

GUIDANCE FOR

**SEWER SYSTEM
EVALUATION**



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**U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER PROGRAM OPERATIONS
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Guidance For
Sewer System Evaluation

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1.0 INTRODUCTION

Extraneous water from infiltration/inflow sources reduces the capability of sewer systems and treatment facilities to transport and treat domestic and industrial wastewaters. Infiltration occurs when existing sewer lines undergo material and joint degradation and deterioration as well as when new sewer lines are poorly designed and constructed. Inflow normally occurs when rainfall enters the sewer system through direct connections such as roof leaders and catch basins. The elimination of infiltration/inflow by sewer system rehabilitation can often substantially reduce the cost of wastewater collection and treatment. However, a logical and systematic evaluation of the sewer system is necessary to determine the cost-effectiveness of any sewer system rehabilitation to eliminate infiltration/inflow.

The Federal Water Pollution Control Act Amendments of 1972 require that after July 1, 1973, all applicants for treatment works grants must demonstrate that each sewer system discharging into the treatment works is not subject to excessive infiltration/inflow. The requirement was implemented in the Rules and Regulations for Sewer System Evaluation and Rehabilitation, 40 CFR 35.927 (pages 9 and 10).

This document is intended to provide engineers, municipalities, and regulatory agencies with guidance on sewer system evaluation.

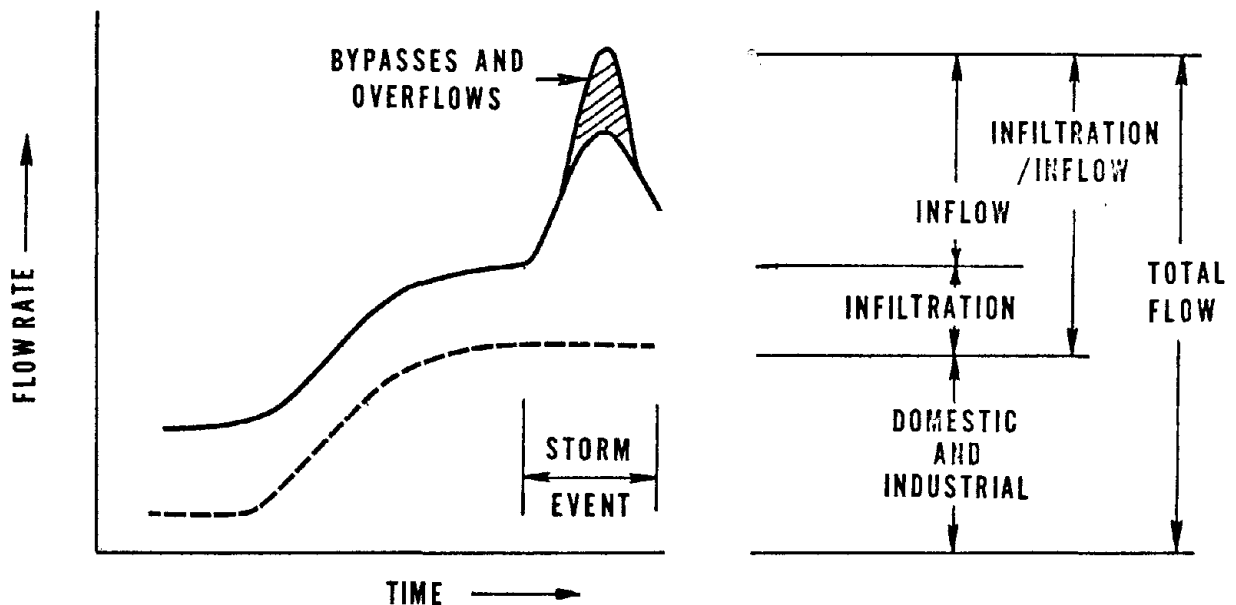
2.0 INFILTRATION/INFLOW ANALYSIS

The infiltration/inflow analysis should provide the information necessary to establish the non-existence or possible existence of excessive infiltration/inflow in the sewer system(s) and justify any proposed sewer system evaluation survey.

