; if a chemical or fuel spill or leak occurs nearby; and/or if recurring gastro-intestinal illness is experienced.

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[79] Ibid, Liu.

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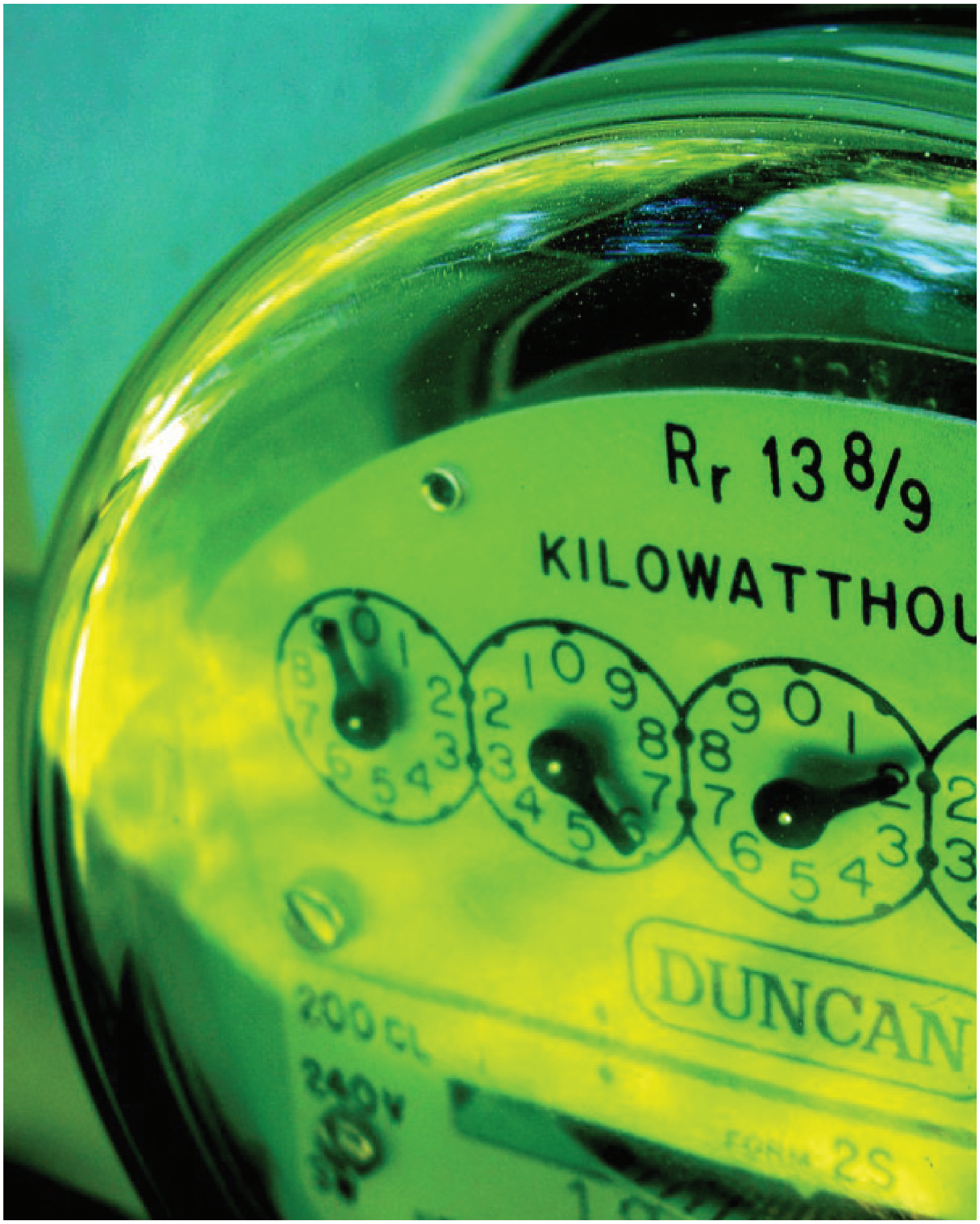
[90] Lombardo, Pio, email by Robert Schwarz, *Owner, Lombardo Associates, Inc.* (March 20, 2012).

[91] Ibid, Lombardo

[92] Ibid, Suffolk County Septic Systems

[93] Lombardo, Pio, email by Robert Schwarz, *Owner of Lombardo Associates, Inc.*(February 24,2012).



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In the United States, commercial and residential buildings consume 40% of total energy resources and about 70% of electricity.

ENERGY EFFICIENCY

Introduction

Buildings significantly impact the release of greenhouse gases into the environment due to their high consumption levels for both primary energy, such as fuel oil, and generated energy, such as electricity. In the United States, commercial and residential buildings consume 40% of total energy resources and about 70% of electricity.[1] Individual building efficiency and performance decline with age, increasing consumption of energy resources and carbon footprint impact and contributing the climate change.[2]

Given the importance of energy efficiency and environmental sustainability in buildings, this section of the report offers traditional and non-traditional energy efficiency opportunities for Mashomack to update its campus for both energy efficiency and carbon reduction. Specifically, the Manor House faces two challenges that cause it to impose greater harm on the environment than should be necessary. First, as with many structures of its age, the house is poorly weatherized and therefore does not maintain thermal comfort well. It is a leaky house with a lot of air infiltration. Additionally, the fuel that is used to heat the house and provide domestic hot water is stored in an underground storage tank. Due to the substandard envelope, the tank is refilled frequently enough to cause structural stress on it and thereby increases risk of seepage and groundwater contamination.

The aim of this research is to address the above mentioned issues and support a sustainable energy management plan. It will promote a long-term pipeline for upgrade projects to be performed at the site. Establishing an agenda with a prioritized list of energy efficiency opportunities allows for fiscal responsibility when planning renovations.

Methodology & Approach

Energy efficiency includes the following categories: general recommendations, passive conditioning, fuel-based efficiency, electric efficiency, weatherization, and best practices relevant to fuel and electric consumption. Energy efficiency opportunities are traditionally broken down into multiple categories, which are general recommendations, envelope performance, HVAC (heating, ventilation, and air conditioning), lighting, and best practices.

In Mashomack's case, the goal is to target these traditional areas while going above and beyond in order to minimize negative ecological impact. Passive conditioning was included to accommodate the use of natural systems to heat and cool the air in the house that will reduce current loads. Fuel-based efficiency and electric efficiency were drawn out as individual categories due to the large amount of fuel used on-site relative to the electricity. Weatherization was included as a more traditional form of envelope evaluation for residential buildings. The general recommendations and best practices give broad guidance for ways that the house can either further enhance the recommendations here or support behavioral changes that will create a positive impact for energy usage on the site.

The energy efficiency Compendium section presents a list of the items that were investigated based upon site evaluations. The Opportunities section goes into further detail. It is important to note that the energy efficiency and renewable sections differ slightly from the water section in their analysis of the opportunities within the Compendium. Because the technologies presented in these next two sections require additional information on the logistics of the technology's operation, a technical information section is added to the opportunities elaborated upon within the Compendium. Additional information on the technologies and basis for their selection, where noted, may be found in the appendices.

Site Conditions

The following section gives an overview of the existing site conditions as they relate to energy efficiency. The primary focus of the energy efficiency opportunities presented here are for the Manor House, with a secondary focus on the other buildings.

Climate Analysis

Some essential considerations when evaluating ways to reduce heating and cooling loads are the buildings' orientation to the sun and the region's climate and historical weather patterns. Mashomack Preserve's regional climate has more Heating Degree Days (HDD) than Cooling Degree Days (CDD) by a ratio of approximately four to one (4:1).[3] Additionally, the clear skies are ideal for solar heat gain and energy.[4] The analysis of climate using HDD/CDD brings clarity when deciding on a particular design strategy over another. In the case of Mashomack, the high number of HDD reveals that design strategies emphasizing energy efficiency of heating strategies and systems is important. However, other considerations such as occupancy patterns and the environment are a factor as well.

Sun Path and Passive Strategies

The sun is a benefit during the winter months as sustainable strategies can leverage direct-gain from the sun by way of radiant heat. During the summer months, however, the same direct-gain is a design challenge as the priority changes from maximizing solar gain for the winter to ensuring that solar radiation does not penetrate the Manor House. Fortunately, nature provides a way for architecture to reduce the impact of solar constants. The Earth moves around the sun at same plane constantly. The earth's axis is tilted, however, which means that the angle at which solar radiation meets the Earth changes throughout the year (this is also the reason for seasonal change). Innovative design can use this feature to keep solar heat in during winter and out during summer without the assistance of mechanical systems. While the characteristics of the Earth's orbit around the sun are complex, the important concepts for design here are:

During the summer the sun is at a higher altitude angle than in the winter. Shading strategies are therefore optimally designed at a higher altitude angle, while solar heat gain design is optimized at a lower altitude angle.

The earth revolves around the sun on the same linear plane, which roughly matches the equator. Subsequently, buildings in the northern hemisphere should always face south to receive direct solar gain.

Buildings on Site

The following section includes building specific information as it relates to energy efficiency.

Primary Building – The Manor House

The siding on the Manor House is cedar shake shingles with painted wood casings, fascias, windows and doors. The windows throughout Manor House are wood, double-hung, single-glazed type units. Storm windows were installed on the Manor House over 20 years ago.[5,6] Each bedroom has its own thermostat for heating (turned off when not in use), which is provided by a baseboard system. While not fully air conditioned, the Manor House does have spot units for on demand cooling in some of the upper bedrooms. These systems are only used for guests when the rooms are occupied. The office addition does have a central air conditioning system. Lighting is provided through a combination of fluorescent and incandescent fixtures, most of which have not been upgraded. There is a large commercial kitchen that sees daily use on a varying scale, as well as a walk-in cold box, which is only used during the Mashomack Preserve Annual Benefit Dinner Dance each summer.

Secondary Buildings – Water Tower, Keeper's Cottage, Barn, Director's House

The Barn is partially insulated, but does not provide much protection against the elements during the full winter season. Heating is provided by a wood stove made from an oil drum. The Barn is in need of additional weatherization and a fixed heat source so that the large bays of the Barn can be used year-round. The Keeper's Cottage and Water Tower are both winterized. For the short period of time the buildings require heat, it is provided electrically. There is also an electric hot water heater. Finally, electric heat in the Director's House is supplemented by a wood stove.

Compendium

The following list of energy efficiency opportunities have been identified and are organized into categories that collectively address the key issues of optimizing benchmarking, weatherization, passive conditioning, fuel-based efficiency, and best practices. Each opportunity identifies an action that involves the use of a technology- and/or behaviorally-based practice to minimize the energy footprint of the operations on the Preserve.

Energy Efficiency Opportunities (EEO):

Efficiency Evaluation:

EEO 1: Perform an Energy Star Benchmarking

EEO 2: Perform a Blower Door Test

Weatherization:

EEO 3a: Seal the Envelope

EEO 3b: Install Envelope Wrap

EEO 4: Protect Basement & Attic

EEO 5: Explore Supplemental Window Insulations

EEO 6: Install Storm Windows

Passive Conditioning:

EEO 7: Create Window Shading through Shutters

EEO 8: Implement Natural Shading through Plantings

EEO 9: Install Outdoor Entryway Plantings

EEO 10: Use Natural Wind Breaks

EEO 11: Utilize Sun Space

EEO 12: Exploit the Stack Effect for Passive Cooling

Fuel-Based Efficiency:

EEO 13a: Implement Boiler Upgrades

EEO 13b: Forego Boiler Upgrades and Replace Existing Boiler

EEO 13c: Explore Supplemental Heating Upgrades

EEO 14: Upgrade Hot Water Heater Insulation and Controls

Electric Efficiency:

EEO 15: Upgrade Indoor Lighting

EEO 16: Evaluate Lighting Automation

EEO 17: Utilize Natural Light Shelves

EEO 18: Evaluate Mechanical Air Conditioning

EEO 19: Replace or Remove Walk-in Refrigerator

Best Practices:

EEO 20: Control Plug Load and Computing

Opportunities

The opportunities presented in this chapter are listed sequentially in the order that represents how the projects could be approached for implementation. One cannot manage what they do not measure; therefore, it is important to have a full understanding of site consumption and building performance as described under the Efficiency Evaluation category. From there, it is recommended to secure the building envelope through weatherization techniques, since this will have the biggest impact on reducing consumption, particularly from heat. After the envelope is secured, passive strategies for heating and cooling can be explored before mechanical installations for heating and air conditioning are pursued, as described in the Electricity sub-category.

Efficiency Evaluation

The first step is measuring the site so that it can be managed. The Efficiency Evaluation section describes opportunities for tracking consumption and understanding how each facility is performing.

EEO 1: PERFORM AN ENERGY STAR BENCHMARKING

Issue:	Unknown leaks and cracks in the building
Recommendation:	Perform a blower door test with thermal imaging to identify envelope leaks
Estimated Cost:	First audit free from NY State

Issue and Recommendation: Mashomack does not currently benchmark its energy profile. It is recommended that they perform an annual benchmarking through the Energy Star Portfolio Manager Tool.

Existing Condition: Currently Mashomack uses a combination of electricity, fuel oil, wood, petroleum and gasoline on-site, along with water. There is not an existing tracking mechanism for recording costs and consumption and, therefore, there is no method for establishing the energy use and carbon footprint on-site.

Technical Information: A common saying in the energy efficiency industry is "you can't manage what you do not measure." The best way to figure out how much reduction work you have to do is to implement a method for tracking it and recording use. The Benchmarking tool by Portfolio Manager allows owners to track and record on a multi-year basis their entire campus of buildings for both energy and water usage. It is an interactive tool that also can provide suggestions for improvement, comparisons to peer institutions, estimations of carbon footprints and tracking progress of projects.

Advantages: The Portfolio Manager program is a free tool for tracking energy consumption and a starting point for determining how the site is performing. It is also a way to prove savings from year to year, track progress, and perform data analysis.

Disadvantages : Additional work will be required to prepare for entering the data into Portfolio Manager. There is a time and labor requirement to gather all the bills, sort them, determine if all the information is available, and then enter it for each facility on-site. Mashomack may not have access to individual usage for each of its buildings and it may not be cost-effective to sub-meter to determine the split. However, the site can be entered as a campus to at least begin the benchmarking process. The other disadvantage of the program is that Mashomack may not fit into an exact sector, limiting opportunities for peer to peer comparison.

Estimated Cost: The Portfolio Manager tool is free to use, however, if no employee currently has the expertise to use the tool and manage the data, it may cost money to hire someone to enter and manage the data. Energy Star does, however, provide free online training for the tool.

EEO 2: PERFORM A BLOWER DOOR TEST

Issue:	Air infiltration through envelope
Recommendation:	Locate and seal building leaks
Estimated Cost:	High $100s to mid $1,000s

Issue and Recommendation: A building's envelope is the sum of many different elements: walls, windows, doors, roofs, eaves, the basement, and so on. Each of these is in turn constructed of multiple pieces. These fragments form a unified whole – the envelope – but the joints and seams where the pieces come together leave many small, and in some cases large, gaps to be exploited by the weather. In historic homes, such as the Manor House, these gaps result in leakage rates well above 100%. This high level of leakage allows massive amounts of heat flow and moisture intrusion in and out of the house through the process of convection. It is recommended that a blower door test and thermal imaging with an infrared camera be performed on the Manor House to detect any leaks in the building envelope.

Existing Condition: The Manor House is vulnerable to envelope leakage in multiple areas. This can compound energy and moisture problems because larger HVAC systems are required to overcome the high level of heat and humidity transfer in historic buildings. Depending on how well an HVAC system is installed, it can effectively condition the indoor environment of the house, but at great cost both in energy consumption and utility bills.

Technical Information: Different conditions on the envelope's interior and exterior force flows in and out of the building. The three basic elements moving across the envelope are heat, air, and moisture. Consistent with the second law of thermodynamics, all of these move from an area of higher concentration to lower concentration. In the winter, heat moves outside. In the summer it does the opposite, trying to get in. Moisture created by showers, cooking, and the human body tries to migrate outside when humidity is low. As these elements cross the envelope, they lead to results like heat loss in winter or cooled air escaping in summer. These two thermal movements represent the loss of "conditioned air" which translates into additional energy being used and money spent to re-condition interior air. Consequently, this movement of conditioned air should be minimized. At the same time, some air exchange with the outside is necessary for ventilation. In terms of moisture flows across the envelope, water vapor can get trapped in building cavities and lead to structural damage.

The blower door test measures how effectively the building envelope provides a barrier to air infiltration. A blower door is a powerful fan that mounts into the frame of an exterior door. The fan pulls air out of the house, lowering the air pressure inside. The higher outside air pressure then flows in through all unsealed cracks and openings. Auditors may also use a smoke pencil to detect and accentuate air leaks.[7]

The blower door test measures infiltration in air changes per hour (ACH). This can be thought of as the percentage of the indoor air that escapes per hour. The standard American home may have 65%-100% ACH under natural conditions, meaning that 65% to 100% of the conditioned air in the house is lost through the building envelope every hour. A house with a well-sealed air barrier may have less than 35% leakage. Homeowners should seek to achieve a 35% level of envelope leakage, which is recommended by many green building standards.[8]

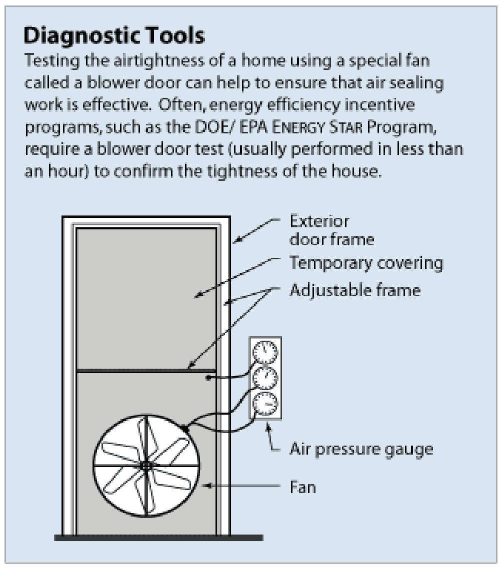


Figure 17 - Blower Door Test[9]

Infrared cameras are also commonly used with a blower door test running. The blower door helps exaggerate air leaking through defects in the building shell, which then appear as black streaks in the infrared camera's viewfinder. Infrared scanning allows energy auditors to check the effectiveness of insulation in a building's construction.

Advantages: In existing buildings, an effective air barrier may offer the cheapest and easiest means to reduce the strain on the HVAC system and consequently reduce energy consumption.[10] This increases comfort and reduces the heating and cooling load, thereby saving energy and reducing utility bills. In addition, future HVAC systems will not have to be as large to overcome heat gain in the building. Green building standards like Energy Star, EarthCraft House, and LEED for Homes have embraced the idea that a solid and well-sealed air barrier is the first step towards energy efficiency. In addition, because wet insulation conducts heat faster than dry insulation, thermal scans of roofs can often detect roof leaks.

Disadvantages: In old houses, there is a risk that accumulation of dust and debris within the walls has occurred. A blower door test may act as a vacuum to suck all of the dust out and into the living areas of the house. Performing a blower door test on all buildings in the Manor House Complex may be cost prohibitive as only one would be free.

Estimated Cost: NYSERDA provides a not-for-profit organization in New York State with energy demand of 100KW or less an initial energy audit, including a blower door test, at no cost to the customer.[11]

Weatherization

A building's envelope is the primary line of protection separating the conditioned indoor space against the outdoors. Without a secure envelope, temperatures cannot be maintained, tenant comfort levels are undermined, and energy use increases as the mechanical systems work harder to accommodate for the loss of heat or air conditioning.

A well-designed envelope takes a building's existing structure and the forces affecting it into account. It balances the desire to slow infiltration with the need for fresh air. Weatherization is the process of achieving this balance. Weatherization will be explored within the framework of major activities and building components, including sealing, the attic and basement, sash windows, and storm windows. The initial steps below should be taken to reduce energy use at Mashomack and decrease the carbon footprint.

EEO 3A: SEAL THE ENVELOPE

Issue:	Air infiltration through envelope
Recommendation:	Locate and seal leaks
Estimated Cost:	High $100s to mid-$1,000s

Issue and Recommendation: The Manor House contains numerous gaps in the envelope that allow for air infiltration. Air movement draws conditioned air with it, circumventing the edges of insulation and rendering it less effective. The result is greater heating and cooling cost caused by the need to constantly condition new air entering the building. The recommendation is to conduct a thorough external and internal sealing of the building.

Existing Condition: Because of its age, design, and size, the Manor House is vulnerable in multiple areas. Its age means the building has settled and joints that were initially tight may have settled and loosened. The building also has many apertures in the form of doors and chimneys. Further, it has a substantial number of transition points (explained below). Finally, the house is large, amplifying all the other characteristics. These vulnerable points are shared to a greater or lesser extent by all buildings. Accordingly, sealing is an effective strategy for all the Preserve's buildings.

Technical Information:

- Utility Penetrations in Walls: The spaces around any wall penetration can allow infiltration.

- Building Apertures: Gaps along the door frame and floor can allow infiltration. Fireplaces represent another building opening.

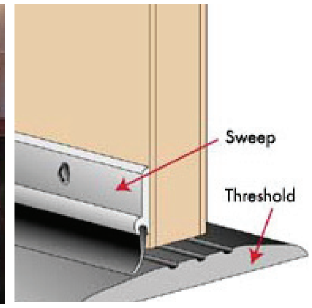


Figure 18 - Manor House – Exterior Wall Outlet, Fireplace

Figure 19 - Door Sweep

- Building Transition Points: The junctures between structural elements are prime candidates for sealing. Corners where two walls meet, the transition point at window dormers, and the eaves between walls and roofs are all areas where gaps may exist

- Exterior Surfaces: Worn exterior surfaces stripped of paint allow for air infiltration. The Manor House includes a lot of shingled area but it is important to make sure the trim is painted.

  The above are all areas to implement sealing strategies, which are different from insulating. Sealing stops air flow, while insulating stops heat flow. For example, the purpose of insulating an attic is to keep conditioned air from escaping the top of a building, but laying fiberglass insulation batts between attic joists does not stop air from seeping around the insulation's edges, taking heat with it. Consequently, sealing and insulation are complementary strategies that should be pursued in a coordinated fashion. Sealing should precede insulation. In some cases where sealing cannot be accomplished, insulation is actually discouraged.[12] Please see the Appendix for further information on sealing strategies.

Advantages: A lot of sealing can be conducted with limited materials – caulk, paint, etc. Consequently, basic sealing is an effective way to stop air and thermal loss without using a lot of physical resources. Doors and inflatable stops represent a greater level of resource use, but they are long term strategies and so have a good payback.

Disadvantages: It is important to note that buildings can be made so tight that fresh air cannot enter to supply oxygen. Some air exchange must take place with the outside. Given the size and age of the Manor House, however, it may not be physically possible to seal the building too tightly. Providing the proper balance between sealing and necessary ventilation can be achieved through discussion with a contractor, installing any new heating/cooling system, or by conducting a blower door test to measure the rate of air exchange after envelope sealing.

Estimated Cost: In general, sealing will not be expensive, but it will be an involved process. Proper sealing means identifying and addressing as many infiltration points as possible.[13] Together, all the recommendations comprise a labor-intensive list, considering the size of the Manor House and the number of other residential buildings. At $35 an hour, a full week of sealing would cost $1, 400 for labor.[14] Lower labor rates would decrease the cost and a longer job would increase it. Material cost for paint and caulk is relatively low. Molding is more expensive as well as time-intensive for a neatly finished job. Depending on how thoroughly the project is completed, expenses could run from the high hundreds to the thousands. A quality wooden storm door could cost $400/$500 plus $400 to install.[15]

EEO 3B: INSTALL ENVELOPE WRAP

Issue:	Shingles on the outside of the Manor House need replacement
Recommendation:	Install energy efficient envelope wrap
Estimated Cost:	$13,200

Issue and Recommendation: Preserve staff noted that they are considering replacing the shingles on the Manor House as a result of the latest property assessment that indicates the Manor House south facing siding is in disarray.[16] The recommendation is to wrap the building envelope with a highly efficient and integrated insulation system in order to substantially reduce heating and cooling loads of the Manor House by passively treating four important control layers, rain, air, vapor, and thermal.

Existing Conditions: The structure of the Manor House is a wood frame structure with siding made of cedar shake shingles. The shingles are weathered, specifically the south facing exterior wall. Even though leaks are not evident, the potential for moisture penetration is high with yearly precipitation around 46 inches, as previously noted in the climate and site conditions.

The layering of the shingles also serves as a wind barrier during storms, when intense winds drive moisture onto and into the exterior walls. Even though historical weather data records demonstrate fairly low annual averages of wind velocity, they also account for highs of 30 to 35 mph within the average. These winds can penetrate the walls and drive moisture into the foundation of the building and cold into the living spaces of the building. Even replacing the porous shingles will not reduce the relatively free flow of outside air passing through the porous and non-insulated walls.

Technical Information: Since the shingles are in bad shape and are planned to be replaced in the near future, the facility has the opportunity implement a "best practices" approach to creating the perfect wall conditions. This approach requires adding spray-applied, closed-cell, high density foam underneath the façade of the building to control the rain, air, vapor, and thermal conditions and prevent the outdoor weather from penetrating the interior living space. An efficient wall is detailed in the below figure. Even though the façade is made of shingles rather than brick, the detail would be the same, except that wood cedar shingles replace the brick detail for historic preservation.

The detail below is equally suitable for cold and hot climates, which is ideal for the Mashomack Preserve. The R-Value of the envelope for this climate should be a minimum of 18.[17] Even with the application of the foam, the drained and vented cavity detail is required in order to make the wrap an effective strategy.

Examples of an application product are Dupont's Tyvek brands: the Drain Wrap, Home Wrap, or the Therma Wraps.[18] An analysis of the ideal product for the Manor House requires involves cost figures, the relative expertise of potential installers, and the product's ability to handle both extreme hot and cold conditions. The product should also be appropriate for attaching the cedar cladding.

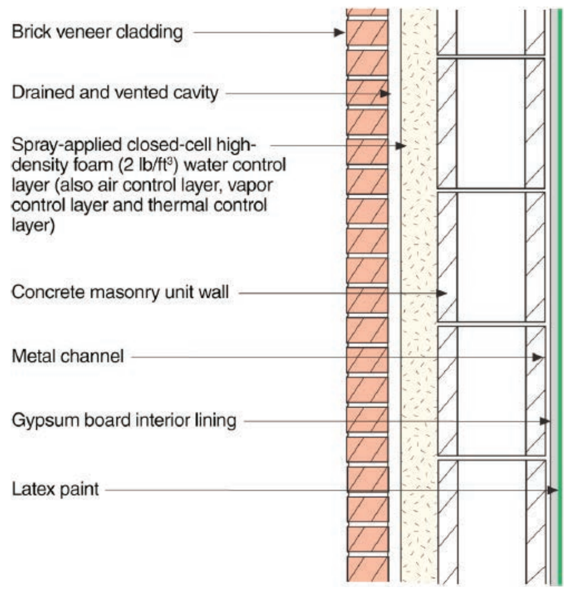


Figure 20 - Envelope Wrap[19]

Advantages: The interior is not well insulated from the exterior conditions, and even though it would seem appropriate to insulate the interior walls as part of weatherization strategies, blowing insulation into the cavity of the walls does not work due to the moisture in the air which would cause the insulation to drop to the bottom of the cavities, rendering the insulation useless. Furring the walls to install batted insulation requires demolition, and even with all the best practices to prepare for demolition, the debris will cause degradation to the indoor air quality because the finite dust from the sheet rock demolition would disperse into the local atmosphere. Additionally, the best place to locate these layers is on the outside structure in order to treat the condition on the outside before contact with the foundation and support structures and to eliminate thermal bridging.[20] Therefore, the most thermally efficient walls are those that control conditions on the outside, such as a building wrap. An added benefit of this strategy is that the thermally efficient conditioning also protects the building structure from weather extremes, increasing the useful life of the building structure substantially.

Disadvantages: While there are many advantages to a building wrap, the added complication and importance of proper installation requires the expertise of an architect and engineer to properly detail the application, taking into account the integration of the wood shingles and flash points with windows, door entrances and roofing structures. Proper training on installation of the application is extremely important; if the application is installed improperly or if the integrity of the application is breached due to improper punctures, then the application's R-Value will be reduced dramatically. In this situation, an experienced contractor that has a proven reputation for quality and proper installation is paramount.

The final disadvantage is that this type of application places and additional cost to the overall project.

Estimated Costs: The costs vary depending on the quality and experience of contractors. Installation is important, as noted in the disadvantages, so ensuring that the contractor and any sub-contractors are properly trained will help to prevent a breach of the system's integrity. Therefore, the estimated cost of the installation was rounded high to factor in quality contractors. The cost of installation is estimated to be approximately \$13,200. The approximate cost per square feet is \$1.65/sq ft and the estimated square feet is 8,000 sq ft.[21]

EEO 4: PROTECT BASEMENT & ATTIC

Issue:	Building spaces with high thermal losses
Recommendation:	Seal then insulate basement and attic
Estimated Cost:	Up to \$12,000

Issue and Recommendation: Basements and attics present two of the better opportunities to improve building envelope performance. The main reasons are, first, together they interact to produce a negative "stack effect" in winter and, second, they are the most accessible spaces in an existing building.[22] The recommendation is to seal and insulate both the basement and attic so as to prevent stack effect.

Existing Condition: The basement and the attic are both currently insulated. They use the same basic approach of placing roll insulation in between structural beams. This is appropriate but its application needs to be modified so that sealing is done first, insulation maximized, and any vapor barrier should be placed appropriately.

Technical Information: Mitigating the stack effect is fundamental to slowing air penetration and minimizing conditioned air loss. The stack effect occurs as heat rises through a building, creating negative pressure at the bottom such that outside air is drawn in.[23] This new air has to be conditioned, which wastes energy. The basement, as a negative pressure zone, and the attic, as a positive pressure zone, are the two primary areas contributing to the stack effect. Coincidentally, they are also the most accessible structural spaces in an existing building.

