

## **6. Climate Change / Greenhouse Gas Evaluation for Preferred Alternative**

### **6.1. Climate Change – Adaptation and Resiliency**

The Town of Falmouth is a coastal community with over 70 miles of shoreline and a large percentage of land area at a low elevation, making it particularly vulnerable to coastal flooding from storm surges, coastal erosion, and future sea level rise.

The MA Climate Resilience Design Standards Tool (MA Resilience Design Tool) prepared by the Resilient Massachusetts Action Team (RMAT) was used to evaluate climate risks and assist in climate resilience strategies for the Preferred Alternative. The Climate Resilience Design Standards Tool Project Report developed for this project is included in Appendix 6-2. The planning horizon recommended by the MA Resilience Design Tool for this project is 2070.

The following design strategies will be implemented to increase the coastal resilience of vulnerable infrastructure:

- Consider alternative locations for any proposed infrastructure within the planning horizon floodplain.
- For infrastructure that needs to be located within the planning horizon floodplain, establish a design flood elevation which incorporates FEMA flood elevations, industry freeboard requirements, and allowances for anticipated sea level rise through the end of the project planning horizon.
- Install watertight hatches and watertight manhole covers on infrastructure within the planning horizon floodplain to minimize pumping floodwater (minimize potential impacts to wastewater infrastructure capacity).

### **6.2. Base Case and Preferred Alternative Greenhouse Gas Evaluation**

A Base Case and Preferred Alternative greenhouse gas (GHG) evaluation was conducted using the United States Environmental Protection Agency's (USEPA) Portfolio Manager. The EPA Portfolio is an online tool designed to assess energy and water consumption at a facility. The tool provides a benchmark score which compares the performance of the facility analyzed with similar facilities. The tool calculates anticipated GHG emissions for the facility based on the data entered. The GHG analysis is included in the 'Falmouth WWTF Fiscal Sustainability Plan Including a Plant Evaluation and Condition Assessment – Final Report' prepared by GHD and dated December 2020 (attached Appendix 4.1).

For a municipal wastewater treatment plant, the following inputs are used to determine energy consumption at a facility:

- Zip code
- Average influent flow
- Average influent biological oxygen demand (BOD5)
- Average effluent biological oxygen demand (BOD5)
- Plant design flow rate
- Presence of fixed film trickling filtration process
- Presence of nutrient removal process
- Annual electricity and fuel usage.

The existing Falmouth WWTF (average design flow = 0.71 mgd) was evaluated as the Base Case. The Preferred Alternative evaluated the proposed Falmouth TASA Improvements WWTF Project, which will increase the average

design flow of the facility to 1.21 mgd. The GHG analysis for the Base Case and Preferred Alternative is summarized in Table 6.1 and in the ‘Falmouth Green House Gas Evaluation – Great Pond TWMP’ memo, prepared by GHD and dated October 2022 (Appendix 6-1).

**Table 6.1. Base Case and Preferred Alternative Greenhouse Gas Evaluation**

Energy Star Output Values					
Scenario	Design Average Annual Flow (mgd)	Utility Benchmark Score	Site (kBTU/ft2/year)	Source (kBTU/ft2/year)	CO2 Emissions (kgCO <sub>2</sub> e/ft2/year)
Base Case	0.71	19	180.1	504.2	11.8
Preferred Alternative	1.21	19	241.4	676.0	15.8
Final GHG Output Values (Converted)					
Scenario	Design Average Annual Flow (mgd)	Utility Benchmark Score	Site (kBTU/gpd/year)	Source (kBTU/gpd/year)	CO2 Emissions (short tons/year)
Base Case	0.71	19	5.17	14.49	265.3
Preferred Alternative	1.21	19	4.07	11.40	355.3

## 6.3. Opportunities for On-Site Energy Generation

### 6.2.1. Biogas / Anaerobic Sludge Digestion

An anaerobic digester can be used at wastewater treatment facilities to convert biosolids to biogas. Anaerobic digestion is a sludge reduction technology with several beneficial byproducts, including biogas which can be converted into electricity, heat and a biosolid byproduct.