The analysis should include each sewer system tributary to the treatment works project. The sewer system(s) should not be limited by political jurisdictions or sewer types. The treatment works grant applicant is responsible for the entire sewer system evaluation and any rehabilitation to eliminate excessive infiltration/inflow. The sewer system included in the evaluation should originate at the wastewater sources, such as commercial buildings or private residences, and terminate at the wastewater facility.

The estimated flow rates of infiltration/inflow, infiltration and inflow entering the sewer system should be stated in the analysis. The following diagram identifies these terms:

INFILTRATION/INFLOW IDENTIFICATION (IDEALIZED)



LEGEND

- FLOWS INCLUDING INFILTRATION/INFLOW
- - - - FLOWS NOT INCLUDING INFILTRATION/INFLOW

The difference between the maximum domestic and industrial flow rate and total flow rate would represent the total infiltration/inflow entering the sewer system. The difference between the maximum domestic and industrial flow rate and the maximum flow rate during periods of high ground water (with no rainfall) normally represents the infiltration entering the sewer system. The amount of flow increase during storm events (including bypasses and overflows) normally represents the inflow entering the sewer system.

Data sources for the analysis should include maps, operation and maintenance records, observations by past and present municipal employees, and previous engineering reports. When complete flow records are not available, estimated flow rates may be computed from observed flow depths. Data presented in the analysis does not have to be based on absolute measurements. A physical examination of key manholes is normally conducted to obtain data for the analysis.

Estimated flow data should be related to rainfall intensity or other pertinent data. A rainfall and sewage flow hydrograph should be included in the analysis. Each bypassed flow and when possible overflows should be identified by location, cause, duration, quantity, frequency, rate and method of discharge from the system.

The total domestic and industrial wastewater flow rates and their relationship to water consumption plus the domestic wastewater flow per capita should be stated in the analysis.

A general description of the geographical and geological characteristics of the area served by the sewer system should be presented in the analysis. This description should include soil types, topography, rainfall data, known ground water levels and other pertinent information.

The general discussion of a sewer system in the analysis should include: the type of sewer system, i.e. sanitary or combined sewers; the known methods of sewer construction; the maximum, minimum, and average depth of the sewers; major known

sources of inflow; the structural condition, operation and maintenance practices, amount and type of deposits, degree of root intrusion, and other pertinent sewer system information; plus an evaluation of the probability of future decreases or increases in the quantities of infiltration/inflow.

A comparison of the cost estimates for transportation and treatment of the infiltration/inflow versus correction of the infiltration/inflow is normally sufficient to determine if infiltration/inflow is non-excessive or possibly excessive. Treatment costs should be based on achieving the effluent limitations that are or will be included in the NPDES permit(s) for discharges from the system.

When a sewer system has bypasses or overflows due to combined sewers and there is or will be no control or treatment required of the bypasses or overflows in the NPDES permit, treatment costs should be based on treatment of the total flow minus the bypasses or overflows attributable to the combined sewer inflow. In those cases where control or treatment of combined sewer bypasses or overflows is required, the cost-effectiveness analysis should be based on control or treatment of the total flow in the system. In all instances, the excessive infiltration should be eliminated from the entire sewer system including the combined sewer portions.

Infiltration/inflow correction cost estimates should include the costs of an evaluation survey, sewer system rehabilitation, and transportation and treatment of the infiltration/inflow not eliminated by rehabilitation.

3.0 SEWER SYSTEM EVALUATION SURVEY

The sewer system evaluation survey is a systematic examination of the sewer system to determine the specific location, flow rate and rehabilitation

costs of the infiltration/inflow problem. The following approach is designed to avoid overstudy of the infiltration/inflow problem, including unnecessary sewer cleaning and internal inspection. Each phase of the evaluation survey is supported by the preceding phase.