As noted above, sealing should precede any insulation application.[24] Regardless of which sealing/insulation configuration is pursued, moisture must be taken into account. **Both the basement and attic vapor barrier should be on the interior of the insulation, facing the conditioned space**. In the basement, the vapor barrier should be above insulation. In the attic, it should be under it. The reason for this is that if moisture from the interior passes through insulation and then encounters a vapor barrier on the insulation's cold exterior edge, it will condense.[25] That condensation can provide an ideal environment for mold. Finally, basement/attic work is completed by weather-stripping, sealing, and insulating the access doors and hatches. This ensures air won't seek out gaps and go around the barriers that time and expense have gone into creating.[26]

Advantages: Foam insulation has the advantage of a good thermal resistance, or R-value, as well as air sealing properties. Additionally, both a Riverhead architect and a Shelter Island builder characterized basement and attic insulation as the most important step in improving envelope performance.[27,28]

Disadvantages: Insulation installed without prior sealing can lower performance. Improperly placed vapor barriers can lead to mold growth. Foam is an effective insulator, its application in a historic structure must be carefully considered, as removal is labor intensive, and complete removal may not be possible.[29]

Estimated Cost: **Basement** – Closed cell spray foam costs $6 per cubic foot (cf) for material and $3-$4 per cf to install. Application of spray foam along the basement sill plus roll insulation in between the rafters could cost $8,000-$10,000. **Attic** – Roll insulation can be installed at $2.50-$3 per square feet.[30]

EEO 5: Explore Supplemental Window Insulations

Issue:	Maximizing sash window performance
Recommendation:	Maintain existing sash windows; prioritize improvement alternatives
Estimated Cost:	$50 to $300 per window

Issue and Recommendation: It is popular to recommend the removal of older windows in favor of new, more technologically advanced and energy efficient windows. Unless the existing windows have reached the end of their useful life, however, replacement is generally not effective in terms of cost, energy savings, or environmental impact. Consequently, it is recommended the Manor House's existing windows be maintained and various supplementary strategies are pursued based on individual window condition and the cost of the strategy.[31]

Existing Condition: The Manor House's current windows are consistent with the building's historical character. They are single pane and include "true divided light" configurations, where individual panes are set in muntins, the wooden pieces that separate them.

Technical Information: Single pane glass is its extremely low R-value of 1 (0 is the lowest R-value, meaning no thermal resistance and 45 is the highest R-value, meaning total resistance).[32] Air and moisture can't get through windows but thermal loss occurs very easily. On the other hand, single pane windows supplemented by properly sealed storm windows that fit snugly in their frame can achieve nearly the same level of efficiency as new windows.[33,34]

A number of simple, inexpensive steps can be taken to improve a window's energy performance. First, the window lock should hold the sash firmly in place. Window sashes that rattle in the jamb when the window is closed make air infiltration possible around the sash edge. If needed, the locks should be replaced and/or shims installed so the sash is held tightly in place. Caulk any open seams along the casing edge using a quality caulk for best effect and longevity.[35] Finally, consider plugging the pulley opening with solid foam or a plastic cover.

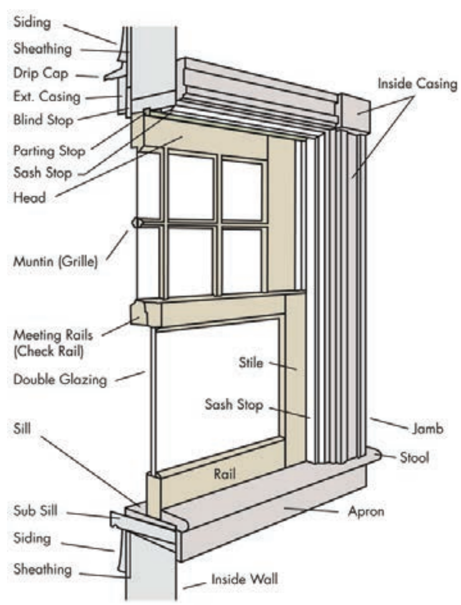


Figure 21 - Window Parts

Figure 22 - Insulating a Window Cavity

A much more robust strategy would be to open the cavities surrounding the window and fill them with caulk or spray foam. Breaking the surrounding sheetrock may not be necessary as the cavity might be accessed by removing the casing and apron. As opposed to the basement, the applied spray foam will not be visible and so will not compromise the Manor House's historic character.

Advantages: Considering that preserving the historic character of the Manor House is a priority, it is appropriate to keep the existing windows. It also makes environmental and economic sense. Replacement would mean a variety of life-cycle impacts for the new windows including raw material extraction, fabrication, shipping, and the disposal of the old windows.[36] In terms of installation cost, payback is hard to achieve over the limited lifetime of new windows even if they are significantly more energy efficient.[37,38]

Disadvantages: There are few disadvantages to this strategy. Although new windows are more energy efficient, their installation cost of at least several hundred dollars each is more expensive than all the strategies above combined. Additionally, the higher R-value of new windows only means thermal performance of the envelope is improved in the space occupied by the window itself. The surrounding envelope – namely the walls – will still have the same R value. Since the wall occupies a much greater surface area, the additional R-value of the window only makes an incremental insulative contribution to the overall envelope.

Estimated Cost: The simple steps of fine-tuning the sash lock, caulking, and sealing the pulley hole should be low – not much more than the hourly cost of a handyman. Insulating the wall cavity is considerably more expensive. A rough upper-end estimate is $200 per window.[39]

EEO 6: INSTALL STORM WINDOWS

Issue:	Storm window performance
Recommendation:	Maintain existing or install new storm windows
Estimated Cost:	$35 to $400 per storm window

Issue and Recommendation: The combination of well-maintained single pane windows and exterior storms will provide sufficient energy efficiency at the same time that they maintain historic integrity. Depending on their current condition, the recommendation is to retain the existing storm windows but to properly seal them. If new storm windows are installed, wooden models should be considered.

Existing Condition: There are currently permanently affixed, triple tracked, aluminum storm windows on almost every window. The storms windows were purchased about 20 years ago.

Technical Information: Choosing the proper storm windows for the Manor House is a matter of balancing historical appearance, ventilation, cost, labor, and environmental considerations.

- Retaining Current Storms: If the current storms are retained, proper sealing is important. External-grade caulking should be applied along the seams, however, there should always be some air penetration. While this may seem counterintuitive in the context of earlier sealing recommendations, it is critical in terms of moisture management. Water vapor cannot remain trapped between the interior sash window and the exterior storm, as it will cause mold and rot. Modern storms come equipped with "weep holes," and care should be taken not to caulk or paint over them.[40]

- Replacement: If new windows are purchased, consider low emissivity (low e) glass.[41] "Low e" windows have factory applied interior coatings that reduce the escape of infrared light from the interior. The reflection of infrared light back into the room increases heat retention in winter months. The tradeoff is that the coating also lowers light transmission into the room from the exterior. If historical accuracy is paramount, cost not a major consideration, and ongoing labor available, then single-frame wood storm windows should be installed.

Advantages: Storm windows are designed to provide a level of air insulation equivalent to a modern window without full window replacement. They can be remarkably effective, cutting heat loss by up to 50%.[42]

Maintaining existing storm windows saves acquisition costs. As discussed with sash window replacement, keeping existing storm windows also has a smaller environmental footprint. The existing storms also have tracks that the panes slide up and down in providing ventilation when needed (new aluminum storms will provide the same level of ventilation).[43] Additionally, tracked storms have lower labor demands as someone does not have to climb up a ladder every spring and fall to remove and then hang them.

Wood storms are historically accurate. They also may be appropriate for Shelter Island's shoreline climate. Nantucket preservationists state wood frames endure better than some metal units on the island.[44]

Disadvantages: Modern aluminum storm are conspicuous and can obscure the historical details of interior windows.[45] Buying new single-frame, wooden storm windows will limit ventilation since they can only be opened slightly at the bottom. Additionally they will have to be taken down in the spring and replaced in the autumn. Finally, careful measurements will have to be taken for wood frame storms to ensure proper fit.

Estimated Cost: Maintaining the existing storms is inexpensive. The only real cost would be sealing with caulk, the price of which is mostly labor. New aluminum storms run cost about $100 plus $100/$150 to install. Wooden storms are about $200 plus $200 to install.[46]

Passive conditioning

It is always better to pursue natural or passive options before mechanical ones. Once the building is weatherized, these passive heating and cooling techniques can be explored to provide mechanical, generation-free heating and cooling.

EEO 7: CREATE WINDOW SHADING THROUGH SHUTTERS

Issue:	Thermal penetration through windows
Recommendation:	Provide natural shading through placement of bushes, other plants, and trees on the south side of building
Estimated Cost:	Dependent on expert consultation

Issue and Recommendation: The properties on Mashomack have a plentiful supply of windows to allow in natural daylight, however, these windows also allow transfer of heat through the glass. This is detrimental year round, as ideally heat should be kept in on HDD and heat should be kept out on CDD. This leads to additional use of mechanical systems to maintain thermal comfort in the Manor House.

The recommendation is to install wood shutters with moveable louvers on either the inside or the outside of the fenestrations at the Manor House. This measure is applicable to the Manor House and all other structures on-site with windows and active use.

Figure 23 demonstrates the application of shutters with moveable louvers on the outside of a house.

Figure 23 - Example of Shutters with Movable Louvers[47]

Existing Conditions: Currently there are neither shutters on the inside nor the outside of the Manor House nor any other buildings in the complex.

Technical Information: Shutters act as another barrier between the air inside and outside of the building. Glass is a better conductor of heat than wood, so having a layer of wood between the inside and outside is beneficial to the building envelope.[48]

Advantages: The application of shutters will result in a thermal benefit for the Manor House. Shutters are useful in blocking solar radiation on CDD as well as reducing transfer of heat through windows on HDD. This will reduce demand on mechanical systems and be especially useful in the unoccupied rooms of the Manor House. Movable louvers on the shutters allow for daylight to still enter the house. Shutters can also serve to improve natural ventilation when locked in place perpendicular to the building wall. The shutters increase velocity of the breeze entering the house for improved natural ventilation and air quality on CDD.[49]

Disadvantages: Shutters will block out some daylight when closed, however, adjustable louvers allow light in while still blocking a majority of the thermal transfer.[50] Another disadvantage is the potential for outdoor shutters to detract from the historical look of the house.

Estimated Cost: Shutters with movable louvers would cost approximately $200-$250/pair. The Manor House contains 83 windows and the cost to add shutters to all of them could be prohibitive, although bulk purchasing will reduce the unit cost, and installation could be performed by in-house labor rather than a contractor. TNC could also decide to strategically install shutters based on areas of need.

Overall, this is a viable strategy for the Manor House to reduce thermal losses and gains in the appropriate seasons. This opportunity should be evaluated among all relevant stakeholders, however, and considered for bundling with additional window upgrade opportunities presented here. If the strategy is deemed to alter the appearance of the Manor house too much, then it can be given lower priority.

EEO 8: IMPLEMENT NATURAL SHADING THROUGH PLANTINGS

Issue:	Thermal penetration through windows
Recommendation:	Provide natural shading through placement of bushes, other plants, and trees on the south side of building
Estimated Cost:	Dependent on expert consultation

Issue and Recommendation: During the summer months, solar energy penetrates through windows and increases the indoor air temperature, which in turn increases the load on the mechanical systems tasked with cooling the Manor House. The recommendation is to use natural shading around the Manor House. The recommendation also applies to the other buildings.

Existing Conditions: Mashomack has an abundance of trees; however, the site around the buildings is relatively clear of trees, shrubs, bushes, and other shading plants. The amount of shading provided by the existing trees in the area is currently unknown, as the trees in the area had no leaves during the site visit.

Technical Information: Deciduous trees are best for south yards because their canopies are broad and dense. In the autumn, deciduous trees shed their leaves and allow more solar energy to reach and penetrate the building. This provides the proper balance of heat gain in the winter and cooling in the summer. Evergreen trees can work well for north and northwest yards. The closer a tree is to the building, the more hours of shade it will provide. To be most effective, trees should be planted between 5 and 20 feet from the building.[51]

It would be advisable to undertake an analysis of current natural shadings and whether they can be improved or changed to enhance their impact. A landscape architect can provide an overview of existing conditions and potential enhancement opportunities.

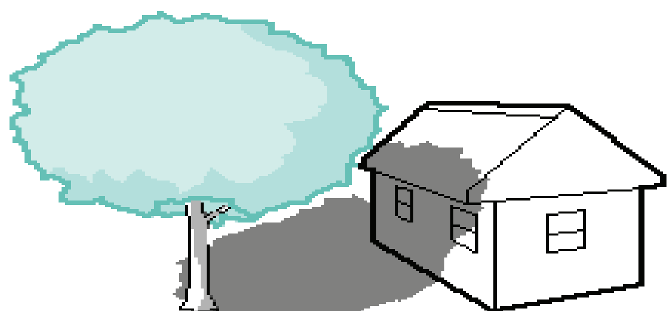


Figure 24 - Tree based shading

Advantages: Natural shading from bushes, plants and trees is the most environmentally efficient way to provide shade for the house. Preventing the sun from directly hitting the Manor House in the summer will reduce the cooling load on cooling degree-days. Trees offer excellent natural cooling. They throw shade over the walls and roof. They will also shade driveways, sidewalks and patios that can bounce heat to the building. Since big trees give more shade than little ones, preserving as many existing trees as possible is paramount. Trees also provide a cooling bonus. To keep cool, trees pump water from the ground into their leaves. As this water evaporates from the surface of the leaves, it cools the tree. This "evaporative cooling" cools the surrounding area too. Shrubs offer less shading, but they have several other advantages. They usually cost less, reach mature size more quickly, and require less space. Shrubs can shade walls and windows without blocking roof-mounted solar panels.

In addition, trees help cleanse the air by intercepting airborne particles, reducing heat, and absorbing such pollutants as carbon monoxide, sulfur dioxide, and nitrogen dioxide. Besides these benefits, using natural shading provides an opportunity for restoring more native vegetation to the cleared area around the Mashomack facilities.[52]

Disadvantages: There is the possibility that too much shading can reduce solar heat gain during heating degree-days. With proper selection of vegetation, there should not be much negative impact during winter months. Additionally, tree root systems may cause damage to foundations when grown too close to buildings.

Estimated Cost: Natural shading could already exist on site, however, should additional shading be desired, the materials are available free on site, and no expert installation is required. As a result, there is little cost associated with this strategy, however, there would be a cost if TNC decided to consult a landscape architect to determine best use of natural shading.

EEO 9: INSTALL OUTDOOR ENTRYWAY PLANTINGS

Issue:	Thermal penetration through entryways
Recommendation:	Install a trellis over doors and patios leading into Manor House
Estimated Cost:	$45 per square foot

Issue and Recommendation: In addition to windows, door and patio apertures are also transfer points for internal and external air in the summer months. The recommendation is to install plantings directly over the Manor House doors by use of trellises.

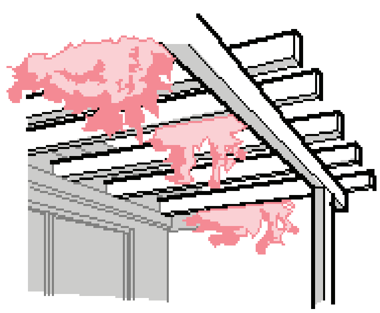


Figure 25 - Trellis

Existing Conditions: Currently the front door of the Manor House has shading, however, other entrances do not. The patio on the south façade of the Manor House is exposed with no shading.

Technical Information: Trellises, which support climbing plants, are permanent structures that partially shade the outside of a building. Clinging vines growing over the trellis can add more shade and evaporative cooling. The air underneath the trellis would be cooler in the summer and thus, less thermal transfer will occur into the Manor House. A special trellis to shade air conditioners, heat pumps, and evaporative coolers will improve equipment performance as long as it does not restrict airflow.[53]

Vines must be chosen carefully both to match the local flora of Mashomack and for a fast rate of growth. Fast growing vines create shade quickly, while trees can take years to provide useful shade. Deciduous vines like grape and Wisteria lose their leaves in winter, allowing the sun's heat to strike the building.

Advantages: A trellis located above and around the entrances to the Manor House will be an attractive solution to cooling air that is entering the building on cooling degree-days and help reduce the cooling load.

Disadvantages: The trellis would have to be newly constructed on the building exterior, and there is a potential that the vines will grow onto the Manor House. In this scenario, it is possible that vines growing on the buildings could shorten the lifespan of the cedar shingle cladding and lead to a shorter cycle of replacement. This additional cost would have to be weighed carefully against the energy cost savings that the trellis provides. Additionally, it is possible that there is not native vegetation which is suitable for use in a trellis.

Estimated Cost: The cost of a trellis varies according to the size needed and the choice of materials used. Not included in the cost would be the choice of climbing plant use, which may be available for free on Mashomack. An approximate cost of $45/sq ft can be used for estimation purposes.

EEO 10: USE NATURAL WIND BREAKS

Issue:	Air infiltration through building envelope
Recommendation:	Install local vegetation around northwest side of Manor House to reduce velocity of winter winds hitting the building
Estimated Cost:	Dependent on expert consultation

Issue and Recommendation: Air infiltration is essentially the exchange of cold outside air with the heated air in the interior of the house.[54] This is undesirable because it increases the volume of air that needs to be heated by the boiler and, correspondingly, increases the amount of fuel used to fire the boiler.

The recommendation is to plant several rows of vegetation on the property to the northwest of the Manor House in order to block winter winds from striking the house.

Existing Conditions: The Manor House alone has 83 windows which are very susceptible to air infiltration and compromise the building envelope. Being located near a large body of water also increases the incidence of strong wind events which exacerbate the infiltration issue.

Technical Information: In most climates the wind is an asset in the summer and a liability in the winter. This is no different on Mashomack. The terrain and climate of Mashomack allow for a relatively steady flow of wind year around. The wind speed varies depending on the time of year, and must be accounted for when targeting improvement in energy efficiency. The winter wind is of particular concern for the properties on Mashomack. The dominant wind direction for the cold weather months (October – February) is from the northwest at an average speed of 6.6 miles per hour.[55]

Below is an illustration of the effect a windbreak would have on the Manor House. In general, the length of the windbreak should measure at least ten times the height of the windbreak. The height of the windbreak has yet to be determined, however, because the vegetation to be used has not been decided. This strategy would be applicable to all facilities at Mashomack but should be evaluated on a case-by-case basis to determine space needs.[56]

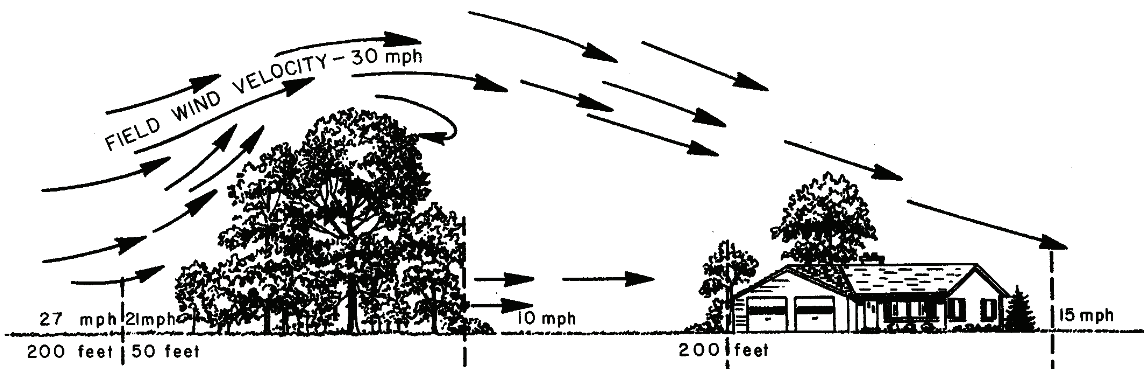


Figure 26 - Windbreak Effectiveness

The area around the Manor House complex should be fully evaluated to determine the feasibility of a wind break. It is possible that there may not be enough space to properly implement a windbreak.

Advantages: The installation of the windbreak would thermally benefit the Manor House by reducing the velocity of the wind striking the house. Because windbreaks can reduce the velocity up to 50%, this can account for a sizable reduction in heating load during heating-degree days.[57] Additionally, the windbreaks can incorporate native vegetation while also providing a natural habitat for wildlife. Situating the windbreak on the northwest of the property will not prevent summer winds (from the southeast) from being channeled into passive cooling strategies.

Disadvantages: This recommendation is not without its caveats. Because trees/bushes must be a certain height in order to be effective, there would be a lag time before wind breaks are functional. There would be additional expense and labor cost if more fully grown trees were planted for the wind break. The existing flora must be evaluated for potential integration into a windbreak, as their presence could hinder proper functioning of a windbreak. The windbreak may also obstruct views from the Manor House. Finally, plantings near buildings may grow root systems that compromise the foundations.

Estimated Cost: Costs depend on an analysis of existing tree, bush, and shrub placement on the site. An expert landscape architect should be consulted, which would incur a cost; however, installation involves merely planting vegetation and could be done with volunteer labor. This is a beneficial strategy for improving energy efficiency of the property; however, it should be evaluated in conjunction with the envelope strategies being considered in this report. It may be decided that primary improvements made to the envelope will make this supplementary strategy too costly for the resulting benefit.

EEO 11: UTILIZE SUN SPACE

Issue:	Passive heating of Manor House
Recommendation:	Restore historic sunspace that was once attached to the Manor House
Estimated Cost:	$4,500

Issue and Recommendation: Heating a large structure such as the Manor House is very energy intensive, which means more fossil fuels are burned to generate that heat. Reducing the amount of fuel used on site is of paramount importance in this sustainability strategy. The recommendation is to recreate the old patio as a sunspace, as formerly existed in the Manor House, and take advantage of its passive heating properties.

Existing Conditions: Future plans to integrate a sun space into the Manor House by restoring a historical patio were discussed at the site visit.

Technical Information: In addition to the aesthetic qualities of the sun space, if it is properly designed to take advantage of direct-gain, it can function as an effective passive heating structure to reduce the heating load. The strategy leverages the sun's long-wave radiation that penetrates through glazing and heats up the surface area of the space. As a result, the thermal mass stores the heat and radiates it out into the house. The space itself also serves as a cold buffer at night. These spaces are not heated or cooled mechanically and are considered a separate thermal zone.

A sunspace requires, most importantly, a south facing and unobstructed exposure to direct sunlight.

Sunspace design guidelines are as follows:

Glazing is installed on the south-facing wall. To maximize solar heating, glazing should be sloped and perpendicular to the sun during the coldest times of the year. Angled windows are more costly, however, and add safety concerns, water leak potential, and provide no sun shading during hot summer months. As a result of these considerations, most sun spaces have vertical glazing. The ratio of glazing should be at least 14% of the floor area and have a solar heat gain coefficient (SHGC) rating of 0.60, and an R-Value of 3.4 with low-e coating.

In order to prevent overheating during warm months, a shading strategy and outside venting is required on the south facing wall. Operable low inlet and an upper exhaust vent are adequate and should be approximately 8% each of the south-facing wall. Additionally, an overhang designed to block the higher summer sun will be sufficient for shading.

The common wall requires an operable door and windows in order to heat up the house. The total opening of these areas should add up to at least 16% of the glazing area. As a general rule, larger openings are better. The mass size of the common wall depends on how the space will be used. As this space is thought to be used during the day for quick warm up and the sleeping quarters are on the second and third floors, a low mass wall with no insulation is should be adequate.[58]

The east and west facing facade walls must be properly insulated in order to trap heat in and deflect the outside elements. Night insulation with an R-value of 9 is adequate. Additionally, the floor in the space should be a highly absorbent +0.8 or higher.

Another strategy that would cost slightly more is a rock bed with venting to circulate the solar heat via convection. This strategy is only applicable to the Manor House.

Advantages: A sun space is an incredibly comfortable and pleasant place for occupants to dwell. Rebuilding the sunspace would not only restore a historic aspect of the Manor House, it would also lessen the heating load in the cold periods of the year.

Disadvantages: Rebuilding the sunspace would incur an undetermined and likely high, monetary cost. There is also a possibility that there is more shading of the sunspace now than there was many years ago due to tree growth.

Estimated Cost: The cost of the sunspace is determined by size and materials; however, the added costs of making the space a more sustainable environment would be an incremental cost of approximately $4,500.[59]

EEO 12: EXPLOIT THE STACK EFFECT FOR PASSIVE COOLING

Issue:	Need for passive cooling on cooling degree-days
Recommendation:	Behavioral change: open aperatures
Estimated Cost:	No cost

Issue and Recommendation: Reduction of cooling loads is a key energy efficiency strategy during the hot weather months. The recommendation is to utilize knowledge of the stack effect to move hot air out of and cooler air into all Mashomack facilities on cooling-degree days.

Existing Conditions: The Manor House and other buildings have apertures on both lower and upper levels through which the stack effect can function.

Technical Information: The stack effect is the moving of air into and out of buildings and is driven by buoyancy. The buoyancy is a result of density differences between indoor and outdoor air temperature and moisture level. These differences in air density result in a positive or negative buoyancy force. For example, during the heating season, the warmer indoor air rises up through the building and escapes at the top through open windows, ventilation openings, or other forms of leakage. The rising warm air reduces the pressure at the base of the building, drawing cold air in through open doors, windows, or other openings and leakage.

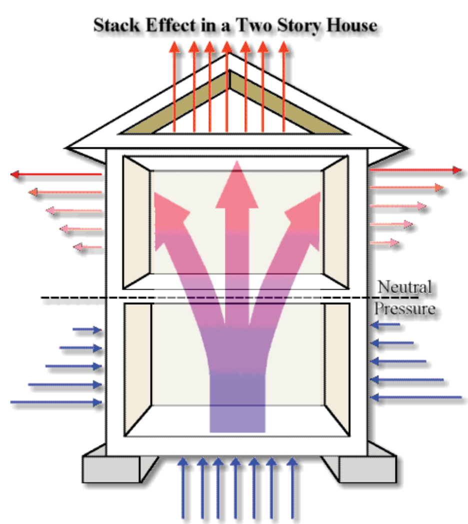


Figure 27 - Stack Effect in a Two Story House

Because of the abundance of trees on Mashomack, the outdoor air on cooling degree-days should remain cooler than unconditioned air within the Manor House and allow better cooling through the stack effect. By opening windows and doors on the lower level and windows on the upper level/attic, the stack effect can be harnessed to drive out the warmer air from the house and bring in cooler air. This should reduce the energy used to cool the house.

Advantages: The stack effect has several advantages including reduction in the building's energy usage, reduction in space costs for additional mechanical systems, and reduction in maintenance costs. Additionally, opening the doors and windows provides a connection to the outside environment. Combining the stack effect with other less intensive mechanical systems, such as an attic fan, could greatly reduce the use of energy-intensive air conditioning systems overall.

Disadvantages: The stack effect should be avoided on HDDs as it will have to opposite effect of reducing energy load. Cold air would be drawn into the building, which is not ideal as it increases heating load.

Estimated Cost: No cost, as this is a behavioral recommendation.

Fuel-Based Efficiency

Mashomack's primary carbon emission release is from oil burning. Once loads are minimized through weatherization and passive conditioning, fuel-based efficiency improvements can be explored.

EEO 13A: IMPLEMENT BOILER UPGRADES

Issue:	An inefficient boiler
Recommendation:	Perform minimal boiler upgrade
Estimated Cost:	$1,000

Issue and Recommendation: Based on the high cost of a full boiler replacement relative to the low cost opportunities for additional efficiencies to the existing system, it is recommended that Mashomack does not upgrade the boiler with an entirely new system and instead reduce oil consumption by calibrating the existing system.

Existing Conditions: Currently, the Manor House uses an eighteen zone heating system (each bedroom has its own thermostat). The H. B. Smith cast iron boiler's estimated output is approximately 408,000 Btu/hr and is in operable and acceptable condition.[61]

Technical Information: Based on the Preserve's climate of cold winters requiring a significant amount of heating, an efficient heating system is of paramount importance to the Manor House. Manor House occupancy is relatively low during the winter months, however, so heat is not required every day during the winter. Limited occupancy results in low costs for fuel. The approximate yearly cost of the fuel oil is $1,100 per year.[62] Due to the high upfront costs to replace the heating system, it is challenging to offer a cost justification for replacing the adequately functioning boiler for a more efficient system. A more cost effective approach is to reduce the heating load and focus on energy efficiency "best practices" such as annual maintenance, damper controls, and supplementing the boiler with "point-of-use" space heaters.[63]

If the Nature Conservancy's forecasts that its occupancy over the next few years will increase during the winter months to more than double the current occupancy for a period of five years or longer, then a cost benefit analyst to replace the existing heat system for a more efficient and less environmentally harmful system would be appropriate.[64]

- Boiler: The best practices in boiler efficiency are to regulate heat losses such as standby heat loss, stack losses, radiation and convection losses, and ambient air temperature.

- Annual Maintenance: Proper calibration of the heating system enables the optimal production of heat output. An annual inspection by a heating system professional before the heating season will ensure that the system has been optimally calibrated. The inspection should cover the following:
  1. Condition of vent connection pipe and chimney
  2. Physical integrity of the heat exchanger
  3. Adjustment of the controls on the boiler to provide optimum efficiency
  4. Perform a combustion-efficiency test
  5. Test pressure-relief valve
  6. Test high-limit control
  7. Inspect pressure tank
  8. Clean the heat exchanger

  The heating system professional should ensure that one of the damper options described below is installed and properly functioning.

- Vent Damper or Barometric Flue Damper: A damper prevents convection heat when the boiler is on standby by preventing heat loss into the chimney. If there is not a vent damper, one should be installed in order to reduce standby heat loss. A damper installation costs approximately $500.

- Burner Replacement: Installing a flame retention burner will block airflow up the chimney when the boiler is not in service and can save approximately 20% on fuel costs. If the burner is worn out due to age or wear and tear, then replacing the burner with a flame retention burner is appropriate and costs approximately $1,000 to purchase and install the efficient burner. A flame retention burner replaces the need for a barometric flue damper.

Advantages: The advantage of a "best practices" approach is the relative ease of implementation. Additionally, daily operations will not change much, and so a low level of training and operational change required. The cost is minimal and will pay back quickly. This strategy allows Mashomack to focus expenditures on sustainability strategies with the most impact.

Disadvantages: The clear disadvantage is that the environmental impacts of leaking fuel oil and greenhouse gas emissions are only minimized and not completely eliminated.

Estimated Cost: Leaving the boiler intact without a full equipment upgrade will not require any additional capital costs and will only require a minimal operating cost increase for the annual inspection and possible replacement of the burner.

EEO 13B: FOREGO BOILER UPGRADES AND REPLACE EXISTING BOILER

Issue:	Replace existing boiler
Recommendation:	Condensing boiler or CHP system replacement
Estimated Cost:	$13,000 to $250,000[65]

Issue and Recommendation: When the opportunity to replace the existing boiler arises, the following alternative strategies are more efficient and/or less environmentally damaging to the Preserve's ecosystem than a conventional replacement.

Existing Conditions: Before buying a new heating system, careful consideration should be given to which envelope and weatherization upgrades and passive strategies will be implemented. Energy efficiency improvements will reduce the heating load requirement for the Manor House and impact the sizing of a new system.

