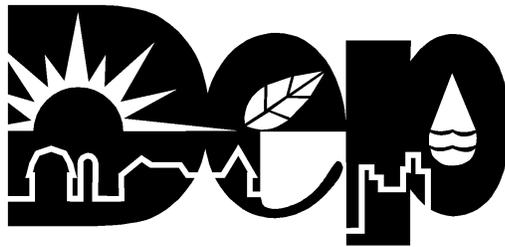


# **DOMESTIC WASTEWATER FACILITIES MANUAL**

**A GUIDE FOR THE PREPARATION OF  
APPLICATIONS, REPORTS AND PLANS**

**BUREAU OF WATER QUALITY PROTECTION**



**<http://www.dep.state.pa.us>**

**COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF ENVIRONMENTAL PROTECTION**

**DEPARTMENT OF ENVIRONMENTAL PROTECTION  
BUREAU OF WATER QUALITY PROTECTION**

**Document ID:** 362-0300-001

**Title:** Domestic Wastewater Facilities Manual

**Effective Date:** October 1, 1997

**Authority** Act 537 of 1966, the Pennsylvania Sewage Facilities Act (as amended), and the Clean Streams Law (35 P.S. §§691.1-691.1001) 25 PA Code Chapter 91.

**Policy:** To improve and preserve the purity of the waters of the Commonwealth for the protection of public health, animal and aquatic life and for recreation

**Purpose:** To amend and clarify the existing 8/91 guidance regarding the design and construction of domestic wastewater treatment facilities.

**Applicability:** This policy amends the 8/91 guidance regarding the design and construction of domestic wastewater treatment facilities.

**Disclaimer:** The policies and procedures outlined in this guidance are intended to supplement existing requirements. Nothing in the policies or procedures shall affect regulatory requirements.

The policies and procedures herein are not an adjudication or a regulation. There is no intent on the part of DEP to give the rules in these policies that weight or deference. This document establishes the framework within which DEP will exercise its administrative discretion in the future. DEP reserves the discretion to deviate from this policy statement if circumstances warrant.

**Page Length:** 117 Pages

**Location:** Vol. 33, Tab 33

**Definitions:** Sewage Facilities: A system of sewage collection, conveyance, treatment and disposal which will prevent the discharge if untreated adequately treated sewage or other wastes into waters of the Commonwealth or otherwise provide for the safe and sanitary treatment and disposal of sewage.

**DOMESTIC WASTEWATER FACILITIES MANUAL  
DEPARTMENT OF ENVIRONMENTAL PROTECTION  
COMMONWEALTH OF PENNSYLVANIA**

The attached Domestic Wastewater Facilities Manual has been prepared as a guide for persons responsible for the design and construction of domestic wastewater facilities. It is being sent to you because you might be interested or because you have requested a copy. The manual is also available to download from the DEP web site at: <http://www.dep.state.pa.us>.

The manual may be revised from time to time as the need arises. If you have suggestions for improvement to this manual or desire that future revisions be sent to you, please return this letter to us with the following completed information.

NAME \_\_\_\_\_

STREET OR ROUTE \_\_\_\_\_

CITY \_\_\_\_\_ STATE \_\_\_\_\_

ZIP CODE \_\_\_\_\_

This manual could be improved by \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

\_\_\_ Yes, send me future revisions.

Send to: Chief, Permits Section  
Pennsylvania Department of Environmental Protection  
Bureau of Water Quality Protection  
RCSOB 11<sup>th</sup> Floor  
P.O. Box 8774  
Harrisburg, PA 17105-8774

## **PREFACE**

The Commonwealth of Pennsylvania provides for the regulation of wastewater disposal “to preserve and improve the purity of the waters of the Commonwealth for the protection of public health, animal and aquatic life, and for industrial consumption and recreation”.

The manual has been prepared as a guide to those persons responsible for the discharge of treated wastewater to waters of the Commonwealth and for the construction of sewers, pump stations and treatment facilities. Parts I and II briefly set forth information regarding the responsibility and the functions of the Department of Environmental Protection (Department) in carrying out the policies and provisions of the Clean Streams Law and the procedure for obtaining permits for discharge and for the construction and operation of treatment facilities.

The Department’s policy for conducting technical reviews and approvals of permit applications contained in DEP document #362-2000-007 is applicable to this manual. The policy states that the Department will consider the registered professional engineer whose seal is affixed to facility design documents to be fully responsible for the adequacy of all aspects of the facility design and compliance with the state standards and requirements. The Department approval or issuance of permit does not, in any way, relieve the design engineer of this responsibility.

Part III is a detailed technical guide for consultants and sanitary engineers, containing minimum requirements and limiting factors used by the Bureau of Water Quality Protection in the review of applications for treatment facilities permits. It has been based primarily on the “Recommended Ten States Standards for Wastewater Facilities” adopted by the Great Lakes and Upper Mississippi River Board of State Public Health and Environmental Managers.

The design of wastewater facilities should not be limited by minimum requirements, but must meet the needs of the particular situation. It is not the purpose of this manual to set forth data which can be used without due regard for the requirements of the particular project under design. The judgment of the skilled professional engineer is still required to apply these data. The Department will apply more stringent criteria when, in its judgment, their use is justified. With the foregoing qualifications definitely understood, the Department considers the items set forth in Part III of this manual as generally representative of good engineering practices.

New processes and variations of processes are proposed from time to time. Lack of description or criteria for a process does not suggest a process should not be used, but only that consideration by the Department will be on the basis of information submitted with a specific design. The manual explains the requirements for experimental processes in Section 9.4, entitled “Applications for New Processes”. Data on newly proven processes are usually meager, and final standards cannot be adopted immediately or included in a revised manual. Tentative standards for such processes will be available as information is submitted and reviewed. The Department reserves the right to amend this manual if and when necessary to incorporate such new processes. Any such amendments will be posted on the DEP site and incorporated into the manual then reprinted at a later date.

## TABLE OF CONTENTS

	PAGE
<b>PART I GENERAL INFORMATION</b>	
1. Acts of the General Assembly of Pennsylvania .....	1
2. The Bureau of Water Quality Protection.....	2
3. Permits .....	3
4. Approval by Other Agencies .....	4
<b>PART II. PROCEDURE FOR OBTAINING A PERMIT</b>	
7. Summary of Procedures .....	5
8. Preliminary Engineering Conference.....	5
9. Applications for Wastewater Facilities Permits.....	6
<b>PART III. STANDARDS FOR DOMESTIC WASTEWATER FACILITIES</b>	
10. Engineering.....	11
11. Designer's Report .....	11
12. Plans .....	11
13. Specifications .....	14
14. Revisions to Approved Plans.....	15
15. Operation During Construction .....	15
16. Blasting During Construction.....	15
20. Design of Sanitary Sewer Systems .....	15
21. Type of System.....	15
22. Design Period .....	16
23. Design Factors.....	16
24. Design Basis.....	16
25. Details of Design and Construction .....	17
26. Manholes.....	20
27. Sewers in Relation to Streams.....	22
28. Protection of Water Supplies.....	23
29. Alternative Sewer Systems.....	24
30. Wastewater Pumping Stations.....	28
31. General.....	28
32. Wet and Dry Well Pump Stations.....	28
33. Suction Lift Pump Stations .....	31
34. Submersible Pump Stations.....	32
35. Alarm Systems .....	33
36. Emergency Operation.....	33
37. Instructions and Equipment.....	35
38. Force Mains .....	35

## TABLE OF CONTENTS

40.	Wastewater Treatment Plants.....	37
41.	General.....	37
42.	Quality of Effluent.....	37
43.	Design.....	37
44.	Plant Details.....	43
45.	Plant Outfalls.....	45
46.	Power Facilities.....	45
47.	Safety.....	47
48.	Operation.....	50
50.	Pretreatment.....	51
51.	Screening Devices.....	51
52.	Comminutors.....	53
53.	Grit Removal Facilities.....	54
54.	Pre-aeration and Flocculation.....	55
55.	Flow Equalization.....	56
60.	Settling.....	58
61.	General.....	58
62.	Design Considerations.....	58
63.	Weirs.....	60
64.	Sludge and Scum Removal.....	61
65.	Protective and Service Facilities.....	63
70.	Sludge Processing, Storage and Disposal.....	64
71.	General.....	64
72.	Sludge Treatment Processes.....	64
73.	Sludge Thickening.....	64
74.	Anaerobic Sludge Digestion.....	64
75.	Aerobic Sludge Digestion.....	69
76.	Sludge Pumps and Piping.....	70
77.	Sludge Dewatering.....	71
78.	Sludge Storage and Disposal.....	73
80.	Biological Treatment.....	74
81.	Trickling Filters.....	74
82.	Activated Sludge.....	77
83.	Rotating Biological Contactors.....	84
84.	Intermittent Sand Filters.....	87
85.	Wastewater Treatment Ponds.....	89
86.	Other Biological Treatment Processes.....	98
87.	Land Treatment.....	98
90.	Advanced Wastewater Treatment.....	99
91.	High Rate Effluent Filtration.....	99
92.	Phosphorus Removal by Chemical Treatment.....	100

## TABLE OF CONTENTS

100. Disinfection .....	104
101. General.....	104
102. Forms of Disinfection .....	104
103. Chlorine Disinfection .....	104
104. Dechlorination .....	108
105. Ultraviolet (UV) Radiation Disinfection.....	110
106. Other Disinfection Processes.....	111

**PART I**  
**GENERAL INFORMATION**

**1. ACTS OF THE GENERAL ASSEMBLY OF PENNSYLVANIA**

Section 207 of Act No. 394, approved June 22, 1937, P.L. 1987, amended through May 30, 1989, provides as follows:

"Approval of Plans, Designs and Relevant Data by the Department - (a) All plans, designs and relevant data for the construction of any new sewer system, or for the extension of any existing sewer system except as provided in section (b), by a person or municipality, or for the erection, construction, and location of any treatment works or intercepting sewers by a person or municipality, shall be submitted to the department for its approval before the same are constructed or erected or acquired. Any such construction or erection which has not been approved by the department by written permit, or any treatment works not operated or maintained in accordance with the rules and regulations of the department, is hereby also declared to be a nuisance and abatable as herein provided.

(b) Except as specifically provided by the rules and regulations of the department, plans, designs and relevant data for the construction of a sewer extension to collect no more than the volume of sewage from two hundred fifty single family dwelling units OR THEIR EQUIVALENT by a person or municipality shall not require a permit from the department if such sewer extension is located, constructed, connected and maintained in accordance with the rules and regulations of the department and is consistent with the approved official plan, required by Section 5 of the Act of January 24, 1966 (1965 P.L. 1535, No. 537), known as the "Pennsylvania Sewage Facilities Act," for the municipality in which the sewer extension is to be located, constructed, connected or maintained. However, all such sewer extensions remain subject to any conditions imposed by the department, the municipality, or any municipal authority whose interest may be affected by the sewer extension. Any such sewer extension which is located, constructed, connected or maintained contrary to the rules and regulations of the department, contrary to the terms and conditions of a permit, inconsistent with the approved official plan for the municipality or contrary to any conditions imposed by the department, municipality or municipal authority is also hereby declared to be a nuisance and abatable as provided herein."

As defined in the Act, "sewer extension" shall be construed to include new pipelines or conduits, and all other appurtenant constructions, devices and facilities except pumping stations and force mains added to an existing sewer system for the purpose of conveying sewage from individual structures or properties to the existing system.

Copies of Act No. 394, approved June 22, 1937, P.L. 1987, the Clean Streams Law, as amended, may be obtained upon request to any regional office listed in Section 2.3.

1.1 Object - In reviewing reports and plans of proposed wastewater treatment, the Department has one dominant interest: the protection of the waters of the Commonwealth against pollution, under the provisions of the law. Engineering reports and plans are, therefore, reviewed from the functional point of view to assure the suitability, adequacy, and operating reliability of the contemplated works to prevent stream pollution.

Matters of structural design, mechanical, electrical and other details are subjects of interest to the Department only to the extent that such items directly affect the functioning of the facilities and are necessary to make the project complete and ready for bidding.

Lack of description or criteria for a specific process does not suggest that it should not be used, but only that consideration by the Department will be on the basis of information submitted with the design.

- 1.2 Functions - In the exercise of its duties, the Department issues orders for the preparation of plans of treatment facilities and orders for the construction of such works. Applications for permits are considered on the basis of the engineering facts presented and, accordingly, permits are issued or denied.

The Department determines environmental priorities for the award of grants/loans under the PENNVEST program towards the construction of wastewater treatment facilities.

## **2. THE BUREAU OF WATER QUALITY PROTECTION**

- 2.1 Functions - The Bureau of Water Quality Protection examines and passes upon the technical aspects of all applications and plans for wastewater projects prior to issuance of a permit. Consistent with DEP Policy #362-2000-007, the design engineer is responsible for all design computations and functioning of the proposed facilities.
- 2.2 Organization - The Bureau maintains regional offices through which it conducts its field work and application review. Matters pertaining to wastewater project applications and the engineering aspects of such projects should be discussed with, and applications filed in, the appropriate regional office.
- 2.3 Regional offices

### **HEADQUARTERS**

Regional Water Quality Manager  
Lee Park, Suite 6010  
555 North Lane  
Conshohocken, PA 19428  
Tel: (215) 832-6130

Regional Water Quality Manager  
2 Public Square  
Wilkes-Barre, PA 18711-0790  
Tel: (717) 826-2553

Regional Water Quality Manager  
One Ararat Boulevard  
Harrisburg, PA 17110  
Tel: (717) 657-4590

Regional Water Quality Manager  
208 W. 3<sup>rd</sup> Street, Suite 101  
Williamsport, PA 17701  
Tel: (717) 327-3669

Regional Water Quality Manager  
400 Waterfront Drive  
Pittsburgh, PA 15222

### **COUNTIES SUPERVISED**

Bucks, Chester, Delaware,  
Montgomery, Philadelphia

Carbon, Lackawanna, Lehigh,  
Luzerne, Monroe, Northampton,  
Pike, Schuylkill, Susquehanna,  
Wayne, Wyoming

Adams, Bedford, Berks, Blair  
Cumberland, Dauphin, Franklin,  
Fulton, Huntingdon, Juniata,  
Lancaster, Lebanon, Mifflin,  
Perry, York

Bradford, Cameron, Centre,  
Clearfield, Clinton, Columbia,  
Lycoming, Montour, Northumberland,  
Potter, Snyder, Sullivan, Tioga,  
Union

Allegheny, Armstrong, Beaver,  
Cambria, Fayette, Greene,  
Indiana, Somerset, Washington,

Tel: (412) 442-4000

Westmoreland

Regional Water Quality Manager  
230 Chestnut Street  
Meadville, PA 16335-3481  
Tel: (814) 332-6942

Butler, Clarion, Crawford,  
Elk, Erie, Forest, Jefferson,  
Lawrence, McKean, Mercer,  
Venango, Warren

### 3. Permits

- 3.1 When Permits are Required - In order to preserve and improve the purity of the waters of the Commonwealth, the law requires that any municipality or person contemplating the construction of a new sanitary sewer or sewer system, the extension of an existing sanitary system, or the wastewater treatment works and related appurtenances shall, with the exception of certain sewer extensions, first OBTAIN PERMIT(S) from the Department of Environmental Protection. Refer to Section 1 (Act of the General Assembly of Pennsylvania) for sewer extension exempted from the permit requirement.

An NPDES Part I Permit, when issued, constitutes approval by the Department and is its authorization for the discharge of treated wastewater to Commonwealth waters. The Part II Permit, when issued, constitutes approval of the plans by the Department and is the authorization for the construction and operation of the proposed facilities.

State institutions planning the construction of sewerage facilities discharging to waters of the Commonwealth are required to file applications and to obtain permits, except that the filing and processing fees are not required.

Federal and other facilities requiring an NPDES Part I and Water Management Part II Permit are required to pay the appropriate fees as specified in Sections 9.1b and 9.1c, respectively.

#### 3.2 On-lot Systems

- 3.21 Permits for the installation of on-lot wastewater disposal systems with a design capacity to discharge subsurface wastewater flows which are less than or equal to 10,000 gallons per day and which do not involve disposal of treated effluent to the groundwater, must be obtained from the local agency (usually the local municipality). These permits must be obtained prior to construction of either the wastewater disposal system or facility served by the system in accordance with the Pennsylvania Sewage Facilities Act (Act 537).

Part II Permits issued by the Department are required for the installation and operation of individual or community on-lot wastewater disposal systems with a design capacity to discharge subsurface flows which are in excess of 10,000 gallons per day or which involve disposal of treated effluent to the groundwater. These permits must be obtained prior to construction of the wastewater disposal systems.

#### 3.3 Storm Sewers

- 3.31 Construction of all storm sewers must be consistent with the watershed Storm Water Management Plans adopted by the county. In some situations, an encroachment permit for the storm sewer construction may be needed. The Bureau of Waterways, Wetlands and Erosion Control of the Department must be contacted for such permit.

#### 4. Approval by Other Agencies

- 4.1 Federal Government - Federal laws and regulations require that permission be obtained from proper federal authority (such as the Army Corps of Engineers) for any outfall or structure which discharges into or enters waters on which there is commercial navigation.
- 4.2 Pennsylvania Department of Labor and Industry - The Building Section of the Bureau of Occupational and Industrial Safety, Department of Labor and Industry, shall be contacted concerning approval of plans for compliance with (1) Building Energy Conservation Act (Act of 1980, P.L. 1203, No. 222) and (2) Fire and Panic Regulations of the Department of Labor and Industry.
- 4.3 Pennsylvania Public Utility Commission (PUC) - In those cases where the applicant is subject to PUC regulations, a Certificate of Public Convenience from the PUC is required before a permit can be issued.
- 4.4 Delaware River Basin Commission - All applications for projects that are defined in the Delaware River Basin Commission's Rules and Regulations as having a substantial effect on the water resources (normally plants discharging greater than 50,000 gpd) of the Delaware River Basin will be submitted by the Department to the Commission for approval. Issuance of a Department permit in such a case will be withheld until the Commission notifies the Department of its approval.
- 4.5 Approval must be obtained from the Department's Bureau of Air Quality Control for all features requiring air pollution control.
- 4.6 Approval must be obtained from the Department's Bureau of Land Recycling and Waste Management for disposal of all solid residues by either land reclamation, agricultural utilization, or municipal waste landfill.
- 4.7 Other agencies who should be contacted, as necessary, are the Pennsylvania Council on the Arts, Pennsylvania Historical and Museum Commission, Pennsylvania State Police (Fire Marshall), Pennsylvania Department of Transportation, and local utilities.
- 4.8 A Users' Guide to DEP Permits is available to review the requirements of all DEP permits.

#### **5. and 6. RESERVED FOR FUTURE USE.**

## PART II

### PROCEDURE FOR OBTAINING A PERMIT TO DISCHARGE TO COMMONWEALTH WATERS AND/OR TO CONSTRUCT AND OPERATE DOMESTIC WASTEWATER TREATMENT FACILITIES

#### 7. Summary of Procedures

- 7.1 The person or municipality desiring to provide wastewater facilities shall engage the services of a registered professional engineer (or registered surveyor, if applicable) skilled in designing wastewater facilities.
- 7.2 The engineer should make a survey of the situation and prepare a preliminary report and design. The design should conform to the standards set forth in Part III of the manual.
- 7.3 The engineer should request a preliminary conference with the regional water quality management staff for complex projects to insure that the proper procedure for obtaining permits is followed and that the proposed design will conform to the requirements of the Department.
- 7.4 Based upon the results of the conference, the engineer may prepare a final report, and upon receiving effluent limits, may prepare final plans and specifications.
- 7.5 Permit applications should be submitted to the regional water quality manager in accordance with instructions given under Chapter 9 of the manual.

#### 8. Preliminary Engineering Conference

##### 8.1 General

- 8.11 Preliminary Conference - A preliminary conference with the regional water quality management staff may be requested for the more complex projects. A conference will not be needed in cases of minor extensions to existing sewer systems or to treatment works, or where prior provision has been made for such extension and in which conditions have not materially changed since such approval. It is realized that no fixed ruling can be established to stipulate under what conditions a preliminary conference or a preliminary report should or should not be requested. Of particular importance is that proper consideration of comprehensive wastewater management planning be given to a project early in the development stages. The regionalization aspects of a project should be discussed with the regional water quality management staff to assure that all Department planning regulations and requirements will be met.
  - 8.12 Project Proposal - At a preliminary conference, the applicant's engineer is expected to set forth the wastewater problem and its proposed solution in such manner as to support the recommendations made and the conclusions reached.
  - 8.13 Plans - Location maps, layout sketches and other illustrative material should be presented. A review of any of the items listed in Part III is in order, although at the time of the preliminary engineering conference many of these factors may not have been determined.
- 8.2 Preliminary Report - The regional water quality management staff may require the submission of a written preliminary report detailing the agreement reached or elaborating on any of the subjects discussed during the conference.

8.3 Scope of Engineering Advice - Advice given by the regional water quality management staff is advisory only and is not to be construed as representing official approval by the Bureau of Water Quality Protection. Favorable consideration of design data submitted at a preliminary conference or in a preliminary report, in no manner, waives the legal requirement for the submission of final plans and an engineer's report at the time a formal application for a permit is submitted, nor does it waive the right of the Bureau to require modification of plans which do not conform to good engineering practice.

9. Applications for Wastewater Facilities Permits

9.1 Action by Applicant

a. Act 537 (Sewage Facilities Act) Planning:

Act 537, enacted by the Pennsylvania Legislature in 1968, requires that every municipality in the state develop and maintain an up-to-date sewage facilities plan. The Act provides the requirements for these plans and allows the payment of a 50 percent grant for the eligible costs incurred in preparing the plans. Act 537 base plans are broad in scope and address existing sewerage needs as well as future growth and development needs.

The main purpose of a municipality's sewage facilities plan is to protect the health, safety and welfare of the citizens living in the municipality. All proposed wastewater facilities must demonstrate consistency with local wastewater facilities plans and conform to state laws. This is accomplished in part by the municipality updating its official sewage plan or by the municipality, owner, subdivider or agent of the proposed land development completing "Planning Modules for Land Development." The modules, including completion instructions, can be supplied by the Department. The municipality will act on the completed modules and submit them to the Department for review and subsequent approval or denial.

b. National Pollutant Discharge Elimination System (NPDES) Part I Permit Giving Discharge Limitations:

Facilities which will discharge to waters of the Commonwealth will require an NPDES Part I Permit for authorization to discharge.