The evaluation survey is normally divided into five consecutive phases: (1) physical survey, (2) rainfall simulation, (3) preparatory cleaning, (4) internal inspection, and (5) survey report. However, in certain situations, it will be possible to acquire the desired information and results more economically by combining or eliminating certain phases of the survey. The physical survey and rainfall simulation phases may provide sufficient data to determine the existence or non-existence of excessive infiltration/inflow. In such cases, the cleaning and internal inspection phases could be eliminated.

3.1 Physical Survey

The first phase of the sewer system evaluation survey should be a physical survey to determine the flow characteristics, ground water levels and physical conditions of the sewer system.

In the first step of the physical survey, flow characteristics, and, if infiltration is a problem, ground water levels at key manholes in the sewer system are determined. Evaluation of this data would enable identification of segments of the sewer system requiring further study. In certain instances, the study area for the sewer system can be determined from data acquired during the infiltration/inflow analysis.

The second step of the physical survey should be an examination of each manhole in the study area to determine the actual physical condition of the sewer system. This examination involves a physical lamping of each pipeline

connected to the manholes. This data should aid in the identification of infiltration/inflow sources and provide a factual base for any sewer cleaning.

3.2 Rainfall Simulation

The second phase of the evaluation survey should be rainfall simulations to identify sections of sewer lines which have infiltration/inflow conditions during periods of rainfall.

Dyed water flooding of storm sewer sections which parallel or cross sanitary sewer sections (including service connections) and have crown elevations greater than the invert elevations of the sanitary sewers is a method of conducting the rainfall simulation phase. Stream sections, ditch sections, and ponding areas located near or above sanitary sewer sections should be dyed water flooded to identify other sources of infiltration/inflow. The downstream sanitary manhole is monitored for evidence of dyed water. The observed presence, concentration, and travel time of the dyed water into the sanitary sewer can be correlated with the soil types to obtain an estimate of the sources and quantities of infiltration/inflow. If the sewer system does not contain water traps or sagged lines, smoke testing could be used to identify connections from catch basins, roof leaders, yard drains and area drains.

3.3 Preparatory Cleaning

The third phase of the evaluation survey should be the preparatory cleaning of selected sewer lines to provide for unobstructed internal inspection. The selection of sewer sections for internal inspection is determined by analysis of the data from the physical survey and rainfall simulation phases. Selected sewer sections should have obvious potential for excessive infiltration/inflow and warrant the necessary preparatory cleaning and internal inspection.

3.4 Internal Inspection

The fourth phase of the evaluation survey should be the internal inspection of selected sections of the sewer system. This phase should determine the specific location, condition, estimated flow rate, and cost of rehabilitation for each source of infiltration/inflow defined in the selected sections. A descriptive record of all structural defects, service connections, abnormal conditions and other pertinent observations should be obtained during the inspection. The source of service connection flows should be identified. An estimated flow rate is determined for each infiltration/inflow source.

Internal inspection for infiltration conditions is normally conducted during periods of maximum ground water levels. One exception to this procedure is when the sewer is located above the maximum ground water level. All storm sewers sections, stream sections, ditch sections, and ponding areas related to the infiltration/inflow conditions are normally flooded during the internal inspection.

The method used for internal inspection of sewer sections should be the best and most cost-effective method of obtaining the necessary information. Television is an acceptable method of obtaining the necessary information. Inspection of large sewers may be accomplished by actual observation. Photographs or video tapes of infiltration/inflow sources can be used to support the field data.

3.5 Survey Report

The final phase of the evaluation survey should be a survey report of the data gathered during the survey, plus a justification for each sewer section cleaned and internally inspected, (costs not justified will be unallowable grant costs) and a proposed rehabilitation program to eliminate all defined excessive infiltration/inflow.

Each source of infiltration/inflow found during the survey should be identified in the report by specific location, condition, flow rate, method and cost of rehabilitation, and cost of transportation and treatment. An infiltration/inflow source should be proposed for rehabilitation if the rehabilitation cost does not exceed the cost of transportation and treatment.