Technical Information:

- Energy Efficient Oil-Fired Boilers: Typically natural gas is a more efficient fuel source than oil and emits substantially fewer greenhouse gases; however, there is no natural gas supply to the Preserve. If natural gas should become available, then a life cycle analysis that accounts for the complete process of supplying both fuel sources should be considered.[66]

- Condensing Boilers: A condensing boiler is more efficient than a traditional boiler. It uses essentially the same type of technology as a traditional boiler, except that it is fitted out to capture the hot flue gasses in order to recapture wasted energy. Condensing boilers have a significant efficiency factor of anywhere from 90-98% thermal efficiency. The typical thermal efficiency of boilers similar to the existing cast-iron boiler is approximately 75% thermal efficiency.[67,68] A condensing boiler captures waste heat venting through the flue, which can be as hot as 200-300° F, and re-uses this latent heat. A traditional boiler can also capture waste heat; however, as these gasses cool in the chamber, the cooling vapor exhibits qualities that corrode cast-iron boilers. It is therefore neither practical nor safe to use a traditional boiler to condense waste heat.[69]

  Things to consider when replacing a conventional boiler with a condensing boiler:

  Sizing the boiler appropriately for occupancy use is of paramount importance. Consideration should be given to what thermal upgrades have been or will be completed in the near future, as those strategies will reduce demand requirements, reducing the size requirements of the boiler. Additionally, understanding the occupancy use profile will help inform decisions on zoning and controls.

Since these systems are relatively new, and plumbing and heating professionals are not as experienced with them, an experienced installer is required. During installation, check the return water temperatures at the boiler. The return water should be less than 131° F to maximize condensation. Also ensure that the controls are set specific for the occupancy of the Manor House.

Ensure the product is Energy Star certified.

- Combined Heat and Power: Because combined-heat-and-power (CHP) systems generate electricity at the site, they are able to utilize much of the heat normally wasted at the power plant and through transmissions lines and eliminate waste by essentially installing a supply source at the point of demand. These units are self-contained and easily integrated into a building. Different fuels, including biodiesel, can be used. These systems have typically been used in large facilities; however, they are becoming more feasible in the residential sector. In Japan there are approximately 90,000 residential units in service.[70] Very few have been installed in the United States, although the technology is advancing rapidly, and many market research analyst suspects residential CHP will be a viable option in the near future, forecasting that residential CHPs will reach 13.5 million homes by 2022.[71]

  A CHP can be even more efficient when combined with a fuel cell. Fuel cells use hydrogen to directly generate electricity and useful heat inside buildings. The fuel cell essentially combines hydrogen with oxygen in the air to form water, electricity and heat. There are no GHG emissions or other pollution.[72] A fuel cell and Combined Heat and Power could eliminate the Manor House's greenhouse gas emissions and would also eliminate the required storage of oil in the underground storage tank.

Advantages: Condensing boilers are significantly more efficient than the existing boiler with no additional training or added complexities in operations required.

The potential of Combined Heat and Power is an exciting option for the preserve, as it has the potential to eliminate all the negative impacts of oil from the preserve if the source of energy were switched to fuel cell technology. CHP has the added benefit of on-site electricity generation, which would reduce the negative impacts of distributed generation inefficiencies.

Disadvantages: Condensing boilers still require fuel oil and fail to eliminate the environmental and health risks of storing and consuming fuel oil at the site.

There are practical challenges with CHP technology that still need to be resolved. Because CHP is not a common, installation would be more costly.[73] The technology and less proven than more conventional solutions. Furthermore, the day-to-day operation of the system would be different than the current system and would require training for staff and add a layer of complexity to the day-to-day operation of the facility.

Estimated Costs: CHP is significantly more costly than a condensing boiler. Initial cost estimates suggest that installing a condensing boiler would cost approximately $13,000 depending on required size, whereas a CHP system is estimated to be approximately $350,000 (including fuel cell).[74,75]

EEO 13C: EXPLORE SUPPLEMENTAL HEATING UPGRADES

Issue:	Efficient supplemental heating
Recommendation:	Use electric space heaters
Estimated Cost:	$200 per unit

Issue and Recommendation: Space heaters are typically the least efficient type of heating because of the small area that space heaters heat relative to energy consumed. In light of the Manor House's low occupancy rate during cold winter months, however, it is more efficient to use space heaters as a supplemental heating source rather than firing up the boiler in order to accommodate one or two overnight guests.

Existing Conditions: The existing boiler is sized to provide heat for 18 rooms; however, the Manor House guest rooms are rarely fully occupied. There are situations when only one or two rooms require heat. It is very inefficient to fire a boiler that will output 408,000 Btus/hour to heat up a 100 square foot room. Therefore, supplementing guest rooms with space heaters that output 10,000 Btu to 40,000 Btu/hour is more efficient during low occupancy (five or fewer guest rooms occupied) so that the boiler remains off or supplies only a minimal amount of heat for the common areas.

Technical Information:

- Space Heaters: Safety Caution - Choosing a safe space heater should be the top priority. The US Consumer Product Safety Commission estimated that 25,000 residential fires each year are associated with the use of space heaters.[76] Therefore, the following guidelines should be considered when purchasing a space heater:

  1. Purchase newer models that have all the current safety features.
  2. Ensure the heater has the Underwriter's Laboratory (UL) label attached to it.
  3. Locate the heater on a level surface away from foot traffic.
  4. Electric heaters should be plugged directly into the wall outlet – no extension cords.
  5. Electric heaters should have a tip-over safety switch that automatically shuts off the heater if the unit is tipped over.

  Even with these safety requirements, there are many energy efficient space heaters. The best practice for choosing an efficient space heater is to ensure it is rightly sized for the space it will heat; most heaters have a general sizing table. There are two categories of space heaters: vented and un-vented. Vented space heaters are the most efficient space heaters; however, they require venting to the outside. This causes operational complexities due to higher set up requirements. Additionally, Manor House guests may not know how to operate nor understand the safety concerns of obstructed venting to the outside. Electric space heaters are the only unvented space heaters that are safe to operate inside a building like the Manor House. The best electric space heater for the typical Manor House room is a convective heater, as it heats up the entire area and incorporates a heat storage liquid that creates a more constant heat source. The electric space heater should have multiple stages (low, medium, high) and a timer setting.

Advantages: The advantages of supplemental space heaters are that they reduce energy consumption at the preserve and are relatively easily to procure. In addition, LIPA, the utility that provides electricity to the Preserve, sources a substantial portion of its power from renewable sources.

Disadvantages: There are some clear disadvantages, such as the aggregate cost of five heaters, to space heaters.[77] There are also operational inconveniences associated with placing heaters in rooms as they are needed and with ensuring guests know how to properly and safely operate the units.

Estimated Cost: A purchase of five space heaters with the appropriate features would cost $1,000.

EEO 14: UPGRADE HOT WATER HEATER INSULATION AND CONTROLS

Issue:	Standby and convective heat loss
Recommendation:	Add insulation and adjust temperature controls
Estimated Cost:	$500 (cost savings if done with boiler)

Issue and Recommendation: The domestic hot water system is a source of energy consumption. Even though the hot water is not measured with regard to how much energy it consumes, it is generally estimated that heating hot water usually takes up a third of energy consumption within a home. The recommendation to reduce hot water energy consumption is to effectively insulate the existing hot water system and adjust the temperature controls.

Existing Conditions: The existing domestic hot water system is a 100 gallon Bock oil-fired water heater located in the basement. It is in good condition and supplies hot water to the entire house. However, piping hot water from the basement to the upper floors is an energy efficiency concern due to line losses.[78] Additionally, standby heat loss is significant in the Manor House since the house is rarely fully occupied, and the Bock system reheats the stored water in the tank as it drops below a preset temperature even when not in use. When the Manor House is minimally occupied, it is inefficient to heat 100 gallons of water when less is required.

Technical Information:

- Water Heater Blanket: The Bock Hot Water tank has an R-Value of 12. The recommended minimum R-value for a hot water tank is 24, according to the US Department of Energy.[79] Therefore, an energy efficient strategy is to insulate the storage tank with a water heater blanket. Adding this additional insulation reduces the standby heat loss approximately 35% and would save approximately 6% of heating costs.

  There are many different products available; however, the ideal water heater blankets will have the following characteristics:[80]

  1. R-value of 10 or higher
  2. Reflective barriers made of pure aluminum, as they usually have higher R-Values
  3. Non-allergenic

  Caution: Oil-fired water heater blankets are complex to install; a certified plumbing and heating contractor should install it. Read the installation guidelines, which will have specific installation directions including areas that should remain uncovered such as the heating element control (thermostat), the drain valve, and the pressure relief valve and overflow tube.

- Pipe Insulation: Insulated hot water pipes can keep water 24°F hotter than non-insulated pipes; as a result, lower set points can be used at the water heater. All pipes should be insulated, but accessing them may be a challenge. In this case, all piping areas within three feet of the water heater, including the cold water inlet pipes, should – at the bare minimum – be insulated.[81]

  The pipes should be fully insulated with a minimum of 1” insulation, and the pipe-sleeves’ inside diameter should match the outside diameter of the pipe to get a snug fit. The insulation product should match or perform better than Armacell products, which have sustainable traits such as low thermal conductivity, built-in vapor resistance, and are free of fiber and dust. Armacell actively seeks product life cycle improvements to minimize environmental impacts of their manufacturing chain, is a founding member of the EuroACE, and is a member of the UN Global Compact.

- Installing heat traps: Another form of heat loss similar to standby heat-loss is convective heat-loss. Convective heat loss in the water tank is caused by changes in the water’s buoyancy related to changing temperatures. The hotter water becomes less dense and rises to the top; it is replaced by colder/denser water, creating a circular current that pushes warmer water out into the hot water pipes and brings colder water in from the cold water inlet valve, causing the stored hot water to be replaced by colder water more quickly. This situation exacerbates standby heat-loss.

  Convective heat loss is prevented by water tank heat traps. In the hot water outlet valve, a ball heavier than water is fitted inside a valve that traps the standby heat, and a ball lighter than water is fitted in the cold water inlet valve to reduce heat loss. When hot water is used, the valves release the proper flow of water.[82]

Material costs associated with installing water tank heat traps are relatively low; however, soldering pipe joints, and thus the services of a professional plumbing and heating contractor, are required. There is a cost saving opportunity in engaging a contractor to install the hot water heater blanket, pipe insulation, and heat traps at the same time.

- Lower Temperature Control Set Point: Lower the hot water temperature settings on the water heater. In general, each 10° F of reduced water temperature settings results in approximately 3-5% in energy costs.[83] The ideal temperature set point is 120° F.

Advantages: The advantages of insulation and lowering set points are that these best practices can substantially reduce the energy consumption with minimal costs and no operational changes.

Disadvantages: The issue of oil consumption is only reduced and not fully mitigated.

Estimated Cost: Because the heat traps and water heater blanket should be installed by a professional, there are minimal costs of four hours of work from a professional. This should cost no more than $800.

Other Fuel-Based Sustainability Considerations

There are other sustainability issues regarding fuel-based heat and potential risks that can negatively impact the preserve's eco-system, to consider. Some examples are described below:

Underground Storage Tank

Fuel oil is stored in a 2000 gallon underground storage tank. Even though test results show no evidence of leaks, the potential risk of environmental damage is great. Future contamination of the facilities' drinking water supply due to a leak is possible. In addition, the routine operation of refilling the tank causes oil spillage that seeps into the ground and damages the environment.

Oil Delivery Logistics

The transport of oil to the preserve has negative environmental impacts. They include the embodied energy – the energy required to produce the truck from extraction of raw material to disposal – of trucking oil onto the preserve and the potential of a fuel spill. This risk increases as more deliveries are made to meet increasing need. There is also the risk of the fuel supply being cut off during extreme weather events.

Electric Efficiency

While electric consumption is not the primary contributor to the carbon footprint at Mashomack, it is a reliable option for reducing it. Electric efficiency incorporates lighting upgrade opportunities as well as air conditioning strategies. It also explores opportunities for efficiency improvements with the walk-in refrigerator that is only used for one annual event.

EEO 15: UPGRADE INDOOR LIGHTING

Issue:	Inefficient lighting options
Recommendation:	Upgrade to LED fixtures across the house
Estimated Cost:	$5,000 (simplest option) to $20,000 (most complex option)[84]

Issue and Recommendation: The Manor House does not currently use the most energy efficient lighting fixtures available for their type of application. While the fixtures they use are traditional light fixtures for residential buildings, they do not represent the most energy efficient options on the market. Therefore, it is recommended that Mashomack update the indoor lighting with either an LED retrofit or an entirely new LED fixture for their screw-in type bulbs. For the office space, which contains less traditional residential lighting (T-8 or T-12 linear fluorescents), an upgrade to either a T-5 high performance bulb or a linear LED option is recommended. These upgrade options will be applicable across all the internal lighting on the Mashomack Campus.

Existing Condition: Currently the Manor House and surrounding buildings are internally illuminated with a combination of fluorescent and incandescent lights. Most of the rooms contain incandescent screw-in lights, such as those in the wall sconces and bedrooms, as seen in Figure 29. Offices and more commercial space contain typical commercial fluorescent lights, as seen in Figure 30.

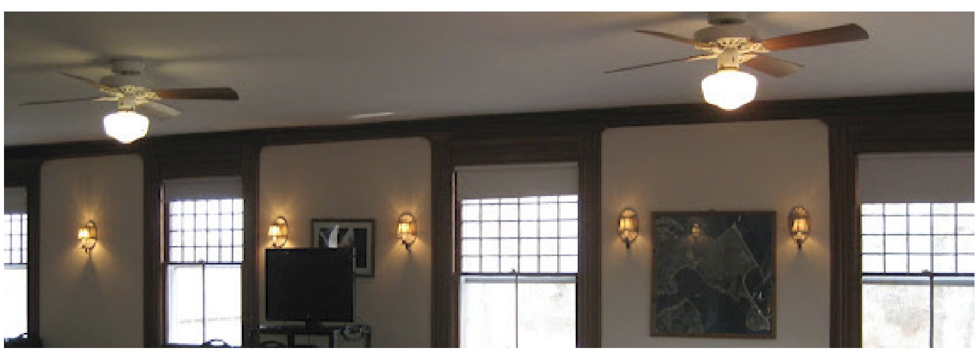


Figure 29 - Current Indoor Lighting for main room in Manor House

Figure 30 - Commercial Indoor Lighting for office in Manor House

Technical Information: It is important to note that "by July 2012, standard T-12 lamps will no longer be made in the USA. As a result, this has become not only an energy issue, but an operations and maintenance issue as well."[85] Should Mashomack Preserve have any T12 linear fluorescents, they should look to switch from a T12 to either a T8 or the recommended high performance T5 or LED equivalent. The switch from a T12 to a T8 luminaire "reduces[s] energy consumption by roughly 30% and increases lighting levels by 20%."[86]

The recommendations in this lighting section were based upon existing lighting fixtures within the buildings and traditional lighting levels for residential buildings. If existing indoor lighting levels are not currently sufficient, the owner should evaluate whether or not a higher lumen lamp is necessary. In order to determine the proper lighting scheme for a space, a few definitions are helpful for understanding how lighting is evaluated in terms of both energy efficiency and the lit environment. The definitions are found in the Appendix and help to provide insight to the important qualities to pay attention to when selecting lighting.[87]

Advantages: Light-emitting diodes (LEDs) are growing in popularity, making the jump from a research recommendation to a practical application in buildings. While high-use, outdoor areas have been the traditional application for LEDs, they are now being used in indoor applications. While they are usually found in commercial buildings, they are increasingly used in residential lighting, especially with energy efficiency and sustainability-conscious users. Advances in LED knowledge and technology have grown immensely over the past five years, and they are currently the best option on the market for an energy efficient lighting fixture. Although they can be quite expensive, their long life cuts the cost of bulb replacement. In combination with incentives like utility rebates, LEDs are a worthwhile choice.

Disadvantages: Because they are new to the market, there is the risk of ineffectual performance, i.e. defects in the product, and there are fewer manufacturers with well-established reputations on the market. LEDs are known to be quite directional, which can change lighting sequences in a space and, depending upon color preference, it can be difficult to select the correct fixture. In order to select a quality LED, the Lighting Resource Center, a nationally recognized lighting research group, has put together guidelines for selecting LEDs, available online. It is recommended Mashomack consult with a lighting designer and the information posted online in order to select a qualified vendor.

Estimated Cost: Payback periods will vary drastically depending on the hours of use in each of the buildings. The most economical initial investments would be to start with the Manor House and the Director's House, which have the highest occupancy and use rates.

The primary recommendation for this energy efficiency opportunity is replacement with an LED equivalent. The cost to update with LED bulbs will be more expensive than traditional compact fluorescent substitutions, but these new bulbs have a lifetime of about five times longer than traditional fluorescent screw-ins. For example, Table 1 shows the price comparison for a bulb retrofit with an LED versus the incumbent bulb in the wall sconces, originally seen in Figure 27.

Table 1 - Bulb Retrofit Comparison

Bulb Type	Incumbent bulb	LED
Wattage	15 Watt	2.5 Watt
Voltage	130 Volt	120 Volt
Design	Clean Bent Tip Decorative Bulb	LED Candelabra Light Bulb
Lifetime	3,000 Hours	15,000 Hours
Cost Per Bulb[88]	$0.80/bulb	$3.00/bulb
Cost for 5 years	$143.08	$30.66

Note: The incumbent bulb type was determined based upon assumptions for typical plug-in options in residential wall sconces. Cost assumptions assume $0.20/kWh and use of light 50% of the year. They also include bulb replacement cost, but not labor for installation of the initial fixture or replacement of the bulb over the five years.

EEO 16: EVALUATE LIGHTING AUTOMATION

Issue:	No lighting controls are installed
Recommendation:	Install a combination of photocells, occupancy sensors, and timers to curtail unnecessary artificial lighting
Estimated Cost:	$30 to $150 per unit

Issue and Recommendation: Mashomack does not currently use any lighting controls to decrease use when the building is not occupied or when artificial light is not needed. Therefore, it is recommended that Mashomack install sensors and timers, particularly in those spaces that have more sporadic use. This recommendation includes the use of daylight controls in areas that receive ample natural light and have regular use during the day.

Existing Condition: The only types of lighting controls currently used in Mashomack's buildings are light switches that turn the lights off or on manually. While occupancy rates may not justify an occupancy sensor or photocell in all areas, there is an opportunity to decrease the use of unnecessary mechanical lighting in favor or ambient light, depending upon the task and occupancy levels.

Technical Information: While a lighting fixture upgrade will be most influential for energy savings and carbon reduction at the Mashomack Preserve, beyond fixtures, automatic controls also can increase lighting efficiency and reduce the carbon footprint. Experts suggest that daylighting and automation of lighting controls make a positive impact, "especially in a house-like environment where lighting is a primary source of electric consumption."[90] There are not currently any light timers, occupancy sensors, or photosensors on the indoor lighting configuration for the buildings. This lack of controls, in spaces that have varying occupancy, can cause significant energy impacts, as when lights are left on in sparsely occupied spaces for extended periods of time before they are discovered.

The most common type of lighting control systems consist of dimming, occupancy/vacancy sensors, relay-controlled time-of-day switching and daylight harvesting.[91] While an entire lighting control system would work for Mashomack, because of the sporadic use of spaces and lack of complicated existing lighting schemes, localized room controls, such as for an individual space like the dining room, should be sufficient from an operational perspective. It will be important when installing this measure to ensure that an engineer reviews control selections along with the lighting fixture upgrade choices to ensure that all systems are compatible and will work together appropriately for maximum energy and carbon reduction.

There are different types of occupancy sensing technology available, of which three are typically considered: ultrasonic (motion-based sensing), passive infrared (heat-based sensing) or dual technology (combined both ultrasonic and passive infrared). The location of the sensor, whether ceiling- or switch-based, also impacts its effectiveness.[92] It is therefore critical to include both someone who understands the technological abilities of each device and someone who understands the usage patterns of the space in any implementation discussions.

See the Appendix for Lighting Control Recommendations.

Advantages: In a typical scenario, should someone forget to turn off a light in a space with sporadic occupancy, it could be on for an extended period of time before it is turned off. Herein lies the advantage of these sensors. In addition, a photosensor can help to stage the lighting in spaces that require only partial lighting to supplement natural light.

Disadvantages: The biggest component in determining the whether or not to install occupancy sensors, photocells, and timers is determining if the costs are worth the investment when a behavioral management program for when and how to turn off lights in all spaces could potentially return the same results at zero cost.

Estimated Cost: The most inexpensive option for controlling lighting levels in a space is the timer, which averages about $20-$30 per unit, including installation. The timer will, however, only turn the light on for a specified period of time, typically between 5 minutes and 3 hours, then turn the light off. The medium option for controls is occupancy sensors, which sense when someone is occupying the space. Depending on the sensor location and technology type, these units range from approximately $45 for the least expensive, ultrasonic technology ultrasonic and switch-mounted sensor to over $100 for the dual technology, ceiling mounted option. The most expensive option, which can be used in tandem with the occupancy sensors, is the photosensor that senses ambient light levels and adjusts the mechanical lighting down or up to balance the levels. This option can range from the low $100s to over $150 per unit.[93]

EEO 17: UTILIZE NATURAL LIGHT SHELVES

Issue:	Daylight penetration through windows into the buildings
Recommendation:	Install light shelves on the inside of the fenestrations to reflect daylight deeper into the rooms and reduce the need for indoor lighting
Estimated Cost:	$100 per unit

Issue and Recommendation: Improved Daylight penetration into the Manor House would be beneficial in reducing the need for indoor lighting during daylight hours. The recommendation is to install light shelves either on the outside or inside of all fenestrations on the southern façade of the Manor House.

Existing Conditions: Daylight penetration appears to be low within the Manor House. During the daytime site visit to Mashomack, indoor lighting was observed to be turned on.

Technical Information: Effective daylighting can yield 30-60% reductions in annual lighting energy consumption, and average energy savings associated with introducing daylight dimming technologies in existing buildings are more than 30%.[94]

Natural light is mostly a design issue, however, and maximizing light entering through fenestrations is a challenge in existing buildings like the Manor House. Fortunately, the orientation of the house and placement of the living areas are mostly conducive to maximizing daylight and minimizing use of interior lighting during the daytime hours.

A light shelf is a horizontal, light-reflecting overhang placed above eye-level with a transom window placed above it. This design, which is most effective on southern orientations, improves daylight penetration (up to 2-3 times), creates shading near the window, and helps reduce window glare.[95] Exterior shelves are more effective shading devices than interior shelves. A combination of exterior and interior shading devices works best to provide an even amount of light inside. It is important to carefully select glazing, location, and design of window openings.[96]

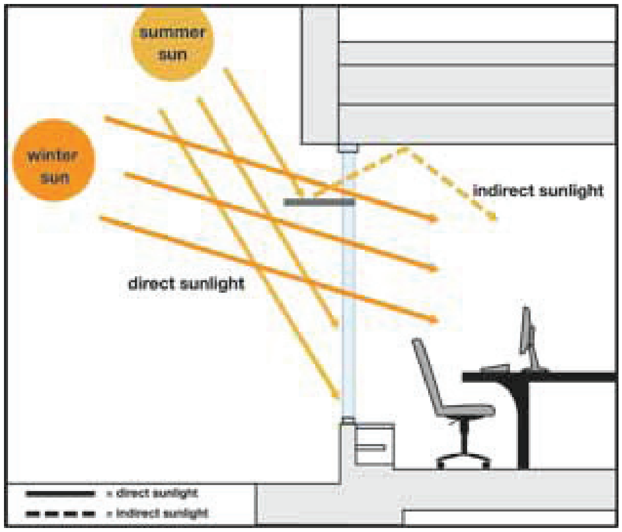


Figure 31 - Lightshelf[97]

Advantages: The improved lighting inside the Manor House will reduce the need for indoor lighting. The space will also become more comfortable, and the user experience will improve, especially during meetings held during the day.

Disadvantages: While not a disadvantage, it should be mentioned that most visitors to Mashomack come with the intention of being outdoors during the daytime and will not need daylighting indoors. Additionally, a light shelf will need to be cleaned often to maximize effectiveness, as dust on the light shelf will degrade the amount and quality of light. The need for improved daylight in the house may not merit the cost of installing light shelves throughout the living areas.

Estimated Cost: A light shelf unit costs about $100 per window,[98] but is subject to variation based on manufacturer, design and volume purchased.

EEO 18: EVALUATE MECHANICAL AIR CONDITIONING

Issue:	Need to add air conditioning capabilities for future load and tenant comfort
Recommendation:	Install air cooled split system chiller with high veloctiy ducts
Estimated Cost:	$5,000 (simplest option) to $38,000 (most complex option)

Issue and Recommendation: As tenant numbers increase and climate projections show a continued warming of the Long Island region, Mashomack has expressed an interest in enhancing their existing air conditioning system in the most efficient way. It is important to note that this will not improve the energy efficiency of the site, nor will its installation and operation have a positive impact on the carbon footprint or ecosystem. Should Mashomack decide to install a more comprehensive air conditioning system, however, it is recommended they install an air-cooled chiller with high velocity ducts for distribution. In order to maximize the energy efficiency and minimize the load installed, the weatherization recommendations should be implemented in the Manor House before proceeding with the air conditioning. This recommendation is solely for the Manor House, as existing air conditioning systems and structural set-ups for new systems were not evaluated at the other buildings on-site.

Existing Condition: The Manor House does not currently have a central air conditioning system. Certain rooms located on the upper floors have, however, been fitted with window air conditioning units. Although age and performance data was not available for these individual systems, they are known to range in age and quality of performance. As occupancy numbers grow and summers become hotter, it may be preferable to fit the entire Manor House with an air conditioning system so that all rooms can be cooled as needed.

Technical Information:

- Chiller: Central air conditioning units have their efficiency governed by U.S. law and are regulated by the U.S. Department of Energy (DOE). A "seasonal energy efficiency ratio" (SEER) is assigned to every air conditioning system to represent its energy efficiency rating. The SEER is defined as the total cooling output (in British thermal units or BTU) provided by the unit during its normal annual usage period divided by its total energy input (in watt-hours) during the same period. The point of the system is to force manufacturers to minimize the amount of electricity used by the unit while maximizing the total cooling output in a way that consumers can recognize – the higher the SEER, the better the unit. An SEER of 13 is representative of a 30% increase in the minimum energy efficiency requirements for air conditioners.[99] Any system selected by Mashomack should be at this rating or higher; it is recommended the site target at least 16 SEER.[100]

  An approved HVAC contractor can help to select the best system. In order to correctly size and select the right type of air conditioner, the selected cooling contractor should first perform an Air Conditioning Contractors of America Manual J load calculation.[101] This is a standardized process for determining the heat gain to which the building is subject. From there, the most efficient system can be selected for installation in the attic or just outside the house. It is recommended to use an air cooled chiller because of the excess process load for water with a water-cooled unit. The availability of water on the island makes a water-cooled chiller less ideal. Although this may sacrifice a small amount on efficiency, the preservation of a secure water resource is more important. An air cooled split system should provide the best opportunity for an energy efficient system with minimized environmental impact.[102]

- Duct and Distribution: Ideally, the easiest way to install a central air conditioning system is to utilize the existing forced air duct system that might have been installed for the heating system. The second option would be to install a traditional ducting system. Below is a picture of how a traditional central air system would be installed for a split system with the compressor outside and the air cooled distribution system on the roof. Based on existing knowledge of Mashomack and the desire to maintain the historical integrity of the Manor House, however, these two options are not recommended. Therefore, alternatives must be evaluated.

Figure 32 - Overview of how central air is incorporated into a house[103]

Bill Chaleff, principal of Chaleff & Rogers, Architects, an expert on historical renovations and someone familiar with the Mashomack site, recommends that the best option for installation of a ducting system at the Manor House is a high velocity system. According to Chaleff, in general, when installing a system the most important consideration is controlling the load. The better controlled the load, the smaller the duct can be. A traditional duct, referred to above, however, has limitations on how small it can be due to the static pressure requirements and minimum volume of air that must be in the rooms to facilitate supply and return and handle dehumidification. The high velocity duct avoids this.

High velocity duct systems are designed to work on the principle of pressure rather than air velocity. The main difference is the diameter of the supply duct, which is small enough that it can be installed within existing walls with minimal remodeling or framing members.[104] When sending the duct through a framing member, mechanics drill through the center with minimized impact on the structural integrity of the beam. It is preferable to have a beam around 8" in depth. This allows the ducts to be run through the beams without sacrificing views or running obvious duct work through the house. They would then connect up to the split system in the attic.[105]

Advantages: The two most important advantages of installing an air conditioning system are dehumidification, which minimizes the growth of mold, and enhanced tenant comfort, which enhances Mashomack's ability to foster donor relations and increase revenue. Another advantage is that a central air conditioning system is more efficient than individual window units in each room. The use of a high velocity duct system will also minimize interference with views or the historical look and feel of the Manor House.

Disadvantages: Installation of a central air conditioning system at the Manor House is not without its disadvantages. The first and most important disadvantages are that such a system neither improves the building's carbon footprint nor works towards a net-zero building – in contradiction to Mashomack's stated goals. The system will also be difficult and costly to install. A traditional system or the high velocity duct system requires a substantial amount of construction, which also has the potential to disturb the historical integrity of the house.

Estimated Cost: The estimated cost for this system's installation will vary depending upon the type of unit selected and the type of duct system used. If there is an existing duct system that can also be used for air conditioning, however, the installation of the chiller can range from $5,000 to $10,000.[106] The installation of a traditional duct system would double that price, making the range $10,000 to $20,000. If a high efficiency chiller with a SEER of at least 16 were installed, a five-ton unit would cost around $4000, with each additional ton of cooling adding approximately $500. Labor and installation would be additional to this pricing. The construction and installation of a high velocity duct system can range widely depending on the labor required to bore the holes for the new ducts, which will be the primary cost driver.[107] Online cost estimators place the costs of installing the high velocity duct system at about twice that of a traditional duct system. Assuming 500 feet of linear duct work needs to be installed, at a estimated cost of $12,500 to $16,700 (based on Mashomack's zip code), the high velocity duct costs range from $25,000 to $33,400 on top of the cost of the air conditioning unit.[108] This creates results in the highest cost scenario of approximately $38,000 for the entire system.

