

*Guidance for evaluating*

**INFILTRATION AND INFLOW**

*for*

State Revolving Fund Projects

**INTRODUCTION**

Each loan applicant must demonstrate that its sewer collection system is not or will not be subject to excessive infiltration and inflow (I&I).

"Infiltration" occurs when groundwater enters a sewer system through broken pipes, defective pipe joints, or illegal connections of foundation drains. "Inflow" is surface runoff that enters a sewer system through manhole covers, exposed broken pipe and defective pipe joints, cross connections between storm sewers and sanitary sewers, and illegal connections of roof leaders, cellar drains, yard drains, or catch basins.

Virtually every sewer system will have some infiltration and/or inflow, and a small amount of I&I can be tolerated. Infiltration and inflow may be considered excessive when the cost to transport and treat the I&I flows exceeds the cost to eliminate the I&I. The cost for larger pipe, pumps, and treatment units (including higher energy, chemical and maintenance costs) is compared to the cost to eliminate a I&I through system rehabilitation. No collection system is ever completely free of I&I and no rehabilitation program will ever eliminate 100% of the I&I in the system. Rehabilitation projects should be planned and implemented using a reasonable expectation of the amount of I&I that may be eliminated. The most cost effective combination of rehabilitation of the collection system and building transport and treatment capacity is selected.

I&I may cause sewage overflows from the collection and treatment system, or high flows may cause the discharge of inadequately treated wastes from the treatment facilities. In these cases, the I&I may not be "excessive" from a cost effective perspective but causes violations of State and Federal laws and genuine health and environmental risks, and corrective actions are required.

**GENERAL PROCEDURE**

All Revolving Loan Fund Applicants are required to evaluate the impacts of I&I on the overall system. This evaluation begins with an initial screening to determine whether a more complete I&I analysis will be required. (Those projects with significant known I&I problems and for which a rehabilitation project is already planned may skip the initial screening and proceed directly to a detailed I&I analysis.) The initial screening consists of comparing flows in the system against two criteria to determine if I&I may be considered "non-excessive" and no further studies required. An additional criteria is available to small communities with no reliable flow information, which consists of a physical inspection of the system.

## CASE 1

The first case involves comparing per-capita flows against wet weather and dry weather screening criteria. The following data will need to be collected:

1. Known Problems Normally, the operating personnel of the municipal wastewater utility system know where the major I/I problems are in the collection system. A meeting early on with these individuals will quickly identify areas where an in-depth investigation will have to be made. The knowledge the operating personnel have about the collection system should continued to be used throughout the analysis.
2. Flow Measurement The total daily influent flow to the treatment facility, or from each collection sub-system, is compared to the population served to screen whether or not I&I may be excessive. If available, existing daily flow data should be used. If flow monitoring is to be performed as a part of the analysis, at least one month of flow data is required (two months preferred). Flows can be measured using any method acceptable to the MFD project engineer. The method must be reasonably accurate and regularly calibrated. Effluent flows from stabilization pond systems, constructed wetlands, and other systems where flows are directly influenced by rainfall, evaporation, and seepage are not acceptable; however, effluent flows from treatment facilities with retention times of 24 hours or less may be used if influent flow information is not available.

It is desirable, especially in large collection systems, to monitor flows at several points in the collection system. By measuring the flows from each drainage basin in the collection system, I&I problems can better be isolated. Flow monitoring by sub-basin may be required if additional I&I investigations are required.

Influent flow data collected daily for one year should be used where available. A two week period during dry weather flows that are not influenced by rainfall should be used for infiltration analysis, and a one week period during wet weather that represents average wet weather flows should be used for inflow analysis. If daily influent flow data is not available for a full year, rainfall data may be used in conjunction with influent flow data to document flows during dry weather and wet weather. If a single storm event is used to document wet weather inflow, it must be an event of one inch or larger precipitation in 24 hours that causes surface ponding and runoff. The event must also occur in a time of high groundwater during the wet season.

3. Population The population served by the sewer system or each collection subsystem being analyzed must be determined through a combination of city records, surveys, and census data.

## INFILTRATION ANALYSIS

The national average for domestic wastewater flow (base flow) plus groundwater infiltration after the cost effective removal of excessive I&I is 120 gallons per capita per day (gpcd).<sup>1</sup> Since groundwater levels in Louisiana are generally higher than average and a larger percentage of the collection system will be below the water table at any given time, this figure will be increased to 150 gpcd. This average flow is used by the MFD as an indicator to screen projects for possible excessive infiltration and contains the following components and assumptions.