To apply for an NPDES Part I Permit, the applicant must submit the following documents to the regional water quality manager in whose region the project is located:

- (1) Three copies of properly completed application forms. The original, signed copy must be notarized. (Application forms may be obtained from appropriate regional office.). One additional copy must be submitted for projects located in Erie County or in the Delaware River Basin.
- (2) Evidence of compliance with the local municipal and county notification requirements under PA Act 14. A copy of the applicant's correspondence notifying the municipality and the county in which the permitted activity will occur of the applicant's intentions and evidence that the municipality and county received notification. Acceptable forms of evidence include a certified mail receipt or a written acknowledgement.

- (3) A check in the amount of \$500.00 for an NPDES Part I Sewerage Permit Application, except for single residence sewage treatment plants where no fee is required, payable to "Commonwealth of Pennsylvania, Department of Environmental Protection." This payment is required as a filing and application fee.
- c. State Water Quality Management Part II Permit to Construct and Operate Sewerage Facilities.

All wastewater facilities, with the exception of certain sewer extensions, will require a Part II permit for authorization to construct and operate wastewater facilities. It is unlawful to begin construction work until the required permit(s) have been received from the Department. Refer to Section 1 of Part I (Act of the General Assembly of Pennsylvania) for sewer extensions exempted from the permit requirement.

To apply for a Part II Permit, the applicant must submit the documents listed below to the regional water quality manager in whose region the project is located. **IF THE REQUIRED NUMBER OF COMPLETE AND CONSISTENT COPIES OF ALL DOCUMENTS ARE NOT SUBMITTED, THEN THE DOCUMENTS WILL BE RETURNED.** The following documents must be submitted:

- (1) Three copies of properly completed application forms. The original, signed copy must be notarized. (Application forms may be obtained from appropriate regional office.)
- (2) Three Two copies of the design engineer's report including appropriate modules. The report should contain all the design factors/assumptions and pertinent calculations used in designing/sizing each of the proposed units or components thereof. When a treatment plant is involved, the report should also include information pertaining to expected effluent quality which the designer should be able to support.
- (3) Three Two copies of construction plans and one copy of specifications bearing a signature and seal.
- (4) Three Two copies of a soil erosion and sedimentation control plan to be implemented and maintained during and following any earthmoving activities associated with the sewerage project. If the county conservation district has approved a plan, please provide a copy of the approval.
- (5) Evidence of compliance with the local municipal and county notification requirements under PA Act 14. A copy of the applicant's correspondence notifying the municipality and the county in which the permitted activity will occur of the applicant's intentions and evidence that he received notification. Acceptable forms of evidence include certified mail receipt or written acknowledgement.
- (6) A check in the appropriate amount for wastewater applicants payable to "Commonwealth of Pennsylvania, Department of Environmental Protection." This payment is required as a filing and processing fee as per schedule below:

Sewer extensions (collectors only)	\$100.00
Sewer extensions with pumping station(s)	\$500.00
Pumping stations only	\$500.00
Sewer extensions with interceptor sewers	\$500.00
Sewer extensions with interceptor sewers & pumping station(s)	\$500.00
Interceptor sewer only	\$500.00
Wastewater treatment plant with or without sewers, etc.	\$500.00
Single residence wastewater treatment facility	\$25.00

In situations where the applicant is other than a federal, state, county or municipal agency, and when there is a stream "encroachment" or "water obstruction" associated with wastewater facilities, an additional application fee of \$50.00 should be submitted (this may be included in the same check for the Water Quality Management - Part I Permit application fee). The \$50 fee is not required for outfalls which are eligible for coverage under BDWM General Permit GP-4 (Intake and Outfall Structures) issued by the Bureau of Waterways Engineering on February 14, 1984 (e.g, 36 inches or less in diameter and not located on Exceptional Value or High Quality Stream).

NOTE: Projects requiring approval by the Delaware River Basin Commission and projects located in Allegheny, Bucks and Erie Counties require an additional set of permit applications and all supporting documentation.

A Part II Permit application will not be accepted and a Part II Permit shall not be issued prior to the issuance of a Part I Permit if an NPDES Part I Permit is required.

- 9.2 Action by Regional Office - If, upon receipt by the regional office, the application forms are found to be properly completed, signed, and attested, and, where applicable, the accompanying report, drawings, specifications, and check appear to be complete and satisfactory, the applications will be accepted. If the application forms are improperly filled out or if any of the enclosures are missing or obviously incomplete (major deficiencies), all papers will be returned to the applicant with a letter stating the deficiency. In this event, the paper should be corrected and completed by the applicant and promptly resubmitted to the regional office. Minor application deficiencies will result in the applicant or design engineer being notified of the additional information that will be necessary to complete the application.

After acceptance, the regional office staff will review the applications and supporting documentation in accordance with policy contained in document # 362-2000-007. The staff will not necessarily check all details of design computations, but will rely upon the professional skill, accuracy and truthfulness of the statements of the consultant (professional engineer or registered surveyor) who signs the applications and will be personally responsible for all information submitted. Consultants are advised not to depend on the Department's review to find design or technical errors or incorrect information which may have been misrepresented or omitted from permit application documents. The consultant is personally responsible for the quality of engineering work and compliance with regulatory requirements. Applications with a significant number of deficiencies will be returned to the consultant without a detailed commentary. Applicants will also be advised of such inadequate applications.

- 9.3 Time for Submission of Material to Regional Office - To allow time for review and processing of the NPDES Part I and Part II applications, the material in acceptance form should be

received in the appropriate regional office not later than 180 and 60 days, respectively, before the applicant needs the permit.

9.4 Applications for New Processes - Wastewater treatment processes, which in principle and/or application are unconventional or new by virtue of the fact that no engineering data prepared by impartial professional engineers recognized as being highly skilled in the field of wastewater treatment are available from the full scale operation at design capacity of a similar plant treating essentially the same type of waste, must be considered experimental.

9.41 Data Required on New Processes - If the results of full-scale studies of new processes are being submitted for consideration, under the provision of the above paragraph, such data shall conform to the following:

a. The data shall be provided by a professional engineer skilled in the field of wastewater treatment and should be from continuous operation of a full-scale plant treating the type of wastes to be handled at design or simulated design loadings.

b. Flow measurements should be noted and composite samples collected at least once a week during a continuous six-month operating period. The composite samples should be collected over a 24-hour period unless correlation of results from shorter test periods with those from 24-hour tests is demonstrated at the plant being tested. The following data should be reported:

(1) Flow

For a 24-hour period

For a test period of other than 24-hour period

For a maximum significant period (e.g., eight-hour for schools or factory shifts)

Maximum rate of flow

Minimum rate of flow

(2) Analyses of influent and effluent samples for the test period and, where applicable, for the maximum significant period, showing:

BOD

Suspended solids (total, volatile and fixed)

(3) Also, where needed to give a complete picture, analyses of turbidity, pH, alkalinity, ammonia, nitrites, nitrates, total solids, chlorides and fecal coliforms. The quantity and characteristics of any wastes other than domestic wastewater shall be given. All analyses are to be made in accordance with the current edition of "Standard Methods for the Examination of Water and Wastewater."

(4) Notations of conditions which may create problems, such as excessive scum or foam, carry-through of large material in the effluent, floating solids on tanks, odors, sludge bulking, etc.

- (5) Method of disposal of sludge, daily quantity of sludge, percent solids (total, volatile and fixed) and sludge drying ability.
  - (6) Operating provisions, such as quantity of air for activated sludge type processes.
  - (7) Operating controls required such as limitations on suspended solids in aeration tanks; operational data needed, such as sludge index. (What factors of operation are required to operate plants successfully?)
  - (8) Amount and quality of operation required (hours per day, whether operator is laborer, custodian, technician, chemist, or engineer).
  - (9) Any other data required by the Department.
- c. Data submitted other than above will be considered on its merits.

9.42 Experimental Permits - The risk incurred in experimentation with unconventional treatment methods must rest upon the proponent of the treatment method rather than the general public. To qualify for a Part II Permit, a method or process must be proved by full-scale studies. Otherwise, an experimental permit may be issued, provided:

- a. Failure of the experiment will not result in serious pollution or hazard to the public health.
- b. Detailed plans are submitted showing how, in case of failure, the experimental plant or unit will be converted to a conventional installation.
- c. Financial resources are assured to make the conversion (funds placed in escrow or bond posted). The bond or certificate of deposit in the appropriate amount must be assigned to the Department to insure the availability of funds if it becomes necessary.

Statewide not more than one experimental permit for the same process or method may be granted during the experimental period.

The experimental permit will require that:

- (1) There be a limited experimental period not exceeding 18 months.
- (2) The permittee must submit reports on operation during the experimental period as required by the Department. The reports shall be prepared by a professional engineer who is skilled in the field of wastewater treatment and acceptable to the Department. The data required will be generally in accordance with Section 9.41.

## PART III

### STANDARDS FOR DOMESTIC WASTEWATER FACILITIES

This section applies to sewers, pumping stations, and wastewater treatment plants proposed for construction under the jurisdiction of the Pennsylvania Department of Environmental Protection, and follows, in general arrangement, the Recommended Standards for Wastewater Facilities adopted by the Great Lakes and Upper Mississippi River Board of State Public Health and Environmental Managers.

#### 10. ENGINEERING

In conformity with the provisions of the Professional Engineers Registration Law, as amended (Act No. 367 of the General Assembly, approved May 23, 1945), the Department adopted the following requirements as contained in Section 91.23 of the Department's Rules and Regulations.

- a. An Engineer's Report, as well as plans and specifications, shall accompany the applications, showing clearly what is proposed and permitting the basis of design to be thoroughly understood and checked.
- b. Plans, reports and specifications shall be prepared by a licensed professional engineer authorized to practice in this Commonwealth.
- c. The front cover or flyleaf of each set of drawings and each copy of the report and specifications shall bear the imprint of the engineer's seal and signature.
- d. All drawings submitted shall bear the imprint or legible facsimile of the engineer's seal.
- e. Reports, drawings and specifications for strip mines or for minor work not involving safety to life or health may be submitted, as approved by law, by a registered surveyor, and shall bear the imprint or facsimile of his seal.

Based on the above considerations, a P.E. seal will be required for all Part II permit applications.

#### 11. Designer's Report

The purpose of the report is to record, for convenient and permanent reference, the controlling assumptions made and factors used in the functional design of the wastewater facilities as a whole and of each of the component units. The report should include appropriate Department modules including calculations and justifications for the overall design of treatment facilities including sewers, pump stations and treatment plant. For projects which cannot be adequately described in modules alone, supplemental calculation sheets bearing the title and number of the appropriate module shall be submitted. Modules can be obtained by contacting a regional office. Data on structural, mechanical and electrical designs may be excluded except to the extent that reference to such elements is necessary in checking the functional operation.

#### 12. Plans

- 12.1 General - All plans for wastewater facilities shall bear a suitable title showing the name of the municipality, sewer district, or institution, and shall show the scale in feet, a graphical scale, the north point, date, and name of the engineer and imprint or legible facsimile of his registered seal.

The plans shall be clear and legible. They shall be drawn to a scale which will permit all necessary information to be plainly shown. To facilitate the microfilming of all approved plans by the Department, the maximum plan size shall be no larger than 36 inch by 50 inch. Datum used should be indicated. Locations and logs of test borings, when made, shall be shown on the plans.

Detailed plans shall consist of plan views, elevations, sections and supplementary views which, together with the specifications and general layouts, provide the working information for the contract and construction of the facilities. Include dimensions and relative elevations of structures, the location and outline form of equipment, location and size of piping, water levels, ground elevations, etc.

## 12.2 Plans of Sewers

12.21 General Plan - A comprehensive plan of the existing and proposed sewers shall be submitted for projects involving new sewer systems or substantial additions to existing systems. The plan shall show the following:

- a. Geographical Features - Topography and Elevation: Existing or proposed streets and all streams or water surfaces shall be clearly shown. Contour lines at suitable intervals should be included.
- b. Streams - The direction of flow in all streams, and high and low water elevations of all water surfaces at sewer outlets and overflows, shall be shown.
- c. Boundaries - The boundary lines of the municipality and the sewer district or area to be sewered shall be shown.
- d. Sewers - The plan shall show the location, size and direction of flow of all existing and proposed sanitary and combined sewers draining to the treatment facility.

12.22 Detailed Plans and Profiles - It is usually desirable that detailed plans and profiles be submitted for sewer construction projects of any magnitude. Profiles should have a horizontal scale of not more than 100 feet to the inch and a vertical scale of not more than 10 feet to the inch, and plans should be drawn to a corresponding horizontal scale. Such plans and profiles shall show:

- a. Location of streets and sewers.
- b. Line of ground surface, size, material and type of pipe, length between manholes, invert and surface elevation at each manhole, and grade of sewer between each two adjacent manholes. All manholes shall be numbered on the plan and correspondingly numbered on the profiles.

Where there is any question of the sewer being sufficiently deep to serve any residence, the elevation and location of the basement floor shall be plotted on the profile of the sewer which is to serve the house in question. The engineer shall state that all sewers are sufficiently deep to serve adjacent basements, except when topographical considerations preclude service. The plans should note when the sewers are not deep enough to serve basements.

- c. Locations of all special features such as proposed finish grade to assure minimum cover, inverted siphons, concrete encasements, elevated sewers, etc.

d. All known existing structures, both above and below ground, which might interfere with the proposed construction, particularly water mains, gas mains, storm drains, etc.

e. Special detailed drawings, made to scale to clearly show the nature of the design, shall be furnished to show the following particulars:

All stream crossings and sewer outlets, with elevations of the stream bed and of normal and extreme high or low water levels.

Details of all special sewer joints and cross-sections.

Details of all sewer appurtenances such as manholes, lampholes, inspection chambers, inverted siphons, regulators, tide gates, and elevated sewers.

### 12.23 Sewer Layouts

a. Where the magnitude or complexity of the project does not necessitate the submission of detailed plans and profiles, sewer layout plans will be acceptable, provided that such layouts:

Are drawn to a scale not smaller than 200 feet to the inch.

Show locations of streets and sewers, size and material of pipe, length between manholes, manhole numbers, invert and surface elevation at each manhole, grade of sewer between each two adjacent manholes, location of special features, surface contours, and minimum cover over sewer. (The engineer shall state that all sewers are sufficiently deep to serve adjacent basements, except where otherwise noted on the plans.) Subsurface information from test borings shall be included in the specifications.

b. Detailed plans as described under Section 12.22 e. shall be submitted for all creek crossings, elevated sewers, special joints and cross-sections, inspection chambers, regulators, tide gates, sewer outlets, etc.

### 12.3 Plans of Wastewater Pumping Stations

12.31 Location Plan - A plan shall be submitted for projects involving construction or revision of pumping stations. This plan shall show the following:

- a. The location and extent of the tributary area.
- b. Any municipal boundaries within the tributary area.
- c. The location of the pumping station and force main and pertinent elevations.

12.32 Detailed Plans - Detailed plans shall be submitted showing the following, where applicable:

- a. A contour map of the property to be used.
- b. Existing pumping station.

- c. Proposed pumping station, including provisions for installation of future pumps or ejectors and location of appurtenances such as heaters, ventilators, electrical controls, etc.
- d. Elevation of high water at the site and maximum elevation of wastewater in the collection system upon occurrence of power failure.
- e. Subsurface information from the test borings and groundwater elevations.
- f. Location and detail of pressure relief valves in force mains.

#### 12.4 Plans of Wastewater Treatment Plants

12.41 Location Plan - A plan shall be submitted showing the wastewater treatment plant in relation to the remainder of the system. A USGS Topographic Map (7.5 minute series, where available) shall be included to indicate its location with relation to streams and the point of discharge of treated effluent.

12.42 General Layout - Layouts of the proposed wastewater treatment plant shall be submitted showing:

- a. Topography of the site.
- b. Size and location of plant structures-existing, proposed and abandoned.
- c. Schematic flow diagram showing the flow through various plant units.
- d. Piping, including any arrangements for bypassing individual units. Materials handled and direction of flow through pipes shall be shown.
- e. Hydraulic profiles showing the flow of wastewater, supernatant liquor, and sludge.
- f. Test borings and groundwater elevations.

12.43 Detailed Plans - Detailed plans shall show the following:

- a. Location, dimensions and elevations of all existing and proposed plant facilities.
- b. Elevations of high and low water level of the body of water to which the plant effluent is to be discharged.
- c. Type, size, pertinent features and manufacturer's rated capacity of all pumps, blowers, motors, and other mechanical devices, unless included in the specifications.
- e. Erosion and sedimentation control measures.

### 13. Specifications

Complete technical specifications for the construction of sewers, wastewater pumping stations, wastewater treatment plants, and all appurtenances, shall accompany the plans.

The specifications accompanying construction drawings shall include, but not be limited to, all construction information not shown on the drawings which is necessary to inform the builder in detail

of the design requirements as to the quality of materials and workmanship and fabrication of the project and the type, size, strength, operating characteristics, and ratings of equipment; allowable infiltration; the complete requirements for all mechanical and electrical equipment, including machinery, valves, piping, and pipe joints; electrical apparatus, wiring, meters, laboratory fixtures, and equipment; operating tools; construction materials; special filter materials such as stone, sand, gravel, or slag; miscellaneous appurtenances; chemicals when used; instructions for testing materials and equipment, as necessary, to meet design standards; operating tests for the completed facilities and component units; and erosion and sedimentation control features where applicable.

14. Revisions to Approved Plans

The facilities shall be constructed under supervision of a professional engineer in accordance with the approved reports, plans, and specifications. Any deviations from approved plans or specifications so revised should, therefore, be submitted well in advance of any construction work which will be affected by such changes to permit sufficient time for review and approval. Structural revisions or other minor changes not affecting capacities, flows or operations will be permitted during construction without approval. "Record Drawings" clearly showing such alterations shall be placed on file with the Department at the completion of the work.

15. Operation During Construction

Specifications shall contain a program for keeping existing treatment plant units in operation during construction of plant additions/modifications. Should it be necessary to take plant units out of operation, a shut-down schedule shall be adhered to which will minimize pollutional effects on the receiving stream.

16. Blasting During Construction

If blasting is anticipated during construction of any portion of the wastewater facility project, the blasting must be done by a licensed professional in accordance with state regulations (Chapter 211 of the Department's rules and regulations). A permit must be secured from the Pennsylvania Fish Commission if blasting is to be done in or along a stream. In addition, the local waterways patrolmen must be notified when explosives are to be used.

17. RESERVED FOR FUTURE USE.

18. RESERVED FOR FUTURE USE.

19. RESERVED FOR FUTURE USE.

**20. DESIGN OF SANITARY SEWER SYSTEMS**

21. Type of System

In general, the Department will approve plans for new sewer systems or extensions to systems only when designed as separate sanitary sewers in which water from roof drains, streets, and other areas, and groundwater from foundation drains are excluded.

Sewers which are designed to carry both sanitary wastewater and storm water will not normally be approved. Exceptions may be made if the new combined sewer is replacing an existing sewer of the same type or if previous approval has been obtained from the Department for an abatement or treatment program for control of storm water overflows by some means other than physical separation. Special exception may also be made when short sections of new combined sewers are appropriate other than at or near the upper terminus of existing combined sewers.

Any combined sewers approved shall provide for the complete interception of wastewater for treatment during dry weather and minimization of discharges of combined wastewater through regulators during wet weather to protect the treatment process from extreme flow rates.

Overflows shall not be permitted at points where they will adversely affect the receiving stream or its uses. Where it is determined by the Department that an untreated overflow may adversely affect the receiving stream, treatment of the overflow may be required.

22. Design Period

In general, sewer systems should be designed to serve the projected future population (in conformance with Act 537 planning), within the present service area and other anticipated areas to be served in the near future. An exception would be in considering parts of the systems that can be readily increased in capacity or where it may be more cost-effective to increase capacity at a later date. Consideration should be given to the maximum anticipated capacity required for non-residential users.

23. Design Factors

In designing sanitary sewers, the following factors should be considered:

- a. Maximum hourly quantity of domestic and other wastewater from residential and non-residential users.
- b. Groundwater infiltration.
- c. Topography of area.
- d. Location of wastewater treatment plant.
- e. Depth of excavation.
- f. Pumping requirements.

The basis of design for all sewer projects shall accompany the plan documents.

24. Design Basis

24.1 Per Capita Flow - New sewer systems should be designed on the basis of an average daily per capita flow of not less than 100 gallons per day unless a rigorous justification for a lesser per capita flow can be established. This figure includes normal infiltration, but an additional allowance should be made where conditions are unfavorable. Generally, the sewers should be designed to carry, when flowing full, not less than the following daily per capita contributions of domestic wastewater, exclusive of wastewater from non-residential users.

24.11 Laterals and sub-main sewers - 400 gallons.

24.12 Main, trunk interceptor and outfall sewers - 250 gallons.

24.13 Interceptors carrying combined wastewater - Interceptors carrying combined wastewater flow should be designed to carry, as a minimum, 350 percent of the gauged or estimated flow during dry weather conditions.

24.2 Alternate Method - When deviations from foregoing per capita rates are proposed, a brief description of the procedure used for sewer design shall be included.

25. Details of Design and Construction

25.1 Minimum Size - Generally, no public sewer carrying untreated wastewater should be less than eight inches in diameter. Refer to Section 29 for the proposals involving use of smaller diameter alternative sewers.

The use of six-inch diameter sewers may be permitted when the following conditions are met:

- a. Topographical, geographical and/or practical conditions indicate that the sewer will not be extended and that the flow to the proposed sewers generated within the natural tributary drainage area will not be augmented by flow generated outside of that area.
- b. The sewers have hydraulic capacity to convey the projected future flows, and the agency responsible for maintaining the sewers must have equipment or be able to obtain immediate services to adequately clean and maintain the sewers.

25.2 Depth - Sewers shall be designed deep enough to prevent freezing. Insulation shall be provided for sewers that cannot be placed at a depth sufficient to prevent freezing. In general, sewers should be designed to allow for basement service of existing houses. As an alternative, an evaluation of existing houses may be performed to determine the most cost-effective solution for providing basement service.

25.3 Slope - Sewers shall be laid with uniform slope between manholes. All sewers shall be so designed and constructed to give mean velocities, when flowing full, of not less than two feet per second, based on Manning's formula using an "n" value of 0.013. Use of other practical "n" values may be permitted by the Department if deemed justifiable on the basis of research or field data presented. The following are the minimum slopes which should be provided; however, slopes greater than these are desirable.