EEO 19: REPLACE OR REMOVE WALK-IN REFRIGERATOR

Issue:	Walk-in refrigerator performs with low annual usage
Recommendation:	Decommision existing walk-in and rent an efficient refrigerator when needed
Estimated Cost:	Rental - $1,895 to $2,995 per month; Replacement - $25,000 and up

Issue and Recommendation: Once a year, Mashomack hosts a major fundraising event that requires the use of large refrigeration capacity for approximately two weeks. This event is responsible for doubling electrical consumption at the Manor House. While the total increase cannot be directly attributed to the walk-in refrigerator, it is thought to be a major component. Because the system is used minimally outside of the annual event and due to the continual upgrade of refrigerator efficiency, it is recommended to disable and remove the existing system. In its place, it is recommended to rent an efficient refrigerator that can either be used in the existing (disabled) refrigerator space or outside the house as needed.

Existing Condition: The existing walk-in refrigerator is located in the basement of the Manor House. It is a large walk-in unit with a freezer component. The freezer is physically isolated from the refrigerator portion by an interior door. The refrigerator and freezer have separate compressors. The unit is turned off when not in use.

Technical Information: The average walk-in, 31 m^2 refrigerator-freezer consumes 30,200 kWh per year.[109] While Mashomack does not use their system year-round, the two weeks of use has a significant impact on the year: July, the month of the Annual Benefit Dinner Dance, experiences double the Preserve's typical monthly energy use. Commercial walk-in refrigerator systems usually have pre-fabricated walls and ceilings insulated to R-27, with an insulated floor. The room is also typically cooled by a package unitary or split refrigeration system. The components of these systems are an evaporator fan-coil, a compressor, and a condensing coil (water or air-cooled). In Mashomack's case, there are two compressors. The diagram below shows the basic lay-out for a traditional system.

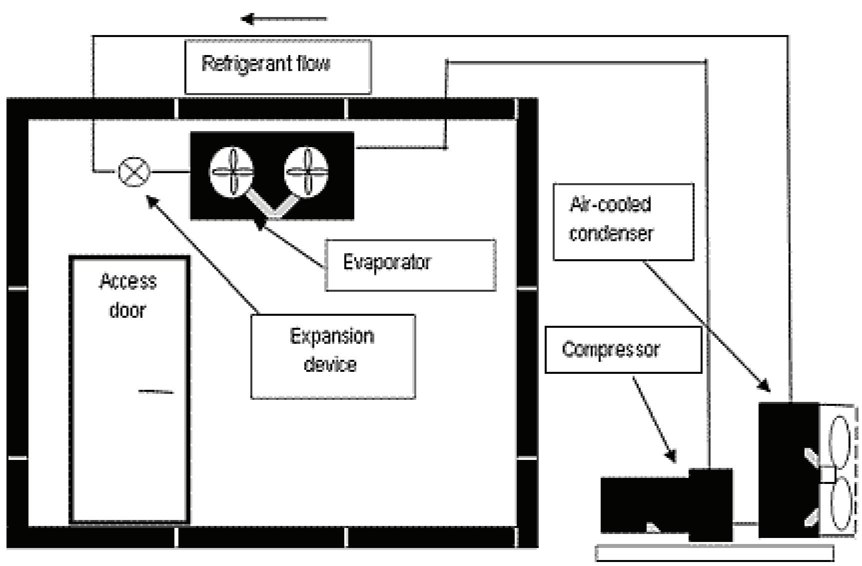


Figure 33 - Typical Commercial Freezer-Refrigerator Set-up[110]

These walk-in systems also use a refrigerant that helps to absorb the heat from the room and reject it through evaporation and condensation within the refrigeration system. The performance of the entire system depends largely upon the refrigerant used. There are environmental consequences related to the various types of refrigerant. Based on the age of the Mashomack system (at least 25 years), it is likely that a refrigerant associated with negative environmental impacts, such as a chlorofluorocarbon (CFC) or hydrochlorofluorocarbon (HCFC), is used in the machine. While these types of refrigerants have been phased out, it is unclear whether or not the Mashomack system has been converted to a newer refrigerant.[111] This should be investigated when determining whether to replace the current system or completely remove it, as there are environmental considerations surrounding refrigerant disposal.

The best way to improve the efficiency of these walk-in systems is to reduce parasitic loads and improve operating conditions and heat recovery. Should Mashomack choose to replace the system, since their predicted rise in occupancy will increase the need for the walk-in system, they should be sure to upgrade to a system with an energy efficient compressor, minimal parasitic loads, low-temperature compact fluorescent light bulbs, strip curtains with automatic door closers and electronically commutated motors (ECM) on the evaporator and condenser fans to reduce fan energy consumption by approximately two-thirds.[112]

If Mashomack does not determine that increased occupancy projections will justify keeping the walk-in refrigerator, there are special event rental options available. The key requirement when issuing the request for proposal to provide the walk-in system is to the energy performance standard for the system. The system should be relatively new and come with the same measures recommended above for an in-house purchased system.

Advantages: The main advantages of pursuing this option are that the system that is used for the event will be able to be the most efficient option on the market and will also allow Mashomack to select the size that best accommodates their event size versus cooling a space that is too large for their needs.

Disadvantages: There are multiple points for Mashomack to consider before deciding whether to upgrade or rent. If occupancy rates are anticipated to increase so much that the system usage will also increase outside the month of the main event, a replacement system may be the better option. In addition, a rental will increase the cost of the event. If there are additional events planned that will also require large-capacity refrigeration, the relative costs of renting versus owning should be evaluated.

Estimated Cost: Monthly rentals for a 20 foot refrigerated container range from $1895 to $2995 in the New York City area.[113] If a larger set-up is needed, the price would increase proportionally. Should Mashomack decide to purchase its own, more efficient on-site system, it will cost approximately $25,000 for energy efficient 9ft x 15ft x 7ft system.[114] The Long Island Power Authority (LIPA) offers a rebate for an upgraded system that should cover approximately 25% of the project cost, depending upon the equipment installed.[115]

Best Practices

Best practices can be pursued independently from the sequential opportunity actions described above. Behavioral changes can reduce consumption at low to no cost to Mashomack.

EEO 20: CONTROL PLUG LOAD AND COMPUTING

Issue:	Vampire loads on electronics
Recommendation:	Educate users to unplug electronics when not in use and/or install smart strips; upgrade to more efficient electronics
Estimated Cost:	$0 to $35 per unit

Issue and Recommendation: The Manor House's primary daily use is staff office space; it is also used for overnight visitors, events, and conferences. This use trend indicates that the primary use of electricity is lighting, followed by electronics. It is therefore recommended that a behavioral plan be implemented to educate users to unplug electronics and computing equipment when not in use and, where available, install smart strips to help curtail use. It is also recommended to upgrade to more efficient electronics to reduce plug load.

Existing Condition: There are neither smart strips nor apparent labeling campaigns on-site to remind visitors and workers to turn off and unplug electronics when not in use. Computers, mostly desktops, are recent but not brand new.

Technical Information: As much as 10% of energy use in a building can come from HVAC equipment running when it is not needed along with plug loads for chargers, computers, copiers and printers, task lights, and other items that are on when not needed. In a building like the Manor House, where these items comprise most electrical use, these sources could add up to more than 10% of energy use. Chargers typically use more energy, when left plugged in constantly, than the equipment they charge.[116]

In order to make power management easier for users, power strips can be placed on desks with signs nearby to remind users to turn off computers at night. It is important to remind and educate users to save their work before turning off the computers. There are also power strips available that automatically turn off after a period of time with no load. This application may be a good fit in tenant rooms for overnight guests. Education, however, will be the most important part of a successful behavioral energy efficiency program.

An upgrade to energy efficient electronics will also have a positive impact on the electricity use. This can include everything from computers and printers to televisions. For example, a plug-load audit performed on the National Renewable Energy Laboratories campus showed that, while in use, a desktop computer consumes an hourly average of 100 W compared a laptop computer that averages 30 W per hour.[117] When aiming for a net-zero energy profile, even the smallest plug load should be identified, modeled, and considered.

When equipment is left plugged in, there are also the inherent effects of vampire load, which can be avoided or minimized by the use of a surge protector or smart strip. Vampire load or phantom load is the energy used by any appliance or electronic when it is turned off. This is frequently seen from equipment that is in "standby" mode versus completely off and unplugged. While they say off, they are actually still minimally operational. An example of this is any appliance with a remote control or a continuous digital display.[118]

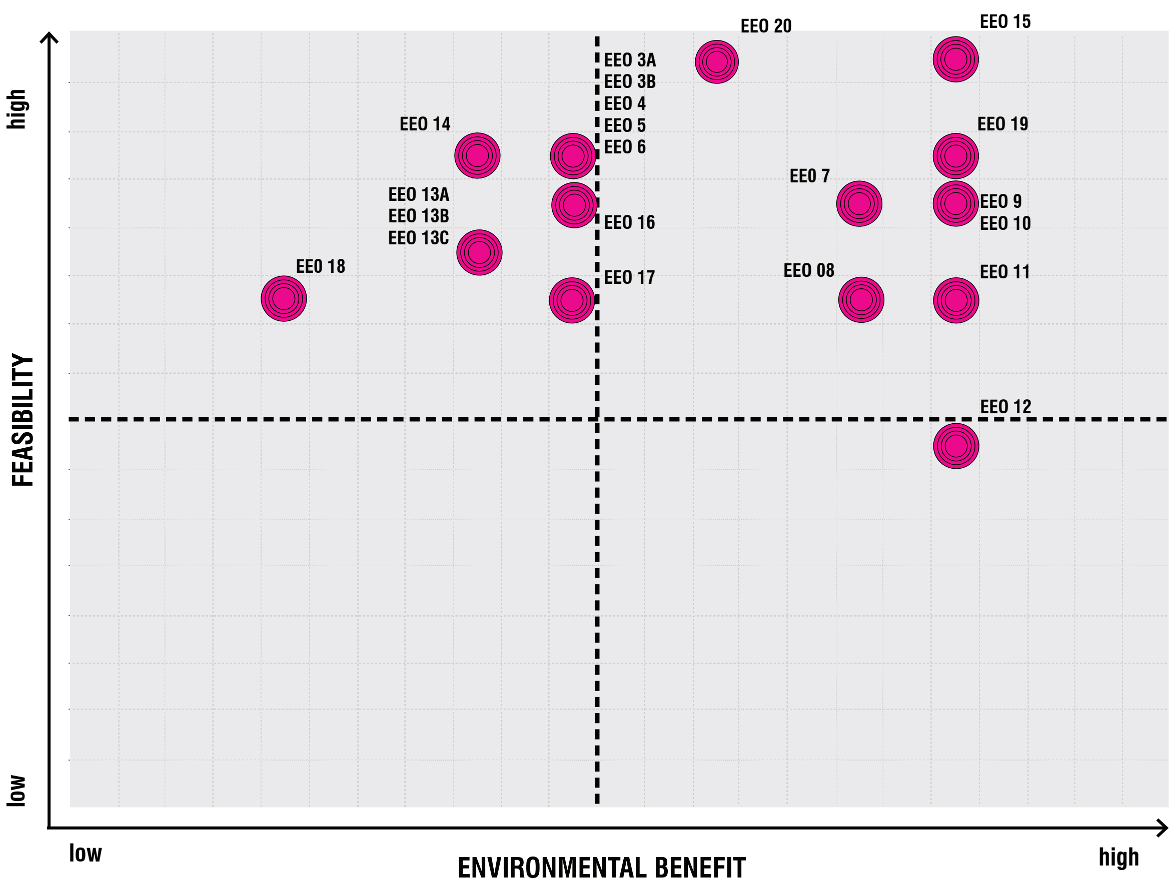
Advantages: The project to institute behavioral changes is a productive way to institute efficiency recommendations and has the advantage of being almost no-cost for Mashomack.

Disadvantages: Although an easy program to implement, visitors may see the push to unplug chargers as inconvenient or a nuisance. Also, without regular reminders, tenants and employees can become forgetful about turning off appliances, causing usage to increase again. Purchasing new electronics and/or smart strips can become costly. It is important to evaluate the reduction in usage from solely behavioral changes before new equipment is purchased.

Estimated Cost: Although replacement and upgrade of all electronics can become costly, implementation of a behavioral program and smart strips for users can be quite inexpensive. Pricing for this recommendation ranges from $0 to $35/unit for costs related to the development of signage and the purchase of these additional smart strips. Smart strips range in price from $25-$35 per unit.[119]

OPPORTUNITY FEASIBILITY EVALUATION MATRIX

The Opportunity Feasibility Evaluation Matrix evaluates the Water Conservation and Wastewater Management opportunities based on **environmental benefit** and **feasibility**. Environmental benefit is measured along the horizontal access and increases from left to right. Feasibility is situated on the vertical axis and shows that opportunities close to the top are more feasible than those on the bottom. This matrix aim to guide decision making by identifying which opportunities have the highest environmental benefit while being relatively easy to implement. Opportunities that fall within the top right quadrant are both very beneficial to the environment and are highly feasible. It would be very favorable for Mashomack to pursue such opportunities.



Energy Efficiency Opportunities (EEO):

Weatherization:

EEO 3a: Seal the Envelope

EEO 3b: Install Envelope Wrap

EEO 4: Protect Basement & Attic

EEO 5: Explore Supplemental Window Insulations

EEO 6: Install Storm Windows

Passive Conditioning:

EEO 7: Create Window Shading through Shutters

EEO 8: Implement Natural Shading through Plantings

EEO 9: Install Outdoor Entryway Plantings

EEO 10: Use Natural Wind Breaks

EEO 11: Utilize Sun Space

EEO 12: Exploit the Stack Effect for Passive Cooling

Fuel-Based Efficiency:

EEO 13a: Implement Boiler Upgrades

EEO 13b: Forego Boiler Upgrades and Replace Existing Boiler

EEO 13c: Explore Supplemental Heating Upgrades

EEO 14: Upgrade Hot Water Heater Insulation and Controls

Electric Efficiency:

EEO 15: Upgrade Indoor Lighting

EEO 16: Evaluate Lighting Automation

EEO 17: Utilize Natural Light Shelves

EEO 18: Evaluate Mechanical Air Conditioning

EEO 19: Replace or Remove Walk-in Refrigerator

Best Practices:

EEO 20: Control Plug Load and Computing

Conclusion: Energy Efficiency

The fuel-based and electric efficiency opportunities defined in this section will make the largest impact on the carbon footprint; therefore, it is important that they are critically analyzed. From a fuel perspective, the overall recommendation is to pursue a fuel-cell based combined heat and power system. It would generate the heat and hot water for the house, as well as supplement the electricity. The balance of the electricity can be provided through renewable energy recommendations, which will be explored in the following section. While the fuel-cell approach is the most environmentally friendly one, the presented intermediate options are worth considering as alternatives. One reason is that a fuel-cell system may be expensive. Additionally, with codes and permitting requirements, it may be cumbersome. However, they are reliable and proven systems, and implementation is feasible.

Depending on the implementation timeline, Mashomack may want to pursue intermediate options to reduce fuel use in the short term while planning further updates. These options have been presented and insulation is a particularly good opportunity. It is also important to note that the continued use of #2 fuel oil is not recommended unless for use in emergency situations and the underground storage tank should be removed once dependence upon fuel oil is eliminated. While the environmental decommissioning process can be complex, it is the overall most effective environmental risk reduction step Mashomack can take. Eliminating fuel oil and removing the underground storage tank will drastically reduce emissions, remove the risk of leaks and potential groundwater contamination, and improve air quality in the local area.

The electric efficiency opportunities recommend the decommissioning and removal of the refrigerated walk-in box. Rental companies can provide the most efficient options when Mashomack requires special event refrigeration. Air conditioning installation is also examined under electric efficiency. Central air conditioning is not recommended on environmental grounds because of the subsequent increase in carbon footprint. Nonetheless, the most efficient system is evaluated because the Preserve wants to increase their air conditioning capabilities to a central system. Running this system off of the electricity produced from the fuel cell would minimize its environmental impact. It is important to note that both structural and mechanical evaluations need to be done for the installation of the recommended high-velocity duct system. Mashomack should engage engineers from the appropriate trades, either independently or through an architect, to move forward.

The local benefits to the recommended energy efficiency measures include cost reduction, emissions abatement, and the general decrease of Mashomack's environmental footprint. There are regional and global impacts of these measures as well. These actions provide the opportunity for Mashomack to model the reduction and elimination of an environmental impact, and benefits will multiply as others follow Mashomack's lead. This in turn decreases the Long Island Power Authority's carbon footprint since it reduces their generation requirements. It also reduces the carbon footprint of oil delivery companies, since the trucks will no longer be making deliveries to the Preserve. This will not only avoid emissions, but reduce noise pollution and traffic congestion that also has a negative impact on air quality and greenhouse gases.

There are a multitude of energy efficiency options that Mashomack can pursue in order to reduce their localized impact on the environment, as well as to benefit the bigger picture and set an example in their actions. While each of the recommendations above could be approached piecemeal, the overall recommendation is that Mashomack pursue their implementation in the most beneficial way. The opportunities are presented in this order, starting with energy evaluations and weatherization and moving all the way through best practices. This approach involves following the recommendations in a pattern that allows for the optimal interactive effect for each additional opportunity implemented. Interactive effects can be both negative and positive. This approach, however, takes advantage of the beneficial aspects of interactive effects. For example, once the house has been weatherized and passive cooling and heating have been maximized, the mechanical process. Overall these options contribute to preserve the valuable ecology of Mashomack for future generations.

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[13] The reason is, thermodynamically, plugging one hole increases air pressure on the remaining holes. While the same volume of air will not be able to move through fewer holes, the more holes that are plugged the lower the total infiltration will be.

[14] Reinckens, Paul (Owner of Atlantis Home Remodelers), interview by Matt Shurtleff.

[15] Ibid, (Reinkens)

[16] Ibid, (Schmitt 2011)

[17] The envelope R-Value strategy is based on the climate region’s historical weather data as described in climate conditions section and the strategy.

[18] Dupont’s Tyvek product lines are some of the most reputable wrap products. While the team is not suggesting solely Tyvek, the product is a good baseline to compare products both in costs and quality: http://www2.dupont.com/Tyvek_Weatherization/en_US/applications/regional.html

[19] Image source: LStibruek, Joe “Insights” Vol. 1, BSC

[20] Thermal bridging is a way in which radiant heat and cold travel from one space to another.

[21] $1.23/sq ft is average of two price checks. First from cost estimating site: http://www.homewyse.com/costs/cost_of_tyvek_wrap.html, using their Best Cost is $.80/sq ft. The second is a price estimate from ICS Building Construction: $75/opening (~30 windows and door entrances) for transition flashing and then $1.50/sq ft for Tyve,k approximately $1.65/sq ft total.

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[60] Ibid, (Harley 2007)

[61] Ibid, (Schmitt 2011)

[62] The average annual cost is based on reported fuel consumption provided by Mashomack Preserve staff (average gallons/year * average cost per gallon).

[63] Based on estimated heating load to heat the building vs. two electric heaters

[64] The average consumption of oil per year is 338 gallons at a cost of $3.24/gallon = $1,089/year. If gallons per year doubled for five years then the cost difference would be $5,449.

[65] Condensing boiler estimate: approximately $13,000; approximately $350,000 for Combined Heat and Power with fuel cell

[66] There are many factors to consider when comparing natural gas to oil deliveries. The potential health and environmental impacts and risks associated with hydraulic fracturing to supply natural gas should be compared to the energy intense and polluting process of trucking oil from supply depots to points of service.

[67] Traditional non condensing boilers used up to 2007 had no more than 75% thermal efficiency

[68] During the site inspection the team observed an inspection decal on the boiler that noted its efficiency was 87 ½ and had a stack temp of 250 degrees. The inspection date was 11/19/1987.

[69] Jamy Bacchus (NRDC Staff Engineer), interview by Anthony Guerrero, April 12, 2012.

[70] Ibid, (Lechner 2008)

[71] Ibid, (Pike Research 2012)

[72] Ibid, (Lechner 2008)

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[78] Line loss is the heat loss due to the distance hot water travels from the source of heat to the point of demand. In addition to distance, the size of the piping is also a contributor to line loss. If the pipe has more surface area than the volume of water, then the heat from the water is also heating up that surface area.

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Renewable energy options are emerging across the country, especially in remote areas similar to this one. Some renewable energy can be considered for Mashomack.

RENEWABLE ENERGY

Introduction

Renewable energy (RE) is the step that should be taken after implementing all possible energy efficiency improvements. Installing RE generation will help Mashomack reduce dependence on fossil fuels and further minimize the impact of the buildings' operations on the environment since electricity by fossil fuel combustion is one of the largest contributors to CO_2 and other greenhouse gas (GHG) emissions.[1]

At the Preserve, the tradeoff in employing RE technology is between the economic benefits incurred and potential environmental degradation that may result. Although the Preserve will benefit from lowered energy bills, reduced CO_2 contributions and fewer GHG emitted from the power plants that supply its electricity, there is the potential for direct negative environmental impacts resulting from the installation of the RE technologies. For example, spinning windmill blades may injure or cause the death of migratory birds, which are protected by a law that prohibits killing them.[2] Likewise, tidal turbines may affect marine ecosystems and their inhabitants. As such, the Preserve will have to weigh the financial and environmental benefits of employing RE against the environmental costs of using electricity produced using fossil fuels. Additionally, the direct, indirect, and inherent values of the Preserve's lands should be taken into consideration when deciding whether or not to employ RE.

There are two options for RE technology: on-site and off-site. The on-site option generates electricity directly on the property of the electricity user. Two common examples of on-site RE are solar panels and wind turbines installed directly on a building's roof. This option involves the previously explained tradeoffs and the further consideration of various incentives that are available at the local, state, and federal levels for non-profit entities that install RE technology.[3]

Off-site sources generate electricity at a location away from the property of the electricity user and supply it through the existing power grid. Hence, a percentage of the consumer's electricity supply is "green," and there is no investment made or environmental risk assumed. While off-site is a great alternative to installing RE on one's property, the following section of this report will examine just on-site opportunities for Mashomack.

Methodology & Approach

All renewable energy opportunities assume that renovation decisions will first prioritize energy efficiency measures. If recommendations identified and presented in the energy efficiency (EE) section of this report are acted upon first, Mashomack will significantly reduce its CO_2 and GHG emissions without introducing the risks and costs associated with RE. Such drawbacks are explained below.

This section contains small scale solutions to incorporate renewable energy. Due to the size of Mashomack Preserve and low average energy usage – except for the high peak use during the Annual Benefit Dinner Dance each July – small scale projects will make the most impact. Although large scale projects are the most effective to meet or exceed renewable energy goals, they are costly and can harm the ecosystems on the Preserve. On the other hand, small scale projects that employ several technology strategies are more environmentally effective with fewer compromises. The logic for small-scale selection is explained throughout each of the renewable energy opportunities presented.

In the sections that follow, four RE technologies (solar, wind, biomass, and tidal)[4] are identified and discussed in the context of use on the Preserve. The technologies, their advantages and their disadvantages are simplified to enable TNC to make informed decisions. Whether or not the benefits outweigh the costs of implementing RE is also identified. Below is a high level introduction to the topics, which will be explored further for application.

Solar energy comes indirectly or directly from the sun, and is captured by solar panels, heating pumps and other photovoltaic technologies.

Wind energy is produced through harnessing energy from the local winds and gathered through turbines that put energy on the grid.

Biomass energy is organic plant matter that can be transformed into electricity through processes such as gasification and fermentation.

Hydropower (or Tidal) energy is harnessed through bodies of water.

Site Conditions

Mashomack uses fossil fuels as its main source of electricity and heat in its primary and secondary buildings. However, application of renewable energy is not new. The history of the Preserve includes the use of windmills. The exact locations of all of them are unknown but from historic photos, it is apparent that one in particular was located roughly 40 feet north of the Water Tower. Although the exact purpose of these windmills are yet undetermined, their presence indicates there was prior consideration of wind energy during the early history of the property.[5]

Photovoltaic panels are currently installed on the Visitor's Center roof. As such, TNC would like to further consider partial or complete use of renewable energy for the remaining buildings on the Preserve, especially at the Manor House since it is the building that is used most often. The site offers relatively cloud free skies under average weather conditions. However, tree placement on the complex results in significant shading at times. The true extent of shading has yet to be determined due to a lack of leaves during the initial observations in the winter.

Due to the island setting of Mashomack Preserve, tidal fluctuations occur on a daily basis. The Manor House and surrounding facilities are located in an open space that is roughly 190 yards from the shore.[6] The distance to the water allows for use of the rising and falling water levels.

The site conditions and ecosystems of the Preserve pose a challenge to incorporating renewable energy technology. Throughout the following section, major consideration was given to feasibility of application on the site. As follows, the natural resources necessary for some specific renewable energy strategies, such as sun for solar, are not sufficient to be applied as a strategy for complete energy replacement of fossil fuels.

Compendium

The following list of opportunities for renewable energy application at Mashomack has been identified. They draw from the types of regenerative energy sources available on the property based on the above described existing conditions.

Renewable Energy Opportunities (REO):

REO 1: Solar Thermal Hot Water Generation

REO 2: Wind and Solar-Powered Outdoor Lighting

REO 3: Solar Electric Energy

REO 4: Woody Biomass Energy

REO 5: Small Wind Turbine Energy

REO 6: Tidal Power Energy

Opportunities

The following renewable energy opportunities presented in this section are ordered from the most to least feasible for Mashomack's specific circumstances. Each one should be carefully considered before implementing due to some of the negative consequences the technologies may impose on the environment. A combination of large- and small-scale projects are described to allow for a range of implementation levels.

REO 1: SOLAR THERMAL HOT WATER GENERATION

Issue:	Domestic hot water & heating supplied by oil-fired boiler
Recommendation:	Upgrade to solar hot water with supplemental instantaneous water heaters for domestic hot water and optional radiant heating
Estimated Cost:	$45,000[7]

Issue and Recommendation: Solar heated water can be used as a heating system to reduce dependency on oil and electric heat. Therefore, it is recommended that the Preserve pursue a shade study analysis during the cold winter months to determine when heat would be needed and to ensure that high tree lines or any other potential objects do not shade the possible placement of solar collectors. If the results are negative, then installing a solar heated water system with supplemental instantaneous water heaters for domestic hot water and possibly radiant heating is recommended.

Existing Conditions: The current Bock hot water system is fairly new and may not require replacement. However, the oil stored in underground containers used to fire the existing domestic hot water system has the potential to leak. As such, it poses an environmental risk. Furthermore, the domestic hot water system is designed for maximum occupancy. The historical trend shows that occupancy is rarely full, which means that the system is mechanically over-sized for the majority of the year. This causes a huge efficiency loss as the system heats up 100 gallons of hot water in order to meet the demands of a few occupants.

Technical Information: A solar water heater system consists of a collector, heat-transfer fluid (water or glycol), heat exchanger and a storage device.[8] An insulated tank located indoors would store the hot water. When using solar energy heat water rather than create electricity, a different type of panel is employed. Instead of using the photovoltaic cells to absorb energy that is converted to electricity, the solar thermal process collects, stores, and uses heat from the sun to make hot water. This is one of the most efficient ways to use solar energy. This heat energy is captured in the fluid and run through a heat exchange using piping to create hot water without mixing the heated fluid with drinking water; the same fluid is then returned to the panel to absorb more energy.[9]

Solar water heaters typically pay back over a five to eight year period depending on the complexity of the system. Most often solar water heating requires a backup heat source for heating water during the evenings or overcast days when solar is not accessible. A solar water heater is therefore not a complete replacement of the existing Manor House system but rather a primary source with the existing system used as back-up.

The most common application of this technology is to use the sun's thermal radiation to pre-heat water during the day. The pre-heated water is then circulated throughout the system's loop and stored in a backup unit such as the existing hot water storage tank. The backup tank then manages the water according to the set temperature controls.

The first consideration is to understand solar resource requirements. Solar collectors need to have full and unobstructed access to direct sunlight. This means that collectors would be required on the south facing side of the Manor house roof. The amount of access to solar resources will determine the sizing of the solar collectors.

Thermo siphon solar water heaters with evacuative tubes are a better fit for Mashomack's climate as they limit the risks of pipes freezing and can hold a larger capacity of hot water (up to 80 gallons).[10] A thermal siphon solar water heater operates with very low maintenance on the principle that hot fluid will rise, thus as the evacuated tube collector heats up the water, the heated water rises into a highly insulated storage tank which is installed directly above the collector. The hot water is then circulated to the indoor back up tank.

- Instantaneous water heaters: An alternative system to the oil-fired domestic water heater is an instantaneous water heater. These water heaters eliminate standby heat loss since water is only heated on demand. An instantaneous water heater can be strategically placed on each floor (the main floor, second floor and third floor) to limit heat loss from line loss. These tanks can be sized appropriately for the demand of each floor. For example, an instantaneous water heater on the main floor, which only has a kitchen and a half-bathroom, can be smaller than one on the second floor, which has six bathrooms.

  There are two options of instantaneous water heaters: Electric or Oil-fired heaters.[11] Electric instantaneous heaters can be as efficient as 98%; oil-fired instantaneous heaters are usually no higher than 88% and there are fewer products out there.[12] Using the pre-heated water from the solar system would help increase the efficiency.

- Radiant heating: The solar hot water system can be tied into the existing space heating system since that uses hot water as well. A solar-heated water radiant heating system utilizes a strategy similar to solar hot water heaters where solar heated water can be used lower the oil based energy demands of heating water. Generally, the heat transfer fluid is an anti-freeze (glycol) and a heat exchanger is needed to capture the energy without mixing with drinking water.

Advantages: Solar heat can dramatically reduce the use of oil and electric heat during days with clear skies. The same advantages to the domestic solar water heater strategies apply to the solar radiant heat strategy. Additionally, the cost of solar hot water is substantially lower than that of solar panels for electricity and has a shorter payback period.

A way to eliminate the use of the oil-fired domestic hot water system is to integrate instantaneous hot water heaters for each floor with solar hot water heating. This eliminates the need for storage tanks and standby loss and reduces line-loss, since the hot water is sent directly to the point of demand on each floor. The advantage of this integrated strategy is that the solar pre-heated hot water is sent directly to the instantaneous hot water heater which passes through the heater, and is heated to the required hot water temperature with minimal energy demand. Because of the lower level of energy demand, the use of electric instantaneous heaters is more efficient.

Disadvantages: There are upfront costs and a requirement for back-up hot water storage. Maintaining hot water during the evening and when the sun is obscured, such as in snow conditions or storms is required thus the oil-fired hot water system is still required for backup and storage. In addition, standby- and line- heat loss, though reduced, are not eliminated. The weatherization and passive conditioning of the building are important in order for the solar hot water radiant heat strategy to be effective. Space on the roof is essential due to the access to sun light and the requirement for static pressure (gravity) to effectively push the heated water down.

Other drawbacks of this strategy are the added cost of integrating two systems and the electrical system review required to ensure that there is the capacity for the electric panels. Finally, the need for toxic antifreeze and an exchanger decreases the desirability of the strategy, although minimally. The installation of a solar hot water system does require maintenance and clear operational guidelines to prevent safety issues, i.e., requirements that no cleaning of the solar collector is allowed during inclement weather so as to prevent slips and falls.

