Guidance for the Consideration of Climate Change Impacts in the Planning and Design of Municipal Wastewater Collection and Treatment Infrastructure

Overview

The following guidance builds on and clarifies existing studies, resources, and coastal efforts available regionally and within Rhode Island, most notably the "TR-16" *Guide for the Design of Waste Treatment Works* issued by the New England Interstate Water Pollution Control Commission; the RIDEM report *Implications of Climate Change for RI Wastewater Collection and Treatment Infrastructure*; and STORMTOOLS, a Rhode Island-based sea level rise and storm surge online map viewer based on the 2015 "North Atlantic Coast Comprehensive Study" (or "NACCS") data from the United States Army Corps of Engineers.

This guidance is intended for the planning and design of all expansions or upgrades of existing municipal wastewater collection and treatment infrastructure as well as new wastewater systems. It is limited to municipal wastewater systems and certain private systems that collect, treat, and discharge wastewater into the waters of the state. This guidance is not intended for use at wastewater systems with subsurface disposal.

Goals

Per TR-16 wastewater facility design guidance, RIDEM seeks at a minimum the protection of systems from:

- ***Interruptions in operations*** *at Base Flood Elevations, or equivalent, as discussed below; as well as,*
- ***Damages to structural and electrical integrity*** *at Base Flood Elevations, or equivalents, as discussed below, with an additional two feet of freeboard for non-critical structures and systems and three feet for critical structures and systems.*
- ***These protections will be achieved to the maximum extent practicable*** *as determined by cost-benefit analyses.*

Notes for guidance use:

RIDEM welcomes preliminary meetings prior to planning and design initiatives for particular projects so the implementation of this guidance can be mutually discussed and agreed upon.

For the purposes of this guidance, *critical components* are all structures and systems that are necessary for process operations, such as forward flow, treatment in accordance with RIPDES permit limits, sludge handling and disposal, etc. *Non-critical components* are all other structures and systems, such as administration buildings and laboratories.

Designers should consider component/system life expectancy to be twenty years for mechanical and electrical systems and fifty years for tankage and similar structures. The location of new infrastructure should consider longer life expectancies, especially in coastal areas subject to sea level rise and coastal erosion.

Base Flood Elevations and their equivalents, now and in the future

The Federal Emergency Management Agency (FEMA) establishes Base Flood Elevations (BFEs) for areas subject to a "100-year" base flood event, which means that the location has a one (1) percent chance of such flooding being equaled or exceeded in any given year. The BFEs are numerical flooding depths modeled for coastal and riverine areas of detailed study. This extent of flooding is represented on FEMA's regulatory Flood Insurance Rate Maps (FIRM) and adopted by each community. For coastal flooding, FEMA BFEs include *both* inundation levels from surge from a 100-year storm event (known as the "stillwater elevation" or "SWEL") *and* an estimate of wave heights, where applicable.

Because FEMA BFEs are based on historic flooding, they are not intended to address climate change. To do so, regional guidance from the NEIWPCC TR-16 design standards for wastewater treatment facilities suggests using current FEMA BFEs with the addition of two and three feet (for non-critical and critical components, respectively) to account for flooding from extreme rain events for inland areas and sea-level rise in coastal areas.

In Rhode Island, the STORMTOOLS mapping tool provides equivalent, future-looking inundation levels for coastal regions. At this time, however, STORMTOOLS inundation levels do not include wave data. Thus, to attain an equivalent BFE for coastal regions using STORMTOOLS, wave heights must be added to those inundation values. The Rhode Island Coastal Resources Management Council (CRMC) recommends that the estimation of wave crest heights be achieved with "STWAVE," which is a two-dimensional model rather than the one-dimensional "WHAFIS" model used by FEMA in the calculation of their coastal BFEs.

Other mapping and modeling efforts (such as recent studies of the Pawtuxet River by the University of Rhode Island and the CRMC Coastal Environment Risk Index) may eventually provide other helpful methods to determine equivalent inland and coastal BFEs, inundation levels, or waves for use in planning and design of future wastewater infrastructure. Also available is the NOAA "high SLR curve" at http://corpsclimate.us/ccaceslcurves.cfm, which provides updated information on sea-level rise projections.

Estimating BFE or equivalent for wastewater planning and design purposes

For riverine facilities:

- **Planning** and **design** of inland wastewater infrastructure, designers may use**:**
  - *FEMA FIRMS and/or corresponding Flood Insurance Study* for current BFEs *(*for uninterrupted operations).
  - *The RIDEM WWTF Climate Study,* which provide FEMA BFEs with the addition of two and three feet (for structural and electrical protections). This data is available on RIGIS.
  - *Or some other method* to determine an equivalent BFE that accounts for climate change.

For coastal facilities:

- For **planning** purposes for coastal wastewater facilities, designers may use either:
  - *FEMA FIRMS and/or corresponding Flood Insurance Study for current BFEs*, with the addition of two and three feet (for non-critical and critical components, respectively); or,
  - *The RIDEM WWTF climate study*. (Note that this study used STORMTOOLS data and methodology to estimate 100-year storm surge elevations with two and three feet of sea-level rise to account for climate change, then added a wave component (based on the 1-dimensional FEMA wave model "WHAFIS") to help derive an equivalent BFE); or, similarly,
  - *STORMTOOLS "TODAY: Extra/Tropical Storms mapping"*, which provides current 100-year storm coastal flooding elevation data, *to which must be added,*
    - \+ Two and three feet (for non-critical and critical components, respectively) to account for future conditions (that is, sea-level rise) during the life of the project; *to which must be added,*
    - \+ STWAVE-derived wave height, to estimate an equivalent coastal BFE.
  - *Or some other method* to estimate equivalent coastal BFEs that account for climate change.

- For more specific **design** purposes for coastal wastewater infrastructure components, designers may use either:
  - *FEMA FIRMS and/or corresponding Flood Insurance Study for current BFEs*, with the addition of two and three feet (for non-critical and critical components, respectively); or,
  - *To incorporate actual sea-level rise predictions for design-life considerations*, STORMTOOLS can also provide 100-year coastal flooding elevations for specific years in the future (such as 2035, 2065), *to which must be added,*
    - \+ STWAVE-derived wave height, to estimate an equivalent coastal BFE.
  - *Or some other equivalent methodology*, as approved by RIDEM. Note that the RIDEM WWTF climate study refers to other data sets and resources that are available as of the date of its publishing, such as individual save points from the Army Corps NACCS study, which can be downloaded at https://chswebtool.erdc.dren.mil.

Cost-Benefit Analysis

Per TR-16, cost-benefit analyses are required to estimate the cost-effectiveness of adaptation measures in light of projected flooding elevations. Such cost-benefit analyses will include an examination of the costs of protection versus cost of equipment/system repairs or replacement, as well as the environmental impacts should collection or treatment components fail or be subject to inundation. In cooperation with RIDEM, designers should consider multiple methods to estimate BFEs (or an equivalent BFE) that account for climate change. Facilities with both coastal and riverine impacts must plan and design for the highest BFEs estimated by analyzing both coastal and riverine impacts.

Operations and Maintenance

Designers must consider operational plans and system flexibility to better respond to flooding conditions or the recovery thereof, such as quick connects for bypass pumping, dedicated locations and connections for emergency generators and backup chemical feeds, safe transformer elevations, etc. Coordination with plant operators must be part of such design elements.