<b>Sewer Size</b>	<b>Minimum Slope in Feet Per 100 Feet</b>
6"	0.60
8"	0.40
10"	0.28
12"	0.22
14"	0.17
15"	0.15
16"	0.14
18"	0.12
21"	0.10
24"	0.08
27"	0.067
30"	0.058
36"	0.046

Under special conditions, if full and justifiable reasons are given, slopes slightly less than those required for the two feet per second velocity when flowing full may be permitted. Such decreased slopes will only be considered where the depth of flow will be 0.3 of the diameter or

greater for maximum monthly average flow. Whenever such decreased slopes are selected, the engineer must furnish with his report computations of the depths of flow in such pipes at minimum hourly, maximum monthly average and peak instantaneous rates of flow. The sewer diameter and slope shall be selected to obtain the greatest practical velocities to minimize settling problems. It is recognized that such decreased slopes may cause additional sewer maintenance expense.

25.31 Sewers on Steep Slopes - Sewers on 20 percent slope or greater shall be anchored securely with concrete anchors or equal. It will be the responsibility of the design engineer to prepare a detailed anchor design. The anchors shall be spaced as follows:

Not over 36 feet center to center on grades 20 percent and up to 35 percent.

Not over 24 feet center to center on grades 35 percent and up to 50 percent.

Not over 16 feet center to center on grades 50 percent and over.

25.4 Alignment - Normally sewers 24 inches or less in diameter shall be laid with straight alignment between manholes. The alignment shall be checked by either using a laser beam or lamping.

On curved roadways where straight alignment would be difficult and expensive, curvilinear alignment may be considered for sewers larger than 24 inches. Only simple curves will be permitted. The radius of curvature shall be at least 100 feet. Manholes shall be installed at each end of the curved section, and the distance between manholes should not exceed 250 feet; however, longer distances up to 400 feet may be approved, especially on a larger size sewer, so long as the interior angle of the curve between manholes does not exceed 90 degrees. Compression or chemically welded joints shall be used, and joint deflection or pull shall not exceed the maximum permissible under ASTM pipe or joint standards C-425, C-447 and C-361. Chemically welded pipe joint specifications D-2680 or equivalent shall apply. The specifications shall contain provisions for sewer cleaning equipment which will adequately maintain the flow capacity of the sewers and will prevent damage during the cleaning operation.

25.5 Increasing Size - When a smaller sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method of securing these results is to place the 0.8 depth point of both sewers at the same elevations.

25.6 High Velocity Protection - Where velocities greater than 15 feet per second are attained at peak instantaneous flow condition, special provision shall be made to protect the sewer against displacement by erosion and shock.

25.7 Materials - Any generally accepted material for sewers will be given consideration, but the material selected should be adapted to local conditions, such as character of industrial wastes, possibility of septicity, soil characteristics, exceptionally heavy external loadings, abrasion, and similar problems.

Suitable couplings complying with ASTM specifications shall be used for joining dissimilar materials. The leakage limitations on these joints shall be in accordance with Section 25.9.

All sewers shall be designed to prevent damage from super-imposed loads. Proper allowance for loads on the sewer shall be made because of the width and depth of the trench. When standard strength sewer pipe is not sufficient, the additional strength needed may be obtained by using extra strength pipe or by special construction.

For new pipe materials for which ASTM standards have not been established, the design engineer shall provide complete pipe specifications and installation specifications developed on the basis of criteria adequately documented and certified in writing by the pipe manufacturer to be satisfactory for the specific detailed plans.

## 25.8 Installation

### 25.81 Standards

Installation specifications shall contain appropriate requirements based on the criteria, standards and requirements established by the industry in its technical publications. Requirements shall be set forth in the specifications for the pipe and methods of bedding and backfilling thereof so as not to damage the pipe or its joints, impede cleaning operations and future tapping, create excessive sidefill pressures or ovalation of the pipe, or seriously impair flow capacity.

### 25.82 Trenching

- a. Trenching shall comply with appropriate OSHA regulations. The width of the trench shall be ample to allow the pipe to be laid and joined properly and to allow the backfill to be placed and compacted as needed. The trench sides shall be kept as nearly vertical as possible. When wider trenches are dug, appropriate bedding class and pipe strength shall be used.
- b. Ledge rock, boulders and large stones shall be removed to provide a minimum clearance of four inches below and on each side of all pipes.

### 25.83 Pipe Embedment

The pipe embedment area consists of bedding, haunching and initial backfill zones. Bedding is the material on which a pipe or conduit is supported. The bedding zone is the area of the bedding underneath the pipe or conduit in a trench. The haunching zone is the area between the bottom of the pipe and the spring line (1/2 the diameter of the pipe) in a trench. The initial backfill zone is the area between the spring line of the pipe and extending some distance above the top of the pipe in a trench. The following describes the embedment material to be used in installing rigid or flexible pipes.

- a. Bedding material shall be classes A, B or C as described in ASTM C12 or WPCF MOP No. 9 (ASCE MOP No. 37) for all rigid pipes, provided the proper strength pipe is used with the specified bedding to support the anticipated load. The same bedding material or other stone aggregate shall be used in the haunching and initial backfill zones such that a minimum cover of six inches above the pipe is provided.
- b. Bedding material shall be classes I, II or III as described in ASTM D2321- for all flexible pipes, provided the proper strength pipe is used with the specified bedding to support the anticipated load. The same bedding material or other stone aggregate shall be used in the haunching and initial backfill zones such that a minimum cover of six inches above the pipe is provided.

### 25.84 Remaining Backfill

- a. Suitable material removed from trench excavation except where other material is specified may be used in backfilling the remainder of the trench. Debris, frozen

material, large clods or stones, organic matter or other unsuitable materials shall not be used as backfill within two feet of the top of the pipe.

- b. Pipe embedment and remaining backfill shall be placed in such a manner as not to disturb the alignment of the pipe.

#### 25.85 Deflection Test

- a. Deflection tests shall be performed on all flexible pipe. Deflection tests for composite pipes, such as truss pipe, shall be performed if the design engineer deems it necessary. The test shall be run not less than 30 days after final backfill has been placed.
- b. No pipe shall exceed a deflection of five percent.
- c. The rigid ball or mandrel used for the deflection test shall have a diameter not less than 95 percent of the base inside diameter or average inside diameter of the pipe, depending on which is specified in the ASTM Specification, including the appendix, to which the pipe is manufactured. The pipe shall be measured in compliance with ASTM D 2122 Standard Test Method of Determining Dimensions of Thermoplastic Pipe and Fittings. The test shall be performed without mechanical pulling devices.

### 25.9 Joints and Leakage Tests

#### 25.91 Joints

The installation of joints and the materials used shall be included in the specifications. Sewer joints shall be designed to minimize infiltration and to prevent the entrance of roots throughout the life of the system.

#### 25.92 Leakage Tests

Leakage tests shall be specified. This may include appropriate water or low pressure air testing. The testing methods selected should take into consideration the range in groundwater elevations during the test and anticipated during the design life of the sewer.

The leakage exfiltration or infiltration shall not exceed 100 gallons per inch of pipe diameter per mile per day for any section of the system. An exfiltration or infiltration test shall be performed with a minimum positive head of two feet.

The air test shall, as a minimum, conform to the test procedure described in ASTM C-828-86 for clay pipe, ASTM C 924 for concrete pipe, and for other materials' test procedures as recommended by the manufacturer and approved by the Department.

### 26. Manholes

- 26.1 Location - Manholes shall be installed at all changes in grade and size, changes in alignment for sewers less than 24" in diameter, at all intersections and at distances not greater than 400 feet for sewers 15 inches or less and 500 feet for sewers 18 inches to 30 inches. Greater spacing may be permitted in larger lines where adequate cleaning equipment for such spacing is provided. Cleanouts may be used only for special conditions and shall not be substituted for manholes nor installed at the end of laterals greater than 150 feet in length.

The location of manholes in streams should be avoided. All manholes subject to flooding shall be protected with watertight covers.

- 26.2 Drop Type - A drop pipe should be provided for the sewer entering a manhole at an elevation of 24 inches or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches, the invert should be filleted to prevent solids deposition.

Drop manholes should be constructed as an outside drop connection. Inside drop connections (when necessary) shall be secured to the interior wall of the manhole and provide access for cleaning.

Due to the unequal earth pressure that would result from the backfilling operation in the vicinity of the manhole and to support the drop pipe, the entire outside drop connection shall be encased in concrete.

- 26.3 Diameter - The minimum diameter of manholes shall be 42 inches; larger diameters are preferable. A minimum access diameter of 22 inches shall be provided.

- 26.4 Flow Channel - The flow channel through manholes should be made to conform in shape and slope to that of the sewers.

- 26.5 Watertightness - Solid watertight manhole covers are to be used whenever the manhole tops may be flooded by street runoff or high water.

Manholes shall be of the pre-cast concrete, fiberglass, PVC, or poured-in-place concrete type. Manholes shall be waterproofed on the exterior. The specifications shall include a requirement for inspection of manholes for watertightness prior to placing into service.

Inlet and outlet pipes shall be joined to the manhole with a gasketed, flexible, watertight connection or any watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place.

- 26.6 Manhole Testing - Exfiltration tests for manholes shall be specified. These may include water or vacuum testing. In the water test, exfiltration shall not exceed a rate of 0.019 gallons-a-day per inch of manhole diameter per vertical foot of manhole during a continuous four hour test period. The vacuum testing shall be in accordance with the testing equipment manufacturer's written instructions and the test results compared to the manufacturer's published vacuum test tables.

- 26.7 Electrical - Electrical equipment installed or used in manholes shall conform to the provisions of Section 32.25. Electrical equipment shall not be located where it could be submerged under water or sewage.

- 26.8 Venting - Gravity sewers must be adequately vented through holes in manhole covers when infiltration/inflow is not a problem, or through other provisions.

## 27. Sewers in Relation to Streams

- 27.1 Location of Sewers in Streams - The top of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the stream bed to protect the sewer line. In general, one foot of cover should be provided where the sewer is located in rock and three feet of cover (including concrete encasement) in other material; in major streams, more than three feet of

cover may be required. Less cover will be considered only if the proposed sewer crossing will not interfere with future improvements to the stream channel. Reasons for requesting less cover should be given in the application. In paved channels, the top of the sewer line should be placed below the bottom of the channel pavement. Sewer outfalls, headwalls, manholes, gateboxes or other structures shall be so located that they do not interfere with the free discharge of flood flows of the stream. Sewers located along streams shall be located outside of the streambed and sufficiently removed therefrom to provide for future possible stream widening and to prevent pollution by siltation during construction.

27.2 Construction - Sewers entering or crossing streams shall be constructed of cast or ductile iron pipe with mechanical joints or concrete encasement around other types of pipes so that they will remain watertight and free from changes in alignment or grade. Sewer systems shall be designed to minimize the number of stream crossings. The stream crossings shall be designed to cross the stream as nearly perpendicular to the stream flow as possible. The construction methods that will minimize siltation shall be employed. Upon completion of construction, the stream shall be returned as near as possible to its original condition. The stream banks shall be seeded, planted or other erosion prevention methods employed to prevent erosion. The consulting engineer shall specify the specific method or methods to be employed in the construction of the sewers in or near the stream to control siltation.

27.3 Siltation and Erosion Control - During construction of sewerage projects, the contractor shall be prohibited by clauses in the specifications from unnecessary disturbing or uprooting trees and vegetation along the stream bank and in the vicinity of the stream, dumping of soil and debris into streams and/or on banks of streams, changing course of the stream without encroachment permit, leaving cofferdams in streams, leaving temporary stream crossings for equipment, operating equipment in the stream, or pumping silt-laden water into the stream.

27.4 Inverted Siphons - Inverted siphons should have two or more barrels, with a minimum pipe size of six inches, and shall be provided with necessary appurtenances for convenient flushing maintenance; the manholes shall have adequate clearance for rodding; and in general, sufficient head shall be provided and pipe sizes selected to secure velocities of at least three feet per second at maximum monthly average flows conveyed by the sewers. The inlet and outlet details shall be arranged so that the normal flow is diverted to one barrel, so that either barrel may be cut out of service for cleaning.

27.5 Aerial Crossings - Support shall be provided for all joints in pipes utilized for aerial crossings. The supports shall be designed to prevent frost heave, overturning and settlement.

Precautions against freezing, such as insulation and increased slope, shall be provided. Expansion joints shall be provided between above-ground and below-ground sewers.

For aerial stream crossings, the impact of flood waters and debris shall be considered. The bottom of the pipe should be placed no lower than the elevation of the 50-year flood.

## 28. Protection of Water Supplies

28.1 Water Supply Interconnections - There shall be no physical connection between a public or private water supply system and a sewer, or appurtenance thereto, which would permit the passage of any sewage or polluted water into the potable water supply. No water pipe shall pass through or come in contact with any part of a sewer manhole.

28.2 Relation to Waterworks Structures - While no general statement can be made to cover all conditions, it is generally recognized that sewers shall be kept remote from public water supply

wells or other water supply sources and structures. When sewers are proposed in the vicinity of any water supply facilities, requirements in the state's Water Supply Manual should be used to confirm acceptable isolation distances. In general, sanitary sewers should be located at least 100 feet from public water supply sources and 50 feet from private water supply sources unless the sanitary lines are encased in concrete or constructed of ductile iron pipe with mechanical joints or equivalent.

### 28.3 Relation to Water Mains

- 28.31 Horizontal Separation - Whenever possible, sewers should be laid at least 10 feet, horizontally, from any existing or proposed water mains. Should local conditions prevent a lateral separation of 10 feet, a sewer may be laid closer than 10 feet to a water main if:
- a. it is laid in a separate trench; or if
  - b. it is laid in the same trench, with the water main located at one side of a bench of undisturbed earth; and if
  - c. in either case the elevation of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main.
- 28.32 Vertical Separation - Whenever sewers must cross under water mains, the sewer shall be laid at such an elevation that the top of the sewer is at least 18 inches below the bottom of the water main. When the elevation of the sewer cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation, for a distance of 10 feet extending on each side of the sewer. If possible, one full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible. The water main should be constructed of slip-on or mechanical-joint cast-iron pipe, PVC pipe, or pre-stressed concrete cylinder pipe and the sewer constructed of mechanical-joint cast-iron pipe for any portion within 10 feet of the water main. Both services shall be pressure tested to assure watertightness prior to backfilling. Where less than an 18" vertical separation exists between the water and sewer line, the sewer line may be concrete encased 10 feet on either side of the water main.

If possible, sewers crossing water mains shall be constructed so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main.

## 29. Alternative Sewer Systems

As an alternative to a conventional gravity sewer system, the use of such systems as small diameter, variable grade, vacuum, pressure sewers and STEP (septic tank effluent pumping) systems may be considered in designing the wastewater conveyance systems. The selection of conveyance systems should be based on both monetary and nonmonetary (e.g., environmental, social, institutional) considerations. This section includes design guidelines/standards for pressure sewer system. Proposals received for the use of any other alternative conveyance systems will be reviewed on their merits on a case-by-case basis. In general, the Department will use the consultant's analysis and recommendations, manufacturer's literature, experience with similar facilities and good engineering practice in reviewing such proposals.

## 29.1 Pressure Sewer System

29.11 Application - The pressure sewer system may be considered as an alternative to a conventional gravity collection system in situations where the use of gravity sewers is not feasible and/or cost-effective. It is expected that a pressure sewer system would generally be used in small sub-systems or areas. This system may be used under conditions such as the following:

- a. Where the topography makes it difficult for the potential users to be served by a gravity collection system.
- b. Where groundwater conditions make it difficult to construct and maintain a gravity collection system.
- c. Where excessive rock excavation makes the gravity collection system impractical.

29.12 Design Criteria - The following considerations shall be used for the design of a pressure sewer system, including the grinder pump units or centrifugal pump units where solids do not present a problem.

### a. Collection System

- (1) No pressure sewer less than 1 1/4 inches inside diameter shall be provided. The required size shall be determined to maintain low frictional losses in the system and a minimum scouring velocity of two feet per second at all points in the system.
- (2) Special care shall be exercised in the hydraulic design of a pressure sewer system which is proposed to serve ultimately more houses than those expected to be served initially.
- (3) The determination of flow in the pressure sewer system shall be made on the basis of the maximum probable number of grinder or centrifugal pump units that would be expected to run simultaneously or some other accepted method of computing the peak sewage flow rate in the system.
- (4) The pressure sewer system shall be laid out in a branched or tree configuration to avoid flow-splitting at branches which cannot be accurately predicted.
- (5) The pressure sewer piping shall be installed in a depth sufficient to protect against freezing and damage from vehicular traffic.
- (6) Although any suitable pipe material can be used, plastic pipe such as PVC SDR-26 or equivalent are considered suitable. A value of C-130 to 150 is recommended to be used for plastic pipes in the Hazen-Williams formula.
- (7) Clean-out connections shall be provided at distances not to exceed capacity of available cleaning equipment (approximately 500-600 feet). Appropriate valves for bypass pumping of the wastewater between cleanouts, necessary during the repair of the pressure sewer piping, shall be provided. Flushing cleanouts should be provided at the upstream end of every major branch.

- (8) Pressure and vacuum release valves shall be employed at appropriate locations. Pressure sewers should be constructed on a gradually ascending slope to minimize air binding.
- (9) The pressure sewer main shall be color taped or coded to distinguish between sanitary sewer and water main, and the direction of flow should be indicated on all pressure sewers inside the buildings.
- (10) Current requirements for protection of water supplies, as outlined in Section 28, shall be followed.
- (11) Pressure sewer system operating pressures in general shall not exceed a range of 40 to 60 psi for any appreciable period of time.
- (12) Thorough pressure testing of all lines, fittings, etc. shall be made prior to start-up.
- (13) Details of construction shall be clearly stated in the drawings and/or specifications.

b. Grinder Pump Units

- (1) The minimum net storage capacity of the grinder pump unit shall be approximately 50 gallons. The grinder pump tank should be able to accommodate normal peak flows and emergency storage during a short power failure.
- (2) If grinder pump units are replacing an existing on-lot system, the existing system should be retained for holding wastewater during an extensive power failure. An emergency overflow should be provided from the grinder pump tank to the emergency holding tank.
- (3) The grinder pump shall have the characteristics which will continue to produce flows of at least eight gpm under all conditions.
- (4) Check and shut-off valves shall be employed to isolate the grinder pump unit from the house service line and the pressure laterals.
- (5) Appropriate high water and overflow detection devices such as visual and/or audio alarm shall be provided. The grinder pump control panel shall contain a separate control circuit and breaker for the alarms.
- (6) Provisions shall be made to insure that the grinder pump operates under power load fluctuations and contains integral protection against back siphonage and over pressure.
- (7) The grinder pump unit shall be capable of reducing any material in the wastewater which enters the grinder unit to such size that the material will

pass through the pump unit and pressure sewer without plugging or clogging. No screens or other devices requiring regular maintenance shall be used to prevent trashy material from entering the grinder pump.

- (8) At least one stand-by grinder pump unit for each 50 units or fraction thereof shall be provided for emergency replacement.
- (9) If the grinder pump unit is installed outside the residence, provision must be made for access, as well as protection, from weather and vandalism. Inside installations shall be quiet and free from electrical and/or health hazards. All installations shall be certified by nationally recognized independent testing laboratories, such as the Underwriter's Laboratories, Inc. and the National Sanitation Foundation.
- (10) The grinder pump unit must be capable of being removed without dewatering the collection tank.

c. Centrifugal Pump Units

- (1) As an alternative to using the grinder pump unit, a centrifugal pump may be used in conjunction with an existing septic tank or other pump tank. Specifically designed centrifugal pumps with cutters may be used in lieu of grinder pump for pumping raw wastewater.
- (2) All conditions applicable to the grinder pump unit as stated in Section 29.12b, which can be utilized with the centrifugal pump unit, shall be considered.

29.13 Operation, Maintenance and Service - Grinder pump units must be serviceable and replaceable under wet conditions without electric hazard to the repair personnel. Provisions should also be made to avoid interruption of sewer service due to mechanical or power failure.

- a. Ownership and Repair Services - Ownership and responsibilities for repair and maintenance of the pressure sewers and grinder pump units shall be clearly defined and established prior to the approval of any installation. The pressure sewer system shall be owned, maintained and operated by a municipal or other governmental body or private company. The grinder or centrifugal pump unit may be owned and operated by a private concern or individual. However, the pump unit should be maintained through a maintenance agreement, by the owner of the pressure sewer system. Private ownership and maintenance will be accepted as a viable alternative. The party maintaining the units shall have full repair service capability on short notice.

## 30. WASTEWATER PUMPING STATIONS

### 31. General

- 31.1 Flooding - Wastewater pumping station structures and electrical and mechanical equipment shall be protected from physical damage by the 100-year flood. Wastewater pumping stations should remain fully operational and accessible during the 25-year flood. Applicable regulations of State and Federal agencies regarding flood plain obstructions shall be followed.
- 31.2 Accessibility - The pumping stations shall be readily accessible by maintenance vehicles during all weather conditions. It is recommended that pump station areas be fenced and that hatches to pump stations be locked, especially for those pump stations located in remote areas. The facility should be located off the traffic way of streets and alleys.
- 31.3 Grit - Where it is necessary to pump wastewater prior to grit removal, the design of the wet well and pump station piping shall receive special consideration to avoid operational problems from the accumulation of grit.
- 31.4 When an existing pumping station is to be modified, the specifications shall include provisions for adequate pumping capacity during the construction period.
- 31.5 Types - Wastewater pumping stations in general use fall into four types: wet well/dry well, submersible, suction lift and screw pump. Wet well/dry well, submersible and suction lift pump stations are described under Sections 32, 33 and 34, respectively.

### 32. Wet and Dry Well Pump Stations

#### 32.1 Structures

- 32.11 Separation - Dry wells, including their superstructure, shall be completely separated from the wet well. A dehumidifier is recommended for moisture control.
- 32.12 Equipment Removal - Provisions shall be made to facilitate removing pumps, motors, and other mechanical and electrical equipment.
- 32.13 Access - Suitable and safe means of access for persons wearing self-contained breathing apparatus shall be provided for both dry and wet wells.