Estimated Cost: Solar hot water heaters with evacuated tubes for 8,000 square feet of living area can cost approximately $5.60 per square foot and results in a total cost of $45,000.[13] Integrating the electric instantaneous water heater requires two systems and installation which can cost approximately $3,700.[14]

REO 2: WIND AND SOLAR-POWERED OUTDOOR LIGHTING

Issue:	Outdoor free-standing light comes from non-renewable sources
Recommendation:	Install wind and solar-powered lighting for free-standing outdoor lamp posts
Estimated Cost:	$10,000 each

Issue and Recommendation: Mashomack currently uses outdoor lighting on the grounds surrounding the Manor House and other buildings. An intermediate option to reduce electricity consumption for these lamps would be bulb replacement with long-lasting LEDs, however, it is recommended that Mashomack take the further step of going "off the grid" and installing solar/wind powered outdoor lamps for the traditional lamp posts.

Existing Conditions: Incandescent bulbs currently provide the light for Mashomack's outdoor lamp posts.

Figure 39 - Example of Incandescent Free-standing Outdoor Lights

Technical Information: Solar/wind lighting systems combine two power sources - sun and wind - in one unit. On days without wind, the solar panel could charge the battery to power the lamp. The reverse would be the case on days with wind but no sun. The collection of solar power is limited by sunny daylight hours. Wind is also variable, but power can be collected overnight as well as during the day. The result is both backup and the ability to collect power at complementary times.[15]

The Brooklyn Navy Yard provides an example of a wind- and solar-powered lamp post. Ninety of these lamps were installed in 2009 as part of an initiative to green the campus.[16] The lights will save $11,000 in annual electric costs, or $120 per lamp post. New York City is looking at testing the same model.

Figure 40 - Wind and Solar-Powered Lamp Posts[17]

The system includes an optional battery back-up to bridge the gap during periods of low light or wind. The batteries have a life span of 3-5 years. The high efficiency LED light needs to be replaced once every 8-10 years. The wind turbine needs maintenance every 2-5 years, and the solar panel has a life span of approximately 15-20 years. The remaining components have an approximately 20 year lifespan.

Advantages: These lampposts, though expensive to purchase and install, have many advantages. The systems are simple to install because they do not require a grid connection or conduit, minimizing electric wiring and allowing for immediate savings realization since nothing is grid-connected.[18] This means the lamps avoid both the ongoing cost of electrical power and that they are operational when general power is lost. The solar/wind power source increases the likelihood of continuous operation. Finally, it is a proven technology successfully implemented in New York City and produced by a local manufacturer.

Disadvantages: The biggest deterrent is the cost of each unit, which will extend the payback period. In addition, the posts are 25 feet high, though the manufacturer may be able to work with Mashomack to determine a more appropriate height for the Preserve.

Estimated Cost: At $10,000 each, the LUMI SOLARI lampposts installed in the Brooklyn Navy yard are priced at many times the cost of a conventional lamppost, which ranges from a few hundred dollars to thousands of dollars depending on style; however, since the technology just requires mounting versus additional wiring or utility coordination, minimizing installation costs, savings begin to accrue immediately.[19]

REO 3: SOLAR ELECTRIC ENERGY

Issue:	Electricity is supplied by fossil fuel based sources
Recommendation:	Further investigate on-site installation of solar photovoltaic panels
Estimated Cost:	$25,000 to $32,000

Issue and Recommendation: As previously stated, average monthly electricity use on the Preserve is about 2100 kWh, which is typical of a two and one-half story building. Peak usage occurs in the summer and is about 4000 kWh. The recommendation is to further investigate on-site installation of solar photovoltaic panels (PV) to meet the everyday electricity needs of the Preserve.

Existing Conditions: The Manor House is currently located in an open area of the preserve that has exposed roofs facing southeast, the prime location for solar panel placement. Long Island based Go Solar Inc. (Go Solar) designs and installs solar systems and, in fact, installed six solar panels on the rooftop of the Visitor Center in 2004.[21] According to the National Renewable Energy Laboratory Solar Energy Resource map, over the course of the year, Shelter Island, receives on average between 4-5 $kWh/m^2/day$ of solar energy.[22] This number represents the potential energy which could be harnessed with photovoltaic (PV) panels to meet the electricity demands of the Manor House.

Technical Information: Solar energy is a free, clean and renewable energy source. It is produced by converting sunlight into usable energy through a variety of technologies. In general, a solar electric system consists of PV panels, inverters, and metering. The PV panel is the technology that absorbs the sunlight's energy, capturing it for conversion to usable electricity. The panel is made up of individual photovoltaic cells that convert the sunlight through the photovoltaic effect, which is the creation of voltage or electric current in a material upon exposure to light.[23] The inverter converts the inconsistent DC power output from the solar panel into a usable stream of electricity to be transported to an electric grid.[24] The metering component allows the user and the user's utility to track how much electricity is supplied to a grid.[25]

PV panels emit zero GHGs when producing electricity.[26] Today, thousands of homes and businesses use PV for electricity. A typical home or business use 20-40 cells which can be mounted on the roof or on the ground.[27] Utility companies also use solar arrays, where hundreds of solar panels combine to create one system that produces electricity for large power stations.[28]

Advantages: Benefits of installing solar panels at the Manor house include reducing current expenses and exposure to future rate increases, as well as the emissions reduction for both the Preserve and the region as a whole. Solar panels are portable, flexible, and easily maintained. According to GoSolar, based upon the current electricity loads, the Manor House could install a photovoltaic system made up of 18 solar photovoltaic modules (or panels), which would produce a total of 4,320 Watts. Depending upon structural integrity, the recommended installation location is the roof. The system would generate approximately 5,100 kWh/year, which accounts for 30% of the Manor House's total electricity demand. To provide electricity for the entire house, additional solar panels could be mounted on the ground.

Disadvantages: The efficiency of the PV panel depends on temperature, location, and the weather. From the satellite view provided by Go Solar (Figure 40), trees that surround the house would create shade on the roof-mounted panels. The shade could affect the absorption of sunlight on the panels. Shade may also affect the permitting process needed to install panels and apply for the LIPA rebate. An evaluation of shading from trees on the Manor House roof is necessary to determine efficiency of the PV panels. Furthermore, even the most recent, efficient solar panels achieve an overall efficiency of only 20%. This is why they cannot yet compete with fossil fuels.[29] There will also be a long payback period for installation of a solar electric system. A further disadvantage is that, as a non-profit, the Preserve is not eligible to receive federal and state tax credits to relieve some of the first cost burden associated with this strategy.

A strong disadvantage would be that trees may have to be removed to increase the efficiency the solar panels. Alternatively, TNC could consult with experts to determine the best way to manage shading by trees on the Manor House roof. Tree trimming or an alternative positioning of the panels may prove sufficient to maximize efficiency. A future evaluation of trees affecting shading on the panel is necessary to further increase efficiency. It is not recommended to remove trees at the preserve in order to install the solar panels.

Figure 41 - The Tree View provided by GoSolar

Estimated Cost: According to Go Solar, the system could be installed as a grid tie system on the roof of the Manor house for under $25,000 or grid tie with battery backup for $32,000. There is a LIPA rebate of $8,640 to reduce the cost; however, the permitting process must verify adequate lighting and eligibility for the panel. The net cost of installing the solar panels without battery backup, which stores solar energy for a brief period of time, is $16,360.[30]

The below Figure 42 provides a sample cost breakdown and payback of a solar-electric system as shown on the LIPA website. To understand the full cost analysis of a system for the Manor House, an expert should be consulted.

Installed Cost (assumes $5.80 per watt):	$30,160
LIPA Rebate (at $1.75 per watt):	($9,100)
Cost after Rebate:	$21,060
Less 30% Federal Tax Credit:	($6,318)
NY State Tax Credit (Lower of 25% or $5,000):	($5,000)
Total Combined Tax Credits:	($11,318)
Final Customer Investment:	$9,742
Annual Estimated Savings: Based on output 6,620kWh annually at 0.196 cents / kWh rate:	$1,297
Approximate Simple Payback:	7.51 years

Figure 42 - Sample Cost for Average 5,200 watt/5.2 kW PV System[31]

CASE STUDY

The Nature Conservancy's Moloka'i office goes solar

TNC's Moloka'i office installed an 8.88-kilowatt photovoltaic array on its rooftop to meet the office's electricity needs. For three years, the PV system has been used for power lights, electronics, air conditioning, and other office needs. The office is also connected to Maui Electric's grid so that even on cloudy days, electricity is still available. The solar PV life expectancy is more than 12 years and can save over $50,000. In the past, the office paid roughly 41 cents per kilowatt-hour. Under the new arrangement, it is 30 cents per kilowatt-hour. The Nature Conservancy estimated energy cost savings at $55,723.31.[32]

REO 4: WOODY BIOMASS ENERGY

Issue:	Current energy demands are supplied by fossil fuel based sources
Recommendation:	Explore opportunities to use on-site renewable biomass for heating
Estimated Cost:	$10,000 plus internal cost of working capital

Issue and Recommendation: Woody biomass has potential to be one of several biomass solutions to reduce energy dependence and carbon emissions. Woody biomass and biomass in its other forms are renewable resources and thus invaluable as a solution to current energy demands.

It is recommended that opportunities for woody biomass harvesting and use should be considered for energy production.

Existing Conditions: With more than 1,200 acres of forests, Mashomack Preserve has the possibility achieving carbon neutrality through the regular collection and burning of wood debris. In addition to trimmings collected off the forest floor after logs are harvested, Mashomack's forests could be "pre-trimmed." This type of trimming can produce biomass for electricity while decreasing the risk of forest fires, insect infestation, and disease.

Burning wood for energy requires a designated area for the storage and preparation of the material and a facility that can contain particle emissions. At present, there is no such facility on Mashomack Preserve. If biomass were to be implemented on the site, it would require construction of a protected area, easily accessible by truck and away from some of the more sensitive habitats on the island.

Additionally, Mashomack is home to at least 20 species of non-native invasive and catbrier, a native problematic species. Invasive plant species inhibit forest regeneration, alter soil chemistry and out-compete native vegetation.[33] They are extremely difficult to eradicate and efforts to do so may result in additional fuel for biomass.

Technical Information: Just recently, biomass has surpassed hydropower as the largest domestic source of renewable energy and provides 3% of the total energy consumption in the United States. This includes all plant and plant-derived materials, including animal manure, starch, sugar and crops. Forestry operations are now being conducted more frequently throughout the United States.

New and existing technology for using wood fuel effectively can employ a combination of wood combustion, wood gasification, cogeneration, and/or co-firing, depending on the fuel application. There is a variety of small modular biomass systems ranging from 3 kilowatt equivalent (kWe) for homes to 5 megawatt equivalent (MWe) for large sawmills.

The woody biomass stove technologies include:

Wood Stoves are an appliance that is usually made of cast iron, steel, or stone and installed indoors.[34] Seasoned firewood generally provides 15.3 million Btu per cord (about 8000 pounds) or about 1900 Btu per pound.[35]

Pellet stoves are similar in appearance to wood stoves; however, instead of wood, pellet stoves burn a renewable fuel made of ground, dried wood and other biomass wastes compressed into pellets. Pellet stoves operate by pouring pellets into a hopper which feeds automatically into the stove. Unlike wood stoves and fireplaces, most pellet stoves need electricity to operate.[36] Pellet stoves also require a pellet making machine to process the woody biomass into fuel pellets. A pound of pellets would provide about 8000 Btus.[37]

Hydronic Heaters, also called outdoor wood heaters or outdoor wood boilers, are typically located outside the buildings they heat in small sheds with short smokestacks. Typically, they burn wood to heat liquid (water or water-antifreeze) that is piped to provide heat and hot water to occupied buildings such as homes, barns and greenhouses. However, hydronic heaters may also be located indoors and they may use other biomass as fuel (such as corn or wood pellets).[38]

To replace the oil demand of 416,174 kBtu, approximately 27 cords of firewood per year is needed or about 26 tons of pellets.

- Soil and Water Quality: The potential risk to soil and water quality in general increases with the amount of woody biomass removed from the site, the topography of the site, and with the frequency of removals. The following are considerations related to soil and water quality:

    1. Topography of the site: The steeper the slope, the more material that should be left.

    2. Location of water resources: The closer to water, the more material that should be left.

- Wildlife Habitat: Downed woody material (DWM) is a fundamental component of forest wildlife habitat, particularly once it has begun to rot and decay. Scores of forest vertebrates, and many more invertebrates, benefit or depend upon DWM for food, escape, cover, or shelter. Standing dead wood, in the form of snags, is an essential resource for many species, and once these have fallen, they enrich the forest's supply of DWM. Forest harvesting operations that do not consider retention of these resources for habitat and ecological processes risk affecting rare species and communities, reducing biodiversity, and degrading overall forest health and sustainability. Responsible biomass harvesting should adhere to the following guidelines:

    1. Snags should only be felled if they pose a risk to safety. If snags are felled, they should be retained on-site.
    2. Retain stumps, roots, and forest litter layer.
    3. Distribute tops and limbs across the site to ensure even nutrient input. Retaining occasional small slash piles may provide habitat for some species.
    4. Utilize existing riparian management zones (RMZ) guidelines and best management practices when harvesting tops and limbs of trees.
    5. Protect sensitive and unique habitats such as spring seeps, vernal pools and ponds, cliffs and ledges, and entrance areas to caves. Generally, biomass harvesting should be avoided near these sites.
    6. Avoid biomass harvesting in nature reserves and leave tree patches within large even-age regeneration openings.

Advantages: Wood fuel has several clear advantages over fossil fuels. As a renewable resource with a sustainable, dependable supply, the emissions released into the atmosphere during the burning process are cleaner than that emitted during the fossil fuel burning. With little to no sulfur or heavy metals in its chemical makeup[39], wood does not pose the threat of acid rain pollution, and particulate emissions are largely controllable. The source of biomass on the Preserve can come from clearing invasive species from the forest floor or from diseased trees. Because these problems present an ongoing issue, this can provide a consistent source of energy while promoting a healthy forest.

Disadvantages: The largest disadvantage is the amount of woody biomass that is needed to meet the current energy demand of Mashomack. Also, recent literature argues that burning wood for biomass is not carbon neutral, as advertised by renewable energy advocates. In fact, scientists believe that carbon neutrality with biomass depends on whether growing forests sequester more CO_2 than burning releases. In other words, carbon neutrality can be achieved if forests are carefully managed, and the sources of biomass are strictly waste wood products or other living material that would otherwise decompose on the forest floor and emit greenhouse gases anyway.[40] With technology such as a pellet stove, a pellet making machine would also have to be purchased to create the fuel pellets onsite. This machine would require additional energy to operate. There are many additional caveats when harvesting woody biomass, however, many of them can be dealt with by careful management of the source.

Estimated Cost: The equipment as noted varies considerably, and several costs are involved. For example, a pellet stove strategy would include the product purchase (including a small pellet maker), installation costs for constructing the appropriate ventilation or ensuring that the pallet stoves properly fit inside the chimneys and that those existing flues work properly. An estimate of these costs are:

Pellet stove can cost approximately $2,000 per stove for 2,000 sq feet of required heated space. Subsequently, the Manor House would require 3 (one per floor).[41]

A small pellet mill can cost approximately $2,300[42]

Installation could cost $2,000

That gives a total capital cost of $10,000. Estimating the cost of pellet stoves also should take into accounting the operational costs as well. As a result of the practical operation of woody biomass day-to-day operations would change. For instance, human and equipment resources required to collect the biomass needs to be operationalized. In addition, storage of the biomass needs to be determined as well as the cost of labor to disburse biomass to the source of conversion, i.e. wood stoves, etc. In addition, the stewardship to manage against overuse of the natural resources needs to be monetized. These operational considerations which could be called the internal cost of working capital and would need to be monetized and budgeted for annually.

REO 5: SMALL WIND TURBINE ENERGY

Issue:	Electricity is supplied by fossil fuel based sources
Recommendation:	Evaluate opportunities for installing small on-shore wind turbines for electricity generation
Estimated Cost:	$3,500

Issue and Recommendation: No renewable energy generation currently exists in the Manor House complex. Given the small scale of use for the primary and secondary buildings, one or more small turbines to supplement part of their energy should be considered rather than a large one such as those that would generate power for a central grid.[44,45] Before investing in such technology, however, it is necessary to perform a detailed investigation of wind data over one year along with a full system model that includes probabilities and network restrictions.

Existing Conditions: Wind on the Preserve comes from the three surrounding bodies of water on the north, east, and south. While wind is present on the Preserve, seasonal fluctuations cause a mixture of average wind speeds from 3-8 miles per hour[46] and thus are not enough to be a reliable energy source throughout the year. Furthermore, as shown in Figure 5 and Figure 6, wind speeds increase with elevation. A small wind turbine would not be feasible at 35 feet, yet at 100 feet, it could meet the minimal wind speed of 5 m/s necessary to operate the turbine. It would, however, interfere with birds and bats.

As previously mentioned, windmills once existed on the Preserve; however, they were removed for unknown reasons. The primary purpose of the former windmills was most likely to pump water, since the island produced barley, buckwheat, rye, oats, turnips, beans, and potatoes in the 19th century. Changes in the agricultural landscape may have contributed to the decision to remove the windmills.[47]

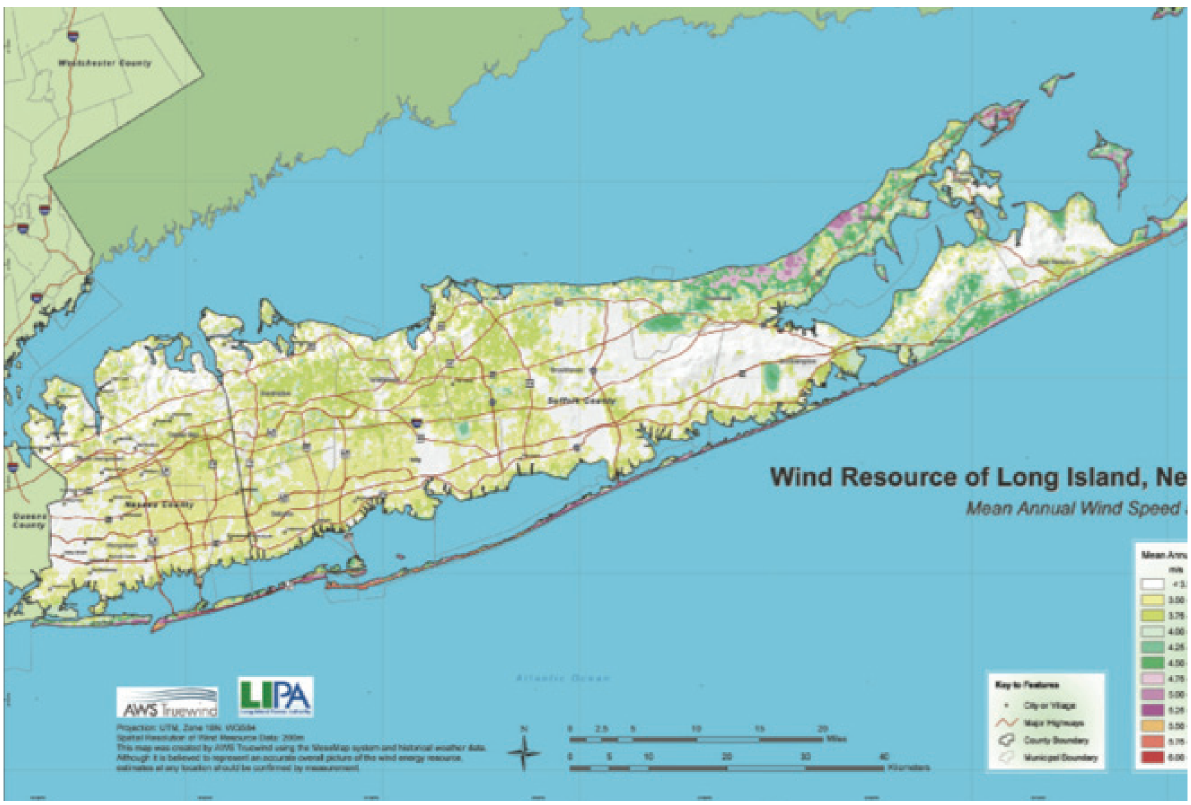


Figure 5 - Mean Annual Wind Speed at 35 Feet[48]

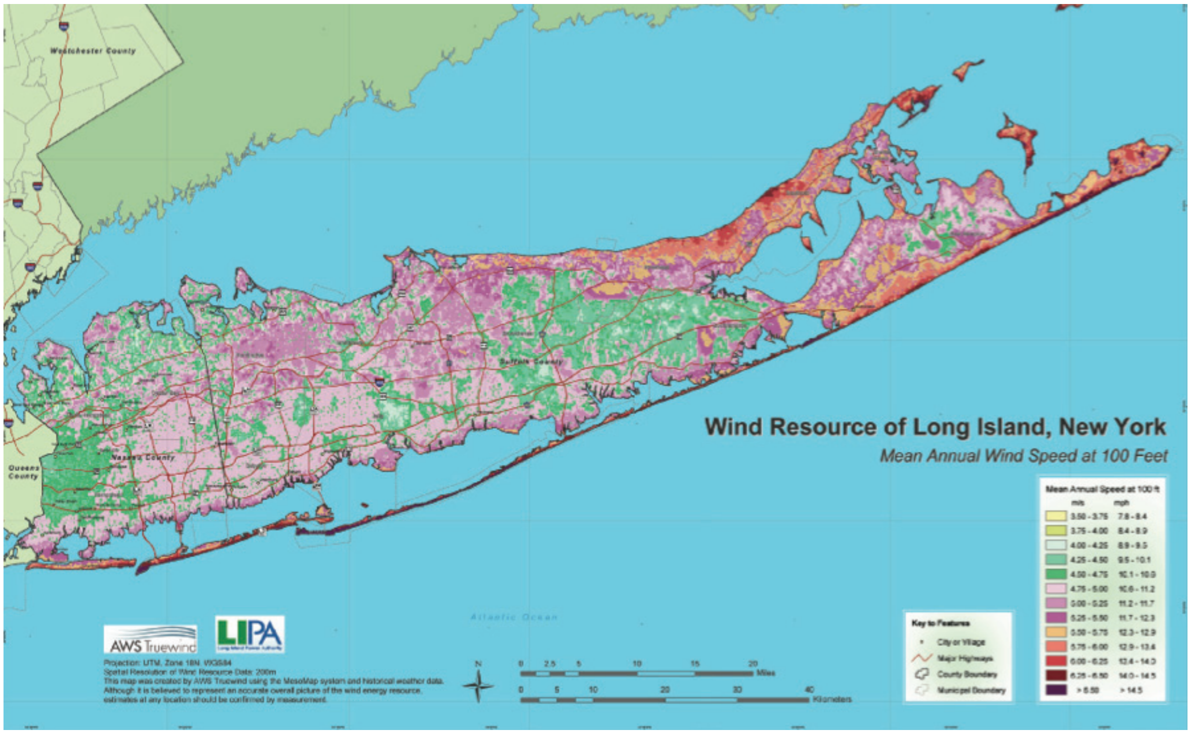


Figure 6 - Mean Annual Wind Speed at 100 Feet[49]

Technical Information: As the sun heats the atmosphere, areas of higher and lower pressure are created; wind is generated as the air flows from areas of higher to lower pressure. This occurs when air above the land heats up more quickly than the air over water during the day. The warm air over land expands and rises. Wind is created as the heavier, cooler air rushes in to take its place. The process is reversed at night. Wind energy from the local winds can be harnessed through the use of wind turbines.[50]

The basic operation of a freestanding turbine is that wind spins blades that turn a shaft connected to a generator to produce electricity. The blades are typically either propellers or have the form of a giant eggbeater.

Wind turbines require a certain amount of land and air space to be effective. For example, a small wind turbine requires about 80 feet of air space and 30-140 feet of land use. Also, with present technology, a wind speed of at least 5 m/s is necessary to turn turbine blades and produce wind energy.[51] Turbines can be mounted on a rooftop, placed in a body of water, or built on land. Onshore turbines are currently more prevalent, since offshore turbines are criticized for disrupting views of the ocean and for being much more capital intensive due to the construction process of building in water.[52]

The process of determining the applicability of wind energy to a particular location occurs in five phases, as shown in Figure 7.

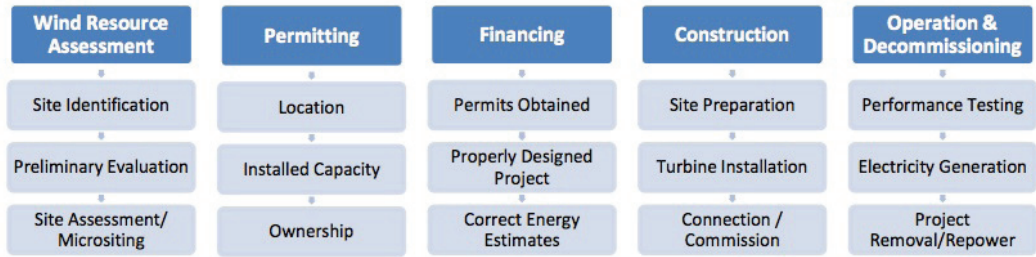


Figure 7 - Wind Energy Applicability

The first phase involves assessing potential placement sites on the Preserve. This can be done by consulting wind resource maps and geographic information system (GIS) software found at the LIPA website.[53] A model created by a wind expert and derived from the GIS program can determine the potential of turbines in a virtual environment.[54] It provides the following findings to the preliminary investigation: site or environment conditions, parameters at the site, location of the measurements, applicable data collection methods, and frequency needed for follow-up measurements and evaluations. Additionally, software programs can measure the amount of air emission reductions that result when fossil fuel-fired electric generating plants are displaced by wind power.

In the second phase, if wind energy application is determined to be viable, permits are investigated in accordance with local code and land ownership patterns. Zoning laws can prohibit visible structures and halt certain placements as a result. The Shelter Island zoning code is silent on the subject of wind turbines, yet most zoning regulations restrict height at 30 feet.[55] The wind model would be able to vet potential necessary turbine height for proper airflow, and the wind expert should consult on applicability regarding code requirements and eligibility.

In the third phase, TNC would evaluate a projected budget. It would include costs for permits and engineering fees. The Wind Powering America organization has a tool on their website to calculate an estimated payback period of a wind energy project.[56] Payback periods can vary tremendously, from 6 to 30 years.[57] A small wind turbine that requires 3 m/s will produce less RE than a turbine that requires 5 m/s as shown in Figure 8. This occurs because of the amount of available wind and due to the height increasing relative to the turbine size. Since the payback is a function of the amount of wind energy generated by the turbines and the amount required by the Preserve for use, the payback period of the smaller turbine would be much longer.

In the fourth phase, construction begins. A contractor would prepare the site and install the turbines. Wind turbines must be transported to the site and installed, after which they are tested for performance and commissioned, or connected to the grid. Operation and maintenance (O&M) costs depend upon the size of the turbine, but can range from 0.5 cents to 5 cents.[58] O&M cost will be a function of the size of the turbine. After the installation of a wind turbine, a skilled technician must be available for maintenance based on the GIS data from phase one.

Manufacturer	Bergey Windpower	SW Wind Power	Raum
	www.bergey.com	www.windenergy.com	www.raumenergy.com
Model	XL1	Whisper 200	Raum 1.3
Swept area (sq ft)	53	63.5	73
Rotor diameter (ft)	8.2	9	9.5
Tower-top weight (lbs)	75	65	86
Predicted annual energy output (kWh)			
8 mph = 3.58 m/s	420	794	908
9 mph = 4.02 m/s	610	1,121	1,110
10 mph = 4.47 m/s	840	1,483	1,539
11 mph = 4.90 m/s	1,110	1,865	2,004
12 mph = 5.36 m/s	1,400	2,254	2,479
Rpm	490	900	800
Generator type	PM	PM	PM
Governing system	Side furling	Angle furling	Tilt-up furling
Governing wind speed (m/s)	12.97	11.62	10.28
Shutdown mechanism	Dynamic brake	Dynamic brake	Dynamic brake
Batteryless grid-tied version	Pending	No	Yes
Battery voltages	24	24, 36, 48	24, 48
Controls included	Yes	Yes	Yes
Tower or installation included in cost	No	No	No
Cost: batteryless version	-	-	$3,650
Cost: battery charging version	$2,790	$3,405	$3,650
Warrenty (years)	5	5	5

Figure 8 - Small Wind Turbine Specifications[59]

Advantages: While the length of payback period or return on investment varies depending on the model chosen, as shown in Figure 8, the initial costs for a small turbine are modest and can be recouped within six years.[60] A small wind turbine that spans 8.2 feet can provide 420 kWh per month in a location with 3.58 m/s annual average wind speed, as shown in Figure 8. In addition, raising the height of a tower for a 10-kW generator from 60 to 100 feet involves a 10% increase in overall system cost. This change can produce 29% more power.[61] A LIPA rebate is available for residential wind installations when a wind turbine produces more energy than required.[62] Net consumption is billed, and any additional energy is sold as credits on the open market to generate income for the Preserve.[63] LIPA generally determines net consumption through "net metering," which is a tool that measures the amount of electricity consumed less the amount of electricity produced.[64]

Disadvantages: There are several issues with using wind turbines. The first is that the amount of open space needed for wind turbine placement is more than what is available in the existing ecosystem.[65] Additionally, such close proximity to animal habitats may result in animal deaths. However, there are mixed reports as to whether wind turbines cause the mortality of birds and bats and negatively affect seasonal bird migrations. A study on wind turbines located in Denmark and California has indicated that the frequency of bird collisions is low given the number of wind turbines. According to this study, a bird will collide into a turbine no more than approximately once every 8 to 15 years. Another study stated that estimated from 0 to 364 bird mortality from wind turbines located in Cape Cod, Massachusetts.[66,67] A permit may also be needed due to the limited space available for these turbines, but none currently exist. Height limitations may impact the applicability of wind turbines.

Second, seasonal winds vary in speed. A small turbine ranging from 20 W to 100 kW generally requires wind speeds of 5 m/s for adequate generation and reliability. On Shelter Island, the wind speeds are below 5 m/s at 35 feet, and above 5 m/s at 100 feet. An adequate height for a wind turbine will need to be carefully investigated to abide by local zoning laws. Variable wind speeds can lead to limited energy generation and low payback.[68]

Finally, turbine manufacture has environmental drawbacks. Transporting wind turbines from off-island will require the use of fossil fuels. Finding wind turbines made of materials that are the least harmful to the environment may be difficult. The rare earth minerals like neodymium and dysprosium used in the permanent-magnet generators inside of turbines are frequently mined overseas under relaxed environmental regulations.[69]

CASE STUDY

In 1983, a farm in Southwestern Kansas installed a 10-kW Bergey wind turbine. This turbine cost $20,000 and produced, on average, 1700 to 1800 kWh per month. With a turbine on-site, the owner's monthly utility bills were decreased by approximately 50%.

