NEIWPCC

TR-16

WHAT'S NEW in the Revised Edition

TR-16: GUIDES FOR THE DESIGN OF WASTEWATER TREATMENT WORKS

2011 EDITION AS REVISED IN 2016

In 2016, NEWPCC revised the 2011 Edition of its TR-16 Guide. "What's New" provides all the significant changes, which concern flooding and resiliency in the face of extreme weather.

Owners of the original 2011 edition may refer to "What's New" to read the 2016 revisions and additions in context.

"What's New" reproduces the new and amended chapter materials, the introduction to the revised edition, and a new appendix acknowledging contributors to the revision. It does not include the updated table of contents or changes in page numbering.

In "What's New," "Revised" material refers to matter that was partially rewritten. "New" material has no corresponding part in the unrevised edition. Material is presented in the order in which it appears in the revised edition.

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Section: Introduction to Revised 2011 Edition

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Introduction to Revised 2011 Edition

In the Northeast and throughout the world, extreme storm events are growing in frequency and force. Hurricanes and blizzards threaten the operation of wastewater infrastructure and in some cases the infrastructure itself. Consequently existing wastewater facilities should be made more resilient though preparedness planning, design changes, and physical upgrades.

To support this important work, NEIWPCC undertook an effort beginning in 2014 at the direction of our Executive Committee to review and revise this book to reflect these resiliency and adaptation considerations. In addition to the revised technical design guidelines in this volume, NEIWPCC is releasing a supplemental guide to provide further information about mitigation measures and present programs, and plans available, in light of lessons learned from facilities that have been affected by major storm events.

New material in this volume defines critical equipment and offers guidance on backup-power requirements, determination of 100-year flood elevation, flood-elevation design considerations, and levels of protection for new equipment. Changes from the 2011 edition include new and revised design considerations in section 1.2.1.h, and expanded discussions of flooding as an emergency condition under section 1.2.13.4 and of flooding as a consideration when siting water-treatment facilities in section 4.1.2.

There are minor revisions or additions to 1.2.1.i, 1.2.12.a, 2.2.4, 3.1.3, and 3.6.2.7. The revised considerations about flooding also had implications for the discussion of plant hydraulics at 4.3.5.

A new Appendix 1 lists the individuals who helped bring this revised edition to publication.

A wastewater treatment facility must be able to operate under all conditions. Failure to operate can lead to raw sewage being discharged into rivers, oceans, and other bodies of water. The threat that hurricanes and other storms pose to wastewater treatment works is thus a direct environmental threat to communities and the public. As a result, most wastewater plants have precautions and plans in place to remain in service even under extreme conditions.

Nonetheless as storms grow more frequent and more powerful, further improved infrastructure and resiliencies are needed at wastewater plants. Wastewater facilities should prepare for flooding, power outages, equipment damage and failures, and much more.

Chapter 1: Procurement of Design and Construction Services

Section: 1.2.1. h. Design Considerations – Page: 1-9

REVISED

Infiltration/Inflow: Measure the quantity of infiltration/inflow (I/I) in existing sewer systems. Compare dry weather and wet weather flows to determine the magnitude of I/I and how I/I can be most economically eliminated— i.e., by reconstruction or repair of the sewer system. When necessary, perform a preliminary I/I flow gauging program.

All systems should evaluate sewer lines that run cross country through easements located in a 100-year floodplain. The sewer manholes in these sections should be protected from I/I in flood conditions. Considerations to include water-tight manholes or manholes raised above the 100-year flood level.

Underground fuel tanks for generators should be safeguarded against buoyancy and lateral movement by floods. Extra ballast can be added above the tank as needed.

Flooding: Include a review and evaluation of existing and projected flood conditions in the project area. This review should take account of sewer-system, pump-station, and wastewater-treatment plant operations and facilities. The evaluation of flood conditions, potential impacts and warranted improvements should consider all potential impacts on flood-water elevations including ice dams, storm surge, wave action, and potential future sea-level rise. The designer should confirm the latest estimate of relevant flood elevations at the project site using the appropriate flood study, which can include documents prepared by: Federal Emergency Management Agency, (FEMA) Flood Insurance Rate Map, a FEMA Advisory Base Flood Elevation Map, a FEMA publically-released working map, and/or a preliminary FEMA Flood Insurance Rate Map), U.S. Army Corps of Engineers (ACOE). The designer should also consult local regulations and ordinances. Federal and state regulations regarding floodplain and floodway obstructions should be considered.

