Sanitary Sewers - Capacity, Management, Operation and Maintenance

An Online Continuing Education Course for Engineers

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Sanitary Sewers: Capacity, Management, Operations, and Maintenance

Chapter 1: Capacity Solutions

1.1 Introduction

Increasing system hydraulic capacity is one of several solution elements for resolving system sanitary sewer overflows (SSOs). This can be done by increasing the conveyance capacity or by storing peak flows until the existing system can safely convey the wet-weather volume stored. Determination of the timing, sizing and scheme for capacity solutions is a major consideration in effectively addressing existing and potential future SSOs due to hydraulic overloads. The need for capacity solutions is identified by executing a series of master planning tasks associated with flow analysis, hydraulic evaluation and sizing and locating potential improvements.

1.2 Capacity Assurance Plan

The Capacity Assurance Plan (CAP) identifies necessary remedial measures that will lead to the elimination of capacity-related SSOs up to the selected design condition and ensure that the system has adequate capacity under existing and projected future design conditions. CAPs are developed based upon analysis of system capacities, knowledge of the condition of the collection system, future expansion considerations, a basis of design and projected impacts of the planned Capital Improvement Projects.

The analysis of the capacity needs and deficiencies can be performed in a master planning context. A master plan will determine existing and future capacity needs, identify existing and projected capacity limitations, evaluate alternatives to address capacity deficiencies and develop solutions. Master plans are updated on a regular basis, usually three-to-five years, to account for changes in land use, annexations, growth and other impacts to the service area and collection system that drives peak flow. The master plan defines the design assumptions for sizing the pipes to accommodate the projected flow.

Flow metering, performed either as an element of the master plan or as a regular feature of an agency's monitoring program, provides the basis for determining peak flows within the system. Since sewer capacity is driven by peak flow, and infiltration and inflow generate the peaks, initial qualification of the measured flows yields a basis for prioritizing subsystems within the collection system.

CAP remedial measures to address capacity-related problems may include elimination of cost-effective infiltration/inflow (I/I) sources, provision for increases in pump station and sewer capacities, incorporation of storage and/or equalization facilities for capturing the excess flow for treatment, or recommendation of increases in wastewater treatment plant capacity.

The CAP also contains provisions to measure the effectiveness of the remedial measures on reducing SSOs. In addition, the plan should provide probable construction costs and annual operation and maintenance costs. Another component of the Capacity Assurance Plan is a schedule of all design and construction elements of the proposed remedial measures. The schedule should present the major milestones for each subsystem.

1.2.1 Infiltration/Inflow

An additional benefit to collecting flow data for incorporation into the master planning component of the CAP is the preliminary evaluation of whether subsequent condition assessment work is needed through a sewer system evaluation survey. Historical wastewater flows, gathered either at the treatment plant or at key subsystem locations, provide a preliminary basis for determining whether infiltration or inflow is excessive.

The October 1991 EPA handbook Sewer System Infrastructure Analysis and Rehabilitation is one resource available for determining whether the level of I/I in a collection system is excessive. The 1991 EPA criteria define the non-excessive infiltration as a flow rate that does not significantly exceed 120 gallons per capita per day (gpcd), typically in the range of 130 gpcd. This sum of domestic base flow and infiltration, based on a 7-14 day average during high groundwater conditions, is used as a basis of comparison when applying the EPA criteria. This assessment uses readily-available information that an agency can assemble from existing sources.

This criteria was prepared many years ago and was used primarily in administering the grants program of that era. However, the current EPA discussions involving the “blending” rule for wet weather treatment plant operation again raised the issue of what constitutes excessive I/I. This 1991 handbook was again cited in the 2004 EPA documentation as the best available guidance for the preliminary evaluation of whether a collection system is subject to cost-effective I/I to pursue.

The value of these I/I criteria is that data is generally readily available. Population tributary to a control meter or a treatment plant, measured wastewater flows from within the collection system or at the plant, and a high groundwater reference, such as a geological survey groundwater well (state or federally maintained), provide three basic elements for the analysis. A possible limitation of these per capita measures is that population densities often have little to do with leakage characteristics of the pipe. Sewer pipes leak due to external loading, weakening or deteriorating pipe and manhole materials, ineffective joint compounds, poor trench and bedding conditions, and the presence of groundwater or rainwater, not as the result of tributary population.

To overcome this drawback, another measure developed during the period of the I/I federal grants program may be more useful. Leakage quantified as gallons per day per inch-diameter mile of sewer (gpdim) measures was routinely utilized to qualify individual sewer segments initially and later entire subsystems or sewersheds for further infiltration evaluation. The inch-diameter miles of a collection system are derived from the length of the sewer expressed as miles times the diameter in inches. This computation is typically performed incrementally by each sewer segment or estimated by multiplying an average diameter across the length of the entire collection system in the study.

These inch-diameter mile measures were useful because they incorporated properties or measures of the leakage expressed by the physical characteristics (length and diameter) of the pipe. The rates also provided standardized units for ranking or prioritizing subsystems for subsequent study, independent of the differences in the size or lengths of the pipe in the actual subsystems. Table 1.1 presents a series of these non-excessive criteria devised by EPA over the years of the grants program.