The owner experienced a high return on investment. Over the years, the turbine has posed few complications; only when a lightning strike occurred did unscheduled maintenance become required. The owner paid only $500, while the insurance company covered the remaining damage costs amounting to $8500.[70]

For more information see: Small Wind Electric Systems: A Kansas Consumer's Guide[71]

CASE STUDY

Off the coast of Maine, a small island called Vinalhaven produces 11,000 MW hours of electricity from three on-site windmills. The wind energy generated is enough to supply locals with electricity and sell a portion back to the grid. The community benefits through reduced carbon emissions and significantly decreased residential electric bills. Negative externalities in the form of noise and visual pollution have, however, divided residents and resulted in a federal legal case.[72] There are tradeoffs in employing RE, and the technologies are not without faults.

Estimated Cost: Estimated Cost: As shown in the Figure 8, a small wind energy system costs about $3,500 to install. Due to challenges like variable wind speeds and potentially long payback periods, wind energy may not be a viable option at the Preserve. A more detailed technical evaluation may find certain locations are better than others on the Preserve for wind production, yet at this time, wind energy is not recommended.

REO 6: TIDAL POWER ENERGY

Issue:	Electricity is supplied by fossil fuel based sources
Recommendation:	Leverage small scale tidal power for dock lighting
Estimated Cost:	Indeterminate

Issue and Recommendation: As the Preserve staff search for ways to reduce the buildings' heating oil and electric power consumption, a responsible review of aquatic power generation should be considered in order to leverage the Preserve's geographic location next to two larges bodies of water.[73] A review of three major ways to harness energy from water (hydropower, tidal, and wave power) demonstrates that tidal power would be the most appropriate.[74] However, due to the relatively low energy consumption of the facilities and potential danger to the Preserve's wildlife, the Nature Conservancy should consider smaller, discrete applications of tidal power for lights and other such devices in close proximity to the area of generation (such as dock lighting), as these "stand-alone" devices pose relatively little threat of environmental damage to the Preserve's ecosystem.

Existing Conditions: With over 1000 miles of coastline, Long Island, New York has been identified as a strong site for tidal power. Since 2004, a handful of scale projects have been proposed by private ventures in and around Shelter Island. These include:

1. 2004: South Ferry Tidal Project (slow moving helical turbines suspended from a barge for

a short-term experimental project)[75]

2. 2007: Shelter Island Tidal Energy Project (65 turbines, ranging in capacity from 25 kW to 1 MW)[76]

Local utility companies have launched parallel initiatives, investigating the potential of tidal power to provide a share of their consumers' electricity needs. In response to New York State's mandate to obtain 25% of its electricity from renewable resources by 2013, the Long Island Power Authority's Clean Energy Initiative and Renewable Portfolio Standards (RPS) divisions requested a study of significant sites for tidal energy projects in and around the coast of Long Island. Based on information available at NOAA data collection sites, LIPA identified 20 priority areas near their service territory that could be considered for power production to help transition their operations from oil and gas to renewable energy. One site is located near Shelter Island and provides the necessary data to review the feasibility of installing tidal energy devices near the Mashomack Preserve:

LIPA Site # 20
Site: North Haven Peninsula, N. of Gardiners Bay
Latitude, Longitude: 41.0411174, -72.3208333
Max Water Speeds: 4.04 knots
Water Depth: 44.70 feet

Technical Information: This section will focus on tidal energy opportunities only, with particular emphasis on those devices that rest on the ocean floor and provide few or no visual or physical obstructions in the water.

Tidal streams are high velocity sea currents created by periodic horizontal movement of the tides, often magnified by local topographical features such as headlands, inlets to inland lagoons, and straits. As tides ebb and flow, currents are often generated in coastal waters. In many places, the shape of the seabed forces water to flow through narrow channels or around headlands. Tidal stream energy extraction is derived from the kinetic energy of the moving flow; this is analogous to the way a wind turbine operates in air and differs from tidal barrages that create a head of water for energy extraction.[77]

The moon is the dominant factor controlling period and height of tides. The sun's large mass, however, causes a significant effect – the average solar tide height is about half that of an average lunar tide. At the time when both moon and sun are positioned such that their gravitational forces are aligned (New Moon and Full Moon), we observe the so-called spring tides, in contrast with neap tides, when gravitational forces are opposed.[78] Spring tides, which occur every two weeks, present the very highest and very lowest tides (i.e. the largest tidal range). Neap tides present a tidal range when high and low water is smallest and occur nearest the time of the first and last lunar quarters. The spring/neap ratio can be as much as 2 to 1. The combination of the spring to neap cycle and the 14-day diurnal tidal cycle results in a variability of the tides through the months of the year.

Unlike the variable patterns of wind and solar energy, the high level of tide predictability makes it an attractive source of renewable energy. In addition, the power density of water is approximately 1,000 times that of air. Due to this energy difference, more electric power can be generated using less material than with wind energy resources.

Tidal power is harnessed through a tidal stream energy converter, a device that extracts and converts the mechanical energy in the current into a transmittable energy form. Most tidal in-stream energy conversion (TISEC) devices contain a rotating element that turns when impacted by flowing waterways, such as tidal currents, and convert this mechanical rotational movement into electricity using a gearbox and electrical generator. These systems are generally one of two primary types:

Horizontal axis – This technology type most closely resembles a modern wind turbine in design, with blades rotating in a plane perpendicular to the axis, which is oriented into the direction of the flow or tidal current. Examples include Sea Gen's Marine Current Turbines and the Verdant Power demonstration in the East River near Roosevelt Island.

Vertical Axis – Vertical axis turbines have their blades oriented parallel with the axis of rotation rather than perpendicular to it. An early example of this was the Darrieus turbine, which looks like an eggbeater. A more recent variation is the Gorlov Helical Turbine (although this device may in fact be deployed such that the axis is oriented either horizontally or vertically). The latter system was tested off the south shore of Shelter Island, NY in the short demonstration deployment mentioned above (co-sponsored by the New York State Energy Research and Development Authority (NYSERDA) and LIPA in 2004).

Based on metrics established by the Electric Power Research Institute (EPRI) that account for tidal current velocity and flow rate, site characteristics, and electrical grid connection and cost,[79] the Mashomack Preserve is not an ideal site location for a large scale tidal power project.

The following table summarizes the findings:[80]

	Mashomack Preserve	LIPA Site # 20
Water Depth	2m at the shoreline 5-6m maximum depth	11 m
Mean Power	50 – 100 w/m^2	300 – 400 w/m^2
Mean Current	0.31 – 0.4 m/s	0.61 – 0.7 m/s

Water depth: The water depth within the 250-foot boundary owned by the Mashomack Preserve varies from 2-3 feet near the shoreline to a maximum of 15-18 feet at the outer limits of the boundaries (see chart above). This depth is on the lower end for installing tidal energy and, combined with the slow water speeds in the area, makes tidal unlikely to be successful near the Preserve. LIPA site # 20, on the other hand, meets the minimum suggested depth of 30ft and boasts water speeds nearly twice that around the perimeter of the preserve. For this reason it has been listed by utility companies as a prime location for tidal power in the area.

A data review conducted with Jonathan Colby, an engineer at Verdant Power (the energy company responsible for the Roosevelt Island Tidal Energy Project), confirmed that the best conditions for exploiting the energy from the tides near Shelter Island indeed exist at LIPA site # 20[81], the area immediately west of Smith Cove, due to the higher velocity available in that region, and that Mashomack Preserve is not ideal given the cost to build such a system in comparison to the low energy demand required. It more cost effective and equally environmentally beneficial to invest in solar panels.

A better strategy is to use tidal power on a smaller scale for local dock lighting, etc. The following is a review of a small scale project that may offer insight into the installation of tidal energy at the Mashomack Preserve.

CASE STUDY

In January 2011 Irish designer Shane Molloy introduced the FLOWLIGHT, a sustainable lighting device that relies on tidal power to illuminate the docks along the Suir River. The light features a carbon fiber outer-shell with custom-designed water turbine blades designed to operate clockwise and counterclockwise to generate power during both the high and low tides. The device is protected by a Sub-Floatation Housing Unit that keeps it at the ideal depth below the water at the same time that it shields the blades from rocks and other debris on the riverbed. The mechanical energy generated from the blades is stored in a battery unit that is used to illuminate LED strip lighting when the built-in sensor registers fading daylight.[82]

Although precise information on the depth and velocity of the Suir at this location is not readily available, the FLOWLIGHT nevertheless provides a compelling example of a potential tidal energy application. The device's ease of use and relatively simple mechanics suggest that tidal power is on its way to a smaller-scale commercial product design market. It also demonstrates the fact that mechanical energy harnessed from the tides can be easily converted and stored for future use quite efficiently and in very small quantities.

With respect to the needs of the Mashomack Preserve, the FLOWLIGHT serves as an example of a potential source of decorative night lighting. A similar device could be affixed to new or existing dock structures around the perimeter of the Preserve or small bodies of water located inland to provide illumination for night tours or visits, provided the artificial light does not disturb the wildlife.

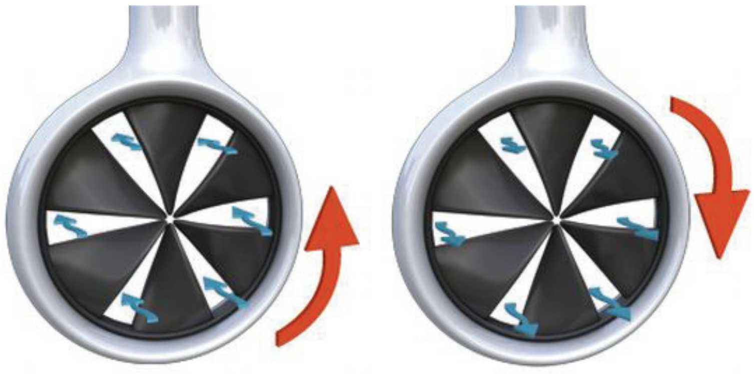


Figure 43 - Custom-designed water turbine blades that operate in clockwise and counterclockwise direction to generate power during both the high and low tides[83]

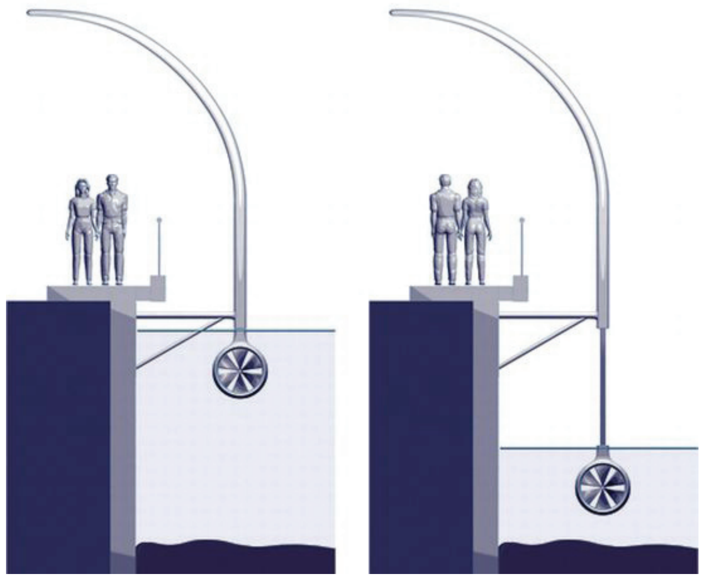


Figure 44 - The FLOWLIGHT features a Tidal Drop Extension Arm that extends and contracts to keep the Sub-Floatation Housing Unit at an ideal depth below the water[84]

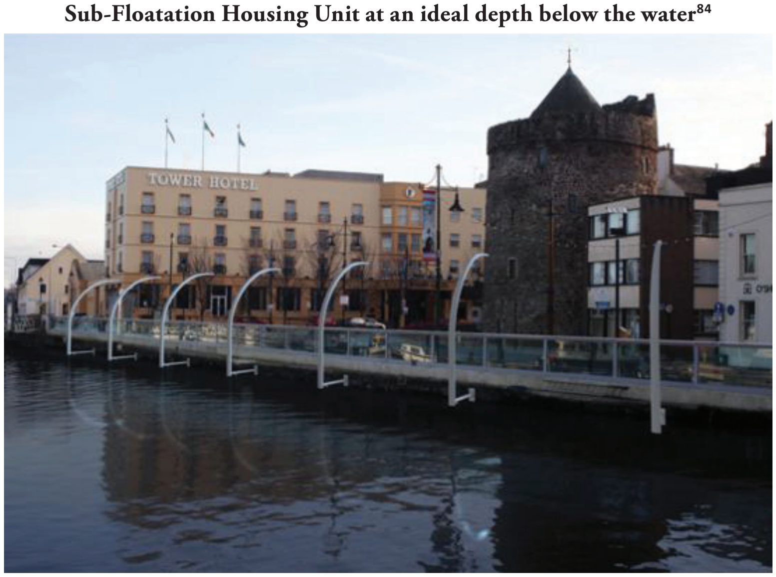


Figure 45 - Flowlight First Phase of Installation along the Suir River[85]

Advantages: Tidal energy is a clean and stable power source based because the precise energy production forecast is entirely governed by astronomy and because slack water facilities deployment and maintenance requirements are highly predictable. Additionally, advanced rotor design and technology makes tidal a technically viable option for Mashomack. Furthermore, TNC owns the area 250 feet from the shoreline that can be utilized for tidal power.

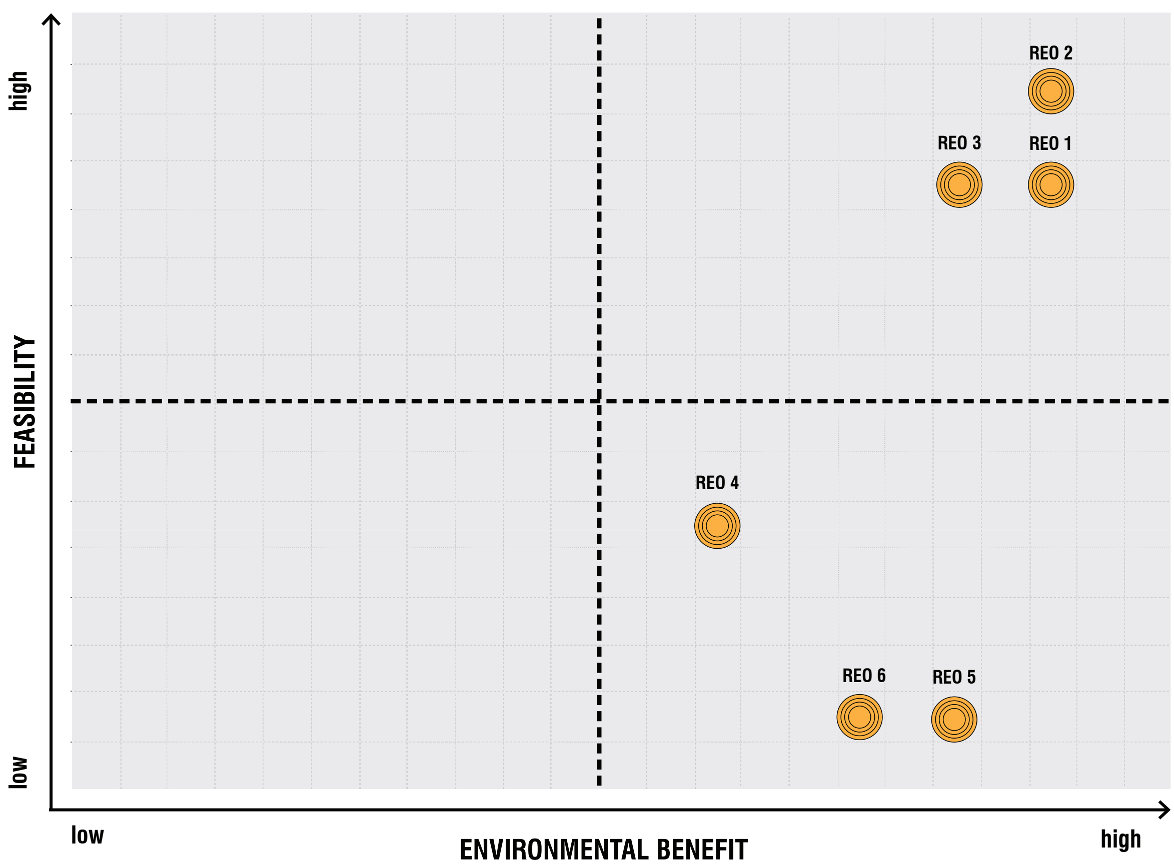
Disadvantages: Some disadvantages in relation to a large scale tidal power strategy pertain to the environmental impact on marine wildlife, in particular seals and otters native to the reserve. Tidal energy is also expensive and difficult to install. Boats, divers, and insurance are required as part of the installation. Tidal can disrupt aquatic activities such as fishing. Lastly, there is a lengthy and challenging permitting process.[86]

There are not that many commercial tidal arrays in existence. The cost of testing and developing a custom turbine would be prohibitive for the relatively low quantity of electricity needed to power the facilities at the Preserve, however, these disadvantages are not applicable to the smaller scale Flowlight system.

Estimated Cost: The Flowlight system is highly customizable thus a price is difficult to determine without site visits by an expert installer.

OPPORTUNITY FEASIBILITY EVALUATION MATRIX

The Opportunity Feasibility Evaluation Matrix evaluates the Water Conservation and Wastewater Management opportunities based on **environmental benefit** and **feasibility**. Environmental benefit is measured along the horizontal access and increases from left to right. Feasibility is situated on the vertical axis and shows that opportunities close to the top are more feasible than those on the bottom. This matrix aim to guide decision making by identifying which opportunities have the highest environmental benefit while being relatively easy to implement. Opportunities that fall within the top right quadrant are both very beneficial to the environment and are highly feasible. It would be very favorable for Mashomack to pursue such opportunities.



Renewable Energy Opportunities (REO):

REO 1: Solar Thermal Hot Water Generation

REO 2: Wind and Solar-Powered Outdoor Lighting

REO 3: Solar Electric Energy

REO 4: Woody Biomass Energy

REO 5: Small Wind Turbine Energy

REO 6: Tidal Power Energy

Conclusion: Renewable Energy

Solar, wind, biomass, and tidal were the different types of renewable energy technologies considered for the Preserve. Research conducted for this project indicates that of these four technologies, solar is the most feasible solution given the specific conditions, more specifically a solar thermal hot water system. This solar thermal hot water system would have the greater positive impact on Mashomack Preserve's sensitive ecosystem versus solar electric as it removes or reduces the dependence upon fuel oil for both heating and hot water. The availability of solar energy to be harvested by solar collectors is plentiful and, upon proper installation, collectors would not damage the sensitive ecosystem during use, unlike a tidal turbine installation that affects marine life, or wind turbines, which affect migrating birds.

While solar electric would offset electric use, by replacing approximately 30% of the energy currently derived from fossil fuels, solar energy technology is not without negative externalities. As outlined previously, harmful environmental effects of solar panels include GHG emissions attributed to panel construction and hazardous materials released when panels are damaged or disposed of improperly.[87]

While large scale solar may have the largest energy impact, the Nature Conservancy may be better off incorporating several small-scale renewable energy solutions. Potential disruptions to the sensitive ecosystem can result from transporting and installing solar panels on the Preserve. Smaller projects, such as dual-powered solar-wind light posts, would be more economical and easier to implement.

The Preserve already takes part in climate change mitigation by opting for renewable energy provided on the grid through LIPA and by obtaining solar energy from the photovoltaic panels on the Visitor Center. LIPA utilizes hydro, solar and wind energy in their normal portfolio. Harnessing energy through additional renewable sources at the Manor House can be beneficial, yet it is unlikely to completely replace all fossil fuel-derived energy. Additionally, high initial costs, even with a LIPA credit, and land required for installation limit the potential of renewable technology.

Ultimately, the Manor House uses a relatively small amount of energy. The introduction of new RE technology would produce a rather modest benefit. The key point for Mashomack to consider is that every effort should be made to maximize energy efficiency in the built environment **before** attempting a renewable energy project. While renewable technologies are high profile and provide the glamour of carbon reduction, Mashomack will make its biggest environmental impact by reducing its electric and fuel load much as possible and then supplementing the remaining generation with renewable options. Mashomack must approach renewable installations, as well as sustainability planning in general, with a master plan and a full-circle perspective, taking into account that all actions on the Preserve create interactive effects on its carbon footprint and impact to the Preserve.

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[11] Gas tankless water heater was not considered an option as there are no gas lines at the preserve. If natural gas was available consideration should be placed on the efficiency of the gas, which is cheaper and more efficient.

[12] A recommended instantaneous heater is the Rheem product line.

[13] Ibid, Edward O'Rourke, Project Manager for ICS Builders, Inc. (suggested pricing based on a ICS Builders NYC project of similar size that provided 48,000 BTU/hr of energy.

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OPPORTUNITIES
CONSIDERED BUT NOT RECOMMENDED

Over the course of the research and development of the recommendations, several opportunities were considered and deemed unsuitable for the current situation at Mashomack. However, the research is collected herein for informational purposes including the reasoning as to why they were not recommended. In the event that circumstances change whereas the opportunities are better suited for implementation the information is available for use.

WATER OPPORTUNITIES

Composting Toilets: While the composting toilets in the Visitor Center are an excellent demonstration project, they are not recommended for application in the Manor House campus. Composting toilets are best suited to circumstances where conventional plumbing and wastewater treatment are not possible. However, the Manor House and surrounding buildings have both conventional plumbing in place and a functional on-site wastewater treatment system. Installation of composting toilets throughout the campus would require significant capital investment (up to $20,000 for commercial installations) and ongoing maintenance, as well as extensive retrofitting of existing buildings that may run counter to the Preserve's historic preservation goals.[1] Composting toilets on this scale would still require a grey water treatment system and would not eliminate the need for leaching fields. The dramatic difference between average and peak loads on the site creates problems for accurately scaling such installation.[2] Furthermore, composting toilets require a power source, thereby increasing electrical load. Dramatic water savings can be achieved with less-costly low-flow toilet technologies, especially when applied in conjunction with harvested rainwater flushing systems. The OWTS recommendations detailed in the wastewater management opportunities section of this report should prove sufficient to handle wastewater on the site into the foreseeable future.

Living Machine OWTS: While researching and considering alternatives to the Preserve's OWTS, the Living Machine was another option that initially seemed promising because of its use of flora and fauna to treat sewage, and nitrates in particular. Essentially, a Living Machine consists of a large underground settling tank and an equally large recirculation tank, to and through which black and grey water flow and undergo initial treatment. From the recirculation tank, the septic fluid is pumped through a series of constructed wetlands, which are essentially large, specially designed outdoor and/or indoor gardens. While flowing through these gardens, the septic fluid is aerated and acted upon by various biological processes. They eventually render it suitable for discharge and/or re-use for applications that do not require potable water.

Although the system has consumer appeal due to its attractive use of flora and fauna, it is not as effective as the Nitrex System. The Living Machine has typical effluent nitrate levels of 5ppm, while the Nitrex system features mean effluent nitrate levels of 3.4 ppm. Although this difference in performance is minute, there are several other factors working against a Living Machine in general, all of which make it unsuitable for implementation at the Preserve. These elements include the following:[3]

1. There is intensive, hazardous, and disgusting regular maintenance involved in operating the system[4]

2. The system requires a minimum of 3 kWh per 1,000 gallons of wastewater treated

3. The smallest system offered at present requires 2,000 GPD to operate properly, which exceeds the Preserves needs of < 1,000 GPD

4. The estimated cost of the system, $150,000.00 - $200,000.00, is expensive and does not include inflow or dispersal infrastructure

5. The system requires 150 square feet of above ground area per 1,000 gallons of wastewater

6. The system is not approved for use by SCDHS

7. If it were to be approved, SCDHS may require a full-time maintenance person to operate the system, which would add significantly to the annual operation costs of the system

8. Being totally outdoors, the system may not be a viable option for S.I. due to cold winter temperatures

9. The system attracts large numbers of flies in the summer months

10. The effluent cannot be re-used unless it undergoes additional chemical and UV treatment

11. A Living Machine system does not align with the Preserve's goal of promoting their solution to greater S.I. and L.I. community as it is not an option for individual residential applications

12. Implementing a Living Machine OWTS would require the existing OWTS to be decommissioned, which would significantly add to the implementation costs

In light of this considerable list of disadvantages, a Living Machine OWTS is not recommended to replace the existing OWTS if, in fact, it needs to be replaced at all.

ENERGY EFFICIENCY OPPORTUNITIES

Do Not Insulate Walls: Walls comprise a significant proportion of a building's envelope and seem like an obvious candidate for insulation. However, retro-insulating the walls without a major rebuild is complicated. Conventional wisdom says leave them alone.

In the beginning, the Manor House's walls were probably lathe covered with plaster. Over the years, renovations like the electrical service upgrade mean some wall surfaces may now be sheetrock. It is possible insulation was left out of the original construction by design. Whether it has been added over the years is difficult to assess.

As stated earlier, air barriers and vapor protection are important components of any envelope strategy. Addressing air infiltration, vapor, and insulation without unfettered access is difficult. In the case of new construction or gut rehabilitations, wall cavities are exposed. Sealants, insulation, and vapor barriers can be methodically applied in between studs when there is no intervening sheetrock.[5]

Existing buildings are different. Unless sheetrock, plaster, and/or lathe are removed, the remaining option is blown-in fill insulation. Although blown-in fill insulation has a decent R-value, it does not create a vapor or air barrier. Consequently, the problem of moisture condensation arises. Existing air and vapor gaps channel moist air through newly installed insulation. That new insulation has the potential to act like a sponge, holding moisture back and leading to mold, rot, and pest infestation.[6] It is for this reason that builders used to intentionally not insulate wall cavities. The empty space allowed moisture to be absorbed by air, which eventually left the cavity.

Figure 46 - Mold in a Wall Cavity

Two separate sources advise this hands-off approach. Sally Zimmerman, the Manager of Historic Preservation Services for Historic New England, a non-profit that owns and preserves properties, states "Rarely is it feasible, let alone advisable, to insulate the walls of an old house. This is because installing wall insulation requires permanently altering the historic fabric of the building or introducing potentially destructive forces the house was never engineered to manage."[7] Bob Yapp, a historic preservation consultant and blogger in Missouri, states, "If your goal is to continue loving your old house, mak[ing] it energy efficient while keeping your costs down, then you absolutely don't want to blow insulation into the sidewalls. One of the top reasons for exterior paint failure, termites, and structural damage to old houses is loose cellulose or fiberglass insulation blown into the sidewalls."[8]

No action prevents the disadvantages of blown-in fill insulation. Moisture does not collect in the wall cavities, thus no mold, rot, or pest infestation occurs. The disadvantage of not insulating the wall is that it leaves a major element of the envelope without thermal protection. There is no cost to leaving the walls as-is. Opening the walls, on the other hand, would be an involved process. Considering the number and various locations of exterior walls, the expense would be considerable. It is not clear whether the payback in terms energy savings would make the process worthwhile.

Heat Recovery Ventilation: Every home requires ventilation to bring in fresh air, to remove stale air, and provide moisture control. Therefore in many cases the recommendation is to install a heat recovery ventilator (HRV) to maintain indoor air quality with minimal energy intensity in the Manor House.

The HRV is designed to provide continuous or timed ventilation throughout a home, and recover the heat carried in the exhausted stale air. The HRV is a balanced system that uses a fan-powered exhaust airflow that is designed to equal the fan-powered supply airflow. HRVs can be retrofit to most existing homes, but a blower door test should be performed first (see EEO 2 in energy efficiency section). HRVs are generally only used in homes that require mechanical ventilation – usually homes with a natural ventilation rate of less than .35 ACH. HRVs typically use about 100 to 200 Watts per hour of electrical energy.

The HRV works by taking the incoming fresh air into a heat recovery core. Heat is exchanged through a core that is made of multiple plates of aluminum or plastic. Water vapor is transferred with a rotating wheel with desiccant material or permeable plates. Models with heat recovery only transfer heat from the exhaust air stream to the incoming air stream in the heating season and from the incoming air stream to the exhaust air stream in the air conditioning season. Models with heat recovery and moisture recovery transfer heat and moisture from the exhaust air to the incoming air during the heating season and transfer heat and water vapor from the incoming air stream to the exhaust air stream during the air conditioning season.[9]

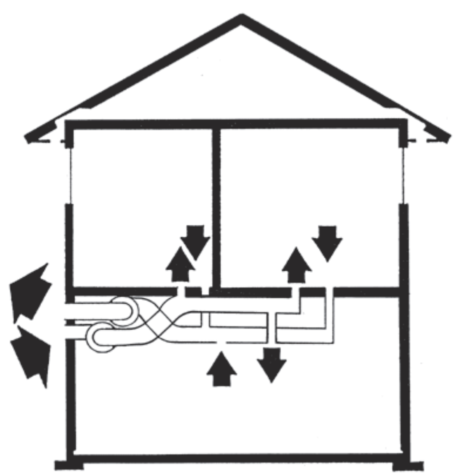


Figure 51 - How an HRV System Works

The HRV provides several unique benefits as a mechanical ventilation system. First, it is a balanced-type ventilation system, meaning it removes and replaces equal volumes of air from the home. No pressure imbalances occur in the house because of the HRV's operation, which improves energy efficiency, comfort, and safety. Second, the HRV recovers 60 to 75% of the heat in the exhaust air, and returns it to the home. Some HRVs (properly called Energy

Recovery Ventilators, or ERVs) will recover moisture from the exhaust stream as well, helping to maintain indoor humidity in cold climates. Third, the HRV is usually located in a closet or utility room, making for a quiet ventilation system. Fourth, the HRV replaces several bath and utility room fans with a single high-quality, long-lived system, which may run continuously or intermittently. Fifth, an HRV allows a tight, well-insulated home, which will only have a 2-4ºF inside temperature difference between the floor and ceiling, for exceptional comfort.

HRVs require their own duct system, except for some installations where the forced air system and HRV share some ducts. The Manor House does not have a forced air system, though, so new duct work would be needed. HRV ducts also require sealing and insulation when outside the thermal envelope. With an HRV system, costs can vary a lot depending on the type and complexity of the installation, as well as on the size and features of the HRV. For new construction, the costs would normally run from $1,000 to $2,500. A retrofit will generally cost more due to the difficulty of running ductwork to the source points.