Rehabilitation costs for an infiltration/inflow source should be based on the most cost-effective method of rehabilitation. (Several sources in a sewer segment between two consecutive manholes could be combined to achieve this objective.) Methods of rehabilitation can include: (1) replacement of sewer sections or service connections; (2) insertion of sewer liners; (3) internal or external pressure grouting with chemical sealants; (4) removal or plugging of inflow connections; (5) manhole grouting; and (6) replacement, elevating and/or sealing of manhole covers. Cement mortar grouting is not an effective method of rehabilitation except for manholes. Chemical sealants used for pressure grouting should have the demonstrated capability to eliminate infiltration under similar soil and sewer conditions. When pressure grouting is the selected method of rehabilitation, the estimated cost for the chemical sealant must be included in the rehabilitation costs.

When the sewer system contains a portion of combined sewers, the major sources of inflow in the sanitary sewer portions tributary to the combined sewer portions, such as cross connections from storm sewers, yard and area drains, roof leaders, manhole covers and catch basins should be proposed for rehabilitation. If control or treatment is or will be required for bypasses or overflows in the NPDES permit, the remaining inflow sources in the sewer system should be proposed for rehabilitation if the cost of rehabilitation does not exceed the cost of transportation and treatment.

EXCERPTS

Title 40—Protection of Environment
CHAPTER I—ENVIRONMENTAL
PROTECTION AGENCY
SUBCHAPTER B—GRANTS
PART 35—STATE AND LOCAL
ASSISTANCE

Final Construction Grant Regulations

§ 35.905-5 Excessive infiltration/inflow.

The quantities of infiltration/inflow which can be economically eliminated from a sewer system by rehabilitation, as determined by a cost-effectiveness analysis that compares the costs for correcting the infiltration/inflow conditions with the total costs for transportation and treatment of the infiltration/inflow, subject to the provisions in § 35.927.

§ 35.905-9 Infiltration.

The water entering a sewer system, including sewer service connections, from the ground, through such means as, but not limited to, defective pipes, pipe joints, connections, or manhole walls. Infiltration does not include, and is distinguished from, inflow.

§ 35.905-10 Infiltration/inflow.

The total quantity of water from both infiltration and inflow without distinguishing the source.

§ 35.905-11 Inflow.

The water discharged into a sewer system, including service connections from such sources as, but not limited to, roof leaders, cellar, yard, and area drains, foundation drains, cooling water discharges, drains from springs and swampy areas, manhole covers, cross connections from storm sewers and combined sewers, catch basins, storm waters, surface run-off, street wash waters, or drainage. Inflow does not include, and is distinguished from, infiltration.

§ 35.905-18 Sanitary sewer.

A sewer intended to carry only sanitary or sanitary and industrial waste waters from residences, commercial buildings, industrial plants, and institutions.

§ 35.905-22 Storm sewer.

A sewer intended to carry only storm waters, surface run-off, street wash waters, and drainage.

§ 35.905-2 Combined sewer.

A sewer intended to serve as a sanitary sewer and a storm sewer, or as an industrial sewer and a storm sewer.

§ 35.927 Sewer system evaluation and rehabilitation.

(a) All applicants for grant assistance awarded after July 1, 1973, must demonstrate to the satisfaction of the Regional Administrator that each sewer system discharging into the treatment works project for which grant application is made is not or will not be subject to excessive infiltration/inflow. The determination whether excessive infiltration/inflow exists, may take into account, in addition to flow and related data, other significant factors such as cost-

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effectiveness (including the cost of substantial treatment works construction delay, see Appendix A to this subpart), public health emergencies, the effects of plant bypassing or overloading, or relevant economic or environmental factors.

(b) The determination whether or not excessive infiltration/inflow exists will generally be accomplished through a sewer system evaluation consisting of (1) certification by the State agency, as appropriate; and, when necessary (2) an infiltration/inflow analysis; and, if appropriate, (3) a sewer system evaluation survey followed by rehabilitation of the sewer system to eliminate an excessive infiltration/inflow defined in the sewer system evaluation. Information submitted to the Regional Administrator for such determination should be the minimum necessary to enable a judgment to be made.