Existing flood studies may be based only on analysis of historical stream- and tide-gauge data and may not consider effects of climate change on future flooding. Climate change may increase currently identified flood risks due to increased precipitation, larger run-off volumes, sea-level rise, and higher storm surges. The design of wastewater conveyance and treatment facilities as well as related flood mitigation measures should reflect projections of future flooding over the planned service life of a wastewater facility.

Until such time that FEMA or ACOE flood criteria are amended to include the impact of climate change, a greater level of flood protection may be warranted. The nature and manner in which improvements are implemented to provide a greater level of protection from existing or potential flood conditions depend on a number of factors, including the configuration and site constraints of the facility and the cost of improvements.

Existing facilities are those constructed using prior editions of these Guidelines and similar documents such as "Recommended Standards for Wastewater Facilities" (10-State Standards). As a result, treatment plants and pump stations upgraded prior to issue of this document should have been designed to (1) provide for uninterrupted operation of all units during conditions of a 25-year (4% annual chance) flood and (2) be placed above or protected against the structural, process, and electrical equipment damage that might occur in a 100-year (1% annual chance) flood elevation. Treatment plants and pump stations that do not currently meet these criteria should be upgraded as soon as practical even if no other improvements are required.

Existing pump stations or treatment facilities that are planned for upgrade or expansion should be improved to the maximum extent possible to meet the flood protection criteria noted herein for new facilities. However, existing facilities may present significant challenges to implementing increased levels of protection. The possible vulnerability and the differential cost of increasing the level of protection above the 100-year flood elevations for uninterrupted operation and protection from damage, respectively, should be weighed against replacement cost in selecting the level of flood protection implemented when upgrading existing facilities.

New pump stations, new facilities within a treatment plant and new wastewater treatment plants should (1) provide for uninterrupted operation of all units during conditions of a 100-year (1% annual chance) flood and (2) be placed above, or protected against, the structural, process, and electrical equipment damage that might occur in an event that results in a water elevation above the 100-year (1% annual chance) flood. The level of protection depends on how critical a component of the facility is to operation of the facility. Specifically, critical equipment

of these facilities should be protected against damage up to a water surface elevation that is 3 feet above the 100-year flood elevation. Non-critical equipment should be protected against damage up to a water surface elevation that is 2 feet above the 100-year flood elevation.

Some agencies, such as USDA Rural Development, may require that flood protection be provided up to the 500-year (0.2% chance) flood elevation. In circumstances where the level of protection noted above for new pump stations and treatment facilities (i.e., 2 or 3 feet above the 100-year flood elevation) exceeds the 500-year flood elevation, the more restrictive elevation should be used.

In addition, all SCADA system components and instrumentation used to monitor and control facility operation should be protected from flood conditions to the maximum extent practical.

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Critical Equipment: Protect critical equipment, which includes conveyance and treatment system components identified for protection including, but not limited to, all electrical, mechanical, and control systems associated with pump stations and treatment facilities that are responsible for conveyance of wastewater to and through the treatment facility to maintain primary treatment and disinfection during the flood event. Other equipment that, if damaged by flood conditions, will prevent the facility from returning to pre-event operation after cessation of flood conditions is also critical equipment.

Backup Power Supply: Normal operation of the treatment processes should be maintained at all times. Furnish the backup power supply for critical equipment by using emergency power generation or an alternative power source of sufficient capacity. In addition, ensure that there is enough fuel to run under full load or peak flow for at least 48 hours, or under normal operating conditions for at least 96 hours, whichever requires the greater amount of fuel.

Flood Elevation: The one-percent annual chance of flood elevation (100-year flood plan) is the flood elevation associated with a flood event that has a one percent chance of occurring in any given year, at the treatment plant and pumping station sites. Confirm that the design is based on the latest one-percent flood elevation using the appropriate FEMA Flood Insurance Study and accompanying Flood Insurance Rate Map.

More recent FEMA flood mapping products, including Advisory Base Flood Elevation Maps, working maps, preliminary updated Flood Insurance Rate maps or FEMA non-regulatory RiskMAPs may be available in some locations. If such maps have higher base flood elevations, those elevations should be considered. Check with your state's NFIP coordinating office, or MSC.FEMA.gov, to find out the status of FEMA flood mapping products in your project area.

Protection of New and Existing Equipment: Apply the standard of a One Percent Annual Chance of Flood Elevation (100-year flood elevation) plus 2 feet for noncritical equipment and plus 3 feet for critical equipment for a new treatment plant, new facilities within a treatment plant, or new pump stations. Safeguard existing equipment that is below the level of protection from water damage or wave action and salt exposure if in tidal zones. Means of protection for existing equipment include construction of barriers, water tight enclosures, or additional methods.

