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Introduction

1.0 OVERVIEW

Wastewater and stormwater collection and conveyance systems are extensive networks of interconnected piping. Because of the expansiveness and topography of these systems, wastewater or stormwater flows cannot always be conveyed by gravity. As a result, pumping stations are needed to lift the flow over high points in the systems or to treatment facilities. Because these stations play a vital role in the collection system, design engineers must produce plans for well-engineered pumping stations that operate reliably and efficiently.

Wastewater or stormwater pumping stations range from simple facilities of low capacity in remote areas to complex facilities capable of pumping billions of liters (gallons) of wastewater or stormwater each day. Often, especially at the influent end of a treatment facility, the pumping station is combined with other preliminary treatment systems. As a result, the design of these facilities is a complex undertaking that requires an understanding of all of the design engineering disciplines. The design engineer should use all the technical disciplines early in the design process to ensure a well-coordinated and functional pumping station.

Originally published in 1993 by the Water Environment Federation, this manual has been prepared to assist the practicing engineer in the design of wastewater and stormwater pumping stations; it is for the experienced designer rather than the novice. While there are many similarities between the design of wastewater and stormwater pumping

stations, there also are differences. For example, while there is similarity between wastewater and stormwater pumps, pipes, valves, and controls, there are differences in station hydraulics and operational considerations such as the intermittent operation of a stormwater pumping station. This manual has been revised to include updated processes and technological advances in pumping stations. For a detailed description of those changes, refer to the chapter descriptions located within Section 2.0.

2.0 GUIDE TO THE MANUAL

The content and organization of the manual is intended to assist in the planning and design of both wastewater and stormwater pumping stations. The manual is divided into eight chapters and should be used in conjunction with other Water Environment Federation manuals that deal with the design of collection and treatment facilities.

Chapter 2, "Station Capacity," covers the methods of determining the need for a pumping station and the station's capacity. Determining the peak hourly wastewater flowrate and developing an inflow hydrograph for determining stormwater flowrate also are discussed. Updates to this chapter include computational fluid dynamics descriptions, inclusion of Ten States Standards, inflow/infiltration modeling, volume sizing determinations, effects of inflow hydrographs on the system, analysis of more scenarios, and evaluating parameters such as peak stage, peak discharge, drain time, and pump cycling.

Chapter 3, "Station Configuration and Design," presents information on facility location, types, aesthetic and safety considerations, and architectural and structural design. Wet well configuration and storage considerations also are addressed. Updates to this chapter include identifying the distinction between wastewater and stormwater stations and describing larger stormwater pumping stations and the unique challenges faced on the coast and/or during major storm events.

Chapter 4, "Pumping Systems," reviews pumping system definitions and describes the types of pumps and drives that are typically used. The chapter also presents pumping system design concerns such as pump curve preparation and pump selection criteria. Updates to this chapter include a more in-depth discussion of "allowable operating range" and "preferred operating range" designations.

Chapter 5, "Piping Systems," reviews fluid flow fundamentals, water hammer and surge considerations, and the design of station piping systems including piping arrangements, piping materials, valves, and flow-metering considerations. Updates to this chapter include a more in-depth discussion

of piping requirements for stormwater pumping stations; expansions on flow meters, fusible pipe, and C factors; and hydraulics such as evaluating minor losses.

Chapter 6, "Electrical Design," describes the layout of a pumping station's electrical system, including reliability and redundancy, voltage considerations, substations, transformers, switchgears, conduit and wire, lightning protection, standby power considerations, and adjustable-speed drives. Updates to this chapter include revised references to National Fire Protection Association and IEEE standards such as National Electrical Code, National Electrical Safety Code, IEEE Color Books, evaluating arc flash hazards, and discussion of the several types of variable frequency drive technologies.

Chapter 7, "Instrumentation and Control Systems," presents information about process and instrumentation diagrams, flow gauges, flow metering elements, system alarms, controls, and telemetry systems. Updates to this chapter include revised instrumentation options such as radar for level measurement, fiber optics for supervisory control and data acquisition systems, and evaluating options for communication between different electrical, control, and instrumentation equipment via Ethernet.

Chapter 8, "Appurtenances," discusses design considerations for typical appurtenances found in pumping stations, including screening, odor control and treatment, noise control, and building services such as heating, ventilation and cooling, lighting, water supply, drainage, utilities, hoists, and safety features. Updates to this chapter include incorporating the latest technology in screening equipment, addressing non-dispersibles, and evaluating the pros and cons of odor control options.