Because the Manor House currently has a leaky envelope, installation of an HRV would be unnecessary with the amount of air already moving through the house. Even with implementation of the weatherization strategies it is unlikely that the building envelope will be completely sealed due to the age and size of the Manor House.

RECOMMENDATIONS
SUSTAINABLE MATERIAL SELECTION

Above and beyond water conservation and wastewater management, energy efficiency, and renewable energy strategies to increase campus sustainability, there are everyday choices that can be made to reduce environmental impact and Mashomack's carbon footprint. To provide assistance in making educated material selections for the Manor House and other buildings on-site, this section outlines the basic considerations for making sustainable decisions in the everyday materials that are used on the campus.

PAINTS AND COATINGS

Recent years have seen an influx in eco-friendly paints for residential applications. Deemed safe and non-toxic, they vary in price, levels of chemical reagent and product quality. There are standards and strong recommendations for what to consider when selecting an environmentally friendly product like paint. This recommendation can be extended to cover general coatings as well as stains, sealants, caulks, and other common household renovation items that typically contain toxic chemicals.

The first step to approaching paint more sustainably is to buy the right amount of paint, which saves money and reduces the amount of paint stored on-site. If there is leftover paint, it should be stored properly so it does not leak.

Some paints on the market contain recycled content. The two types of recycled paint are reprocessed and reblended. Reprocessed paint goes through a rigorous testing standard to ensure it is equally good as fresh, new paint; it tends to be very high quality. Reblended paints consist of remixed leftover paint and do not go through the same testing program. A reprocessed paint would be recommended over a reblended paint.

Beyond the high level make-up of the paint (fresh or recycled), there are also varying volatile organic compound (VOC) levels in paint. The most eco-friendly versions are zero-VOC or low-VOC paints; these are typically water-based paints. Zero-VOC does not guarantee that the paint will not contain irritants or even carcinogens that can be hazardous to health; therefore, it is important to review the Material Safety Data Sheet for the names and ingredients included in the paint and to watch for those that may have been deemed health hazards. It is also important to avoid paints that contain heavy metals or other hazards that cause health risks. Latex is recommended over oil-based paint.[10]

All the materials under the paints and coatings category release the highest level of VOCs (if they contain them when wet) once dry. Gases may continue to be released for years, and during this release, all the fabric in the area will absorb and store the gases. It is therefore important to look for zero- or low-VOC products under all these categories. Products designated with the Green Seal certified mark have gone through a vetting process and are also a good, sustainable option.[11] Green Seal offers third party certification for products, services, and companies that meet their strict sustainability standard. They are internationally recognized by many sustainable accreditation programs, too, such as LEED (Leadership for Energy and Environmental Design).[12]

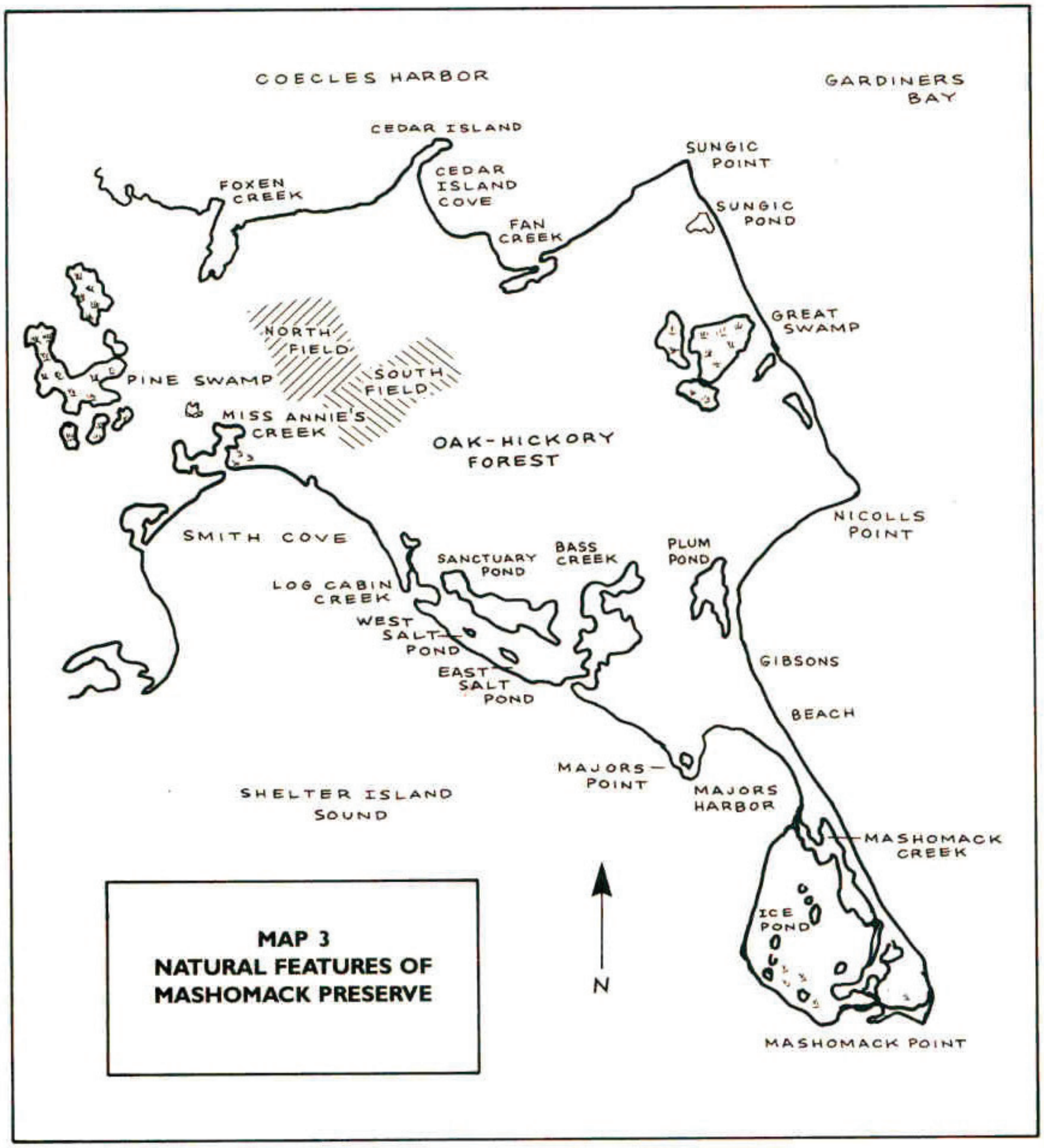
Figure 3 - Example of the Seal for a Green Seal Certified Product

CLEANING MATERIALS AND PROCESS

Many of the concepts that apply to paint and coatings selection also apply to the selection and use of cleaning materials. The purpose of a green cleaning program is to reduce exposure to chemicals, biological agents, and particulates that are deemed hazardous. These same items can also affect air quality, health, building finishes, and the surrounding environment.[13] New York State has its own Green Cleaning Program that promotes best practices and procedures for equipment and chemicals that are used in the cleaning. Relevant excerpts from their best practices for General Cleaning, Carpet Cleaning, Floor Cleaning, Food Area/Kitchen Cleaning, and Restroom Cleaning can be found in Appendix III.

AIR QUALITY

The primary way to improve air quality and maintain a high level of air quality on-site is to encourage environmental tobacco smoke control, as described in the LEED program. The goal is “to prevent of minimize exposure of building occupants, indoor surfaces and systems to environmental tobacco smoke (ETS).” The primary way to achieve this is to prohibit smoking within the building and within 25 feet of entries, outdoor air intakes, and operable windows.[14]



MAP 3
NATURAL FEATURES OF MASHOMACK PRESERVE

Mashomack Preserve, © Muriel Porter Weaver

REPORT CONCLUSION

Sustainability plans are now critical components of any renovation project, especially those located in delicate ecosystems. This report identifies, evaluates, and outlines best practices and sustainable strategies to upgrade and retrofit the buildings on the Mashomack Preserve while considering the impact or benefit of each approach to the surrounding ecosystems.

Within the above presented work, three areas were identified that held the highest potential to reduce the environmental impact of the building operation on the Preserve; water conservation and wastewater management, energy efficiency and renewable energy. The opportunities were evaluated based upon anticipated environmental impacts and benefits, local viability, suitability of the technology or approach and relative ease of implementation.

Reducing the water footprint and the negative environmental impacts of the wastewater treatment at the Preserve are the focus of the water conservation and wastewater management opportunities offered in this report. Three key issues are addressed which include optimizing ground water recharge, reducing water consumption and minimizing nitrate emissions from the onsite wastewater treatment system. The recommendations that offer the greatest potential to reduce the water use on the Preserve are simple water conservations such as installing low flow fixtures and implementing water conservation behaviors. Verifying the proper function of the onsite waste water treatment system can be the first step in reducing the risk of nitrogen contamination of the local waters.

Fuel oil for heating purposes combined with a substandard envelope was identified as Mashomack's main energy efficiency obstacle. The goal outlined in the energy efficiency opportunities was to reduce the overall energy load in several stages. The phases are benchmarking, weatherization, passive conditioning, fuel-based efficiency, electric efficiency and implementing behavioral best practices. Opportunities in any of these categories will reduce the GHG emissions and in turn the ecological footprint of the Preserve.

Even with the suggested energy efficiency measures being implemented on the Preserve, some amount of energy will still be required. Renewable energy technologies including, tidal, wind, solar and biomass were considered for Mashomack in an attempt to further reduce the use of fossil fuel and dependence on the energy grid. Research conducted for this project indicates that solar is the most feasible technology to be considered. Specifically, a solar thermal hot water system would have the greatest potential for the site as it reduces the need for fuel oil for both heating and hot water, therefore reducing the impact on the sensitive ecosystem.

Recommendations follow a general principle of capturing the most environmental benefit with the greatest feasibility and least operational impact. Many recommendations within this report are easy-to-implement, low cost opportunities that can make a dramatic difference in the buildings' performance, comfort and ecological footprint.

The aim of this feasibility study is to facilitate conversation among stakeholders. It produced a guidebook that prioritizes opportunities and can lead the decision making process for the facility upgrade. This tool can be used by engineers, architects and contractors who can apply their expertise to implement the recommendations to maximum effect given the sensitive site conditions.

TNC's goals for renovation of the facilities on the Mashomack Preserve are several. They aim to mitigate and plan for climate change while demonstrating their mission to preserve the planet's precious diversity. This objective operates in concert with the planned effects of increased fund raising activities and additional occupancy. The numerous strategies included in this report will assist in reducing the impact of operating TNC's facilities at Mashomack on the sensitive surroundings while assisting furthering their educational mission.

The vision of the Nature Conservancy is to "leave a sustainable world for future generations." Declining natural resources, threatening climate change and shifting biodiversity require collaboration to reach positive solutions. The strategies suggested to sustainably renovate the building on the Mashomack Preserve will maintain this unique natural setting, if not improve it over years to come.

APPENDIX I - V

The following pages include supplementary information about the research, analysis and opportunities contained within the report.

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APPENDIX II GLOSSARY OF TERMS

Ambient air temperatures: The temperature of the surrounding air.[15]

Aquifer: A geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to springs and wells.[16]

Ballast factor: The multiplier representing the percentage of total lumens a particular lamp and ballast combination will provide.[17]

Batt insulation: Flexible strips of insulating material placed between building structural members; made from glass or rock wool fibers.[18]

Biomass: Biological material produced from living, or recently living, organisms that can be used as an energy source.[19]

Blower door test: A test using a fan affixed to the door to measure air leakage in a building and its ductwork.[20]

Boiler efficiency: The ratio of heat delivered by a boiler to the heat supplied in the fuel.

British thermal unit (BTU): The amount of heat required to raise 1 pound of water 1 degree Fahrenheit.[21]

Burner: The component of a boiler where fuel is emitted and ignites producing a flame.

Carbon dioxide equivalent (CO_2e): The method of comparing the emissions of different greenhouse gases based upon their global warming potential.[22]

Carbon footprint: The total amount greenhouse gas emitted by a specified activity.[23]

Climate change (CC): A change in the steady state of the climate that can be identified, e.g. using statistical tests, by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.[24]

Color-rendering Index: A scale from 0 to 100 that describes how accurately a light source renders color.[25]

Combined heat and power: The use of a heat engine station to simultaneously generate heat and electricity.[26]

Combustion-efficiency test: The assessment of how well a boiler burns fuel. (Distinguished from boiler efficiency, which measures the whole system).

Convection loss (convective heat loss): Heat loss is created by a natural current of gases and liquids that, as they heat up, become less dense and rise above cooler gases or fluid thus creating a current that transfers heat away from the heating source.

Cooling degree-days (CDD): The sum number of degrees that each day's average temperature exceeds 65 Fahrenheit.[27] These can be summed for a day, week, month, year, etc. For the purposes of this report, monthly cooling degree-days are used.

Damper control: A mechanical lever that opens and shuts a furnace flue.

Deciduous: Shedding leaves at the end of a growing season.

Demand-side management (DSM): The process of managing the consumption of energy. DSM programs include, for instance, offering discounts on new, high efficiency appliances so that consumers get rid of their older, less efficient models.

Desalination: The removal of dissolved minerals (including salts) from seawater or brackish water.[28]

Direct-gain: The process by which sunlight directly enters a building through the windows and is absorbed and stored in massive floors or walls.[29]

Door sweep: A strip along the bottom of a door that prevents infiltration.

Draft stop: A device or object placed in a flue to lower air infiltration.

Drought: A period of abnormally dry weather that is sufficiently prolonged to lead to a lack of water that causes serious hydrologic imbalance in the affected area.[30]

Ecosystem services: Are the aspects of ecosystems utilized (actively or passively) to produce human well-being.[31]

Embodied Energy: Also referred to as embedded energy; Can be defined as a measure of the total energy consumed by a product during its life or complete life cycle. It includes all the energy used during mining or milling the raw materials, manufacturing the raw materials into a product, transporting the product, and installing the product, as well as finally removing or recycling the product.[32]

Energy grid: A network of power lines or pipelines used to move energy from its source to consumers.

Energy Star Certified: A voluntary certification program that establishes criteria of energy efficiency.

Energy Star Portfolio Manager: An online tool developed by the EPA to track building energy use.[33]

Evergreen: A plant that retains leaves throughout the year.

Externality: The effect of a purchase or use decision by one party on another party that did not have a choice and whose interest was not taken into account.[34]

Fluorescent light: A lamp that uses mercury vapor to excite the fluorescent inner coating of a tube.[35]

Foam board: A plastic foam insulation product that comes in a rigid board form.[36]

Foam insulation: A high R-value insulation that can be injected into cavities or sprayed; it expands and sets quickly.[37]

Gallons per day (GPD): The rate of flow, in gallons, of water used by an individual or a building.

Gallons per flush (GPF): The number of gallons of water used per toilet flush.

Gallons per minute (GPM): The rate of flow, in gallons, of water from a plumbing fixture.

Glazing: The transparent material in a window; mostly refers to glass.[38]

Grey water: Also known as gray water; Reusable wastewater from residential, commercial and industrial bathroom sinks, bath tub shower drains, and clothes washing equipment drains.[39]

Groundwater recharge: The hydrologic process in which surface water percolates through the subsurface to groundwater sources below.

Heat recovery ventilation: A mechanism that provides ventilation while recovering the heat carried by exhausted stale air.[40]

Heating degree-days (HDD): The sum of the number of degrees that each day's average temperature is below 65°F. These can be summed for a day, week, month, year, etc. For the purposes of this report, monthly cooling degree-days are used.[41]

Heating Load: The amount of heating required to keep a building at a specific temperature.[42]

Hydropower: Electricity generated by passing water through turbines.

Impaired water: Water that is too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes.[43]

Incandescent light: A traditional form of light that passes electricity through a filament.[44]

Inflatable stops: A type of draft stop that is inserted in a flue then inflated as a semi-permanent measure.

KW: Kilowatt; A standard unit of electrical power equal to one thousand watts.[45] It measures power generation capability or total possible demand.

KWh: Kilowatt Hour; A unit or measure of electricity supply or consumption of 1,000 Watts over the period of one hour. It measures power use.[46]

Light shelf: A passive architectural device consisting of a reflective horizontal shelf that reflects daylight deeper into a building.[47]

Louver: A set of angled slats fixed to a window that allow air or light to penetrate. Louvers can be fixed or movable.[48]

Low-flow fixture: A plumbing fixture designed to use less water than a standard unit.

Lumen depreciation: The numerical representation of how the quality of a light source will decrease over time.[49]

Lumens: The numerical description of the amount of light physically emitted.[50]

Muntins: The strip of wood or metal separating the panes of glass in a window.

MW: Megawatt = 1,000 kilowatts; A measure of power generation capability or total possible demand.

Neap tides: The smallest tidal range; Occurs when the sun and moon's gravitational pulls are in opposition.

Net-zero building: A building where the net of energy drawn from and fed back into the grid equals zero, or is negative.

Nitrate: A chemical compound of nitrogen and oxygen (NO_3) found in nature and in many food items.[51]

Off-peak power: Electricity supplied during periods of low system demand.

Onsite wastewater treatment system (OWTS): A private sewage treatment system composed of a septic tank, distribution box, cesspool(s), and piping connecting these three components.

Passive conditioning: Providing thermal comfort to the occupants of a building by enhancing natural conditions, such as wind or sunlight without resorting to fuel or generated power.

Plug load: The amount of energy drawn by devices from an electrical outlet.[52]

Pressure-relief valve: A component of a water heating system that opens at a designated pressure to prevent rupture.[53]

Quarter round molding: Baseboard molding with a rounded 90° angle.

Radiation loss: Heat lost through a space; the space can contain air or be a vacuum.

Rain garden: An excavated pit filled with a filter bed of planting media including soil, sand, and organic matter that provides temporary storage and treatment of storm water runoff from rooftops and driveways.[54]

Rainwater harvesting: The collection, storage, and direct use of precipitation on or near a residential, agricultural, or commercial site. Popular rainwater harvesting systems employ the collection of rainwater diverted from rooftops in a cistern or rain barrel.

Renewable energy: Energy that comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat.

Reverse osmosis: The process that causes water in a salt solution to move through a semipermeable membrane to the freshwater side; it is accomplished by applying pressure in excess of the natural osmotic pressure to the salt solution.[55]

Rockbed: A heat storage strategy that utilizes rocks to retain heat for radiation at a later time.

Roll insulation: Flexible insulating material placed between building structural members; made from glass or rock wool fibers. Includes the traditional pink insulation rolls.[56]

R-value: The unit measure of thermal resistance (insulating power).[57]

Saltwater incursion: The movement of saline water into fresh water reservoirs.

Seasonal energy efficiency ratio (SEER): The total cooling output provided during normal annual usage divided by the total energy input.[58]

Solar heat gain coefficient (SHGC): SHGC measures how well a window blocks solar heat. SHGC is expressed as a number between 0 and 1. Lower numbers indicate better blocking ability. Limiting solar heat gain is desirable in hot climates, but not in cold ones.

Solar power: Energy that comes indirectly or directly from the sun, and is captured by solar panels, heating pumps and other photovoltaic technologies.

Spring tides: The largest tidal range; occurs when the sun and moon's gravitational pulls are aligned.

Stack effect: The movement of air up through a building driven by buoyancy due to temperature differences.[59]

Stack Loss: Sensible and latent heat contained in combustion gases and vapor emitted to the atmosphere.

Standby heat loss: The heat lost and energy wasted by heating water and storing it in a tank.

Sun space: A room that faces south (in the northern hemisphere), or a small structure attached to the south side of a house, that is designed to collect heat for the main part of a building as well as serve as a secondary living area. [60]

Thermal efficiency: A measure of the efficiency of converting a fuel to energy and useful work;

= (useful work + energy output) ÷ (higher heating value of input) x (100).[61]

Thermal imaging: The use of heat-sensitive equipment to detect thermal (heat) flows.

Thermal mass: A material that stores heat.[62]

Tidal power: The form of hydropower that exploits the bulk motion of the tides.

Transmission: The transfer of electric current from a power plant to a destination.

Trellis: A framework of light wooden or metal bars used to support climbing plants.

Vampire load: The electric power consumed by electronic and electrical appliances while they are switched off.[63]

Visual pollution: Unattractive, man-made elements that negatively impact one's ability to enjoy the vista and/or landscape of which the structure is part.

Waste heat: The heat produced by machines, electrical equipment and industrial processes that is not used in the primary process and is lost.

Wave power: Power that uses the energy in a surface wave.

Weather stripping: A narrow strip of material used to seal the gap around a door or window and slow thermal loss.[64]

Weatherization: The practice of protecting a building and its interior from the elements.[65]

Wind power: The conversion of wind energy to useful energy through devices including turbines.

APPENDIX III SUPPORTING INFORMATION

The following information is intended to supplement certain previously discussed opportunities in water conservation, energy efficiency, and renewable. The section contains information that is intended to further guide implementation of certain opportunities from the report and was referenced in those applicable sections. Additionally, information regarding renewable energy derivatives and renewable energy hedging was included in the case that TNC seeks to offset fossil fuel use with purchased renewable energy or emissions offsets.

Water Conservation: The information contained in the following sections supports implementation of previously discussed water conservation opportunities. Included are explanations and/or guidelines on conducting a water audit, estimating rainwater harvest capacity, rain garden installation, and the process of reverse osmosis desalinization.

WCO 1a: Water Audit

The following is a step-by-step instructional on how to obtain an estimated total water consumption figure (as referenced in **WCO 1**) for the buildings on the Preserve given that water use is not metered at the Preserve.

In order to determine this figure it is necessary to measure the rate of water flow from each faucet, spigot, showerhead, fixture and appliance on the Preserve.

Items required:

- A calculator
- A writing instrument
- A timekeeping device that counts seconds
- A gallon sized container with a liquid measurement scale
- A spreadsheet of all the indoor and outdoor faucets, spigots, and showerheads at the Preserve. An example using the Manor House is provided below. This format can be adapted to each building on the Preserve.

Instructions:

1. To calculate the flow rate for each indoor and outdoor faucet, spigot, and showerhead:

Note: this step must be done separately for each for each indoor and outdoor faucet, spigot, and showerhead at the Preserve.

A. Turn the water on to the normal flow rate used then hold the container under the tap for 10 seconds.

B. Measure the quantity of water in the container.

C. Multiply the measured quantity of water by 6 to calculate the gallons per minute (GPM).

D. Record the figure in the appropriate line of Column I in the spreadsheet.

2. To calculate the volume for each toilet:

Building: Manor House

	Column I	Column II	Column III
Water Source:	GPM: (Measured amount of water x 6)	Min. used/day: or Times used/day:	Total gallons/day: (GPM x Min. used/day) or (GPM x Times used/day)
Kitchen Faucet 1			
Kitchen Faucet 2			
Kitchen Faucet 3			
Dishwasher			
Bathroom Faucet 1			
Bathroom Shower 1			
Bathroom Toilet 1			
Bathroom Faucet 2			
Bathroom Shower 2			
Bathroom Toilet 2			
Bathroom Faucet 3			
Bathroom Shower 3			
Bathroom Toilet 3			
Outdoor Spigot 1			
Outdoor Spigot 2			
Washer Machine			
		Total Gallons/day:	

Note: this step must be done separately for each for each non-composting toilet at the Preserve.

A. Remove the top of the toilet tank and place it on a secure level surface while you work.

B. Mark the water line on the inside of the tank with your writing instrument.

C. Turn off the water supply to the toilet.

D. Flush the toilet.

E. Using the container with a liquid measurement scale, manually fill the toilet tank with water up to the waterline mark, being sure to keep track of the volume required to do so.

F. Record the figure in the appropriate line and column in the spreadsheet.

G. Replace the top of the toilet tank.

H. Turn the water back on to the toilet.

3. If the appliances are relatively new, you may be able to obtain the flow rate data from the manufacturer's website. Otherwise, use of the following averages is suggested:

- Washing machine: 50 gal per use
- Dishwashing machine: 10 gal per use

A. Record the figure in the appropriate line of Column I in the spreadsheet.

Note: If appliances are not used daily, estimate the number of times each is used per week then divide that number by 7 to get a figure for daily use.

4. Determine how many minutes each faucet, spigot, showerhead, and fixture is used each day.

A. Record the figure in the appropriate line of Column II in the spreadsheet.

5. Determine how many times each appliance is used each day.

A. Record the figure in the appropriate line of Column II in the spreadsheet.

6. Multiply the figure in each line of Column I by the figure in the immediately adjacent line of Column II, then record the product in the adjacent line in Column III.

7. Add the figures in the lines of Column III then enter the sum in the final line of Column III.

8. The figure arrived at in step 7 is the total gallons of water used per day for the Building.

9. To get a total gallons of water used per day for all the buildings on the Preserve, follow this procedure for each building then add the total for each building.

Note: The contents of the Source column will need to be modified to reflect the presence of each type of source as well as the actual number sources in each building.

WCO 5: Estimated Rainwater Harvest Capacity

The chart below gives a rough estimation of expected rainwater harvesting potential (as discussed in WCO 5) at the Manor House compared to estimated average monthly toilet flushing requirements. Average occupancy rates were calculated from information supplied by Preserve staff, and average rainfall figures are taken from calendar year 2011.[66] Calculations assume the presence of four downspouts and associated rain barrels. Although there are deficits in three months, storage capacity should be able to make up the difference, as there is an estimated annual surplus of more than 16,000 gallons. Although these calculations are rough, it is clear that Mashomack can reasonably expect captured rainwater to supply toilet flushing requirements throughout most of the year, with plenty of water remaining for watering outdoor plants, etc.

Estimated Rainwater Harvest Capacity

	Average Number of Full-time Staff	flushes per day	Average Number of Day Visitors	flushes per day	Average Number of Overnight Visitors	flushes per day	GPD (at 1.28gpf)	Days per month	Gallons per month	Avg monthly rainfall	Monthly harvest capacity (in gallons), based on an estimated roof area of 2400 sf	Difference (in gallons per month)
January	8	3	13	2	12	5	140	31	4354	4	6060	1706
February	8	3	2	2	1	5	42	28	1183	4	5715	4532
March	8	3	8	2	3	5	71	31	2196	5	7605	5409
April	8	3	17	2	15	5	167	30	5012	5	6780	1768
May	9	3	70	2	15	5	312	31	9676	4	5685	-3991
June	10	3	15	2	9	5	132	30	3966	4	6210	2244
July	11	3	38	2	10	5	202	31	6250	3	5175	-1075
August	10	3	16	2	6	5	113	31	3517	4	6030	2513
September	8	3	13	2	15	5	157	30	4718	5	6900	2182
October	9	3	18	2	10	5	144	31	4469	4	6150	1681
November	7	3	22	2	16	5	183	30	5493	4	6555	1062
December	8	3	85	2	3	5	269	31	8325	4	6555	-1770
											Total surplus	16260

WCO 6: Rain Garden Installation

The following information includes guidelines on the proper sizing and construction of a rain garden (as discussed in WCO 6). The size of the garden should be 20% of the size of the roof,[67] and the following steps should be taken prior to installing a rain garden:[68]

1. Conduct a soil test to ensure the proposed site does not contain heavy clay soils.

2. Conduct an infiltration test to ensure water infiltrates at a rate of at least one inch per half hour.

3. Ensure that at its shallowest, the water table is at least 2 feet from the surface.

4. Ensure that the slope at the site of the garden is not more than 12%.

5. Ensure that the site is at least 10 feet from the building.

6. Ensure that the site should not be over any utilities.

7. Ensure that the site is not over or near a septic tank, drain-field, or wellhead.

8. Ensure the site does not negatively affect any nearby trees due to wet soil conditions.

For more information on how to install a rain garden, the University of Connecticut offers two-day residential rain garden training sessions.[69] Additionally, Robert Alvey of the USEPA, suggests contacting the Long Island Plant Institute in Riverhead for a list of suggested native plants.[70]

WCO 7: Decommissioning a Well

The following steps must be undertaken in order to properly decommission a well as discussed in WCO 7:

1. Contact the municipal authorities at the NYSDEC Region 1, #631-444-0405.

2. Send a written account of decommissioning operations to the Bureau of Water Resource Management. The account should include the original well log and/or construction record, type and volume of grout material used, and grout placement method.

3. Remove obstructions that may interfere with sealing the well (i.e., equipment, materials, debris).

4. Disinfect the well with calcium hypochlorite products (these do not contain fungicides, algaecides, or other disinfectants).

5. The decommission procedures for the well casing depend on the type of casing. An open annular space must be either grouted in place or removed. For a collapsing formation, grout is pumped through a tremie pump to ensure the bottom of the well is filled. When a casing is grouted in place, it is cut off at least 24 inches below grade. Wells located in buildings are grouted then filled to the floor level with at least 12 inches of cement. Casing in a wells ending in a well pit are cut off not less than 12 inches below the grade established when the pit is filled. After grouting, steel casing are sealed with welded steel plate; PVC casings with a PVC cap.

6. Fill the well screen with clean sand or gravel.

7. Grout the well using one of the following: slurry mixture and pumping (neat cement slurry or concrete slurry), cement slurry, or coarse grade or pelletized bentonite.

8. For flowing wells, test the casing seal for any leakage prior to decommissioning. The casing exterior must be sealed before the well is decommissioned.

9. Restore the well site to its original condition before the decommissioning process began.

WCO 9 Reverse Osmosis Desalinization

The following information furthers explains the process of reverse osmosis desalinization as discussed in WCO 9.

To turn brackish water into fresh water, a multi-vane windmill is installed on a tower to power a two-stage pumping device. During the first stage, the windmill drives a piston pump that raises the pressure of the feed water. The water is then stored in a tank until it reaches a certain pre-set level, which initiates the start of the second stage. At this point the pressure is raised again, readying it for the final step of reverse osmosis. During the third stage, the brackish water is filtered through a semi-permeable membrane. One side of the membrane retains the salt and other impurities, while the opposite end yields potable water.