Section: 1.2.1, i. Wastewater Treatment Alternatives – Page: 1-10

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i. Wastewater Treatment Alternatives

Provide a description of alternative wastewater treatment and solids handling processes screened for consideration, as well as factors considered in selecting processes. Such factors should include the following:

- Compatibility with existing facilities
- Flexibility for expansion
- Ability to meet required permit limits
- Ability to be adapted to meet potential future limits
- Suitability to handle probable variations in plant loading
- Proven effectiveness

- Land area requirements
- Labor requirements
- Construction costs
- Operational and maintenance costs
- Energy requirements
- Sustainability
- Odor potential and impact
- Sea level rise, storm surge, wave action

Provide preliminary alternative site layouts, showing the proposed overall layout and process unit orientation on the proposed treatment plant site.

Provide process schematics for each process evaluated, along with a tabular summary of process unit loading and/or sizing parameters applicable to each process unit.

Section: 1.2.12 Environmental Considerations – Page: 1-16

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1.2.12 Environmental Considerations

a. Floodplains

The proposed facilities may be located adjacent to an area that is subject to upland or tidal flooding every 100 years or less. The report should evaluate the presence of floodplains, discuss the controlling elevations and the effects of abnormally high water caused by ice jams, and state what precautions against flooding are incorporated in the design.

Delineation of floodplains should account for historical precipitation, stream flow and tidal data as well as projections of future flooding due to climate change for the life of the project. Refer to Paragraph 1.2.1.h.

Section: 1.2.13.4 Emergency Conditions – Page: 1-18

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1.2.13.4 Emergency Conditions

Potential emergencies should be considered in the design of wastewater treatment works. During emergencies as well as routine operations, primary concerns are personal safety and the ability to maintain the process equipment efficiently. Designs should include consideration of operations activities that may occur after daylight hours. Effective drainage inside and outside of buildings is key to avoiding icing issues and health impacts, and to ensuring safe working conditions.

Designs should avoid creating "confined space" conditions whenever possible. Emergency access and egress for emergency vehicles should be included in the engineering report as well as recommendations for permanent safety features (e.g., sprinklers, fire hydrants, and alarm systems).

In areas where hazardous chemicals are stored or used, provide appropriate emergency equipment such as eye wash stations and emergency showers. Ensure all areas where emergency equipment is located have appropriate signage and means of access and egress for emergency personnel. In areas of the plant where powdered or granular chemicals that can generate dust are handled, provide adequate ventilation. At plants that use chlorine gas, chlorine gas detection alarm systems should be provided with consideration for redundancy of the system.

The potential for flooding of the treatment plant site should be evaluated. Recognize the need for locating process units above potential flood levels to avoid possible process unit and equipment damage or process interruption. When eliminating the potential for process interference is not practical due to high receiving stream levels under flood conditions, provide emergency effluent pumping facilities.

Consideration should also be given to the use of berms or dikes to protect structures from flooding.

Wastewater facilities susceptible to flooding should consider implementing a flood monitoring protocol to enable advance warning of rising water. For example, an upstream river gauge can provide effective warning of a pending flood condition if a correlation between water levels at the upstream gauge and WWTP can be established. Spring snowmelt and heavy rain events can have major flooding impact on downstream facilities.

Any basement structure in a building located in a flood plain should consider including a flood alarm.

An emergency power generator or alternative secondary, backup or emergency power source should have enough fuel to run under full load or peak flow for at least 48 hours or under normal operating conditions for at least 96 hours, whichever requires the greater amount of fuel to supply power to critical equipment in the event of a power outage at the wastewater treatment facility, pumping stations, and facilities in the system responsible for conveying flow to the plant. Use local utility records to determine historical outage durations and to determine which process units should be powered by the emergency power source.

Section: References Chapter 1 – Page: 1-31

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Great Lakes-Upper Mississippi River Board, "Recommended Standards for Wastewater Facilities" 2014 Ed., 2014.

Chapter 2: Sanitary Sewers/Wastewater Collection Systems

Section: 2.2.4 Peak Design Flow – Page: 2-2

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When designing sewers, increased wet weather flow due to infiltration and inflow (I/I) must be considered. Refer to guidance included in 1.2.1.h *Infiltration/Inflow*. The area to be served should submit evidence that excessive I/I does not exist. If a reduction of I/I is proposed, a careful evaluation of the anticipated flow reduction should be made. Flow increases due to the elimination of sewer bypasses and backups should also be evaluated.