(c) Guidelines on sewer system evaluation published by the Administrator provide further advisory information.

§ 35.927-1 Infiltration/Inflow analysis.

(a) The infiltration/inflow analysis shall demonstrate the non-existence or possible existence of excessive infiltration/inflow in each sewer system tributary to the treatment works. The analysis should identify the presence, flow rate, and type of infiltration/inflow conditions, which exist in the sewer systems. Information to be obtained and evaluated in the analysis should include, to the extent appropriate, the following:

(1) Estimated flow data at the treatment facility, all significant overflows and bypasses, and, if necessary, flows at key points within the sewer system.

(2) Relationship of existing population and industrial contribution to flows in the sewer system.

(3) Geographical and geological conditions which may affect the present and future flow rates or correction costs for the infiltration/inflow.

(4) A discussion of age, length, type, materials of construction and known physical condition of the sewer system.

(b) For determination of the possible existence of excessive infiltration/inflow, the analysis shall include an estimate of the cost of eliminating the infiltration/inflow conditions. These costs shall be compared with estimated total costs for transportation and treatment of the infiltration/inflow. Cost-Effectiveness Analysis Guidelines (Appendix A to this subpart), which contain advisory information, should be consulted with respect to this determination.

(c) If the infiltration/inflow analysis demonstrates the existence or possible existence of excessive infiltration/inflow a detailed plan for a sewer system evaluation survey shall be included in the analysis. The plan shall outline the tasks to be performed in the survey and their estimated costs.

§ 35.927-2 Sewer system evaluation survey.

(a) The sewer system evaluation survey shall consist of a systematic examination of the sewer systems to determine the specific location, estimated flow rate, method of rehabilitation and cost of rehabilitation versus cost of transportation and treatment for each defined source of infiltration/inflow.

(b) The results of the sewer system evaluation survey shall be summarized in a report. In addition, the report shall include:

(1) A justification for each sewer section cleaned and internally inspected.

(2) A proposed rehabilitation program for the sewer systems to eliminate all defined excessive infiltration/inflow.

§ 35.927-3 Rehabilitation.

(a) The scope of each treatment works project defined within the Facilities Plan as being required for implementation of the Plan, and for which Federal assistance will be requested, shall define (1) any necessary new treatment works construction, and (2) any rehabilitation work determined by the sewer system evaluation to be necessary for the elimination of excessive infiltration/inflow. However, rehabilitation which should be a part of the applicant's normal operation and maintenance responsibilities shall not be included within the scope of a Step 3 treatment works project.

(b) Grant assistance for a Step 3 project segment consisting of rehabilitation work may be awarded concurrently with Step 2 work for the design of the new treatment works construction.

§ 35.927-4 Sewer use ordinance.

Each applicant for grant assistance for a Step 2, Step 3, or combination Steps 2 and 3 project shall demonstrate to the satisfaction of the Regional Administrator that a sewer use ordinance or other legally binding requirement will be enacted and enforced in each jurisdiction served by the treatment works project before the completion of construction. The ordinance shall prohibit any new connections from inflow sources into the sanitary sewer portions of the sewer system and shall ensure that new sewers and connections to the sewer system are properly designed and constructed.

§ 35.927-5 Project procedures.

(a) *State certification.* The State agency may (but need not) certify that excessive infiltration/inflow does or does not exist. The Regional Administrator will determine that excessive infiltration/inflow does not exist on the basis of State certification, if he finds that the State had adequately established the basis for its certification through submission of only the minimum information necessary to enable a judgment to be made. Such information could include a preliminary review by the applicant or State, for example, of such parameters as per capita design flow, ratio of flow to design flow, flow records or flow estimates, bypasses or overflows, or summary analysis of hydrological, geographical, and geological conditions, but this review would not usually be equivalent to a complete infiltration/inflow analysis. State certification must be on a project-by-project basis. If the Regional Administrator determines on the basis of State certification that the treatment works is or may be subject to excessive infiltration/inflow, no Step 2 or Step 3 grant assistance may be awarded except as provided in paragraph (c) of this section.