If a facility has excess capacity in its anaerobic digester, it can also consider co-digestion where additional energy-rich organic waste materials such as fats, oils, grease, and food scraps are added to the existing waste stream in order to increase methane production. The WEF MOP 32 estimates that the biogas produced by the digestion of biosolids is approximately 60% methane. It is also possible to use the methane gas from anaerobic digestion as a hydrogen source to fuel hydrogen fuel cells. The biogas can be used to power boilers, generators, pumps, or blowers. In a combined heat and power (CHP) application the biogas can be used to power an engine or turbine and the waste heat can be recovered to heat the anaerobic digester.

Ideally a plant considering co-digestion should be located in close proximity to an industry or business that is a source of carbon-based waste, however the Falmouth facility is in an isolated area and the town does not have a large industry base that would typically support such a facility. Anaerobic digestion was evaluated in the ‘Falmouth WWTF Fiscal Sustainability Plan Including a Plant Evaluation and Condition Assessment – Final Report’ prepared by GHD and dated December 2020 (attached Appendix 4.1). Due to the high infrastructure costs of anaerobic digestion, it was not recommended that the technology be retained for further evaluation as part of this project.

### 6.2.2. Solar Photovoltaic (PV) Systems

Solar photovoltaic (PV) arrays can be used by facilities with adequate space to produce renewable energy on-site. Arrays can be ground-mounted or roof-mounted depending on the orientation of the facility’s building and available roof space. South facing roofs with minimal shadow interference provide the most ideal conditions for a roof-mounted solar array.

A shade analysis would need to be conducted at a potential site to determine the feasibility of a solar installation. On average, Massachusetts experiences 4.5 sun hours per day of solar energy. This means that over an entire year,

direct sunlight hits an area for an average of 4.5 hours per day. By comparison Phoenix, Arizona experiences 6.4 sun hours per day. For an equivalent amount of power output from a PV panel in Massachusetts, the module area would be designed to be approximately 40% larger than in Phoenix.

The Town conducted an evaluation as part of the Fiscal Sustainability Plan and Plant Evaluation on the feasibility of installing a solar array system at the Falmouth WWTF (at the former location of the Town wind turbines). The former wind turbines site is approximately 16,000 square feet in area and sits at an angle approximately 10 degrees from due south, which is near ideal for the orientation of a solar array. It is estimated that approximately 65% of the available space (10,400 square feet) could be utilized for a solar array installation, which would allow for spacing between rows of solar panels to prevent neighboring rows from casting shadows on the rows behind them (which would decrease the overall efficiency of the array). Assuming that each solar panel is 17.55 square feet with a nameplate rating of 315 watts, a 600-panel installation could be constructed with an overall solar array nameplate rating of approximately 190 kW.

Based on solar data obtained from a weather station 1.2 miles from the Town of Falmouth, this area receives an average of 4.86 sun hours per day of solar energy. Assuming standard modules are used, mounted in a fixed tilt position of 41 degrees at above 10 degrees off due south, the estimated annual energy production from the array is 270 kWh per year. At an estimated utility cost of \$0.13/kWh, the value of the offset energy is approximately \$35,000.

Presently, the cost of installing a solar array on Cape Cod is approximately \$3.35 per watt. The estimated installation cost for a 190 kW array would be approximately \$635,000 and the system would have a simple payback period (without taking any potential grants or incentives into account) of approximately 18 years. This analysis was conducted using the National Renewable Energy Lab's online software and solar data.

The panels require little to no maintenance and have a life cycle of approximately 30 to 40 years. The system inverters would be anticipated to last 15 to 20 years.

### 6.2.3. Hydroelectric Energy Recovery

Hydropower can be used to harvest potential energy in a pipeline or at the outfall of a wastewater treatment plant. The higher elevation of the water surface leaving the final process relative to the invert of the effluent discharge pipe provides a static elevation head that can potentially be converted into kinetic energy through a small hydro-turbine. Several low head generation devices could be explored during design. The system's energy grade line and anticipated flow are the two most important factors to size a proposed turbine and estimate power generation and cost of the installation.