For built-in-place pump stations, a stairway with rest landings should be provided at vertical intervals not to exceed 12 feet. For factory-built pump stations over 15 feet deep, a rigidly fixed landing should be provided at vertical intervals not to exceed 10 feet. Where a landing is used, a rigidly fixed barrier should be provided to prevent an individual from falling past the intermediate landing to a lower level. A manlift or elevator may be used in lieu of landings in a factory-built station, provided emergency access is included in the design.

- 32.14 Construction Material - Due consideration shall be given to the selection of materials because of the presence of hydrogen sulfide and other corrosive gases, greases, oils, and other constituents frequently present in wastewater.
- 32.15 Buoyancy - Where high groundwater conditions are anticipated, buoyancy of the wastewater pumping station structures shall be considered and, if necessary, adequate provisions shall be made for their protection.

## 32.2 Pumps and Pneumatic Ejectors

- 32.21 Multiple Units - At least two pumps or pneumatic ejectors shall be provided. A minimum of three pumps should be provided for stations designed to handle maximum monthly average flows of greater than one mgd.

Where only two units are provided, they shall be of the same capacity. Each shall be capable of handling peak instantaneous flows. Where three or more units are provided, they should be designed to fit actual flow conditions and must be of such capacity that with any one unit out of service, the remaining units will have capacity to handle peak instantaneous flows.

- 32.22 Protection Against Clogging - Pumps handling sanitary or combined wastewater shall be preceded by one or more of the screening devices such as a manually cleaned bar screen, mechanically cleaned bar screen, comminutor, or coarse bar rack to protect the pumps from clogging or damage. Where a manually and/or mechanically cleaned bar screen is used, refer to Section 51.131 for appropriate bar spacing. Where a manually cleaned bar screen or coarse bar rack is provided, convenient facilities must be provided for handling screenings.

- 32.23 Except where grinder pumps are used, pumps shall be capable of passing spheres of at least three inches in diameter, and pump suction and discharge piping shall be at least four inches in diameter.

- 32.24 Priming - The pump shall be so placed that under normal operating conditions, it will operate under a positive suction head, except as specified in Section 33 for suction lift pump stations.

- 32.25 Electrical Equipment - Electrical systems and components in wet wells (e.g., motors, lights, cables, conduits, switchboxes, control circuits, etc.) shall comply with the National Electrical Code requirements for Class I, Division 1, Group D, locations. In addition, equipment located in the wet well shall be suitable for use under corrosive conditions. Each flexible cable shall be provided with a water-tight seal and separate strain relief. A fused disconnect switch located above ground shall be provided for all pumping stations. When such equipment is exposed to weather, it shall meet the requirements of weather proof equipment. NEMA 3R or 4.

Electrical systems and components in dry well shall comply with the National Electrical Code requirements for Class I, Division 1, Group D locations, if the structural configuration or piping arrangement could lead to a situation where hazardous concentrations of flammable gases or vapors "could reasonably be present".

A 110 volt power receptacle to facilitate maintenance should be provided inside the control panel for lift stations that have control panels outdoors. Ground fault interruption protection shall be provided for all outdoor outlets.

- 32.26 Intake - Each pump should have an individual intake. Wet well design should be such as to avoid turbulence near the intake and to prevent vortex formation. Intake piping should be as straight and short as possible.

- 32.27 Dry Well Dewatering - A sump pump equipped with dual check valves shall be provided in the dry wells to remove leakage or drainage with the discharge above the high water level of the wet well. Water ejectors connected to a potable water supply will not be

approved. All floor and walkway surfaces should have an adequate slope to a point of drainage. Pump seal water shall be piped to the sump.

32.28 Pumping Rates - The pumps and controls of main pumping stations, and especially pumping stations operated as part of the treatment facility, should be selected to operate at varying delivery rates. Such pump stations should be designed to deliver as uniform flow as practicable in order to minimize hydraulic surges.

32.29 Quick disconnect provisions should be considered in wet well type pumping stations for ease in replacing pumps.

### 32.3 Controls

32.31 Type - Control systems shall be of the air bubbler type, the encapsulated float type, the sonic detector type, or the flow measuring type. Float tube control systems on existing stations being upgraded may be approved, provided that related electrical equipment complies with the National Electrical Code requirements for Class I, Division 1, Group D locations.

32.32 Location - The control system shall be located away from the turbulence of incoming flow and pump suction. Float tubes in dry wells shall extend high enough to prevent overflow. Provisions should be made to automatically alternate the pumps in use.

32.4 Valves - Suitable shutoff valves shall be placed on the suction line of dry pit pumps.

Suitable shutoff and check valves shall be placed on the discharge line of each pump (except on screw pumps). The check valve shall be located between the shutoff valve and the pump. Check valves shall be suitable for the material being handled and shall be placed on the horizontal portion of discharge piping. Check valves shall not be placed on the vertical portion of discharge piping except that check valves may be approved on vertical risers when plans and specifications require a specific valve which is designed and is advertised by the manufacturer as suitable for raw wastewater on a vertical riser (e.g. ball check valves). Valves shall be capable of withstanding normal pressure and water hammer. Motorized slow closing plug valves are acceptable.

All shutoff and check valves shall be operable from the floor level and accessible for maintenance. Outside levers are recommended on swing check valves.

Where limited pump backspin will not damage the pump and low discharge head conditions exist, short individual force mains for each pump may be considered in lieu of discharge valves.

Valves shall not be located in the wet well.

### 32.5 Wet Wells

32.51 Divided Wells - Consideration should be given to dividing the wet well into multiple sections, properly interconnected, to facilitate repairs and cleaning.

32.52 Size - The wet well size and control setting shall be appropriate to avoid heat buildup in the pump motor due to frequent starting and to avoid septic conditions due to excessive detention time. The effective capacity (e.g., capacity between working levels) of the wet well shall generally provide a holding period not to exceed 10 minutes for the maximum monthly average flow. Where tributary flow distance is short, a holding period not to exceed 30 minutes for the maximum monthly average flow should be considered.

32.53 Floor Slope - The wet well floor shall have a minimum slope of one horizontal to one vertical (1:1) to the hopper bottom. The horizontal area of the hopper bottom shall be not greater than necessary for proper installation and functioning of the inlet.

32.6 Ventilation - Ventilation shall be provided for all pump stations. Where the dry well is below the ground surface, mechanical ventilation is required. If screens or mechanical equipment requiring maintenance or inspection are located in the wet well, permanently installed ventilation is required. There shall be no interconnection between the wet well and dry well ventilation systems.

In dry wells over 15 feet deep, multiple inlets and outlets are desirable. Dampers should not be used on exhaust or fresh air ducts, and fine screens or other obstructions in air ducts should be avoided to prevent clogging.

Switches for operation of ventilation equipment should be marked and located conveniently. All intermittently operated ventilating equipment shall be interconnected with the respective pit lighting system. Consideration should be given for the use of automatic controls where intermittent operation is used. The manual lighting ventilation switch shall override the automatic controls. The fan wheel should be fabricated from non-sparking material. Automatic heating and/or dehumidification equipment shall be provided in all dry wells. The electrical equipment and components shall meet the requirements in Section 32.25.

32.61 Wet Wells - Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least 12 complete air changes per hour; if intermittent, at least 30 complete air changes per hour. Air shall be forced into the wet well by mechanical means rather than exhausted from the wet well.

32.62 Dry Wells - Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least six complete air changes per hour; if intermittent, at least 30 complete air changes per hour.

32.7 Flow Measurement - Suitable devices for measuring wastewater flow shall be considered at all pumping stations.

32.8 Water Supply - There shall be no physical connection between any potable water supply and a wastewater pumping station which, under any conditions, might cause contamination of the potable water supply. If a potable water supply is brought to the station, it should comply with conditions stipulated under Section 46.2.

### 33. Suction Lift Pump Stations

Suction lift pumps shall be of the self-priming or vacuum-priming type and shall meet the applicable requirements under Section 32. Suction lift pump stations using dynamic suction lifts exceeding the limits outlined in the following sections may be approved by the Department upon submission of factory certification of pump performance and detailed calculations indicating satisfactory performance under the proposed operating conditions. The pump equipment compartment shall be above grade or offset and shall be effectively isolated from the wet well to prevent the humid or corrosive atmosphere from entering the equipment compartment. Wet well access shall not be through the equipment compartment. Valving shall not be located in the wet well.

- 33.1 Self-Priming Pumps - Self-priming pumps shall be capable of rapid priming and repriming at the "lead pump on" elevation. Such self-priming and repriming shall be accomplished automatically under design operating conditions. Suction piping should not exceed the size of the pump suction and shall not exceed 25 feet in total length. Priming lift at the "lead pump on" elevation shall include a safety factor of at least four feet from the maximum allowable priming lift for the specific equipment at design operating conditions. The combined total of dynamic suction lift at the "pump off" elevation and required net positive suction head at design operating conditions shall not exceed 22 feet.
- 33.2 Vacuum Priming Pumps - Vacuum priming pump stations shall be equipped with dual vacuum pumps capable of automatically and completely removing air from the suction lift pump. The vacuum pumps shall be adequately protected from damage due to wastewater. The combined total of dynamic suction lift at the "pump off" elevation and required net positive suction head at design operating conditions shall not exceed 22 feet.
34. Submersible Pump Stations
- Submersible pump stations shall meet the applicable requirements under Section 32, except as modified in this Section.
- 34.1 Construction - Submersible pumps and motors shall be designed specifically for raw wastewater use and shall meet the requirements of the National Electrical Code for such units. An effective method to detect shaft seal failure should be provided.
- 34.2 Pump Removal - Submersible pumps shall be readily removable and replaceable without dewatering the wet well or disconnecting any piping in the wet well.
- 34.3 Electrical
- a. Electrical supply, control and alarm circuits shall be designed to provide strain relief and to allow disconnection at a junction box located or accessible from outside the wet well. Terminals and connectors shall be protected from corrosion by location outside of the wet well or by water-tight seals. If located outside, weatherproof equipment shall be used.
  - b. The motor control center shall be protected by a conduit seal or other appropriate sealing method meeting the requirements of the National Electrical Code for Class I, Division 1, Group D locations.
  - c. The pump motor shall meet the requirements of the National Electrical Code for Class I, Division 1, Group D locations.
  - d. Pump motor power cords shall be designed for flexibility and serviceability under conditions of extra hard usage. Ground fault interruption protection shall be used to deenergize the circuit in the event of any failure in the electrical integrity of the cable.
  - e. Power cord terminal fittings shall be provided with strain relief appurtenances and shall be designed to facilitate field connection.
- 34.4 Valves - Valves required under Section 32.4 shall be located in a separate valve pit. Accumulated water shall be drained to the wet well or to the soil. If the valve pit is drained to the wet well, the discharge point shall be above the high water level of the wet well.

34.5 Operation - Submersible pumps shall be capable of unsubmerged operation without damage or reduction of service capability, or positive provisions (e.g., back-up controls) shall be made to assure submergence.

### 35. Alarm Systems

Alarm systems shall be provided for pumping stations. The alarm shall be activated in cases of power failure, pump failure, use of the lag pump, unauthorized entry, high water, or any cause of pump station malfunction. Pumping station alarms should be telemetered, including identification of the alarm condition, to a municipal facility that is manned 24 hours a day. If such a facility is not available, the alarm shall be telemetered to city offices during normal working hours and to the home of the person(s) in responsible charge of the pump station during off-duty hours. Audio-visual alarm systems with a self-contained power may be acceptable in some cases in lieu of the telemetering system outlined above, depending upon location, station holding capacity, and inspection frequency.

### 36. Emergency Operation

Pumping stations and collection systems shall be designed to prevent or minimize bypassing of raw wastewater. For use during possible periods of extensive power outages, mandatory power reductions or storm events, consideration should be given to providing a controlled, high-level wet well overflow to supplement alarm systems and emergency power generation in order to prevent backup of wastewater into basements, or other discharges which may cause severe adverse impacts on public interests, including public health and property damage. Where a high-level overflow is utilized, consideration shall also be given to the installation of storage detention tanks or basins, which shall be made to drain to the station wet well. Where such overflows affect public water supplies, shell fish production or waters used for culinary or food processing purposes, a storage detention basin or tank shall be provided having a two-hour detention capacity at the anticipated overflow rate.

36.1 Overflow Prevention Methods - A satisfactory method shall be provided to prevent or minimize overflows. The following methods should be evaluated on an individual basis. The choice should be based on least cost and least operation problems of the methods providing an acceptable degree of reliability.

36.11 Storage Capacity - Storage capacity, including trunk sewers for retention of wet weather flows, should be evaluated. Storage basins must be designed to drain back into the wet well or collection system after the flow recedes.

36.12 In-Place or Portable Pump - An in-place or portable pump driven by an internal combustion engine meeting the requirements of Section 36.2 below, capable of pumping from the wet well to the discharge side of the station, should be considered.

36.13 Independent Public Utility Sources - Independent public utility sources or engine-driven generating equipment meeting the requirements of Section 36.2 below should be considered.

### 36.2 Equipment Requirements

36.21 General - The following general requirements shall apply to all internal combustion engines used to drive auxiliary pumps, service pumps through special drives or electrical generating equipment.

- 36.211 Engine Protection - The engine must be protected from operating conditions that would result in damage to equipment. Unless continuous manual supervision is planned, protective equipment shall be capable of shutting down the engine, activating an alarm on site and as provided in Section 35. Protective equipment shall monitor for conditions of low oil pressure and overheating, except oil pressure monitoring will not be required for engines with splash lubrication.
- 36.212 Size - The engine shall have adequate rated power to start and continuously operate all connected loads.
- 36.213 Fuel Type - Reliability and ease of starting, especially during cold weather conditions, should be considered in the selection of the type of fuel.
- 36.214 Engine Ventilation - The engine shall be located above grade with adequate ventilation of fuel vapors and exhaust gases.
- 36.215 Routine Start-up - All emergency equipment shall be provided with instructions indicating the need for regular starting and running of such units at full loads.
- 36.216 Protection of Equipment - Emergency equipment shall be protected from damage at the restoration of regular electrical power.
- 36.22 Engine-Driven Pumping Equipment - Where permanently installed or portable engine-driven pumps are used, the following requirements, in addition to general requirements, shall apply.
  - 36.221 Pump(s) Capacity - Engine driven pump(s) shall meet the design pumping requirements unless storage capacity is available for flows in excess of pump capacity. Pumps shall be designed for anticipated operating conditions, including suction lift, if applicable.
  - 36.222 Operation - The engine and pump shall be equipped to provide automatic start-up and operation of pumping equipment unless manual start-up and operation is justified. Provisions shall also be made for manual start-up. Where manual start-up and operation is justified, storage capacity and alarm system must meet the requirements of Section 36.223.
  - 36.223 Portable Pumping Equipment - Where part or all of the engine- driven pumping equipment is portable, sufficient storage capacity with alarm system shall be provided to allow time for detection of pump station failure and transportation and hookup of the portable equipment. A riser from the force main with quick connect coupling and appropriate valving shall be provided to hook up portable pumps.
- 36.23 Engine-Driven Generating Equipment - Where permanently installed or portable engine-driven generating equipment is used, the following requirements, in addition to general requirements, shall apply.
  - 36.231 Generating Capacity - Generating unit size shall be adequate to provide power for pump motor starting current and for lighting, ventilation, and other auxiliary equipment necessary for safety and proper operation of the lift station.

The operation of only one pump during periods of auxiliary power supply must be justified. Such a justification may be made on the basis of maximum

anticipated flows relative to single pump capacity, anticipated length of power outage, and storage capacity.

Special sequencing controls shall be provided to start pump motors unless the generating equipment has the capacity to start all pumps simultaneously with auxiliary equipment operating.

36.232 Operation - Provisions shall be made for automatic and manual start-up and load transfer. The generator must be protected from operating conditions that would result in damage to equipment. Provisions should be considered to allow the engine to start and stabilize at operating speed before assuming the load. Where manual start-up and transfer is justified, storage capacity must meet the requirements in Section 36.233.

36.233 Portable Generating Equipment - Where portable generating equipment or manual transfer is provided, sufficient storage capacity to allow time for detection of pump station failure and transportation and connection of generating equipment, shall be provided. The use of special electrical connections and double throw switches are recommended for connecting portable generating equipment.

### 37. Instructions and Equipment

Wastewater pumping stations and their operators should be supplied with a complete set of operational instructions, including emergency procedures, maintenance schedules, special tools, and such spare parts as may be necessary.

### 38. Force Mains

38.1 Velocity - At maximum monthly average flow, a velocity of at least two feet per second shall be maintained.

38.2 Air and Vacuum Relief Valve - An air relief valve shall be placed at high points in the force main to prevent air locking. Vacuum relief valves may be necessary to relieve negative pressure on force mains. The force main configuration and head conditions should be evaluated as to the need for and placement of vacuum relief valves.

38.3 Termination - Force mains should enter the gravity sewer system at a point not more than two feet above the flow line of the receiving manhole.

38.4 Pipe and Design Pressure - Pipe and joints shall be equal to water main strength materials suitable for design conditions. The force main, reaction blocking and station piping shall be designed to withstand water hammer pressures and associated cyclic reversal stresses that are expected with the cycling of wastewater pump stations. Surge protection chambers should be evaluated.

38.5 Special Construction - Force main construction near streams shall meet applicable requirements of Section 27.

38.6 Design Friction Losses - Friction losses through force mains shall be based on the Hazen-Williams formula or other acceptable method. When the Hazen-Williams formula is used, the following values for "C" shall be used for design.

Unlined iron or steel	-	100
PVC	-	130-150
All other	-	120

When initially installed, force mains will have a significantly higher "C" factor. The higher "C" factor should be considered only in calculating maximum power requirements.

- 38.7 Minimum Size - No public force main shall be less than four inches in diameter, except where grinding facilities are used.
- 38.8 Separation from Water Mains - There shall be at least a 10-foot horizontal separation between water mains and sanitary sewer force mains. Force mains crossing water mains shall be laid to provide a minimum vertical distance of 18 inches between the outside of the force main and the outside of the water main. This shall be the case where the water main is either above or below the force main. At crossings, if possible, one full length of water pipe shall be located so both joints will be as far from the force main as possible. Special structural support for the water main and force main may be required.
- 38.9 Identification of Force Mains and Leakage Testing - Where force mains are constructed of material which might cause the force main to be confused with potable water mains, the force main should be appropriately identified.

Leakage tests, including testing methods and leakage limits, shall be specified in contract documents.

39. RESERVED FOR FUTURE USE

## 40. WASTEWATER TREATMENT PLANTS

### 41. General

41.1 Design Information - The engineer should confer with the Department before proceeding with the design of detailed plans for wastewater treatment plants. Plants should be designed to serve about 20 years projected population from the initiation of design. Deferred construction of those units which can be easily increased in capacity is a consideration to minimize the initial construction costs.

41.2 Plant Location - In general, to avoid local objections, a wastewater treatment plant site should be as far as practicable from any present built-up area or any area which will probably be built up within a reasonable future period. It is recommended that the treatment plant be at least 250 feet from an occupied dwelling or recreational area. The direction of prevailing winds should be considered when selecting the plant site. If a critical location must be used, special consideration must be given to the design and type of plant provided. Space should be provided to allow for plant expansion in the event of a population expansion or requirement for additional treatment. Compatibility of treatment process with the present and planned future land use, including noise, potential odors, air quality, and anticipated sludge processing and disposal techniques should be considered.

Where a site must be used which is critical with respect to these items, appropriate measures shall be taken to minimize adverse impacts.

Local soil characteristics, geology, hydrology, and topography should be considered.

41.3 Flood Protection - The treatment plant structures, electrical and mechanical equipment shall be protected from physical damage by the 100-year flood. Treatment plant should remain fully operational and accessible during the 25-year flood. This applies to new construction and to existing facilities undergoing major modification.

41.4 Climate Protection - At treatment plants designed to be operated during the winter months, a walk-in housing with heaters shall be provided for equipment such as blowers, chlorinators, chemical feeders, and controls which may be adversely affected by low temperatures. Special design consideration shall also be given to treatment units which, based on practical operating experience, will operationally be adversely affected by cold weather.

### 42. Quality of Effluent

The wastewater treatment plant shall be designed to meet all NPDES Part I Permit effluent limitations.

### 43. Design

43.1 Type of Treatment - Careful consideration should be given to the type of treatment before making a final decision. A few of the important factors which would influence the selection of the type of treatment are: the location and topography of the plant site, the effect of industrial wastes likely to be encountered, the effect of cold temperatures on treatment efficiency, operating costs, the probable type of supervision and operation which the plant will need, and present and future effluent requirements.

Other considerations, such as space available for future plant expansion, ultimate disposal or utilization of sludge, energy requirements, process complexity, environmental impact on present and future adjacent land use, and construction in floodplains and wetlands should be taken into account.

43.2 New Processes, Methods and Equipment - See Section 9.4.

43.3 Industrial Wastes - Wherever applicable, information on the expected physical, chemical, and biological characteristics of industrial wastewater should be obtained in order to determine its treatability characteristics and acceptability for discharge into the sewerage system (e.g. to determine what pretreatment requirements may be appropriate). It may be necessary to conduct a pilot plant study of the treatability of the wastewater to establish appropriate design parameters.

43.4 Design Flow - The wastewater received at the treatment plant is made up of domestic wastewater, industrial wastewater, and the infiltration/inflow within the sewer system. Domestic wastewater consists of flow from residential, commercial, institutional, and recreational establishments. Industrial wastewater includes wastewater generated by employees and any process or cooling water discharged to the sewer system.

The design flow of a treatment plant is a generalized term reflective of all of the above components, which indicates the flow conditions, up to which the facility will be capable of providing a predetermined level of treatment. The treatment plant shall be designed to accommodate the design flow conditions while meeting the NPDES (Part I) and Water Quality Management (Part II) permit requirements, and also to avoid potential overload situations as defined in Chapter 94 of the Department's rules and regulations.

The treatment plant/unit process design necessitates the use of a set of specific design flow parameters to accurately express the different design flow conditions which will occur due to: (a) diurnal variations (e.g. morning flush), (b) non-domestic source variations (e.g. industrial process flows), (c) seasonal domestic variations (e.g. vacation homes and recreational facilities), and (d) seasonal weather-induced variations (e.g., infiltration/inflow). The individual unit process design standards contained in this manual describe the appropriate design flow parameters to be used in designing a particular unit. The name, general definitions, and typical application of the commonly used design flow parameters are given below.