(b) *Pre-award sewer system evaluation.* Generally, except as otherwise provided in paragraph (c) of this section, an adequate sewer system evaluation, consisting of a sewer system analysis and, if

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required, an evaluation survey, is an essential element of Step 1 facilities planning and is a prerequisite to the award of Step 2 or 3 grant assistance. If the Regional Administrator determines through State Certification or an infiltration/inflow analysis that excessive infiltration/inflow does not exist, Step 2 or 3 grant assistance may be awarded. If on the basis of State certification or the infiltration/inflow analysis, the Regional Administrator determines that possible excessive infiltration/inflow exists, an adequate sewer system evaluation survey and, if required, a rehabilitation program must be furnished, except as set forth in paragraph (e) of this section before grant assistance for Step 2 or 3 can be awarded. A Step 1 grant may be awarded for the completion of this segment of Step 1 work, and, upon completion of Step 1, grant assistance for a Step 2 or 3 project (for which priority has been determined pursuant to § 35.915) may be awarded.

(c) *Exception.* In the event it is determined by the Regional Administrator that the treatment works would be regarded (in the absence of an acceptable program of correction) as being subject to excessive or possible excessive infiltration/inflow, grant assistance may be awarded provided that the applicant establishes to the satisfaction of the Regional Administrator that the treatment works project for which grant application is made will not be significantly changed by any subsequent rehabilitation program or will be a component part of any rehabilitated system: *Provided*, That the applicant agrees to complete the sewer system evaluation and any resulting rehabilitation on an implementation schedule the State accepts (subject to approval by the Regional Administrator), which schedule shall be inserted as a special condition in the grant agreement. Compliance with this schedule shall be accomplished pursuant to § 35.935-16 and § 30.304 of this chapter.

(d) Municipalities may submit the infiltration/inflow analysis and when appropriate the sewer system evaluation survey, through the State agency, to the Regional Administrator for his review at any time prior to application for a treatment works grant. Based on such a review, the Regional Administrator shall provide the municipality with a written response indicating either his concurrence or nonconcurrence. The Regional Administrator must concur with the sewer system evaluation survey plan before the work is performed for the survey to be an allowable cost.

§ 35.920-3 Contents of application.

(a) Step 1. Facilities plan and related elements required to apply for Step 2 grant assistance. An application for a grant for Step 1 shall include:

(1) A plan of study presenting (i) the proposed planning area; (ii) an identification of the entity or entities that will be conducting the planning; (iii) the nature and scope of the proposed Step 1 project, including a schedule for the completion of specific tasks; and (iv) an itemized description of the estimated costs for the project;

(2) Proposed subagreements, or an explanation of the intended method of awarding subagreements for performance of any substantial portion of the project work;

(3) Required comments or approvals of relevant State, local, and Federal agencies (including "clearinghouse" requirements of OMB Circular A-95, promulgated at 38 FR 32874 on November 28, 1973).

(b) Step 2. Preparation of construction drawings and specifications. Prior to the award of a grant or grant amendment for a Step 2 project, the following must have been furnished:

(1) A facilities plan (including an environmental assessment in accordance with Part 6 of this chapter) in accordance with §§ 35.917 through 35.917-9.

(2) Satisfactory evidence of compliance with the user charge provisions of §§ 35.925-11 and 35.935-13;

(3) Satisfactory evidence of compliance with the industrial cost recovery provisions of §§ 35.925-12, 35.928, and 35.935-13, if applicable;

(4) A statement regarding availability of the proposed site, if relevant;

(5) Satisfactory evidence of a proposed or existing program for compliance with the Relocation and Land Acquisition Policies Act of 1970 in accordance with § 30.403(d) and Part 4 of this chapter, if applicable;

(6) Satisfactory evidence of compliance with other applicable Federal statutory and regulatory requirements (see Part 30, Subpart C of this chapter);

(7) Proposed subagreements or an explanation of the intended method of awarding subagreements for performance of any substantial portion of the project work.