Chapter 3: Wastewater Pumping Stations

Section: 3.1.3 Flood Protection – Page: 3-1

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3.1.3 Flood Protection

Existing wastewater pumping stations, including all electrical and mechanical equipment, should be protected from physical damage by flood conditions as noted in Section 1.2.1.h.

Section: 3.6.2 Submersible Pump Motors – Page: 3-9

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3.6.2 Submersible Pump Motors

3.6.2.1 Electrical supply and control circuits should allow disconnection at a junction box located at or accessible from outside a wetwell. Terminals and connectors should have watertight seals located outside of the wetwell, and should be protected by separate strain relief.

3.6.2.2 The motor control center should be located outside of the wetwell, above the 100-year flood elevation, and protected by a conduit seal or other appropriate sealing method meeting the requirements of the National Electrical Code for the area classification as determined by NFPA 820.

3.6.2.3 The pump motor should meet the requirements of the National Electrical Code for the area classification as determined by NFPA 820.

3.6.2.4 Submersible pump motors that are totally submerged during all operational modes (including maintenance cycles) are not required to protect against explosions.

3.6.2.5 Power cords for pump motors should be flexible and serviceable under conditions of extra hard use. Ground fault interruption protection should de-energize the circuit in the event of a failure in the electrical integrity of the cable.

3.6.2.6 Power cord terminal fittings should be provided with strain relief appurtenances, and should facilitate field connecting.

3.6.2.7 Where electrical equipment is at a facility that is in or near a 100-year flood elevation, give consideration to whether or not the electrical equipment should be elevated to avoid impacts from potential flooding to elevations indicated in Section 1.2.1.h.

Chapter 4: Wastewater Treatment Works

Section: 4.1.2 Flooding – Page: 4-1

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4.1.2 Flooding

Treatment plants should provide for uninterrupted operation and be protected from physical damage as noted in Section 1.2.1.h. All first floors, tank walls, and structural openings should be protected from damage at the 100-year flood elevation. Provide floodproofing (e.g., stoplogs at garage entrances, raised motor drives and pumps, lab cabinets with positive latching systems to prevent lab chemicals from mingling with floodwaters, storage at the highest practical elevation in a facility, and adequate structural strength to buildings) to above the 100-year flood elevation. All facilities should be constructed outside of coastal velocity flood zones.

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Consult with FEMA or the agency's local or state designee regarding permissible encroachments and restrictions on building obstructions in regulatory floodways and flood plains. For plants located in flood plains, hydraulic modeling of pre- and post-construction conditions may be required by regulatory authorities.

Existing treatment plant design should consider the possibility that flood elevations may rise in the future due to changing weather patterns or global climate change. Refer to Paragraph 1.2.1.h regarding flood protection criteria for treatment plants.

Section: 4.3.5 Plant Hydraulics – Page: 4-5

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4.3.5 Plant Hydraulics

Hydraulic profiles of each treatment process should be included in the construction drawings. The profiles should indicate water surface elevations for peak hourly, average, and minimum hourly design flows against high and normal levels of the receiving waters. The hydraulic design should allow peak hourly flows, including associated sidestream flows, to be passed through the plant with the largest or longest flow path of each unit process removed from service and with the receiving water at the 100-year flood elevation. Peak flows should be able to pass through the plant when the largest pump or other piece of mechanical equipment is out of service.

Note that the projected design flood elevations may change over the life of the wastewater treatment facility due to effects from climate change. See Section 1.2.1.h for flood protection guidelines for potential conditions that are not yet reflected in current flood studies.

A minimum velocity of 2.0 feet per second at design average flow and 1.5 feet per second at minimum flow should be provided in channels carrying unsettled wastewater unless wastewater is mixed to prevent sedimentation of solids. Mixing should be considered for all channels carrying activated sludge mixed liquor or return activated sludge. Hydraulic profiles should identify areas of vulnerability—e.g., structures and buildings that could be rapidly flooded at peak flows due to catastrophic mechanical failure or electrical (and backup power) failure. Due to

the possibility of such events, consideration should be given to providing hydraulically operated gates that close under certain conditions to protect equipment and infrastructure.

Section: Appendices

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Appendix 1
TR-16: 2011 (Revised 2016) Reviewers

The project of revising this work to reflect recent experience and thinking in preparing for storm surge and extreme weather events began with NEIWPCC's governing Commission in 2014 and grew to involve the Commission's staff and many at EPA, state environmental agencies, and private consulting firms. NEIWPCC is grateful to the below individuals who contributed to or guided the revision of the 2011 edition in 2015 and 2016.

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