Both the 1991 handbook criteria and the inch-diameter mile criteria have also been developed as threshold criteria for the inflow assessment (Table 1.1). Cumulative and subsystem inflow rates should be determined for each subsystem to provide a spatial distribution of inflow. In systems with significant inflow, a comparison of cumulative inflow and subsystem-generated inflow rates should show that the cumulative inflow for interior subsystems is less than the sum of individual subsystem-generated inflows. This would be consistent with expected system flow dynamics in which peak flows are dampened as they travel through the system.

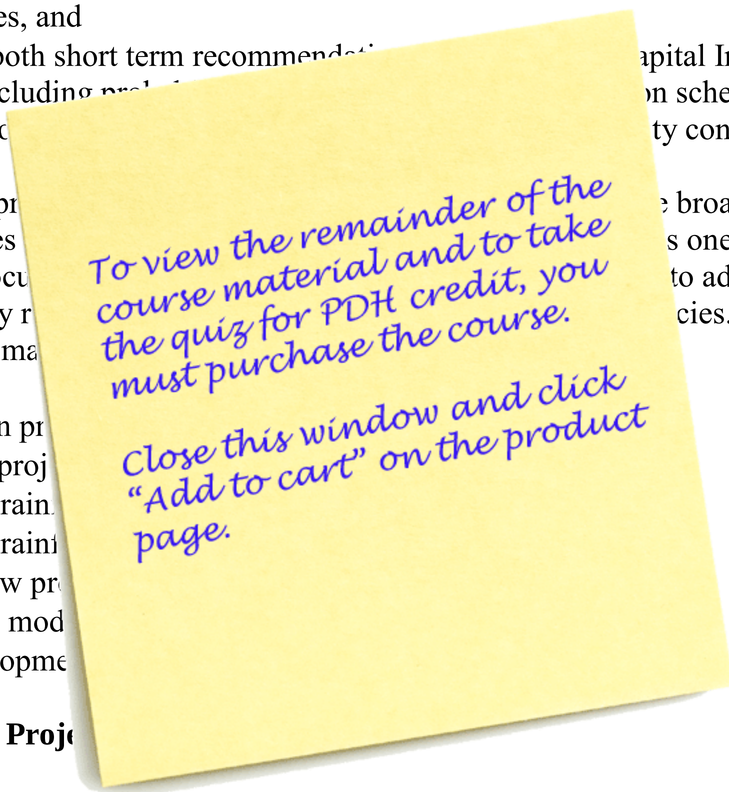
Table 1-1 Selected Historical Excessive Infiltration Inflow Criteria

Criteria Source	Criteria for Non-Excessive Infiltration Determination	
EPA Program Requirements Memorandum (PRM 78-10, 1978)	Established 1500 gpdim as non-excessive leakage allowance, perform a cost-effective analysis to determine if the leakage is possibly excessive and qualifies for investigation	
Draft Program Requirements Memorandum (PRM) 80 ,1980	Proposed 3,000 gpdim as non-excessive allowance, maximum of 30% infiltration removal for use in cost-effectiveness analysis (CEA)	
EPA Handbook: Procedures for Investigating Infiltration/Inflow, EPA 68-01-4913, 1981	Non-Excessive Allowance Ranges	
	Non-Excessive Rate	Length of Sewer
	2,000-3,000 gpdim	>100,000 lf
	3,000-5,000 gpdim	50,000-100,000 lf
	5,000-8,000 gpdim	1,000-50,000 lf
EPA Handbook: Facilities Planning, 1981	Non-Excessive Rate	Length of Sewer
	2,000-3,000 gpdim	>100,000 lf
	3,000-6,000 gpdim	10,000-100,000 lf
	6,000-10,000 gpdim	<10,000 lf
EPA Handbook: Sewer System Infrastructure Analysis and Rehabilitation EPA 625/6-91/030, 1991	Non-Excessive Infiltration -Preceding year's 7-14 day high groundwater wastewater flow $\le$ 120 gpcd Non-Excessive Inflow -Total daily average storm flow $\le$ 275 gpcd -No operational problems in collection system and WWTP	

1.3 Master Planning

Master planning, sometimes referred to as capacity planning or facility planning, is a rigorous and systematic analysis of a collection system to:

- Determine its existing and future capacity needs,
- Assess its current conditions,
- Identify existing and projected capacity limitations,
- Evaluate alternatives to address capacity deficiencies and select the most cost- effective alternatives, and
- Develop both short term recommend... apital Improvement Plans (CIPs), including pr... on schedules and financing impacts, to... ty constraints in the system.



Master planning pr... broad scope will address all the deficiencies ... s one or more deficiencies. For example, a focu... to address capacity-related issues without any r... cies. The elements of a capacity-focused ma...

- Population pr...
- Land use proj...
- Flow and rain...
- Flow and rainf...
- Future flow pr...
- Hydraulic mod...
- CIP developme...

1.3.1 Population Proj...

Current and future population projections are used to estimate wastewater flow productions. The United States Bureau of Census provides both historical population data and national population forecast for high, medium and low growth rates at the national level (see Figure 1.1). State and local planning agencies also develop population forecasts at the state and local level that take into consideration regional and local economic conditions, and positive or negative migration patterns.

There are a variety of other planning tools developed by local and state organizations involved in regional planning efforts. Metropolitan Planning Organizations (MPO) and similar planning commissions develop long range projections for growth and economic development in regional areas. Transportation planners utilize traffic analysis zones (TAZ) for assessments of future dwelling units and employment centers to determine the "trip" potential and impacts on arterial and primary roads. The value of TAZ is in providing a spatial distribution to the future