(8) Required comments or approvals of relevant State, local, and Federal agencies (including "clearinghouse" requirements of OMB Circular A-95) if a grant application has not been previously submitted.

(c) Step 3. Building and erection of a treatment works. Prior to the award of a grant or grant amendment for a Step 3 project, each of the items specified in paragraph (b) of this section, and in addition (1) two sets of construction drawings and specifications, suitable for bidding purposes, and (2) a schedule for or evidence of compliance with §§ 35.925-10 and 35.935-12 concerning an operation and maintenance program, must have been furnished.

(d) Step 2/3. Design/Construct Project. Prior to the award of a grant or grant amendment for a design/construct project the items in paragraphs (b) and (c) of this section must have been furnished, except that, in lieu of construction drawings and specifications, the proposed performance specifications and other relevant design/construct criteria for the project must have been submitted.

§ 35.917-1 Content of Facilities Plan.

Facilities planning which is initiated after April 30, 1974, must encompass the following to the extent deemed appropriate by the Regional Administrator:

(a) A description of the treatment works for which construction drawings and specifications are to be prepared. This description shall include preliminary engineering data, cost estimates for design and construction of the treatment works, and a schedule for completion of design and construction. The preliminary engineering data may include, to the extent appropriate, such information as a schematic flow diagram, unit processes, design data regarding detention times,

flow rates, sizing of units, etc.

(b) A description of the selected complete waste treatment system(s) of which the proposed treatment works is a part. The description shall cover all elements of the system, from the service area and collection sewers, through treatment, to the ultimate discharge of treated wastewaters and disposal of sludge.

(c) Infiltration/inflow documentation in accordance with § 35.927.

(d) A cost-effectiveness analysis of alternatives for the treatment works and for the waste treatment system(s) of which the treatment works is a part. The selection of the system(s) and the choice of the treatment works on which construction drawings and specifications are to be based shall reflect the cost-effectiveness analysis. This analysis shall include:

(1) The relationship of the size and capacity of alternative works to the needs to be served, including reserve capacity;

(2) An evaluation of alternative flow and waste reduction measures;

(3) An evaluation of improved effluent quality attainable by upgrading the operation and maintenance and efficiency of existing facilities as an alternative or supplement to construction of new facilities;

(4) An evaluation of the capability of each alternative to meet applicable effluent limitations. The treatment works design must be based upon not less than secondary treatment as defined by the Administrator pursuant to sections 301(a)(1)(B) and 304(d)(1) of the Act;

(5) An identification of, and provision for, applying the best practicable waste treatment technology (BPWTT) as defined by the Administrator, based upon an evaluation of technologies included under each of the following waste treatment management techniques:

(i) Biological or physical-chemical treatment and discharge to receiving waters;

(ii) Treatment and reuse; and

(iii) Land application techniques.

All Step 2, Step 3 or combination Step 2-3 projects for publicly-owned treatment works construction from funds authorized for any fiscal year beginning after June 30, 1974, shall be based upon application of BPWTT, as a minimum. Where application of BPWTT would not meet water quality standards, the facilities plan shall provide for attaining such standards. Such provision shall consider the alternative of treating combined sewer overflows.

(6) An evaluation of the alternative means by which ultimate disposal can be effected for treated wastewater and for sludge materials resulting from the treatment process, and a determination of the means chosen.

(7) An adequate assessment of the expected environmental impact of alternatives including sites pursuant to Part 6 of this Chapter. This assessment shall be revised as necessary to include information developed during subsequent project steps.

(e) An identification of effluent discharge limitations, or where a permit has been issued, a copy of the permit for the proposed treatment works as required by the National Pollution Discharge Elimination System.

(f) Required comments or approvals of relevant State, interstate, regional, and local agencies.