<b><u>Design Flow Parameter</u></b>	<b><u>General Definition</u></b>	<b><u>Typical Application</u></b>
Annual Average Flow	The total flow received at the facility during any one calendar year divided by 365 (the number of days in that period).	The “nominal” design flow of a facility.  Used for cost comparisons and annual estimates of O&M costs.  Used for water quality modeling.  Used for evaluating Act 537 plan updates.  Used to determine allowable mass loadings in NPDES permits.
Monthly Average Flow	The total flow received at the facility during any one calendar month divided by the number of days in that month.	A flow reporting parameter used in discharge monitoring reports.
Maximum Monthly Average Flow	The highest monthly average flow during any one calendar year.	Determine the overall hydraulic design of the facility.  Used for evaluating Act 537 plan updates and planning modules.  Is the “hydraulic capacity” for Chapter 94 determinations.  Establishes the monthly average flow limitation on NPDES permit.
Peak Hourly Flow	The maximum flow rate received at the facility averaged over a period of one hour.	Designing clarifiers, chlorine contact tanks, and other hydraulically sensitive units.
Peak Instantaneous	The maximum instantaneous flow rate received at the facility at any given time.	Designing comminutors, pump stations, piping, and units subject to peak flow conditions.
Minimum Hourly Flow	The least flow rate received at the facility over a period of one hour.	Designing pump stations, and other units sensitive to excessive detention times.

- 43.41 New Systems - For municipal systems and subdivisions of over 150 homes, the design annual average flow shall be based on 100 gallons per capita per day, with a 24-hour runoff period. The design annual average flow for plants serving less than 150 homes may be based on 75 gallons per capita per day, with a 16-hour runoff period. These flow figures include an allowance for infiltration.

Any deviation from these values should be based on actual data for water consumption and projected or anticipated flow due to infiltration (during high groundwater conditions). The pipe manufacturer's recommendations and/or actual infiltration values obtained in the field with the use of a similar kind of pipe having similar field conditions may be used to establish the projected flow due to infiltration.

The design flow for institutional and recreational establishments should be based on the design data in Section 43.51 of the manual and/or water consumption data (actual or estimated).

Estimates of design wastewater flows for industrial/commercial dischargers must take into account the expected amounts of process wastewater, sanitary wastewater, and cooling water which will be discharged into the sewerage system. Such information should be obtained directly from the owner/operator of the industrial/commercial establishment.

- 43.42 Existing Systems - When an existing treatment plant is expanded/upgraded, the volume and strength of existing flows shall be determined. As a minimum, the existing plant's past five years of data (if available) shall be reviewed, and a design engineer's report summarizing the monthly flows, loadings and corresponding performance of various units and/or plant as a whole should be prepared for at least three years' representative data (exclude the data pertaining to abnormal rain or drought conditions). The report should serve as the basis for development of the design flow and organic loadings based on the past as well as projected future conditions.

The design flow for the proposed plant expansion/upgrade should be based on the maximum monthly average flow derived from historical data, plus the additional projected maximum monthly average flow due to future flow contributions during the design period of the plant. The projected flow should include domestic wastewater flow, industrial wastewater flow, and infiltration/inflow within the sewer system based on future conditions.

The submission of a Water Quality Management Part II Permit application must be accompanied with a design engineer's report. The report must include information concerning the basis of design flow, the proposed and existing unit processes, the design and operational standards applied to each of the process units, and the source of information used as the basis of the design standards.

When an existing sewer system (currently not served by a treatment facility) is to be served by a new or modified treatment facility, the volume and strength of existing flows shall be determined. Flow monitoring of the sewer system should be conducted to obtain such information as maximum monthly flow, maximum monthly loading, peak hourly flow, etc., necessary to design various treatment units utilizing the appropriate flow parameters as described in the manual or other design literature for each treatment unit.

43.43 Flow Equalization - Facilities for equalization of flows shall be considered at all treatment plants in order to provide flexibility in plant operation and facilitate optimal plant performance. This will better insure that the desired effluent quality will be consistently obtained.

43.5 Organic Design - The organic loading received at the treatment plant is made up of domestic loading and industrial loading. Domestic loading consists of loadings from residential, commercial, institutional, and recreational establishments and includes all loadings except from industries. The design organic loading is the rated/permitted organic capacity of the treatment plant to provide a predetermined level of treatment. The treatment plant shall be designed to meet the NPDES as well as Part II permit requirements and avoid potential overload as defined under Chapter 94 of the Department's rules and regulations. The plant should be designed to treat the maximum monthly average organic loading. The shock effects of high concentrations and peak diurnal flows for short periods of time on the treatment process, particularly for small treatment plants, should be considered.

Biological Oxygen Demand (BOD) as used in this manual is defined as the amount of oxygen required to stabilize biodegradable organic matter under aerobic conditions within a five-day period.

43.51 New Systems - The following design data should be used in the design of wastewater treatment plants to serve new sewerage systems unless information is submitted to justify different values. The most recent U.S. Census data should be used to develop population projections.

For municipalities:

Flow	100 gpd/cap, including infiltration
BOD	0.17 lb/day/cap (0.22 lb/day/cap may be used when garbage grinders are prevalent)
Suspended Solids	0.20 lb/day/cap (0.25 lb/day/cap may be used when garbage grinders are prevalent)
Runoff Period	24 hours

Note: Add appropriate allowance for industrial, commercial, institutional and recreational contributions. Also, any contributions from such sources as septic tank cleaners, landfill leachates, etc. should be added.

For subdivisions of not over 150 houses and mobile home spaces:

Flow	75 gpd/cap, including infiltration
BOD	0.17 lb/day/cap (0.22 lb/day/cap may be used when garbage grinders are prevalent)
Suspended Solids	0.20 lb/day/cap (0.25 lb/day/cap may be used when garbage grinders are prevalent)
Runoff Period	16 hours

For public schools:

Toilet Rooms only:

Flow 7 gpd/cap

BOD 0.04 lb/day/cap

For kitchen add 3 gpd/cap and 0.04 lb/day/cap BOD allowance if appropriate

For gym add 3 gpd/cap and 0.02 lb/day/cap BOD allowance if appropriate

Runoff Period 8 hours

For boarding schools:

Flow 75 gpd/cap

BOD 0.17 lb/day/cap

Runoff Period 16 hours

For factories:

Flow 35 gpd/cap

BOD 0.085 lb/day/cap

Runoff Period Length of shift

Note: The facility shall be designed for largest shift.

For camps:

Flow 60 gpd/cap

BOD 0.12 lb/day/cap

Runoff Period 16 hours

For hospitals and similar institutions:

Flow 150-250 gpd/cap

BOD 0.17 lb/day/cap plus proper allowance for extra facilities

Runoff Period 12-24 hours

43.511 Design by Analogy - Data from similar municipalities or subdivisions may be utilized in the case of new systems; however, the designer must be able to clearly

show to the Department the similarities between the existing municipalities or subdivisions (whose data are to be used) and the proposed facility. The designer should submit a narrative outlining the rationale for the data from similar municipalities or subdivisions.

43.52 Existing Systems - When an existing treatment plant is to be expanded/upgraded, the design organic loading shall be based on the maximum monthly average organic load the facility is required to treat during the design life of the facility. The design organic loading is based on the maximum monthly average organic loading derived from historical data plus the additional projected maximum monthly average organic loading due to future load contributions. The design engineer's report (as described under Section 43.42) should serve as the basis for the development of the design organic loading. The determination should take into account both dry weather and wet weather conditions.

43.6 Conduits - All piping and channels should be designed to carry the peak instantaneous flows. The incoming sewer should be designed for unrestricted flow. Bottom corners of the channels must be filleted. Conduits shall be designed to avoid creation of pockets and corners where solids can accumulate. Suitable gates should be placed in channels to seal off unused sections which might accumulate solids. The use of shear gates, stop gates, or stop planks is permitted where they can be used in place of gate valves or sluice gates. Corrosion resistant materials shall be used for these control gates. All piping and channels shall be accessible for cleaning out settled solids.

43.7 Arrangement of Units - All treatment units and their components should be arranged for greatest operation and maintenance convenience, flexibility, economy, continuity of effluent quality, and for facilitation of the installation of future units. Cold weather operation should also be considered when arranging the treatment units and their component parts to utilize, where feasible, solar radiant heat and natural protection from wind and weather.

43.8 Flow Division Control - Flow division control facilities shall be provided, as necessary, to insure organic and hydraulic loading control to plant process units and shall be designed for easy operator access for change, observation, and maintenance. The use of head boxes equipped with adjustable sharp-crested weirs or similar devices is recommended. The use of valves for flow splitting is not recommended. Appropriate flow measurement shall be incorporated in the flow division control design.

#### 44. Plant Details

44.1 Installation of Mechanical Equipment - The specifications should be so written that the installation and initial operation of major items of mechanical equipment will be supervised by a representative of the manufacturer.

44.2 Unit Bypasses - Properly located and arranged bypass structures and piping shall be provided so that each unit of the plant can be removed from service independently. The bypass design shall facilitate plant operation during unit maintenance and emergency repair so as to minimize deterioration of effluent quality and insure rapid process recovery upon return to normal operational mode. The system with two or more units and involving open basins (such as settling basins, aeration basins, disinfectant contact basins) shall not be required to have provisions for bypassing if the peak instantaneous wastewater flows can be handled hydraulically with the largest flow unit out of service.

44.21 Unit Bypass During Construction - Final plan documents shall include bypass requirements as deemed necessary by the Department to avoid unacceptable temporary water quality degradation.

44.3 Drains - Means shall be provided to dewater each unit to an appropriate point in the process. Due consideration shall be given to the possible need for hydrostatic pressure relief devices to prevent flotation of structures. Pipes subject to clogging shall be provided with means for mechanical cleaning or flushing.

44.4 Construction Materials - Due consideration should be given to the selection of materials which are to be used in a wastewater treatment plant because of the possible presence of hydrogen sulfide and other corrosive gases, greases, oils, and similar constituents frequently present in the wastewater. This is particularly important in the selection of metals and paints. Contact between dissimilar metals should be avoided to minimize galvanic action.

44.5 Painting - The use of paints containing lead or mercury should be avoided. In order to facilitate identification of piping, particularly in the large plants, it is suggested that the different lines be color coded. The following color scheme is recommended for purposes of standardization:

Raw sludge line - brown with black bands

Sludge recirculation suction line - brown with yellow bands

Sludge draw off line - brown with orange bands

Sludge gas line - orange (or red)

Natural gas line - orange (or red) with black bands

Nonpotable water line - blue with black bands

Potable water line - blue

Chlorine line - yellow

Wastewater line - gray

Compressed air line - green

Water lines for heating digesters or buildings - blue with a six-inch red band spaced 30 inches apart

The contents and direction of flow shall be stenciled on the piping in a contrasting color.

44.6 Operating Equipment - A complete set of tools, accessories, and spare parts necessary for the plant operator's use shall be provided. Readily accessible storage space and work bench facilities shall be provided, and consideration should be given to provisions of a garage area for large equipment, maintenance, and repair.

44.7 Erosion Control During Construction - Effective site erosion control shall be provided during construction. A soil erosion and sedimentation control plan shall be included in the construction documents.

44.8 Grading and Landscaping - Upon completion of the plant, the ground should be graded and sodded or seeded. All weather walkways should be provided for access to all units. Where possible, steep slopes should be avoided to prevent erosion. Surface water shall not be permitted to drain into any unit. Particular care shall be taken to protect trickling filter beds, sludge beds, and intermittent sand filters from storm water runoff. Provisions should be made for landscaping, particularly when a plant must be located near residential areas.

#### 45. Plant Outfalls

45.1 Discharge Impact Control - The outfall sewer shall be designed to discharge to the receiving stream in a manner which will assure adequate dispersion and prevent nuisance conditions. The outfall and/or headwall and stream crossings associated with the sewerage applications are permitted under the Water Quality Management Part II Permit. Consideration should also be given to the following:

- a. Preference for free fall or submerged discharge at the site selected.
- b. Utilization of cascade aeration of effluent discharge to increase dissolved oxygen.
- c. Limited or complete across stream dispersion, as needed, to protect aquatic life movement and growth in the immediate reaches of the receiving stream.
- d. Headwalls may be used where adequate dispersion is obtained without carrying the outfall into the stream.
- e. Requirements of Section 27.1 concerning an outfall extended into the stream.

45.2 Protection and Maintenance - The outfall sewer shall be so constructed and protected against the effects of flood water, tide, ice, or other hazards as to reasonably insure its structural stability and freedom from blockage. A manhole should be provided at the shore end of all gravity sewers extending into the receiving waters. Hazards to navigation shall be considered in designing outfall sewers.

45.3 Sampling Provisions - All outfalls shall be designed so that a sample of the effluent can be obtained at a point after the final treatment process and before discharge to or mixing with the receiving waters.

#### 46. Power Facilities

46.1 Emergency Power Facilities - All plants shall be provided with an alternate source of electric power or pumping capability to allow continuity of operation during power failures. Methods of providing alternate sources include:

- a. The connection of at least two separate and independent public utility sources such as substations. A power line from each substation will be required, unless documentation is received and approved by the Department, verifying that duplicate lines are not necessary to minimize water quality violations.
- b. Portable or inplace internal combustion engine equipment which will generate electrical or mechanical energy.
- c. Portable pumping equipment when only emergency pumping is required.

For more specific information refer to Section 36 - Emergency Operation for pumping stations.

46.11 Standby Equipment - Standby generating capacity normally is not required for aeration equipment used in the activated sludge process. In cases where a history of long-term (four hours or more) power outages have occurred, auxiliary power for minimum aeration of the activated sludge will be required. Full power generating capacity and/or other special waste treatment facilities may be required by the Department for waste discharges to certain critical stream segments. Examples of critical stream segments are

ones where there are discharges above: (a) a bathing beach, (b) a public water supply source that does not have chlorination facilities and/or (c) other similar situations.

46.12 Disinfection - Continuous disinfection, where required, shall be provided during all power outages.

## 46.2 Water Supply

46.21 General - An adequate supply of potable water under pressure should be provided for use in the laboratory and for general cleanliness around the plant. No piping or other connections shall exist in any part of the treatment plant which, under any conditions, might cause the contamination of a potable water supply. The chemical quality should be checked for suitability for its intended uses such as for heat exchangers, chlorinators, etc.

46.22 Direct Connections - Potable water from a municipal or separate supply may be used directly at points above grade for the following hot and cold supplies:

- a. Lavatory
- b. Water closet
- c. Laboratory sink (with vacuum breaker)
- d. Shower
- e. Drinking fountain
- f. Eye wash fountain
- g. Safety shower

Hot water for any of the above units shall not be taken directly from a boiler used for supplying hot water to a sludge heat exchanger or digester heating coils.

46.23 Indirect Connections - Where a potable water supply is to be used for any purpose in a plant other than those listed in Section 46.22, a break tank, pressure pump and pressure tank shall be provided. Water shall be discharged to the break tank through an air gap at least six inches above the maximum flood line or the spill line of the tank, whichever is higher. Vacuum breaker or reduced backflow preventer may be used in lieu of break tank, pressure pump, and pressure tank.

Under some conditions, the cost differential for an air gap separation may be very high when compared to a mechanical back-flow prevention device or it may be extremely difficult to provide an air gap separation. Under these conditions, a Reduced Pressure Zone Device (RPZD) may be selected for cross connection control. Such device should conform to AWWA standards C-506. RPZD provides protection from back-flow due to both back-pressure or back-siphonage. Malfunctioning of the RPZD is indicated by a discharge of the water from the relief port. This factor is an important factor over the double check valve assembly which shall not be approved, except as provided for under Section 46.22.

A sign shall be permanently posted at every hose bib, faucet, hydrant, or sill cock located on the water system beyond the break tank to indicate that the water is not safe for drinking.

46.24 Separate Potable Water Supply - Where it is not possible to provide potable water from a public water supply, a separate well may be provided. Location and construction of the well should comply with requirements of the state and local regulations.

Requirements governing the use of the supply are those contained in Section 46.22 and Section 46.23.

- 46.25 Separate Non-Potable Water Supply - Where a separate non-potable water supply is to be provided, a break tank will not be necessary, but all system outlets shall be posted with a permanent sign indicating the water is not safe for drinking.
- 46.3 Sanitary Facilities - Toilets, showers, lavatories, and lockers shall be provided in sufficient numbers and at convenient locations to serve the expected plant personnel. Such facilities may not be necessary at plants where a part-time operator is employed.
- 46.4 Laboratory - All treatment works should include a laboratory for making the necessary analytical determinations and operating control tests. Isolation is required to render the laboratory reasonably free from the adverse effects of noise, heat, vibration, and dust contamination.
- 46.5 Floor Slopes - Floor surfaces shall be sloped adequately to a point of drainage.
- 46.6 Stairways - Stairways shall be installed in lieu of ladders for access to units requiring inspection and maintenance, such as digesters, trickling filters, aeration tanks, clarifiers, tertiary filters, etc. Stairways should be installed with consideration to facilitate carrying samples, tools, etc. All risers in a stairway should be of equal height.
- 46.7 Flow Measurement - Flow measurement facilities shall be provided at all plants. Indicating, totalizing, and recording flow measurement devices shall be provided for all plants with maximum monthly average flow of 0.1 mgd or greater. Flow measurement facilities for lagoon systems shall not be less than pump calibration time clocks or calibrated flume.
- Flow measurement devices should be selected for reliability and accuracy. The effect of changes in backwater elevations due to intermittent cleaning of screens should be considered in locations of flow measurement equipment.
- 46.8 Septage and Holding Tank Waste - Facilities should be provided at municipal treatment plants for the acceptance and safe and sanitary handling of liquid organic waste material such as septic and/or holding tank pumpings delivered to the site by tank truck or other similar means. Such facilities should be designed to discharge the waste into the treatment plant during off-peak flow hours at a rate which does not adversely affect the operation of the treatment units and the efficiency of the treatment plant.

47. Safety

Adequate provisions shall be made to effectively protect the operator and visitors from hazards. The following shall be provided to fulfill the particular needs of each plant:

- a. Enclosure of the plant site with a fence designed to discourage the entrance of unauthorized persons and animals.
- b. Installation of hand rails and guards around tanks elevated less than four feet, trenches, pits, stairwells, and other hazardous structures. Grating over areas of the treatment units where maintenance is required.
- c. Provisions of first aid equipment.

- d. Posting of "No Smoking" signs in hazardous areas.
- e. Provisions of protective clothing and equipment such as air packs, goggles, gloves, hard hats, safety harnesses, etc.
- f. Provisions of portable blower and sufficient hose.
- g. Portable lighting equipment approved by the U.S. Bureau of Mines for use in confined spaces.
- h. Appropriately placed warning signs for slippery areas, non-potable water fixtures, low head clearance areas, open service manhole, hazardous chemical storage areas, flammable fuel storage areas, etc.
- i. The provisions of Section 32.6, with respect to ventilation which may apply to wastewater treatment plants shall be followed.
- j. Provisions for local lockout on stop motor controls.
- k. Provisions for a handicapped person to gain access to laboratory, administrative, and other buildings.

#### 47.1 Hazardous Chemical Handling

Underground storage facilities for chemicals such as alum or ferric chloride or fuels shall be constructed in accordance with EPA regulations and the State Storage Tank and Spill Prevention Act (Act 32) for underground storage tanks for both fuels and hazardous materials.

47.11 Containment Materials - The materials utilized for storage, piping, valves, pumping, metering, splash guards, etc., shall be specially selected considering the physical and chemical characteristics of each hazardous or corrosive chemical.

47.12 Secondary Containment - Chemical storage areas shall be enclosed in dikes or curbs which will contain the stored volume until it can be safely transferred to alternate storage or released to the wastewater at controlled rates which will not damage facilities, inhibit the treatment processes or contribute the stream pollution. Liquid polymer should be similarly contained to reduce areas with slippery floors, especially to protect travelways. Non-slip floor surfaces are desirable in polymer- handling areas.

47.13 Eye Wash Fountains and Safety Showers - Eye wash fountains and safety showers utilizing potable water shall be provided in the laboratory and on each floor level or work location involving hazardous or corrosive chemical storage, mixing (or slaking), pumping, metering or transportation unloading. These facilities are to be as close as practicable to possible chemical exposure sites and are to be fully useful during all weather conditions.

The eye wash fountains shall be supplied with water of moderate temperature (50o-90oF.), separate from the hot water supply, suitable to provide 15 to 30 minutes of continuous washing of the eyes.

The emergency showers shall be capable of discharging 30 to 50 gpm of water at moderate temperature at pressures of 20 to 50 psi. The eye wash fountains and showers shall be no more than 25 feet from points of hazardous chemical exposure.

- 47.14 Splash Guards - All pumps or feeders for hazardous or corrosive chemicals shall have guards which will effectively prevent spray of chemicals into space occupied by personnel. The splash guards are in addition to guards to prevent injury from moving or rotating machinery parts.
- 47.15 Piping Labeling, Coupling Guards, Location - All piping containing or transporting corrosive or hazardous chemicals shall be identified with labels every 10 feet and with at least two labels in each room, closet, or pipe channel. Color coding may also be used, but is not an adequate substitute for labeling. All connections (flanged or other type), except adjacent to storage or feeder areas, shall have guards which will direct any leakage away from space occupied by personnel. Pipes containing hazardous or corrosive chemicals should not be located above shoulder level except where continuous drip collection trays and coupling guards will eliminate chemical spray or dripping onto personnel.
- 47.16 Protective Clothing and Equipment - The following items of protective clothing or equipment shall be available and utilized for all operations or procedures where their use will minimize injury hazard to personnel:
- a. Respirators, air supply type recommended for protection against chlorine.
  - b. Chemical workers' goggles or other suitable goggles. (Safety glasses are insufficient.)
  - c. Face masks or shields for use over goggles.
  - d. Rubber gloves.
  - e. Rubber aprons with leg straps.
  - f. Rubber boots. (Leather and wool clothing should be avoided near caustics).
  - g. Safety harness and line.
- 47.17 Warning System and Signs - Facilities shall be provided for automatic shutdown of pumps and sounding of alarms when failure occurs in a pressurized chemical discharge line. Warning signs requiring use of goggles shall be located near chemical unloading stations, pumps, and other points of frequent hazard.
- 47.18 Dust Collection - Dust collection equipment shall be provided to protect personnel from dusts injurious to the lungs or skin and to prevent polymer dust from settling on walkways. The latter is to minimize slick floors which result when a polymer-covered floor becomes wet.
- 47.19 Container Identification - The identification and hazard warning data included on shipping containers, when received, shall appear on all containers (regardless of size or type) used to store, carry or use as a hazardous substance. Wastewater and sludge sample containers should be adequately labeled. Below is a suitable label for a wastewater sample:

**RAW WASTEWATER**

Sample point no. \_\_\_\_\_

Contains Harmful Bacteria.