- The base flow from residential, commercial and small industrial customers is assumed to average 70 gpcd. Where higher base flows can be documented, these values may be used in the analysis. Significant commercial and industrial flows greater than 50,000 gallons per day or greater than 5% of the base flow are excluded.
- The average daily infiltration flow during a two week period of high groundwater is 80 gpcd. Flows from days with rainfall events that cause inflow into the system (sometimes assumed to be rain greater than one-tenth of an inch) are excluded from the average.

If the measured average daily flow is less than 150 gpcd (or the measured base flow plus 80gpcd), the loan applicant may proceed with project planning without further infiltration investigation.

## INFLOW ANALYSIS

A strong correlation exists between inflow rates and the service population.<sup>2</sup> If the average daily flow recorded during wet weather does not exceed 300 gpcd and the collection system and treatment plant do not experience hydraulic overloads, then inflow is not considered to be excessive.

If average wet weather flows do not exceed 300 gpcd and the system will have adequate hydraulic capacity in the design year, no further inflow investigation is required and the applicant may proceed with project planning and design.

## CASE 2

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<sup>1</sup>Based on data from the EPA Needs Survey for 270 Standard Metropolitan Statistical Area Cities.

<sup>2</sup>Based on an EPA analysis of 45 different Sewer System Evaluation Surveys.

The second case involves comparing infiltration and inflow flows to the size of the total collection system, in inch-miles. While per-capita flow information may work well in urban areas, systems in rural areas have larger collection systems per-capita than urban areas. Groundwater infiltration, and, to a great extent, wet weather inflow, will increase as the magnitude of the collection system increases. In addition to the data collected for Case 1, the following data will be needed:

1. A complete map of the collection system showing the size of all lines. The map will be accompanied by tabulated information indicating the total inch-miles of lines in the complete system and each subsystem evaluated.
2. Water consumption data, preferably records of metered consumption, sufficient to calculate base flows. Base flows may be calculated as eighty percent of the average daily water consumption by residential and commercial customers during the winter months. Industrial customers, if any, may be added separately.

Dry weather infiltration and wet weather infiltration/inflow will be calculated by deducting the base flow from the influent flow using the same flow criteria as in Case 1 above. If the dry weather infiltration does not exceed 1800 gallons per inch mile per day, and the wet weather infiltration/inflow does not exceed 3600 gallons per inch mile per day, then I&I may be certified non-excessive and the loan applicant may proceed with project planning without further investigation of infiltration and inflow.

#### *SPECIAL CASE FOR SMALL COMMUNITIES*

Some small communities are not required by their discharge permits to measure and record flows daily or use a totalizing flow meter, and some permits only require instantaneous measurements be made a few times each month. If reliable flow information is not available and if the collection system serves a population of 5,000 or less, a physical survey of the system might be performed to determine whether the system is subject to I&I problems. The following procedure should be used:

1. Interview operating personnel to determine whether there are any known overflows or bypasses in the system or complaints from residents of sewage backups, overflowing manholes, etc.
2. Review Discharge Monitoring Reports to determine if there are any problems with meeting permitted effluent limits during periods of wet weather, and if the effluent quality during wet weather is significantly lower than during dry weather.
3. Physically inspect a number of manholes for evidence of surcharging during wet weather. At least ten percent of the total manholes should be inspected and manholes in low lying areas most susceptible to flooding should be selected.

If all of the above criteria indicate that I&I is not a significant problem with the system, and the collection system has adequate hydraulic capacity to handle design flows, then no further I&I studies will be required.

When using either Case 1 or Case 2 to demonstrate that I/I is not excessive, and the measured flows exceed the screening criteria, additional investigation may be required to establish whether or not I&I is excessive as discussed below.

The applicant may request approval from the Municipal Facilities Division to proceed with the project without further investigation of infiltration and/or inflow correction alternatives. It must be demonstrated that the collection system has adequate hydraulic capacity to handle present and future design flows. It must also be demonstrated that it will be less costly to design the treatment facility to treat the base plus infiltration/inflow flows rather than undertake an in-depth evaluation of the condition of the sewer system and undertake a rehabilitation program. The methodology used in making the cost effectiveness determination must be given as well as calculations supporting it.