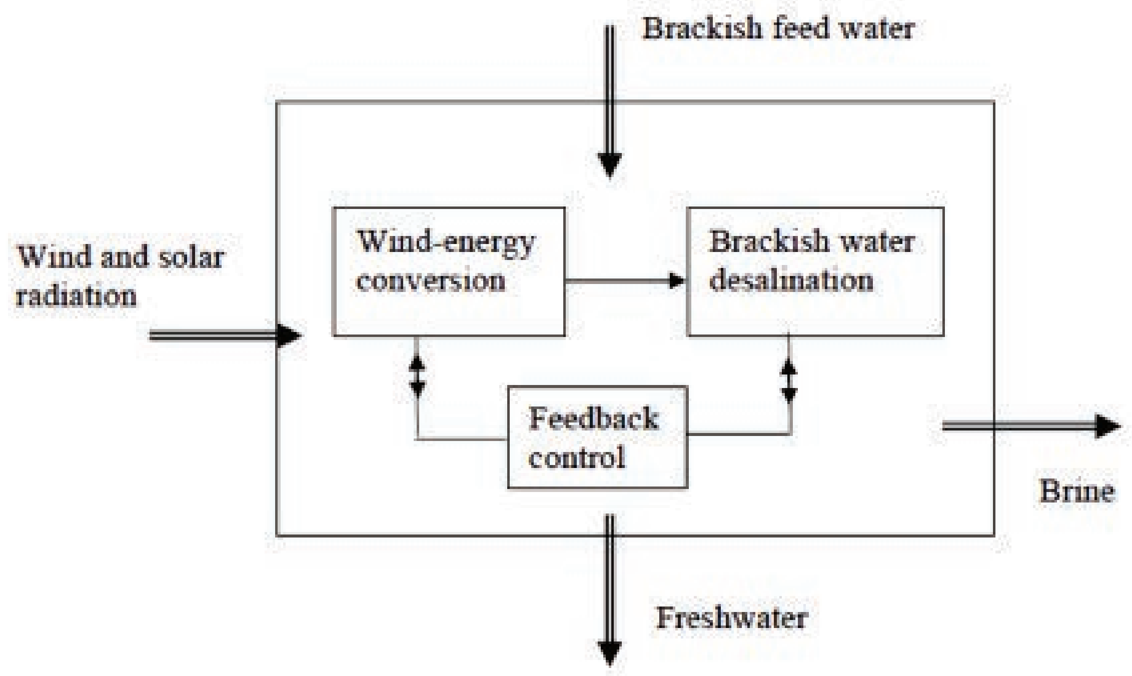

Figure 47 - Basic diagram of wind-driven reverse osmosis desalination[71]

ENERGY EFFICIENCY

The information contained in the following sections supports implementation of previously discussed energy efficiency opportunities. Included is additional technical information including explanations and/or guidelines on sealing a building envelope, protecting the basement and attic from infiltration, and lighting automation.

EEO 3: Seal the envelope

The following information provides additional technical information on sealing the building envelope from EEO 3. The information discusses particular areas of focus when implementing the opportunities and best practices where applicable.

Utility Penetrations in Walls:

Foam gaskets can be installed behind the wall plates of any electrical outlets on exterior walls.[72] Also, all utility lines coming in and out of the building (i.e., water, oil, and electric lines) in the basement can be caulked. In general, the use of zero and low-volatile organic compound (VOC) paints and caulks should be prioritized (VOCs are identified by the EPA as having a variety of negative health effects.[73] However, the growing market for green products means quality substitutes for high-VOC products are available, frequently at comparable prices).[74]

Building Apertures:

With doors, the least expensive investment is weather-stripping around the frame. Similarly, a sweep can be added underneath the bottom rail to block air. More expensive would be to install wooden storm doors that are consistent with the Manor House's historical character.[75] Fireplaces are another building opening, and nonfunctioning fire places should have draft stops installed if dampers do not exist. This is especially important, considering chimneys are designed to create drafts and draw air out of a building. Inflatable stops make for a smooth installation.[76]

Building Transition Points:

At these junctures the primary concern of the original builder was frequently structural integrity, not continuity of protection from the exterior elements. Consequently, interior and exterior features like lathe, sheetrock, and shingles may not be fully joined. Professional energy audits with infrared scans can assist in locating these gaps. For example, installing quarter round molding over a gap between the baseboard and floor would seal the space. Adding batt insulation into the crevice would further prevent infiltration. In general, a water-based latex caulk can be used to seal thin, interior gaps.[77,78] Note that visible, finished areas may have to be painted after caulk application or molding installation.

Exterior Surfaces:

Use caulk for linear gaps such as under a window sill or where shingles meet trim. The quality of caulk makes a difference. Hybrid modified-silicone polymers provide the best sealant and durability for exterior jobs.[79]

EEO 4: Protect basement and attic

The following information provides additional technical information on protecting the Manor House basement and attic from EEO 4. The information discusses keys considerations when implementing the opportunities and best practices where applicable.

Basement

When planning basement insulation, the initial concern is whether to consider it as a "conditioned" space. Unless a basement is residentially occupied residentially or used as an office, insulating the floors and foundation is unnecessary. However, if the walls and floor are included, seal the cracks in the foundation. The foundation walls can be insulated with foam. A filter fabric sheet can be applied first to make foam removal more feasible in the future.[80]

Figure 48 - Basement Wall – Spray Foam

Regardless of the basement's use, both the sill area and the basement ceiling should be insulated. The juncture between the foundation and sill plate is a major air/heat/vapor infiltration threat. It is recommended fiberglass batting or foam board be tightly fitted into the box sills. A more aggressive strategy is to insert cut polystyrene boards in between joists then spray foam over it to make sure all the seams are sealed.

Figure 49 - Basement Sill – Spray Foam

Attic

As in the basement, the first question is where to place attic insulation. One inspected attic space in the Manor House had roll insulation layered between the joists along the top of a bedroom ceiling. Considering the attic spaces are not used for habitation, this placement strategy is a good one to continue. It is recommended the total R-value - whether foam or roll - be equal to R-38.

Figure 50 - Attic Sealing of Gap in Eaves

EEO 15: Upgrade indoor lighting

The following information provides additional technical information to assist with planning for upgrading the Manor House indoor lighting as discussed in EEO 15. The information provides keys definitions and terms to know in order to best design and select a proper lighting scheme.

1. Lamp Lumens: Lamp lumens are a numerical description of the amount of light physically emitted from a light source. This definition is not to be confused with fixture lumens, which are for the total lumens for all lamps within the fixture and is affected by the ballast factor (defined below). This measurement is just for a single light source.

2. Ballast Factor: This factor is a multiplier provided by the manufacturer of a light source. It represents the percentage of total lumens a particular lamp and ballast combination will provide.

3. Lumen Depreciation: Lights do not remain the same color and quality over their life. Lumen depreciation provides a numerical representation of how the quality of a light source will decrease over time.

4. Color-Rendering Index: This is a scale from 0 to 100 that describes how accurately a light source renders color. This measurement is subjective, but tends to have a consistent scale across light sources. LEDs tend to have the most variability in the subjective judgment of their true color.

These definitions, however, are related and need to be considered along with input watts when selecting an energy efficient light fixture. For example, a low ballast factor equals low energy use (input watts), but also low light output (lumens). The last critical factor to consider when selecting lights is the life of the lamp. It is important to keep in mind that an newer lamp option will provide a significantly longer life, changing from 20,000 hours to 35,000 hours, and some as high as 60,000 hours – especially when LED options are considered.[81]

EEO 16: Evaluate Light Automation

The following lighting control analysis recommendation provides additional technical information to assist with upgrading the Manor House indoor lighting control system as discussed in EEO 16.

In order to ensure that the maximum utility is gained from the implementation of occupancy controls and sensors, it is also recommended that Mashomack use an engineer to perform a lighting control analysis to determine the best type of sensor application based upon usage levels and lighting needs. It is important to do this analysis because, while there is a benefit to these types of controls, the wrong installation will actually increase energy use. For example, when a space is wired with daylight controls, if the space is unoccupied and the photosensor does not read the right light levels, the controls will turn the electric lights to full output, and no energy savings will be realized. Therefore, it is important to understand whether this condition could exist in a facility (among many other similar circumstances) to determine the best application for lighting controls.[82]

RENEWABLE ENERGY

The information contained in the following sections supports previously discussed renewable energy opportunities. Included is justification as to why hydropower and wave power were initially deemed unsuitable for exploration on Mashomack and an alternative way to use renewable energy at the Preserve without installing any generation.

Consideration of Hydro- and Wavepower

Hydropower, where electricity is generated by passing water through large turbines, is the most established technology and accounts for roughly 20% of global electricity production, making it by far one of the largest renewable energy sources to date.

Wave power, on the other hand, is a largely untapped resource with enormous potential: the energy in a surface wave is proportional to the square of the amplitude, and typical ocean waves transport 30 – 70 kW of power per meter width of wave-front. The challenge in the development of wave technology lies in engineers' ability to design a device capable of withstanding turbulent sea conditions. Furthermore, wave technology requires excellent wind conditions in order to create waves whose movement initiates the vertical displacement necessary to generate power.

In all cases, the opportunities and challenges of power generation are a factor of the conditions at the site (water velocity, depth and occupancy) and the ability of the technology to effectively generate, harness and transfer power in a variety of weather and climate conditions.[83]

After careful review of the water bodies surrounding the Mashomack Preserve, it became evident that hydropower and wave power were not suitable for this application. The reason for this is that hydropower requires a barrage/dam and this would hamper traffic on the water. Mashomack staff confirmed that commercial fishing takes place in the waters around the Preserve during the summer months in addition to a lot of recreational activity. Barrage/dam infrastructure would block all of this. The dam would also affect the ability of marine life to circulate freely, and this would be a major environmental issue. Wave power, on the other hand, requires absolutely perfect wind conditions, which are not available on the Preserve. Furthermore, wave energy devices sit on the surface of the water and so they are visible and could pose an obstruction to boat traffic.

Renewable Derivatives and a Renewable Hedging Processes

The common understanding of renewable energy use involves on-site installation of generating capacity such as PV panels or a wind turbine. However an alternative to on-site generation exists in the form of purchasing derivatives on the energy market. Even when on-site generation exists, this method allows offsets to correct for the emissions that cannot be physically removed from the Preserve. Should this be desired, it is recommended Mashomack pursue direct purchase of renewable electricity through the Green Choice Program through LIPA or the Long Island Choice Program.

Mashomack has two approaches to add more renewable energy sources within its energy portfolio. One approach is offsetting the purchase of traditional electricity through purchasing renewable energy credits. Another approach is purchasing renewable energy directly from LIPA. There are two distribution processes for how electricity reaches Mashomack's door. The first portion is through the commodity or supply side. This is the physical generation of the electricity at the plant, regardless of generation process, and delivery to what is called the "city gate" or to the transmission and distribution lines within the power company's property, in this case, Long Island. The second is through the transmission and distribution side, which is where LIPA, transmits electricity at the "city gate" to Mashomack's buildings. LIPA restricts Mashomack's options during the purchasing process for energy. The loads are smaller and therefore limit purchasing capability, which is the reason for the two approaches presented below, are the best option for Mashomack and can be explored directly with LIPA.

The first option, which is an off-set through renewable energy credits, is a purchase that can be done directly through companies that are Green-e certified. Green-e is the nation's leading independent consumer protection program for the sale of renewable energy and greenhouse gas reductions in the retail market. In this case, Mashomack would not directly purchase electricity, but rather receive credits to off-set the emissions they produce through their grid-supplied electricity.[84] While the Green-e website[85] has a list of renewable energy providers, LIPA also has a program called the Green Choice Program that allows customers to purchase offsets to make support renewable production and off-set their emissions.

The Green Choice program provides information and assistance to Long Islanders on how they can become Green Power purchasers and help in the advancement of Green Power Resource development. While LIPA continues to grow their own renewable generation, this program allows customers to purchase these offsets. The environmental benefit of a buying from these Green Power Marketers that supply these off-sets is determined by the amount of polluting emissions that a green power source displaces or avoids. Mashomack does not purchase the electricity directly through this program, but rather offset, and therefore the green attributes of that electricity. A green attribute is the value of the environmental benefit that a Green Power plant creates. It is the credit that comes from producing renewable electricity.[86]

Mashomack could alternatively elect to directly the purchase the renewable energy from a generator. The best option for pursing this path is through LIPA's Long Island Choice Program. This program provides customers with the option to purchase their electric supply directly from energy service companies (ESCO) other than LIPA. In this scenario, Mashomack could choose a renewable energy provider as its energy service provider.[87] LIPA does have particular licensed ESCOs that they must use, however, there are renewable generators within this list. The residential authorized provider is People's Power and Gas, who can help Mashomack select from a renewable generator for their supply. This process allows Mashomack to directly purchase renewable energy.[88]

Mashomack may consider these options because they work to offset the remaining emissions from electricity on-site after energy efficiency efforts have been made. These are the best options to pursue to eliminate carbon emissions. Furthermore, the renewable energy credits available through a green-e company can be purchased to offset the emissions of any type of fuel, including oil.

There are some key disadvantages from these options, however. The primary recommendation for reducing Mashomack's carbon footprint is from energy efficiency and on-site renewable generation. Why pay another organization to produce clean electricity to offset the dirty fuels being burned on-site? This option should only be considered after the other recommendations have been implemented. The second disadvantage is that LIPA currently offers reasonable electric rates with a relatively robust renewable component. Pricing through an ESCO may not be competitive compared to LIPA's rate; additionally, the renewable energy credits are an extra cost on top of what Mashomack is currently paying for electricity.

Renewable energy credits currently sell on the market at $0.005/kWh to $0.012/kWh.[89] This cost would be in addition to the current LIPA rate paid for electricity.

APPENDIX IV
SUMMARY OF COSTS & PRIORITIES

The tables on the following pages include tables summarizing all of the opportunities within the three strategy areas and provide their costs along with their level of prioritization.

Key:
TE = time and effort All prices are estimates and on a per unit basis
Priority Levels:
1 - As soon as possible. 2 - Complete as funding is available and time permits. 3 - Can be delayed without significant negative impact until funding and/or TE becomes available.

Figure 52 -Summary of costs and prioritization for water conservation and wastewater management

	WATER CONSERVATION OPPORTUNITIES	Priority & Estimated Cost		
		1	**2**	**3**
I	**Measure and document the volume of water used at the facility.**			
WCO 1a	Conduct a water audit at all of the buildings in which water is used on the Preserve.	TE		
WCO 1b	Install water meters throughout the facilities on the Preserve and begin monitoring and tracking water use.		TE, $60 + Labor	
II	**Adopt and institute water conservation behaviors for all facilities on the Preserve.**			
WCO 2	Institute the recommended list of behaviorally based water conservation practices.	TE		
III	**Install low-flow fixtures and low-use appliances at all facilities.**			
WCO 3a	Replace standard toilets with low-flow, dual-flush toilets.	$200 to $350		
WCO 3b	Make use of low-flow fixtures and faucet aerators.	$5 to $30		
WCO 3c	Eliminate sprinkler use in favor of a soaker hose or drip irrigation system and hand watering.	$20		
IV	**BMPs that contractors must adhere to during construction.**			
WCO 4a	Institute the recommended list of Anti-Pollution/Waste Management and Anti-Erosion BMPs.	TE		
WCO 4b	Conduct a tour of the Preserve for the contractors and laborers.	TE		
V	**Investigate means of capturing and using rainwater for toilets and non-potable water needs.**			
WCO 5a	Implement rainwater collection and storage capability on site.	$200 to 10,000		
WCO 5b	Use captured stormwater to supply toilet fixtures.	TE		
WCO 5c	Use captured stormwater to meet garden and landscaping irrigation needs.	TE		
VI	**Ensure storm water not captured for re-use is managed for optimal groundwater re-uptake.**			
WCO 6	Install a rain garden(s)			$300
VII	**Ensure all unused wells have been properly abandoned.**			
WCO 7	Decommission all unused wells per DEC recommendations		$300 to $1,500	
VIII	**Determine the adequacy of the water treatment technology in place.**			
WCO 8	Have the Preserve's well-water tested annually	$25 to $300		
IX	**Consider desalination options to prepare for the possibility of water scarcity.**			
WCO 9	Wind-driven reverse osmosis desalination			$5.40/1000 gal.
	WASTEWATER MANAGEMENT			
I	**Modify or replace the existing OWTS in order to reduce nitrate emissions.**			
WMO 1a	Have the soil surrounding the OWTS tested for nitrate emissions	$1,500		
WMO 1b	Have the OWTS serviced as may be necessary		>$1,000	
WMO 1c	Install a Nitrex System			$160,000

Figure 53 -Summary of costs and prioritization for energy efficiency

ENERGY EFFICIENCY OPPORTUNITIES		Priority & Estimated Cost		
		1	2	3
I	**Efficiency Evaluation**			
EEO 1	Perform an EnergyStar Benchmarking	TE		
EEO 2	Perform a Blower Door State	TE		
II	**Weatherization**			
EEO 3	Seal the Envelope	High $100's to mid $1000's		
EEO 4	Protect Basement and Attic	$12,000		
EEO 5	Sash windows	$50 - $300/window		
EEO 6	Storm windows		$35-$400/window	
III	**Passive Conditioning**			
EEO 7	Create Window Shading through Shutters		$200-$250/pair	
EEO 8	Implement Natural Shading through Plantings	Dependent upon Consult		
EEO 9	Install Outdoor Entryway Plantings		$45/sq ft	
EEO 10	Use Natural Wind Breaks		Dependent upon Consult	
EEO 11	Utilize Sun Space		Indeterminate	
EEO 12	Exploit the Stack Effect for Passive Cooling	No Cost		
IV	**Fuel-Based Efficiency**			
EEO 13A	Implement Boiler Upgrades		$1,000	
EEO 13B	Forego Boiler Upgrades and Replace Existing Boiler		$13,000 - $350,000	
EEO 13C	Explore Supplemental Heating Upgrades			$200/unit
EEO 14	Upgrade Hot Water Heater Insulation and Controls	$500		
V	**Electric Efficiency**			
EEO 15	Upgrade Indoor Lighting	$5,000 - $20,000		
EEO 16	Evaluate Lighting Automation			$30-$150/unit
EEO 17	Utilize Natural Light Shelves	$100/unit		
EEO 18	Evaluate Mechanical Air Conditioning			$5,000 - $38,000
EEO 19	Replace or Remove Walk-in Refrigerator	$1895/month - $2995/month		
VI	**Best Practices**			
EEO 20	Control Plug Load and Computing	$0-$35/unit		

Figure 54-Summary of costs and prioritization for renewable energy

RENEWABLE ENERGY OPPORTUNITIES		Priority & Est. Cost		
		1	2	3
I	**Renewable Energy Technology**			
REO 1	Solar Thermal Hot Water Generation	$45,000		
REO 2	Wind and Solar-powered Outdoor Lighting		$10,000/unit	
REO 3	Solar Electric Energy		$25,000 to $32,000	
REO 4	Woody Biomass Energy			$10,000 +
REO 5	Small Wind Turbine Energy			$3,000 to $5,000/installation
REO 6	Tidal Power Energy			indeterminate

APPENDIX V
GREEN CLEANING BEST PRACTICES

The primary function of the buildings at Mashomack is to host visitors as previously discussed. These visitors come for many reasons and have different lengths of stay, but what is constant is a need for a clean environment in the buildings which house them. Accordingly, the following best practices are included to help TNC provide and maintain the best and cleanest environment for visitors to stay in and enjoy their experience at the Mashomack Preserve. The best practices and recommendations are derived from New York State's Green Cleaning Best Practices.[90]

Green Cleaning Program

- Consider using the American Society for Testing and Materials' (ASTM) Standard Guide on Stewardship for Cleaning Commercial and Institutional Buildings for direction when starting a green cleaning program.
- Develop a Green Cleaning Program that involves all stakeholder groups by building a team; performing a baseline facility assessment; producing a written program based on goals and objectives; implementing the program; and evaluating its effectiveness over time.
- Cultivate a philosophy of practice that uses less-toxic products and invests in high-performance cleaning equipment.
- Set a goal to create high-performance green cleaning processes and systems.
- Provide a procedure for keeping critical staff current on new methods, products and equipment.
- Establish methods to assess the impact of the Green Cleaning Program by using quantifiable results such as measuring changes in absenteeism or nurse office visits; and qualitative results like satisfaction surveys from staff.
- Provide a means for building occupants to report feedback on the Green Cleaning Program to the Green Cleaning Team.

Green Cleaning Program, Plans, Procedures, and Policies

Plans

- Create a stewardship plan that codifies the Preserve's green cleaning goals, policies, and stakeholder roles and responsibilities.
- Create a green cleaning plan that sets cleaning frequency based on traffic level and impact areas. The plan should balance the workload by creating a maintenance schedule that meets

the goals of the Green Cleaning Program. Frequent, thorough, and routinely scheduled maintenance is the most efficient and effective method for facility maintenance.

- Include in the cleaning plan the following:
  - A summary of cleaning tasks with chemical products used for each.
  - Cleaning procedures that provide step-by-step guidelines for each task, including estimated times for completion, required products, safe handling of chemicals and equipment, and training requirements.
  - Cleaning schedules that identify the frequency (e.g. daily, weekly, monthly) of each task, as well as a timetable for inspection.
- Create a communication plan that establishes:
  - Approaches for introducing the Green Cleaning Program that stress improvements to air quality, set appropriate expectations for the program, and explain the changes required to reach program goals.
  - Protocols for communicating non-routine cleaning activities, such as stripping and finishing floors, that may impact occupant activities.
  - Procedures for notifying stakeholders of progress.
  - Processes of communication with outside vendors regarding the Green Cleaning Program.
  - Ways for building occupants and custodial staff to communicate feedback.

Procedures and Policies

- Institute a campus-wide policy for disinfectant use.
- Establish handling procedures for chemicals and equipment used in the green cleaning process.
- Develop cleaning procedures for each task that reduce cross-contamination between areas.
- Consult manufacturers for recommendations on product use. All products should be used following instructions or precautions provided by the manufacturer. Carefully follow the instructions for diluting the product before use. Using more product than recommended can result in damage to surfaces being cleaned and/or will produce a residue. Germicides must be left on the surface for the time specified on the product label for it to be effective. Carefully follow mixing precautions. Some products can produce hazardous gases if they are mixed with other products.
- Consider the impact and Life Cycle Costs (LCC) of maintenance in choosing floor products.
- The use of walk off mats, as noted above will also help with limiting dirt, dust and grime

carried into the building and onto floor coverings, thereby helping with maintenance of all types of flooring.

- Stress green cleaning before using disinfectants or germicides; use these only if necessary.
- Incorporate the use of cold water instead of hot water for cleaning tasks. The products listed on the OGS Green Cleaning Product List and certified under Green Seal, Inc. are designed to work with cold water.
- Identify key high-risk areas and address them separately from general cleaning procedures. High-risk areas include places regulated by the state or that collect moisture, and bathroom knobs, drinking fountains, and other touch-points.
- Establish a policy for non-custodial staff regarding the use of personal cleaning products. Prohibit the use of products brought from home and provide teachers and staff with the school's general green cleaning products.
- Establish a policy for eating in offices and classrooms to reduce the frequency of spills or other instances of contamination.
- Establish a policy for reporting spills. Early notification of spills results in better cleaning outcomes and reduces the need for more extreme cleaning measures.

Training

- Establish training requirements for custodial staff on the proper use and handling of chemicals, operation and maintenance of high-performance cleaning equipment, and all cleaning procedures and policies, including proper restroom cleaning and elimination of cross-contamination.
- OGS developed a series of on-line green cleaning training courses. The purpose of this curriculum is to encourage learning about green cleaning. Therefore, while pretests and posttests have been included, and a Certificate of Completion can be printed, the main focus is on learning. As such, supervisors are encouraged to consider the best method to offer this training to their employees. It can be provided so that staff take each course individually and work through the material by themselves, or a supervisor could meet with staff as a group and review the slides and take the pretests and posttests together. You are in the best position to determine how to utilize this information to most effectively meet your needs.
- Integrate the proper use of disinfectants, sanitizers, or other special cleaning products into the training as required by health, education, labor, and environmental regulations.
- Offer faculty and administrative staff training on the proper use of the Preserve's general green cleaning products.

Preventative Measures

- Remove dirt/debris from the sidewalks and parking lots outside all entranceways. If unable to remove dirt or debris, redirect pedestrian traffic by roping off affected areas.

- Assess vegetation around entrances and remove any that contribute to debris entering the building. Replace with low maintenance vegetation that does not have berries, flowers, or leaves.

- Focus cleaning in high-traffic areas, usually within 30 to 50 feet around an entrance.

- Investigate areas with high humidity and determine corrective actions to reduce levels; high humidity is a major factor for mold growth. Consider using dehumidifiers in humid areas of the school where other alternative actions cannot be taken.

- Provide adequate ventilation in all work areas.

- Voluntarily investigate the procurement and use of green sanitary paper products:

  Paper Towels - Singlefold & Multifold (Group 23400, Award 21629): http://www.ogs.state.ny.us/purchase/spg/awards/2340021629CAN.HTM

1. Jumbo Roll Toilet Tissue (Group 23500, Award 21040): Product is 100% recycled including a minimum of 20% post consumer recycled content, processed chlorine free (PCF) and Environmental Choice Certified. http://www.ogs.state.ny.us/purchase/spg/awards/2350021040CAN.HTM

2. Link is to the Industrial and Commercial Supplies contract, which offers many different types of paper towel (rolls and sheets) and toilet tissue products. http://www.ogs.state.ny.us/purchase/spg/awards/3900020304CAN.HTM

Some cost savings and waste reduction suggestions related to the procurement and use of sanitary paper products.

- Consider replacing single roll tissue dispenser with a dispenser that can hold multiple rolls. This will reduce the number of small rolls that get thrown away because the tissue would run-out before they were to be changed the following day or cleaning shift.

- Consider replacing multi-fold towel dispensers with large rolls dispensed from a touch-free dispenser to reduce not only paper consumption, but possible cross-contamination (the passing of potentially harmful organisms) from touching levers and cranks.

- Consider utilizing paper products that eliminate cores and wrappers that must be discarded.

- Consider utilizing paper that uses a case configuration to allow more to be shipped on a truck, thus reducing transportation impacts.

These simple strategies have been found to, among other things: reduce sanitary paper product consumption between 10 and 15 percent, which can be a good strategy to help offset any potential increase in cost for recycled paper.

General Cleaning Equipment

- Always follow the manufacturer's recommendations for using cleaning equipment.
- Use high-performance cleaning equipment with low environmental impact. High-performance equipment is an important component of green cleaning because these tools, such as high-efficiency particulate air (HEPA) filtration vacuum cleaners, microfiber mops and cloths, multilevel walk-off mats, and two-chamber mop buckets, are designed to trap and remove dirt and soil more effectively than traditional products, thus reducing the amount of additional chemicals required for cleaning.
- Purchase cleaning equipment based on durability, energy efficiency, effectiveness, and quietness, not cost.
- Establish an equipment maintenance program to ensure equipment operates at peak performance.
- Equipment powered by batteries should be fitted with environmentally friendly gel batteries.
- Start a program that evaluates and investigates new cleaning technologies.

Vacuum Equipment

- Vacuums should have high airflow or suction along with HEPA filtration capable of capturing 96% of particulates 0.3 microns in size.
- Vacuums should have the Carpet and Rug Institute (CRI) Green Label or Seal of Approval/ Green Label certification.
- For help choosing the right vacuum for your facility, consult the list of OGS-approved vacuum cleaners on the OGS Green Cleaning Product List.
- Maintain vacuum cleaners and filters regularly.

Microfiber Cleaning Products

- Use microfiber cloths and mops, which are statically charged. The static electricity attracts dirt, pet hair, dust, and micro particles and reduces chemical and water use. They also clean more effectively and are less work-intensive than conventional mops, virtually eliminating cross-contamination during janitorial tasks.
- With proper use, microfiber cloths and mops can be laundered and reused more than 100 times.

Matting Systems

- Establish outdoor and indoor walk-off mats at all facility entrances.

- Rotate out mats once every other week, or twice a week, depending on weather conditions when entrances are subjected to high moisture and heavy traffic.

- Establish a routine cleaning and maintenance program for entrances and other carpeted areas.

Chemicals

- Use cleaning products approved for use by OGS and listed on the OGS Green Cleaning Product List.

- Purchase universal mounting dispersing/proportioning systems. This type of system allows for the testing of various green cleaning products without the expense of purchasing proprietary systems for each one. OGS recommends that facilities purchase only cleaning products with generic tops because universal dispensing/proportioning system only accepts such containers.

- Consider using cold water cleaning solutions. The products listed on the OGS Green Cleaning Product List and certified under Green Seal, Inc. are designed to work with cold water. Benefits to using cold water instead of hot water cleaning solutions are:

- Undertake a pilot program to test the effectiveness of approved green cleaning products under various conditions, including cold/hot water cleaning. This will help determine the pros and cons of the products before committing to one.

- Minimize the amount of product used by following the manufacturer's recommended dilutions. This can eliminate product waste and reduce residual cleaner on surfaces. Oftentimes, user dissatisfaction of cleaning products is a direct result of improper dilution.

- Use products that leave no residue and do not require a rinsing step when properly diluted.

- Minimize, to the extent possible, chemical products that leave a scent. Some chemicals used in fragrance formulations can be irritating to the eyes and airways. Some people with hyper-responsive airways or skin allergies experience asthma symptoms in response to inhalation or eye exposure to fragrances and related chemicals or to the perception of odor. Therefore, to the extent feasible, reduce the use of cleaning products that leave a scent in the room. One way to accomplish this is to avoid using products that have a fragrance added to create a scent.

- The OGS Green Cleaning Product List identifies which products contain and do not contain fragrances. If odors persist after cleaning, make adjustments to the cleaning frequency and methodology. An assessment may determine a physical problem with the area experiencing the odor, such as blocked trap drains or dry drain traps.

- Create a chemical inventory system to track the types and quantities of chemicals in the building. This inventory should record storage locations, purchase dates, costs; material safety data sheets (MSDS), product expiration dates, and usage of each chemical. An inventory system reduces chemical waste by rotating chemicals based on expiration, and aids in managing inventory. A chemical inventory system is also helpful in documenting the purchase of sustainable cleaning products under the LEED-EB IEQ.

- Provide administrative staff with voluntary access to labeled spray bottles that contain the building's general green cleaning products. This will help prevent potential problems that can develop when cleaning products are brought from home and/or used in combination with other facility cleaning products. The mixing of unauthorized products and chemicals can lead to unsafe and unhealthy environments. Mashomack should offer prerequisite training to administrative staff on the proper use and handling of green cleaning products before allowing their use.

Food Area/Kitchen Cleaning

Equipment

- Use color-coded microfiber products for different cleaning tasks in the kitchen to reduce cross contamination.
- Investigate the uses of "No Touch" cleaning systems to clean kitchen counters and other hard surfaces.

Chemicals

- Use only cleaning products approved for use by OGS and listed on the OGS Green Cleaning Product List.
- Use disinfectants, only when necessary, that are registered with the New York State Department of Environmental Conservation. **http://www.dec.ny.gov/chemical/8528.html**
- Follow the manufacturer's recommended dilutions to eliminate product waste and reduce residual cleaner on surfaces.

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