May contain hazardous or toxic material.

Do not drink or swallow.

Avoid contact with openings or breaks in the skin.

48. Operation

The wastewater treatment plant must be operated by competent persons and be under the responsibility of an operator certified by the State Board for Certification of Sewage Treatment Plant and Waterworks Operators to ensure efficiency of operation and protection of the waters of the Commonwealth.

49. RESERVED FOR THE FUTURE

## 50. PRETREATMENT

### 51. Screening Devices

In order to protect the plant from reduced efficiency and/or physical damage, all plants shall be equipped with one or more of the screening devices such as manually cleaned bar screen, mechanically cleaned bar screen, comminutor, or coarse bar racks. Selection of a particular device will be governed by its intended purpose and the circumstances as detailed in this chapter. Provisions for odor control should be investigated and provided whenever a potential problem may develop.

#### 51.1 Bar Screens

51.11 Specific Provisions - A manually cleaned bar screen shall be required as the sole screening device or as an emergency bypass to the mechanically cleaned bar screen or comminutor.

#### 51.12 Location

51.121 Indoors - Screening devices installed in a building where other equipment or offices are located should be in a separate portion of the building which is accessible only through a separate outside entrance.

51.122 Outdoors - Screening devices installed outside shall be protected from freezing.

51.123 Access - Screening areas shall be provided with stairway access, adequate lighting and ventilation, and a convenient and adequate means for removing the screenings and maintaining equipment.

#### 51.13 Design Considerations

51.131 Bar Spacing - Clear openings between bars for manually cleaned screens should be no less than one inch. Clear openings for mechanically cleaned screens should be no less than 5/8 of an inch and no greater than 1 3/4 inches.

51.132 Slope - Manually cleaned screens should be placed on a slope of 30 to 45 degrees to the horizontal.

51.133 Velocities - At maximum monthly average flow and peak instantaneous flow conditions, approach velocities should be no less than 1.25 feet per second to prevent settling, and no greater than 3.0 feet per second to prevent forcing material through the openings.

51.134 Channels - Dual channels shall be provided and equipped with the necessary gates to isolate flow from any screening unit. Provisions shall also be made to facilitate dewatering each unit. The channel preceding and following the screen shall be shaped to eliminate stranding and settling of solids.

51.135 Invert - The screen channel invert should be three to six inches below the invert of the incoming sewer.

51.136 Flow Distribution - Entrance channels should be designed to provide equal and uniform distribution of flow to the screens.

51.137 Screenings Removal and Disposal - A convenient and adequate means for removing screenings shall be provided. Hoisting or lifting equipment may be necessary depending on the depth of pit and amount of screenings or equipment to be lifted.

Facilities must be provided for handling and storage of screenings. Screenings shall be disposed at the Department approved facility. Separate grinding of screenings and return to the wastewater flow is unacceptable. Manually cleaned screening facilities should include an accessible platform from which the operator may rake screenings easily and safely. Suitable drainage facilities shall be provided both for the platform and for storage areas.

#### 51.14 Access and Ventilation

Screens located in pits more than four feet deep shall be provided with stairway access. Access ladders are acceptable for pits less than four feet deep, in lieu of stairways. Screening devices, installed in a building where other equipment or offices are located, shall be isolated from the rest of the building, be provided with separate outside entrances, and be provided with separate and independent fresh air supply.

Fresh air shall be forced into enclosed screening device areas or in open pits more than four feet deep. Dampers should not be used on exhaust or fresh air ducts, and fine screens or other obstructions should be avoided to prevent clogging. Where continuous ventilation is required, at least 12 complete air changes per hour shall be provided. Where continuous ventilation would cause excessive heat loss, intermittent ventilation of at least 30 complete air changes per hour shall be provided when workmen enter the area.

Switches for operation of ventilation equipment should be marked and located conveniently. All intermittently operated ventilation equipment shall be interconnected with the respective pit lighting system. The fan wheel should be fabricated from non-sparking material.

#### 51.15 Safety

51.151 Railings and Gratings - Channels for manually cleaned screen shall be protected by guard railings and deck gratings, with adequate provisions for removal or opening to facilitate raking.

Channels for mechanically cleaned screen shall be protected by guard railings and deck gratings, with adequate provisions for access to facilitate maintenance and repair.

51.152 Mechanical Devices - Mechanically cleaned screens shall have adequate removable enclosures to protect personnel against accidental contact with moving parts and to prevent dripping in multi-level installations.

A positive means of locking out each mechanical device shall be provided.

## 51.16 Control Systems

51.161 Timing Devices - All mechanical units which are operated by timing devices shall be provided with auxiliary controls which will set the cleaning mechanism in operation at a pre-set high water elevation. If the cleaning mechanism fails to lower the high water, a warning should be signaled.

51.162 Electrical Fixtures and Controls - Electrical fixtures and controls in screening areas where hazardous gases may accumulate shall meet the requirements of the National Electric Code for Class I, Division 1, Group D locations.

51.163 Manual Override - Automatic controls shall be supplemented by a manual override.

51.17 Auxiliary Screens - Where a single mechanically cleaned screen is used, an auxiliary manually cleaned screen shall be provided. Where two or more mechanically cleaned screens are used, the design shall provide for taking any unit out of service without sacrificing the capability to handle the peak instantaneous flow.

## 51.2 Fine Screens

51.21 General - Fine screens as discussed here have openings of approximately 1/16 inch. The amount of material removed by fine screens is dependent on the waste stream being treated and screen opening size.

Fine screens should not be considered equivalent to primary sedimentation but may be used in lieu of primary sedimentation where subsequent treatment units are designed on the basis of anticipated screen performance. Selection of screen capacity should consider flow restriction due to retained solids, gummy materials, frequency of cleaning, and extent of cleaning. Removal of oils and greases shall be considered.

51.22 Design - Tests should be conducted to determine BOD and suspended solids removal efficiencies at the peak hydraulic and peak organic loadings.

A minimum of two fine screens shall be provided, with each unit being capable of independent operation. Capacity shall be provided to treat peak design flows with one unit out of service.

Fine screens shall be preceded by a mechanically cleaned bar screen or other protective device. Comminuting devices shall not be used ahead of fine screens.

51.23 Electrical Fixtures and Controls - Electrical fixtures and screening areas where hazardous gases may accumulate shall meet the requirements of the National Electric Code for Class I, Division 1, Group D locations.

51.24 Servicing - Hosing equipment shall be provided to facilitate cleaning. Provisions shall be made for isolating or removing units from location for servicing.

## 52. Comminutors

52.1 Specific Provisions - Comminutors and/or mechanically cleaned bar screens (Barminutors) shall be used in plants that do not have primary sedimentation. Comminutors should be provided at plants where mechanically cleaned bar screens will not be used. Consideration should be given

to providing protection for comminutors by coarse bar racks, especially when the flow is received from a combined sewer system.

52.2 Location - The same requirements apply as for bar screens. Refer to Section 51.12 of this chapter.

If all the flow to the plant is received from grinder pumps, a comminator is not needed.

### 52.3 Design Considerations

52.31 General - Comminutors should be located downstream of any grit removal equipment. Comminutors not preceded by grit removal equipment shall be protected by a six inch deep gravel trap.

52.32 Size - Comminutor capacity shall be adequate to handle peak instantaneous flow.

52.33 Installation - A bypass channel with a screening device shall be provided. The use of the bypass channel should be automatic at depths of flow exceeding the design capacity of the comminator or in case of comminator failure.

52.34 Servicing - Provisions shall be made to facilitate servicing units in place and removing units from location for servicing.

52.35 Electrical Controls and Motors - Electrical equipment in comminator chambers where hazardous gases may accumulate shall meet the requirements of the National Electric Code for Class I, Division 1, Group D locations. Motors in areas not governed by this requirement shall be protected against accidental submergence.

52.36 Railings and Gratings - Comminutors and bypass channels shall be protected by guard railings and deck grittings with adequate provisions for access to facilitate maintenance and repairs.

## 53. Grit Removal Facilities

53.1 Specific Provisions - Grit removal facilities should be provided for all wastewater treatment plants and are required for plants receiving wastewater from combined sewers or from sewer systems receiving substantial amounts of grit. If a plant serving a separate sewer system is designed without grit facilities, consideration shall be given to possible damaging effects on pumps, comminutors, other preceding equipment, and the need for additional storage capacity in treatment units where grit is likely to accumulate. The design shall include provisions for future installation of grit removal facilities.

### 53.2 Location

53.21 General - Grit removal facilities should be located ahead of pumps and comminuting devices. Coarse bar racks should be placed ahead of grit removal facilities.

### 53.22 Housed Facilities

53.221 Ventilation - Uncontaminated air shall be introduced continuously at a rate of 12 air changes per hour or intermittently at a rate of 30 air changes per hour. Odor control devices may also be warranted.

- 53.222 Access - Adequate stairway access to above or below grade facilities shall be provided.
  - 53.223 Electrical - All electrical fixtures and controls in enclosed grit removal area where hazardous gases may accumulate shall meet the requirements of the National Electric Code for Class I, Division 1, Group D locations.
  - 53.224 Lighting - Adequate lighting with explosion protection shall be provided to operate and maintain equipment.
- 53.23 Outside Facilities - Grit removal facilities located outside shall be protected from freezing.

53.3 Type and Number of Units - Plants treating wastes from combined sewers should have at least two mechanically cleaned grit removal units with provisions for bypassing. A single manually cleaned or mechanically cleaned grit chamber with bypass is acceptable for small wastewater treatment plants serving separate sanitary sewer systems. Minimum facilities for larger plants serving separate sanitary sewers should be at least one mechanically cleaned unit with a bypass. Facilities other than channel-type are acceptable if provided with adequate grit collection and removal equipment and variable controls for agitation.

#### 53.4 Design Considerations

- 53.41 General - The design effectiveness of a grit removal system shall be commensurate with the requirements of the subsequent process units.
- 53.42 Inlet - Inlet turbulence shall be minimized in channel-type units.
- 53.43 Velocity and Detention - Channel-type chambers shall be designed to control velocities during normal variations in flow as close as possible to one foot per second. The detention period shall be based on the size of particle to be removed. All grit removal facilities should be provided with adequate automatic control devices to regulate detention time, agitation, or air supply.
- 53.44 Grit Washing - The need for grit washing should be determined by the method of final grit disposal.
- 53.45 Drains - Provisions shall be made for isolating and dewatering each unit.
- 53.46 Water - An adequate supply of water under pressure shall be provided for cleanup.
- 53.47 Grit Handling - Grit removal facilities located in deep pits should be provided with mechanical equipment for hoisting or transporting grit to ground level. Impervious non-slip working surfaces with adequate drainage shall be provided for grit handling areas. Grit transporting facilities shall be provided with protection against freezing and loss of material.
- 53.48 Aeration - An aerated grit removal facility should be considered. This facility must have a metered and adjustable air supply.

#### 54. Pre-aeration and Flocculation

Pre-aeration of wastewater to reduce septicity may be required in special cases.

Flocculation of wastewater by air or mechanical agitation, with or without chemicals, is worthy of consideration when it is desired to reduce the strength of wastewater prior to subsequent treatment. Also, flocculation may be beneficial in pretreating wastewater containing certain industrial wastes.

54.1 Arrangement - The unit should be designed so that its removal from service will not interfere with normal operation of the remainder of the plant.

54.2 Detention Period

54.21 Coagulation - When air or mechanical agitation is used in conjunction with chemicals to coagulate or flocculate the wastewater, the detention period should be about 30 minutes but never less than 20 minutes at the peak hourly flow.

54.22 BOD Reduction - When air or mechanical agitation (either with or without the use of chemicals) is used for the additional purpose of obtaining increased reduction in BOD, the detention period should be at least 45 minutes at maximum monthly average flow.

54.3 Stirring Devices

54.31 Paddles - Paddles should have a peripheral speed of 1 1/2 feet to 2 1/2 feet per second to prevent deposition of solids.

54.32 Aerators - Any of the types of equipment used for aerating activated sludge may be utilized. It shall be possible to control agitation, to obtain good mixing, and maintain self-cleaning velocities across the tank floor.

54.4 Details - Inlet and outlet devices should be designed to insure proper distribution and to prevent short-circuiting. Convenient means should be provided for removing grit.

54.5 Quick Mix - At plants where there are two or more flocculation basins utilizing chemicals, provision shall be made for a quick mix of the wastewater with the chemical so that the wastewater passing to the flocculation basins will be of uniform composition. The detention period provided in the quick mix chamber should be very short -- one-half to three minutes.

55. Flow Equalization

55.1 General - Use of flow equalization to reduce the variations in hydraulic and organic loadings shall be considered at all wastewater treatment plants. When a significant portion of the plant's flow will be from high peak flow sources (such as restaurants, schools, nursing homes and commercial laundry), flow equalization facilities shall be provided.

55.2 Location - Equalization basins should be located downstream of pretreatment facilities such as bar screens, comminutors and grit chambers.

55.3 Type - Flow equalization can be provided by using separate equalization basins or on-line treatment units such as aeration tanks. Equalization basins may be designed as either in-line or side-line units. Unused treatment units, such as sedimentation or aeration tanks, may be utilized as on-line equalization basins during the early period of design life.

55.4 Size - Equalization basin capacity should be sufficient to equalize anticipated flow variations. The determination of equalization volume should be based on the wastewater flow hydrograph during wet weather conditions.

## 55.5 Operation

55.51 Mixing - Aeration or mechanical equipment shall be provided to maintain adequate mixing. Corner fillets and hopper bottoms with draw-offs shall be provided to alleviate the accumulation of sludge and grit.

55.52 Aeration - Aeration equipment shall be sufficient to maintain a minimum of one mg/l of dissolved oxygen in the mixed equalization basin contents at all times. Air supply rates based on standard air (standard air is defined as air at a temperature of 68oF, a pressure of 14.7 psia, and a relative humidity of 36 percent) should be a minimum of 1.25 cfm/1,000 gallons of storage capacity. The air supply should be isolated from other treatment plant aeration requirements to facilitate process aeration control. Standard process aeration equipment may be utilized as a source of standby aeration.

55.53 Controls - Inlets and outlets for all equalization basin compartments shall be equipped with accessible external valves, stop plates, weirs, or other devices to permit flow control and the removal of an individual unit from service. Facilities shall also be provided to measure and indicate liquid levels and flow rates.

55.6 Electrical - All electrical work in housed equalization basins shall meet the requirements of the National Electric Code for Class I, Division 1, Group D locations.

55.7 Access - Suitable access shall be provided to facilitate the maintenance of equipment and cleaning.

56 through 59. RESERVED FOR FUTURE USE

## 60. SETTLING

61. General - This chapter covers design guidelines for primary, intermediate and final settling tanks.

61.1 Number of Units - Multiple units capable of independent operation are desirable and shall be provided in all plants where maximum monthly average flow exceeds 100,000 gallons per day. Plants not having multiple units shall include other provisions to assure continuity of treatment.

61.2 Arrangement - Settling tanks shall be arranged such that the criteria in Sections 43.7 and 62.7 can be met.

61.3 Flow Distribution - Effective flow splitting devices and control appurtenances (e.g., valves, gates, splitter boxes, etc.) shall be provided to permit proper proportioning of flow to each unit, through the expected range of flows.

61.4 Tank Configuration - Consideration should be given to the probable flow pattern, the selection of tank size and shape, and inlet and outlet type and location.

62. Design Considerations

62.1 Dimensions - The minimum length of flow from inlet to outlet should be 10 feet unless special provisions such as baffles are made to prevent short circuiting. The side water depth for primary clarifiers shall be as shallow as practicable, but not less than seven feet. Clarifiers following the activated sludge process shall have side water depths of at least 12 feet to provide adequate separation zone between the sludge blanket and the overflow weirs. Clarifiers having less than 12 feet side water depth may be permitted for package plants, if justified, based on successful operating experience. Clarifiers following fixed film reactors shall have side water depth of at least seven feet.

62.2 Surface Overflow Rates

62.21 Primary Settling Tanks - Surface overflow rates for primary tanks receiving waste activated sludge should not exceed 1,000 gallons per day per square foot at maximum monthly average flow (including recirculation flows) or 1,500 gallons per day per square foot for peak hourly flow (including recirculation flows).

Surface overflow rates for primary tanks not receiving waste activated sludge should not exceed 1,000 gallons per day per square foot at maximum monthly average flow (including recirculation flows) or 2,500 gallons per day per square foot for peak hourly flow (including recirculation flows).

Settling tank sizing shall be calculated for both (average and peak hourly) flow conditions and the larger surface area determined shall be used. A BOD removal of 30 percent to 35 percent will indicate efficient primary treatment. Design of treatment units following primary settling tanks shall take into consideration the expected BOD5 removal in the primary.

62.22 Intermediate Settling Tanks - Surface overflow rates for intermediate settling tanks following units of fixed film reactor processes shall not exceed 1,500 gallons per day per square foot based on peak hourly flow.

62.23 Final Settling Tanks - Settling tests should be conducted wherever pilot study of biological treatment is warranted by unusual waste characteristics or treatment

requirements. Testing shall be done where proposed loadings go beyond the limits set forth in this section.

- a. Fixed Film Biological Reactors - Surface overflow rates for settling tanks following trickling filters or rotating biological contactors shall not exceed 1,200 gallons per day per square foot based on peak hourly flow.
- b. Activated Sludge - To perform properly while producing a concentrated return flow, activated sludge settling tanks must be designed to meet thickening as well as solids separation requirements. Since the rate of recirculation of return sludge from the final settling tanks to the aeration or reaeration tanks is quite high in activated sludge processes, surface overflow rate and weir overflow rate should be adjusted for the various processes to minimize the problems with sludge loadings, density currents, inlet hydraulic turbulence, and occasional poor sludge settleability. Settling tanks in activated sludge systems must be designed not only for surface overflow rates, but also for solids loading rates. The following parameters should be utilized in the design of intermediate and/or final settling tanks for various activated sludge processes. In applying surface overflow and solids loading values from this table, sizing shall be calculated for both surface overflow and solids loading using peak and average conditions, and the larger surface area determined shall be used.\* Consideration should be given to flow equalization.

**Table**

<u>Type of Process</u>	<u>Surface Overflow Rate*</u> (gpd/sq. ft.)*		<u>Solids Loadings***</u>	
	<u>Average</u>	<u>Peak**</u>	<u>Average</u>	<u>Peak**</u>
Conventional Activated Sludge Step Aeration and Contact Stabilization	800	1,200	40	50
Extended Aeration	500	1,000	30	50
Separate Nitrification Stage	500	800	30	50
Carbonaceous Stage of Sparate Stage Nitrification	900	1,200	45	50

\* The area upstream of the inlet baffle should not be used in calculating the surface overflow rate and, furthermore, only maximum monthly average flow (i.e. excluding the return flow) should be used.

\*\* Anticipated peak hourly flow.

\*\*\* Based on mixed liquor flow - (i.e. wastewater and return sludge flow).

62.3 Inlet Structures - Inlets should be designed to dissipate the inlet velocity, to distribute the flow equally both horizontally and vertically and to prevent short-circuiting. Channels should be designed to maintain a velocity of at least one foot per second at one-half the maximum monthly average flow. Corner pockets and dead ends shall be eliminated and corner fillets or channeling

used where necessary. Provisions shall be made for elimination or removal of floating materials in inlet structures.

62.4 Drains - Provisions shall be made for complete dewatering of each unit to an appropriate point in the process. Due consideration should be given to the possible need for hydrostatic relief devices to prevent flotation of structures. Portable dewatering pumps may be sufficient for complete dewatering.

62.5 Bypasses - Design shall provide for independent removal of each settling tank unit for maintenance and repair so as to minimize deterioration of effluent quality and insure rapid process recovery upon return to normal operational mode. The bypass design should also provide for redistribution of the plant flow to the remaining units.

62.6 Anti-flotation Devices - Adequate systems, such as hydrostatic pressure relief valves, tension piles, or foundation slab projections shall be incorporated in the design to prevent flotation of dewatered tanks.

62.7 Freeboard - Walls of settling tanks shall extend at least six inches above the surrounding ground surface and shall provide not less than 12 inches of freeboard. Where walls of settling tanks are more than four feet above the surrounding ground surface, consideration should be given to providing a walkway for safe access to clean the weirs and weir troughs. Additional freeboard or the use of wind screens is recommended where larger settling tanks are subject to high velocity wind currents that would cause tank surface waves and inhibit effective scum removal.

### 63. Weirs

63.1 General - Overflow weirs shall be adjustable for levelling.

63.2 Location - Overflow weirs shall be located to optimize actual hydraulic detention time and minimize short-circuiting.

63.3 Design Rates - Weir loadings should not exceed 10,000 gallons per day per lineal foot at maximum monthly average flow (excluding recycle flows) for plants designed for average flows of one mgd or less. Higher weir loadings may be used for plants designed for larger average flows, but should not exceed 15,000 gallons per day per lineal foot maximum monthly average flow (excluding recycle flows). If pumping is required, weir loadings should be related to pump delivery rates to avoid short-circuiting.

63.4 Weir Troughs - Weir troughs shall be designed to prevent submergence at peak instantaneous flow and to maintain a velocity of at least one foot per second at one-half the maximum monthly average flow.

63.5 Submerged Surfaces - The tops of troughs, beams and similar submerged construction elements shall have a minimum slope of one horizontal to 1.4 vertical (1:1.4); the underside of such elements should have a slope of one horizontal to one vertical (1:1) to prevent the accumulation of scum and solids.

### 64. Sludge and Scum Removal

64.1 Scum Removal - Effective scum collection and removal facilities, including baffling, shall be provided for all settling tanks. The unusual characteristics of scum which may adversely affect pumping, piping, sludge handling, and disposal shall be recognized in design. Provisions may

be made for the discharge of scum with the sludge; however, other special provisions for disposal may be necessary.

64.2 Sludge Removal - Sludge collection and withdrawal facilities shall be so designed as to assure rapid removal of the sludge. Suction withdrawal should be provided for activated sludge plants designed for reduction of the nitrogenous oxygen demand and is encouraged for those plants designed for carbonaceous oxygen demand reduction.