In making its evaluation of a request to proceed without further infiltration investigation, the Municipal Facilities Division will consider such factors as:

- The magnitude of the infiltration and/or inflow as compared to the base flow.
- Whether or not the infiltration and/or inflow is evenly distributed throughout the collection system or can be isolated to a particular sub-system of the collection system.
- The magnitude that the infiltration and/or inflow exceeds the screening criteria and the adequacy of the flow data. For example, an I&I Analysis based on data collected over a year or more generally provides more assurance that inflow is not excessive than an analysis based on one wet period.
- The results of system smoke testing to identify sources of inflow and whether or not inflow correction is to be performed by the municipality.
- The cost-effectiveness of transporting and treating the infiltration/inflow flows in the design year versus continuing to identify and correct sources of infiltration. Temporary storage of high flows must also be considered in this cost effectiveness analysis.
- Whether the municipality has an ongoing program for rehabilitation maintenance.

#### SEWER SYSTEM EVALUATION SURVEY

Should the I&I Analysis conclude that either infiltration or inflow are excessive to the extent that further detailed investigation is justified, a Sewer System Evaluation Survey (SSES) is to be performed for

municipalities with over 5,000 population. The survey will make an in-depth evaluation of the condition of the collection system and will, through TV inspection of lines, smoke and/or dye testing, additional flow monitoring and other methods, attempt to identify specific sources of I&I. The specific procedures and requirements for performing a SSES should be discussed with the Municipal Facilities Division Project Engineer prior to commencing.

An SSES may not be required if either excessive infiltration or inflow exists for a municipality with a population of 5,000 or under. An extensive smoke program may produce the desired results of determining the location of infiltration or inflow points that are cost effective to repair. The Municipal Facilities Division Project Engineer must be contacted for a decision as to which methodology is to be used.

The results of the SSES or smoke program include recommendations as to the most cost effective rehabilitation program to be undertaken.

## DEVELOPMENT OF DESIGN FLOWS

The average wet weather and peak daily flows measured in the preparation of the I&I Analysis and, if applicable, the SSES are to be used in the development of design year flows. The design flows of the wastewater treatment facility must specifically be given. Where rehabilitation of the collection system is proposed to reduce I&I flows, design year projections should be revised accordingly. Predicting I&I reductions however is difficult, as is predicting the future condition of the sewer system, so design year I/I projections should not be overly optimistic. The rationale for developing the design flows must be given.

## FINDINGS FROM PREVIOUS I&I ANALYSES

Past studies have frequently overestimated the amount of I&I reduction that can be achieved with a particular degree of system rehabilitation. The Municipal Facilities Division will generally not accept a plan for rehabilitation that proposes to remove more than 30% of the infiltration or to reduce peak inflow by more than 40% unless the proposed rehabilitation program is extensive.

Inflow removal is generally cost effective as long as numerous line segment replacements are not required. A minor amount of inflow correction based on the results of smoke testing and manhole inspection may be approved for loan participation with a population greater than 5,000 even if an SSES has not been performed. Inflow problems with private services are not eligible for loan participation and must be addressed by the loan applicant.

Sewerage systems in Louisiana tend to be more than 30 years old and have historically not been well maintained. The standard materials of construction in the past have been clay and concrete pipe with brick manholes. These systems were often installed with little regard for leak free construction. These materials also tend to fracture over time causing infiltration to increase. Because this type of problem tends to be widely scattered throughout the system, infiltration reduction has been frequently found to not be cost

effective unless there is significant structural or system overflow problems. Some communities have found that the cost to provide additional treatment capacity is less than performing an in depth SSES and implementing a infiltration rehabilitation program.

It is generally not cost effective for municipalities under 5,000 in population to perform a SSES unless I&I problems are extreme. Where inflow exceeds the screening criteria, additional investigation should be performed in most cases before an in-depth SSES is undertaken. The additional investigation should include smoke testing and inspection of manholes, particularly those manholes in low lying areas of the collection system.. Additional flow monitoring may be necessary to identify "problem" sub-systems in the collection system and to eliminate sub-systems that are not subject to excessive I&I.

Larger communities in Louisiana should have an ongoing I&I maintenance program. Requirements for performing an in-depth SSES may be waived if a determination is made that the applicant has an adequate I&I maintenance program.