Each settling tank shall have its own sludge withdrawal lines to insure adequate control of sludge wasting rate for each tank.

64.3 Sludge Hopper - The minimum slope of the side walls shall be one horizontal to 1.7 vertical (1:1.7). Hopper wall surfaces should be made smooth with rounded corners to aid in sludge removal. Hopper bottoms shall have a maximum dimension of two feet. Extra depth sludge hoppers for sludge thickening are not acceptable.

63.4 Cross-Collectors - Cross-collectors serving one or more settling tanks may be useful in place of multiple sludge hoppers.

64.5 Sludge Removal Piping - Each hopper shall have an individually-valved sludge withdrawal line of at least six inches in diameter. The static head available for withdrawal of sludge shall be 30 inches or greater as necessary to maintain a three feet per second velocity in the withdrawal pipe. Clearance between the end of the withdrawal line and the hopper walls shall be sufficient to prevent bridging of the sludge. Adequate provisions shall be made for rodding or back-flushing individual pipe runs. Piping shall also be provided to return secondary waste sludge for further processing.

64.6 Sludge Removal Control - Separate settling tank sludge lines may drain to a common sludge well. Sludge wells equipped with telescoping valves or other appropriate equipment shall be provided for viewing, sampling, and controlling the rate of sludge withdrawal. The use of easily maintained sight glass and sampling valves may be appropriate. A means of measuring the sludge removal rate shall be provided. An air lift type of sludge removal will not be approved for removal of primary sludges. Sludge pump motor control system shall include time clocks and valve activators for regulating the duration and sequencing of sludge removal.

64.7 Return Sludge Equipment

64.71 Return Sludge Rate - The minimum permissible return sludge rate of withdrawal from the final settling tank is a function of the concentration of suspended solids in the mixed liquor entering the settling tank, the sludge volume index of these solids, and the length of time these solids are retained in the settling tank. Since undue retention of solids in the final settling tanks may be deleterious to both the aeration and sedimentation phases of the activated sludge process, the rate of sludge return expressed as a percentage of the maximum monthly average flow of wastewater should generally be variable between the limits set forth as follows:

	<u>Minimum</u>	<u>Maximum</u>
Standard Rate	15	100
Step Aeration	15	100
Contact Stabilization	50	150
Extended Aeration (including oxidation ditches)	50	150
Carbonaceous Stage of Separate Stage Nitrification	15	100
Nitrification Stage of Separate Stage Nitrification	50	200

The rate of sludge return shall be varied by means of variable speed motors, drives, or timers (at small plants) to pump sludge at the above rates.

- 64.72 Return Sludge Pumps - If motor driven return sludge pumps are used, the maximum return sludge capacity shall be obtained with the largest pump out of service. A positive head should be provided on pump suction. Pumps should have at least three inch suction and discharge openings.

If air lifts are used for returning sludge from each settling tank hopper, no standby unit will be required. However, the design of the air lifts must be such that they are amenable to rapid and easy cleaning. Also, suitable standby equipment for returning sludge should be available. Air lifts shall be sized to maintain a velocity at not less than two feet per second when return sludge facilities are operating at minimum sludge return rates. Provisions shall be made to prevent large objects from entering and plugging air lifts and return sludge piping.

- 64.73 Return Sludge Piping - Discharge piping should be designed to maintain a velocity of not less than two feet per second when return sludge facilities are operating at normal return sludge rates. Suitable devices for observing, sampling and controlling return activated sludge flow from each settling tank hopper shall be provided.

- 64.74 Waste Sludge facilities - Waste sludge control facilities should have a capacity of at least 25 percent of the average rate of wastewater flow and function satisfactorily at rates of one-half percent of average wastewater flow or a minimum of 10 gallons per minute, whichever is larger. Means for observing, measuring, sampling, and controlling waste activated sludge flow shall be provided. Waste sludge may be discharged to the concentration or thickening tank, primary settling tank, sludge digestion tank, vacuum filters, or any practical combination of these units.

- 64.8 Measuring Devices - Devices should be installed in all plants for indicating flow rates of raw wastewater or primary effluent, return sludge, and air to each tank unit. Measuring devices in plants designed for wastewater flows of 100,000 gpd or more should totalize and record, as well as indicate flows. Where the design provides for all return sludge to be mixed with the raw wastewater (or primary effluent) at one location, the mixed liquor flow rate to each aeration unit should be measured.

65. Protective and Service Facilities

- 65.1 Operator Protection - All settling tanks shall be equipped to enhance safety for operators. Such features shall appropriately include machinery covers, life lines, stairways, walkways, hand rails and slip resistant surfaces.
- 65.2 Mechanical Maintenance Access - The design shall provide for convenient and safe access to routine maintenance items such as gear boxes, scum removal mechanism and baffles, weirs, inlet stilling baffle area, and effluent channels.
- 65.3 Electrical Fixtures and Controls - Electrical fixtures and controls in enclosed settling basins shall meet the requirements of the National Electric Code for Class I, Division 1, Group D locations. The fixtures and controls shall be located so as to provide convenient and safe access for operation and maintenance. Adequate area lighting shall be provided.

66. through 69. RESERVED FOR FUTURE USE

## 70. SLUDGE PROCESSING, STORAGE AND DISPOSAL

71. General - Facilities for sludge processing/storage shall be provided at all wastewater treatment facilities. The selection of sludge treatment/handling unit processes should be based on such considerations as characteristics of the sludge, method(s) of ultimate disposal, stabilization requirements, cost-effectiveness, storage requirements, back-up techniques available, equipment complexity, and staffing requirements.

### 72. Sludge Treatment Processes

The processes used for sludge treatment are grouped in the following categories:

- a. Sludge thickening
- b. Sludge digestion/stabilization
- c. Sludge dewatering

### 73. Sludge Thickening

73.1 General Considerations - Sludge thickeners to reduce the volume of sludge should be considered. The design of thickeners (gravity, dissolved air flotation, centrifuge, and others) should consider the type and concentration of sludge, the sludge stabilization processes, the method of ultimate sludge disposal, chemical needs, and the cost and ease of operation. Particular attention should be given to the pumping and piping of the concentrated sludge and possible onset of anaerobic conditions. Sludge should be thickened to at least five percent solids by weight prior to transmission to digesters.

73.2 Gravity Thickening - Both solids and hydraulic surface loading must be considered when designing gravity thickeners. A hydraulic loading of 400 to 800 gpd/sq. ft. and a solids loading of five to 12 pounds/day/sq. ft. are recommended for thickeners. Solids loading is generally the controlling parameter and usually dictates the required surface area of the thickener. Thickener covers to prevent odor problems shall be considered when use of lower hydraulic rates than described here is proposed.

73.3 Air Flotation - The use of air flotation is limited primarily to thickening of sludges prior to dewatering. Air flotation thickening is best applied to thickening waste activated sludge, and it is possible to thicken the sludge to six percent solids. A solids loading of 20 pounds/day/sq. ft. without the application of polyelectrolyte and 40 pounds/day/sq. ft. with the application of polyelectrolyte is recommended in the design of air flotation thickening units. The hydraulic loading should not exceed 0.8 gpm/sq. ft..

### 74. Anaerobic Sludge Digestion

74.1 Multiple Units - Multiple tanks or alternate methods of sludge processing shall be provided for continued plant operations. Facilities for sludge storage and supernatant separation in an additional unit may be required, depending on raw sludge concentration and disposal methods for sludge and supernatant.

74.2 Depth - The depth of the tank should be such as to allow for the formation of a reasonable depth of supernatant liquor. A minimum sidewater depth of 20 feet is recommended.

74.3 Maintenance Provisions - To facilitate emptying, cleaning and maintenance, the following features are desirable:

74.31 Slope - The tank bottom shall slope to drain toward the withdrawal pipe. Where the sludge is to be removed by gravity alone, the tank bottom should have a slope of four horizontal to one vertical (4:1). For tanks equipped with a suction mechanism for withdrawal of sludge, a bottom slope of twelve horizontal to one vertical (12:1) or greater is recommended.

74.32 Access Manholes - At least two 36-inch diameter access manholes should be provided in the top of the tank in addition to the gas dome. There should be stairways to reach the access manholes. A separate sidewall manhole to facilitate removal of grit and sand should be considered.

74.33 Safety - Non-sparking tools, safety lights, rubber-soled shoes, safety harnesses, gas detectors for inflammable and toxic gases, gas masks and at least two self-contained breathing units shall be provided for emergency use.

74.4 Sludge Inlets, Outlets, Recirculation and High Level Overflow

74.41 Multiple sludge inlets and draw-offs and, where used, multiple recirculation suction and discharge points to facilitate flexible operation and effective mixing of the digester contents shall be provided unless adequate mixing facilities are provided within the digester.

74.42 Sludge inlet discharge points should be so located as to minimize short circuiting to the digested sludge or supernatant draw-offs. One inlet should discharge above the liquid level and be located at approximately the center of the tank to assist in scum breakup. The second inlet should be opposite to the suction line at approximately the 2/3 diameter point across the digester.

74.43 Sludge withdrawal to disposal should be from the bottom of the tank. The bottom withdrawal pipe should be interconnected with the necessary valving to the recirculation piping to increase operational flexibility in mixing the tank contents.

74.44 An unvalved vented overflow shall be provided to prevent damage to the digestion tank and cover in case of accidental overfilling. This emergency overflow shall be piped to an appropriate point in the treatment process or sidestream treatment facilities to minimize the impact on process units.

74.5 Tank Capacity

74.51 Rational Design - The total digestion tank capacity should be determined by rational calculations based upon such factors as volume of sludge added (including allowance for chemical treatment for P), its percent solids and character, the temperature to be maintained in the digesters, the degree or extent of mixing to be obtained, and the degree of volatile solids reduction required. The capacity should consider appropriate allowances for gas, scum, supernatant, and digested sludge storage. Secondary digesters which are utilized for digested sludge storage and concentration shall not be credited in the calculations for volumes required for sludge digestion. Calculations shall be submitted to justify the basis of design.

## 74.52 Standard Design

When calculations justifying the design based on the factors in Section 74.51 are not submitted, the minimum combined digestion tank capacity outlined below will be required. Such requirements assume that a digestion temperature is to be maintained in the range of 90° to 100°F., and that 40 to 50 percent volatile matter will be maintained in the digested sludge.

74.521 Digester Mixing - Facilities for mixing the digester contents shall be provided where required for proper digestion by reason of loading rates or other features of the system. Where sludge recirculation pumps are used for mixing, they shall be provided in accordance with appropriate requirements of Section 76.1.

74.522 Completely-Mixed Systems - Completely-mixed primary systems shall provide for intimate and effective mixing to prevent stratification and to measure homogeneity of digester content. The system may be loaded at a rate up to 100 pounds of volatile solids per 1,000 cubic feet in volume per day in the active digestion units. At least 15 days of solids retention time shall be provided.

When grit removal facilities are not provided, the reduction of digester volume due to grit accumulation should be considered.

74.523 Moderately-Mixed Systems - For primary digestion systems where mixing is accomplished only by circulating sludge through an external heat exchanger, the system may be loaded at a rate up to 50 pounds of volatile solids per 1,000 cubic feet of volume per day in active digestion units. At least 30 days of solids retention time should be provided.

74.53 Multistage Systems - For digestion systems utilizing two stages (primary and secondary units), the first stage (primary) may be either completely mixed or moderately mixed. The second stage (secondary) is to be designed for sludge storage, concentration and gas collection and shall not be credited in the calculations for volumes required for sludge digestion.

## 74.6 Gas Collection, Piping and Appurtenances

74.61 General - All portions of the gas system, including the space above the tank liquor, storage facilities, and piping, shall be so designed that under all normal operating conditions, including sludge withdrawal, the gas will be maintained under positive pressure. All enclosed areas where any gas leakage might occur shall be adequately ventilated.

74.62 Safety Equipment - All necessary safety facilities shall be included where gas is produced. Pressure and vacuum relief valves and flame traps, together with automatic safety shutoff valves, shall be provided and protected from freezing. Water seal equipment shall not be installed. Safety equipment and gas compressors should be housed in a separate room with an exterior entrance.

74.63 Gas Piping and Condensate - Gas piping shall have a minimum diameter of four inches. A smaller diameter pipe at the gas meter is acceptable. Gas piping shall slope to condensation traps at low points. The use of float-controlled condensation traps is not permitted. Condensation traps shall be protected from freezing.

- 74.64 Gas Utilization Equipment - Gas-burning boilers, engines, etc. shall be located in a separate, well-ventilated room not connected to the digester gallery. Gas lines to these units shall be provided with suitable flame traps.
- 74.65 Electrical Fixtures - Electrical fixtures and controls in enclosed places where hazardous gases may accumulate shall comply with the National Electrical Code for Class I, Division I, Group D locations.
- 74.66 Waste Gas - Waste gas burners shall be readily accessible and should be located at least 50 feet away from any plant structure. Waste gas burners shall be of sufficient height and so located to prevent injury to personnel due to wind or downdraft conditions.

All waste gas burners shall be equipped with automatic ignition, such as pilot light or a device using a photoelectric cell sensor. Consideration should be given to the use of natural or propane gas to insure reliability of the pilot light.

Gas piping shall be sloped at a minimum of two percent up to the waste gas burner with a condensation trap provided in a location not subject to freezing.

In remote locations, it may be permissible to discharge the gas to the atmosphere through a return-bend screened vent terminating at least 10 feet above the ground surface, provided that the assembly incorporates a flame trap.

- 74.67 Ventilation - Any underground enclosures connecting with digestion tanks or containing sludge or gas piping or equipment shall be provided with forced ventilation in accordance with Sections 32.6 and 32.62. The piping gallery for digesters should not be connected to other passages.
- 74.68 Meter - A gas meter with bypass shall be provided to meter total gas production for each active digestion unit. Total gas production for two-stage digestion systems operated in series may be measured by a single gas meter with proper interconnected gas piping. Where multiple primary digestion units are utilized with a single secondary digestion unit, a gas meter shall be provided for each primary digestion unit. The secondary digestion unit may be interconnected with the gas measurement unit of one of the primary units. Interconnected gas piping shall be properly valved with gas tight gate valves to allow measurement of gas production from either digestion unit or maintenance of either digestion unit. Gas meters may be of the orifice plate, turbine or vortex type. Positive displacement meters should not be utilized. The meter must be specifically designed for contact with corrosive and dirty gases.

#### 74.7 Digester Heating

- 74.71 Insulation - Wherever possible, digestion tanks should be constructed above groundwater level and should be suitably insulated (with earth embankment or by other means) to minimize heat loss.
- 74.72 Heating Facilities - Sludge may be heated by circulating it through external heaters or by heating units located inside the digestion tank.

For external heating, piping shall be designed to provide for preheating of feed sludge before introduction to the digesters. Provisions shall be made in the layout of the piping and valving to facilitate heat exchange tube removal and cleaning of the lines.

The use of hot water heating coils affixed to the walls of the digesters, or other types of internal heating equipment that require emptying the digester contents for repair, is not acceptable.

- 74.73 Heating Capacity - Heating capacity sufficient to consistently maintain the design sludge temperature in the range of 90° to 100°F. shall be provided. Where digester tank gas is used for sludge heating, an auxiliary fuel supply is required.

The use of multiple units sized to provide the heating requirements shall be considered, unless an acceptable alternative means of handling raw sludge is provided.

#### 74.74 Hot Water Internal Heating Controls

74.741 Mixing Valves - A suitable automatic mixing valve shall be provided to temper the boiler water with return water so that the inlet water to the heat removable heat jacket or coil in the digester can be held at a temperature of 140°F. or less. Manual control should also be provided by suitable bypass valves.

74.742 Boiler Controls - The boiler should be provided with suitable automatic controls to maintain the boiler temperature at approximately 180°F. to minimize corrosion and to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level, low gas pressure, or excessive boiler water temperature or pressure.

74.743 Boiler Water Pumps - Boiler water pumps shall be sealed and sized to meet the operating conditions of temperature, operating head and flow rate. Duplicate units shall be provided.

74.744 Thermometers - Thermometers shall be provided to show inlet and outlet temperatures of the sludge, hot water feed, hot water return and boiler water.

74.745 Water Supply - The chemical quality should be checked for suitability for boiler use and possible addition of water conditioning chemical.

- 74.75 External Heater Controls - All controls necessary to ensure effective and safe operation are required. Provision for duplicate units in critical elements should be considered.

#### 74.8 Supernatant Withdrawal

Where supernatant separation is to be used to concentrate sludge in the digester units and increase digester solids retention time, the design shall provide for ease of operation and positive control of supernatant quality.

- 74.81 Piping Size - Supernatant piping should not be less than six inches in diameter.

#### 74.82 Withdrawal Arrangements

74.821 Withdrawal Levels - Piping should be arranged so that withdrawal can be made from three or more levels in the digester. A positive-unvalved vented overflow shall be provided. The emergency overflow shall be piped to an appropriate point in the treatment process or side stream treatment units to minimize the impact on process units.

74.822 Withdrawal Selection - On fixed cover tanks the supernatant withdrawal level should preferably be selected by means of interchangeable extensions at the discharge end of the piping.

74.823 Supernatant Selector - A fixed screen supernatant selector or similar type device shall be limited for use in an unmixed secondary digester unit. If such supernatant selector is provided, provisions shall be made for at least one draw-off level located in the supernatant zone of the tank in addition to the unvalved emergency supernatant draw-off pipe. High pressure backwash facilities shall be provided utilizing non-potable utility water.

74.83 Sampling - Provisions should be made for sampling at each supernatant draw-off level. Sampling pipes should be at least 1 1/2 inches in diameter, equipped with quick opening valve, and should terminate at a suitably-sized sampling sink or basin. High pressure backwash facilities for the sampling pipe should be provided utilizing non-potable utility water.

74.84 Supernatant Disposal - Supernatant should be bled back to the raw wastewater influent of the treatment plant at a regulated rate. Aeration of supernatant should be considered to avoid odors and an upset of the treatment process.

An alternate disposal method for the supernatant liquor should be provided for in case the supernatant is not suitable or other conditions make it advisable not to return to the plant.

## 75. Aerobic Sludge Digestion.

75.1 General - Aerobic digestion can be used to stabilize primary sludge, secondary sludge, or a combination of the two. Digestion is accomplished in single or multiple tanks designed to provide effective air mixing, reduction of the organic matter, supernatant separation, and sludge concentration under controlled conditions. Aerobic digestion tanks are open and generally require no special heat transfer equipment or insulation.

75.11 Digestion Tanks - Multiple tanks are recommended. A single sludge digestion tank may be used in the case of small treatment plants or where adequate provision is made for sludge handling and where a single unit will not adversely affect normal plant operations.

75.2 Mixing and Air Requirements - Aerobic sludge digestion tanks shall be equipped with devices which can maintain solids in suspension and which provide complete mixing of the digester content. Sufficient air shall be provided to keep the solids in suspension and maintain dissolved oxygen between one and two mg/l. For minimum mixing and oxygen requirements, an air supply of 30 cfm per 1,000 cubic feet of tank volume shall be provided with the largest blower out of service. If diffusers are used, the non-clog type is recommended, and they should be designed to permit continuity of service. If mechanical aerators are utilized, a minimum of one horsepower per 1,000 cubic feet should be provided. A minimum of two aerators per tank shall be provided to permit continuity of service. Use of mechanical aerators is discouraged where freezing temperatures are normally expected.

75.3 Tank Capacity - The determination of tank capacities shall be based on rational calculations, including such factors as quantity of sludge produced, sludge characteristics, time of aeration, and sludge temperature.

- 75.31 Volatile Solids Loading - It is recommended that the volatile suspended solids loading not exceed 100 pounds per 1,000 cubic feet of volume per day in the digestion units. Lower loading rates between 25 to 100 pounds/1,000 cubic feet/day may be necessary depending on temperature, type of sludge, and other factors.
- 75.32 Solids Retention Time - Required minimum solids retention time for stabilization of biological sludges vary depending on temperature and type of sludge. Normally, a minimum of 15 days retention should be provided for waste activated sludge and 20 days for combination of primary and waste activated sludge, or primary sludge alone. Where sludge temperature is lower than 59°F., additional detention time should be considered.
- 75.4 Supernatant Separation - Facilities shall be provided for effective separation and withdrawal of supernatant and for effective collection and removal of scum and grease. Provision should be made to withdraw supernatant from multiple levels of the supernatant withdrawal zone.
- 75.5 High Level Emergency Overflow - An unvalved high level overflow and any necessary piping shall be provided to return digester overflow back to the head of the plant or, preferably, to an aeration process in case of accidental overfilling. Design considerations related to the digester overflow shall include waste sludge rate and duration during the period the plant is unattended, potential effects on plant process units, discharge location of the emergency overflow, and potential discharge of suspended solids in the plant effluent.
- 75.6 Digested Sludge Storage Volume - Sludge storage must be provided in accordance with Section 78 to accommodate daily sludge production volumes and as an operational buffer for unit outage and adverse weather conditions. Designs utilizing increased sludge age in the activated sludge system as a means of storage are not acceptable.
76. Sludge Pumps and Piping
- 76.1 Sludge Pumps
- 76.11 Capacity - Pump capacities should be adequate but not excessive. Provision for varying pump capacity is desirable.
- 76.12 Duplicate Units - Duplicate units shall be provided where failure of one unit would hamper plant operation.
- 76.13 Type - Plunger pumps, screw feed pumps, recessed impeller type centrifugal pumps, progressive cavity pumps, or other types of pumps with demonstrated solids handling capability shall be provided for handling raw sludge. Where centrifugal pumps are used, a parallel positive displacement pump should be provided as an alternate to pumping heavy sludge concentrations, such as primary or thickened sludges, that may exceed the pumping head of a centrifugal pump.
- 76.14 Minimum Head - A minimum positive head of 24 inches shall be provided at the suction side of centrifugal type pumps and is desirable for all types of sludge pumps. Maximum suction lifts should not exceed 10 feet for positive displacement pumps.
- 76.15 Sampling Facilities - Unless sludge sampling facilities are otherwise provided, quick closing sampling valves shall be installed at the sludge pumps. The size of the valve and piping should be at least 1 1/2 inches and should terminate at a suitably sized sampling sink or floor drain. Provision should be made for sampling at various levels in the mixing zone.

## 76.2 Sludge Piping

- 76.21 Size and Head - Sludge withdrawal piping should have a minimum diameter of eight inches for gravity withdrawal and six inches for pump suction and discharge lines. Where withdrawal is by gravity, the available head on the discharge pipe should be adequate to provide at least four feet per second velocity.
- 76.22 Slope - Gravity piping should be laid on uniform grade and alignment. The slope of gravity discharge piping should not be less than three percent. Provisions should be made for cleaning, draining and flushing discharge lines. All sludge pipes shall be suitably located and adequately protected to prevent freezing.
- 76.23 Supports - Special consideration should be given to the corrosion resistance and continuing stability of supporting systems located inside the digestion tank.

## 77. Sludge Dewatering

### 77.1 Sludge Drying Beds

- 77.11 General - Sludge drying beds may be used as a sole means, or in combination with other dewatering systems, to dewater digested sludge from either the anaerobic or aerobic process. Various types of drying beds such as sand, wedge-wire, vacuum assisted, and sand-reed may be used.
- 77.12 Area - Sludge drying bed area shall be calculated using a rational basis considering such factors as the climatic conditions, the character and volume of sludge to be dewatered, the digester volume and other wet sludge storage facilities, the time required on the bed to produce a removable cake, and other methods of sludge dewatering. For design purposes, a depth of eight to 12 inches of wet sludge should be utilized.

In the absence of rational design, the size of the sand drying bed may be estimated on the basis of 1.0 to 1.5 sq. ft./capita for primary digested sludge, 1.25 to 1.75 sq. ft./capita for primary and humus digested sludge, and 1.75 to 2.5 sq. ft./capita for primary and activated digested sludge, when drying beds is the primary method of dewatering. The drying bed area based on one sq. ft./capita may be used when it is to be used as a backup dewatering unit. Sand drying beds may be reduced in size by 25 percent when covered.

### 77.13 Percolation Type

#### 77.131 Media

- a. Gravel: The lower course of gravel around the underdrains should be properly graded and should be 12 inches in depth, extending at least 6 inches above the top of the underdrains. It is desirable to place this in two or more layers. The top layer of at least three inches should consist of gravel 1/8-inch to 1/4-inch in size.
- b. Sand: The top course should consist of at least six to nine inches of clean, coarse sand. The finished sand surface should be level. The sand should have an effective size of 0.3 to 1.2 mm and a uniformity coefficient of less than 5.0.

- 77.132 Underdrains - Underdrains should be at least four inches in diameter and laid with open joints. Underdrains should be spaced not more than 20 feet apart and discharge back to the treatment process. Various pipe materials may be selected provided the material is of suitable strength and corrosion resistant.
- 77.14 Walls - Walls should be watertight and extend 15 to 18 inches above, and at least six inches below, the surface of the bed. Outer walls should be curbed to prevent soil from washing onto the beds.
- 77.15 Sludge Removal - A minimum of two beds should be provided. Each bed should be constructed so as to be readily and completely accessible to mechanical cleaning equipment. Concrete runways spaced to accommodate mechanical equipment should be considered. Special attention should be given to assure adequate access to the areas adjacent to the sidewalls. Entrance ramps down to the level of the sand bed should be provided. These ramps should be high enough to eliminate the need for an entrance end wall for the sludge bed.
- 77.16 Sludge Influent - The sludge pipe to the drying beds should terminate at least 12 inches above the surface and be so arranged that it will drain. Concrete splash slabs should be provided at sludge discharge points.
- 77.17 Drainage Disposal - Drainage from beds shall be returned to the raw or settled wastewater.
- 77.18 Protective Enclosure - A protective enclosure shall be provided if winter operation is required.

## 77.2 Mechanical Dewatering Facilities

- 77.21 General - Provisions shall be made to maintain sufficient continuity of service so that sludge may be dewatered without accumulating beyond storage capacity. Before determining the required number of dewatering units, consideration shall be given to other sludge disposal methods (e.g., liquid sludge disposal, drying beds) to be utilized and the available storage capacity. The number of vacuum filters, centrifuges, filter presses, belt filters, or other mechanical dewatering facilities should be sufficient to dewater the sludge produced with one unit out of service. If stand-by dewatering facilities are not available, adequate storage facilities equivalent to a three-month sludge production or other means of sludge disposal shall be provided. Documentation must be submitted justifying the basis of design of mechanical dewatering facility.
- 77.22 Ventilation - Adequate facilities shall be provided for ventilation of the dewatering area. The exhaust air should be properly conditioned to avoid odor nuisance.
- 77.23 Chemical Handling - Dry chemical mixing facilities should be completely enclosed to prevent the escape of dust. Chemical handling equipment should be automated to eliminate the manual lifting requirement.
- Polymers and other chemicals shall be handled and stored as per manufacturer's instructions.
- 77.24 Drainage and Filtrate Disposal - Drainage or filtrate from dewatering units shall be returned to the raw or settled wastewater.

77.25 Water Supply Protection - Provisions for water supply protection shall be in accordance with Section 46.23.

77.26 Quantity Measurement - A means of measuring the quantity of sludge processed should be provided.

78. Sludge Storage and Disposal

78.1 Sludge Storage - Sludge storage facilities should be provided at all treatment plants. The storage facilities may consist of a combination of drying beds, additional volume in sludge stabilization units, separate tanks, pad areas, or other methods approved by the Department for the storage of either liquid or dried sludge. Storage facilities shall be determined based on the available sludge disposal options and may be on or off site.

Those proposals involving on-site domestic wastewater sludge storage facilities are reviewed and approved under the Part II Water Quality Management Permit, and a separate permit from the Bureau of Land Recycling and Waste Management shall not be required. The applicant shall submit the appropriate calculations justifying the number of days of storage required based on the sludge handling or disposal options at the facility. Drainage and/or leachate collection from the storage pads shall be piped to a treatment facility for treatment.

Proposals involving the off-site sludge storage facilities shall be reviewed and permitted by the Bureau of Land Recycling and Waste Management. The applicant shall contact the Bureau of Land Recycling and Waste Management for the requirements for an off-site sludge storage facility.

78.2 Sludge Disposal - All domestic wastewater sludge disposal proposals are reviewed and permitted by the Bureau of Land Recycling and Waste Management. The applicant shall contact the Bureau of Land Recycling and Waste Management for appropriate sludge disposal requirements. Sludge and sludge residue shall be disposed of as approved by the Bureau of Land Recycling and Waste Management.

79. RESERVED FOR FUTURE USE.

## 80. BIOLOGICAL TREATMENT

### 81. Trickling Filters

81.1 General - Trickling filters may be used for treatment of wastewater amenable to treatment by aerobic biological treatment processes. Trickling filters shall be preceded by effective settling tanks equipped with scum and grease collecting devices, or other suitable pretreatment facilities.

Filters shall be designed to meet the discharge requirements for the receiving waters as established by the National Pollutant Discharge Elimination System (NPDES) permit, or to properly condition the wastewater for subsequent treatment processes. Multi-stage filters may be considered if needed to meet more stringent effluent standards.

#### 81.2 Hydraulics

##### 81.21 Distribution

81.211 Uniformity - The wastewater may be distributed over the filter by rotary distributors or other suitable devices which will ensure uniform distribution to the surface area. At maximum monthly average flow, the deviation from a calculated uniformly distributed volume per square foot of the filter surface shall not exceed plus or minus 10 percent at any point. All hydraulic factors involving proper distribution of wastewater on the filters shall be carefully calculated.

Reverse reaction nozzles or hydraulic brakes shall be provided to not exceed the maximum speed recommended by the distributor manufacturer and to attain the desired media flushing rate.

81.212 Head Requirements - For reaction type distributors, a minimum head of 24 inches between low water level in siphon chamber and center of arms is required. Similar allowance in design shall be provided for added pumping head requirements where pumping to the reaction type distributor is used.

81.213 Clearance - A minimum clearance of six inches between media and distributor arms shall be provided. Greater clearance is essential where icing may occur.

81.22 Dosing - Wastewater may be applied to the filters by siphons, pumps, or by gravity discharge from preceding treatment units when suitable flow characteristics have been developed. Application of the wastewater shall be practically continuous. The piping system shall be designed to permit recirculation.

81.23 Piping System - The piping system, including dosing equipment and distributor effluent underdrains, shall be designed to provide capacity for the peak hourly flow rate, including recirculation required under Section 81.65.

81.3 Unit Sizing - Required volumes of rock or slag media filters shall be based upon pilot testing with the particular wastewater or any of the various empirical design equations that have been verified through actual full scale experience. Such calculations must be submitted if pilot testing is not utilized. Pilot testing is recommended to verify performance predictions based upon the various design equations, particularly when sufficient amounts of industrial wastes are present.

Expected performance of filters packed with manufactured media shall be determined from documented full scale experience and/or through actual use of a pilot plant on site.

#### 81.4 Media

81.41 Quality - The media may be crushed rock, slag or manufactured material. The media shall be durable, resistant to spalling or flaking, and relatively insoluble in wastewater. The top 18 inches shall have a loss by the 20-cycle, sodium sulfate soundness test of not more than 10 percent, as prescribed by ASCE Manual of Engineering Practice, Number 13. The balance is to pass a 10-cycle test using the same criteria. Slag media shall be free from iron or other leachable material that will adversely affect the process or effluent quality. Manufactured media shall be resistant to ultraviolet degradation, disintegration, erosion, aging, all common acids and alkalies, organic compounds, and fungus and biological attack. Such media shall be structurally capable of supporting a man's weight, or a suitable access walkway shall be provided to allow for distributor maintenance.

81.42 Depth - Rock and/or slag filter media shall have a minimum depth of six feet above the underdrains. Rock and/or slag filter media depths shall not exceed 10 feet, and manufactured filter media depths shall not exceed the recommendations of the manufacturer. Forced ventilation should be considered in accordance with Section 81.53.

#### 81.43 Size, Grading and Handling

81.431 Rock, Slag and Similar Media - Rock, slag and similar media shall not contain more than five percent by weight of pieces whose longest dimension is three times the least dimension.

They shall be free from thin elongated and flat pieces, dust, clay, sand, or fine material, and shall conform to the following size and grading when mechanically graded over vibrating screen with square openings.

Passing 4 1/2 - inch screen -- 100 percent by weight  
Retained on 3-inch screen - 95-100 percent by weight  
Passing 2-inch screen - 0 - 2 percent by weight  
Passing 1-inch screen - 0 - 1 percent by weight

81.432 Manufactured Media - Suitability will be evaluated on the basis of experience with installations handling similar wastes and loadings. To insure sufficient void clearances, media with specific surface areas of no more than 30 square feet per cubic foot is acceptable for filters employed for carbonaceous reduction and 45 square feet per cubic foot for second stage ammonia reduction.

81.44 Handling and Placing - Material delivered to the filter site shall be stored on wooden planks or other approved clean, hard-surfaced areas. All material shall be rehandled at the filter site and no material shall be dumped directly into the filter. Crushed rock, slag, and similar media shall be washed and rescreened or forked at the filter site to remove all fines. Such material shall be placed by hand to a depth of 12 inches above the tile underdrains and the remainder of material may be placed by means of belt conveyors or equally effective methods approved by the engineer. All material shall be carefully placed so as not to damage the underdrains. Manufactured media shall be handled and

placed as approved by the engineer. Trucks, tractors, or other heavy equipment shall not be driven over the filter during or after construction.

#### 81.5 Underdrainage System

81.51 Arrangement - Underdrains with semi-circular inverts or equivalent should be provided and the underdrainage system shall cover the entire floor of the filter. Inlet openings into the underdrains shall have an unsubmerged gross combined area equal to at least 15 percent of the surface area of the filter.

81.52 Hydraulic Capacity - The underdrains shall have a minimum slope of one percent. Effluent channels shall be designed to produce a minimum velocity of two feet per second at average daily rate of application to the filter.

81.53 Ventilation - The underdrainage system, effluent channels, and effluent pipe shall be designed to permit free passage of air. The design should consider installation of vent stacks on the filter periphery for additional ventilation. The size of drains, channels, and pipes should be such that not more than 50 percent of their cross-sectional area will be submerged under the design peak hydraulic loading, including proposed or possible future recirculated flows.

Forced ventilation should be provided for covered trickling filters to insure adequate oxygen for process requirements. Windows or simple louvered mechanisms so arranged to ensure air distribution throughout the enclosure shall be provided. The design of the ventilation facilities shall provide for operator control of air flow in accordance with outside seasonal temperature. Design computations showing the adequacy of air flow to satisfy process oxygen requirements shall be submitted.

81.54 Flushing - Provision should be made for flushing the underdrains unless high rate recirculation is utilized. In small rock and slag filters, use of a peripheral head channel with vertical vents is acceptable for flushing purposes. Inspection facilities should be provided.

#### 81.6 Special Features

81.61 Flooding - Appropriate valves, sluice gates, or other structures shall be provided so as to enable flooding of rock or slag media filters for filter fly control.

81.62 A freeboard of four feet or more should be provided for tall manufactured media filters to contain windblown spray. Provide at least six foot headroom for maintenance of the distributor on covered filters.

81.63 Maintenance - All distribution devices, underdrains, channels, and pipes shall be installed so that they may be properly maintained, flushed, or drained.

81.64 Winter Protection - Adequate protection, such as covers in severe climate or wind breaks in moderate climates, shall be provided to maintain operation and treatment efficiencies when climatic conditions are expected to result in problems due to cold temperatures.

81.65 Recirculation - The piping system shall be designed for recirculation as required to achieve the design efficiency. The recirculation rate shall be variable and subject to plant operator control between the range of one-half to four times the maximum monthly average flow. A minimum of two recirculation pumps shall be provided.

- 81.66 Recirculation Measurement - Devices shall be provided to permit measurement of the recirculation rate. Elapsed time meters and pump head recording devices are acceptable for facilities treating less than one mgd. The design of the recirculation facilities shall provide for both continuity of service and the range of recirculation ratios.
- 81.7 Rotary Distributor Seals - Mercury seals shall not be permitted. Ease of seal replacement shall be considered in the design to ensure continuity of operation.
- 81.8 Multi-Stage Filters - The foregoing standards also apply to all multi-stage filters.
- 81.9 Design Safety factors - Trickling filter performance is affected by diurnal load conditions. The volume of media required, as determined from either pilot plant studies or use of acceptable design equations, shall be based upon the design peak hourly organic loading rate rather than the maximum monthly average organic rate. An alternative would be to provide flow equalization.
82. Activated Sludge
- 82.1 General
- 82.11 Applicability
- 82.111 Biodegradable Wastes - The activated sludge process and its various modifications may be used where wastewater to be treated is amenable to the aerobic biological treatment process. Effects of any industrial wastes and toxics present in the wastewater should be evaluated before selecting the activated sludge process.
- 82.112 Operational Requirement - This process requires close attention and competent operating supervision, including routine laboratory control. These requirements shall be considered when proposing this type of treatment.
- 82.113 Energy Requirements - This process requires major energy usage to meet aeration demands. Energy costs and potential mandatory emergency public power reduction events in relation to critical water quality conditions must be carefully evaluated. Capability of energy usage phasedown while still maintaining process viability, both under normal and emergency energy availability conditions, must be included in the activated sludge design.
- 82.12 Specific Process Selection - The activated sludge process and its several modifications may be employed to accomplish varied degrees of removal of suspended solids and reduction of carbonaceous and/or nitrogenous oxygen demand. Choice of the process most applicable will be influenced by the degree and consistency of treatment required, type of waste to be treated, proposed plant size, anticipated degree of operation and maintenance, and operating and capital costs. All designs shall provide for flexibility in operation. Plants over one mgd shall be designed to facilitate easy conversion to various operation modes.
- 82.13 Winter Protection - In severe climates, protection against freezing shall be provided to insure continuity of operation and performance. Insulation of tanks by earthen banks should be considered.

82.2 Pretreatment - Where primary settling tanks are not used, effective removal or exclusion of grit, debris, excessive oil or grease, and comminution or screening of solids shall be accomplished prior to the activated sludge process.

Where primary settling is used, provision shall be made for discharging raw wastewater directly to the aeration tanks to facilitate plant start-up and operation during the initial stages of the plant's design life.

### 82.3 Aeration

82.31 Capacities and Permissible Loadings - The size of the aeration tank for any particular adaptation of the process shall be determined by full-scale experience, pilot plant studies, or rational calculations based mainly on food to microorganism ratio and mixed liquor suspended solids levels. Other factors such as size of treatment plant, diurnal load variations, and degree of treatment required shall also be considered. In addition, temperature, pH, and reactor dissolved oxygen shall be considered when designing for nitrification.

Calculations should be submitted to justify the basis for design of aeration tank capacity. Calculations using values differing substantially from those in the accompanying table should reference actual operating plants. Mixed liquor suspended solids levels greater than 5,000 mg/l may be allowed provided that adequate data is submitted that shows the aeration and clarification system is capable of supporting such levels.

When process design calculations are not submitted, the aeration tank capacities and permissible loadings for the several adaptations of the processes shown in the following table shall be used. These values apply to plants receiving peak to average diurnal load ratios ranging from about 2:1 to 4:1. Thus, the utilization of flow equalization facilities to reduce the diurnal peak organic load may be considered by the Department as justification to approve organic loading rates that exceed those specified in the table.

**PERMISSIBLE AERATION TANK CAPACITIES AND LOADINGS**

**(Note: For Proper Use of This Table, See Section 82.31)**

<b>Process</b>	<b>Mode of Aeration</b>	<b>Minimum Aeration Retention Period - Hours (based on maximum monthly average flow)</b>	<b>Maximum Aeration Tank Organic Loading - lb.***** BOD/1000 cu.ft./day</b>	<b>F/M Ratio lb. BOD/lb. MLVSS/day</b>	<b>MLSS mg/liter</b>
Step Aeration, Complete Mix and, Conventional Activated Sludge	Air System	6	40	0.2-0.5	1,000-3,000
	Pure Oxygen System	2	160	0.3-1.0	3,000-5,000-
Contact Stabilization	Air System	5*	60	0.2-0.6	1,000-3,000
Combined Carbon Oxidation-Nitrification**	Air System	12	20	.08-.16	2,000-5,000
	Pure Oxygen System	4	60	.10-.20	3,000-5,000
Extended Aeration and Oxidation Ditches	Air System	24	15	.05-0.1	3,000-5,000
Carbonaceous Stage of Separate Stage Nitrification	Air System	4	70	0.3-0.8	1,000-2,500
	Pure Oxygen System	1.5	250	0.5-1.0	3,000-5,000
Nitrification Stage of Separate Stage Nitrification	Air System	6	10***	.05-.20*****	1,000-3,000
	Pure Oxygen System	2	25***	.08-.20*****	3,000-5,000

\* Total aeration capacity, includes both contact and reaeration capacities. Normally the contact zone equals 30 to 35 percent of the total aeration capacity.

\*\* Not recommended if wastewater temperatures are expected to fall below 10°C.

\*\*\* Lb. NH<sub>3</sub>-N/1000 cu. ft./day

\*\*\*\* Lb. NH<sub>3</sub>-N/lb. MLVSS/day

\*\*\*\*\* Based on the maximum daily BOD load to the aeration tank.

(Note: In designing nitrogen reduction systems with biological processes, provisions shall be made for providing 10 mg/l of alkalinity per 1 mg/l of nitrogen reduced.)

## 82.32 Arrangement of Aeration Tanks

### 82.321 General Tank Configuration

- a. Dimensions - The dimensions of each independent mixed liquor aeration tank or return sludge reaeration tank shall be such as to maintain effective mixing and utilization of air. Ordinarily, liquid depths should not be less than 10 feet or more than 30 feet except in special design cases such as oxidation ditch design.
- b. Short Circuiting - For very small tanks or tanks with special configuration, the shape of the tank, the location of the influent and sludge return, and the installation of aeration equipment should provide for positive control of short circuiting through the tank.

82.322 Number of Units - Consideration should be given to dividing the required aeration tank volume into two or more units at all plants. For plants designed to receive maximum monthly average flow of 50,000 gpd or more, total aeration tank volume shall be divided among two or more units capable of independent operation, when required by the Department to meet applicable effluent limitations and reliability guidelines.

### 82.323 Inlets and Outlets

- a. Controls - Inlets and outlets for each aeration tank unit shall be suitably equipped with valves, gates, stop plates, weirs, or other devices to permit controlling the flow to any unit and to maintain a reasonably constant liquid level. The hydraulic properties of the system shall permit the peak instantaneous flow, including the maximum sludge return flow, to be carried with any single aeration tank unit out of service.
- b. Conduits - Channels and pipes carrying liquids with solids in suspension shall be designed to maintain self-cleansing velocities or shall be agitated to keep such solids in suspension at all rates of flow within the design limits. Adequate provisions should be made to drain segments of channels which are not being used due to alternate flow patterns.

82.324 Freeboard - All aeration tanks should have a freeboard of not less than 18 inches. Where a mechanical surface aerator is used, the freeboard should be not less than three feet to protect against windblown spray freezing on walkways.

82.325 Froth Spray - Use of a froth spray system to cut down the foam in the aeration tank should be considered. The froth spray pump(s) should preferably be located in the chlorine contact tank to prevent clogging of nozzles. The froth spray lines in the aeration tank should point perpendicular to the flow.

### 82.326 Oxidation Ditches

- a. Depth - The maximum liquid depth in the ditch shall be 12 feet for vertical sidewalls and six feet for sloping sidewalls. Large ditches should have at

least two bottom drains for ease of emptying and cleaning. For ditches greater than six feet deep, consideration should be given to placing baffles within 15 feet downstream of aerators to provide proper mixing of the entire depth of the channel.

- b. Inlet/Outlet - The raw wastewater inlet and return sludge flow shall be located immediately upstream from the first brush (rotor). The outlet or overflow weir device shall be located between the last brush and the inlet of each ditch.
- c. Brushes - Rotors or brushes are used to provide surface aeration for oxygen transfer and to keep the contents of the ditch mixed and moving. A velocity of the liquid in the ditch must be maintained at 1.0 to 1.5 feet per second to prevent the settling of solids. There shall be a minimum of two brushes per ditch for oxygen control and for continued operation should a brush have a mechanical breakdown. With one brush out of service, adequate aeration and velocity shall be maintained by the remaining brushes through the sizing of the brushes and controlling the submergence. Consideration should be given in the colder areas to cover both the brush and motor drive units to prevent an ice buildup problem at the two ends of the brush shaft.
- d. Weirs - Each ditch shall have an easily adjustable effluent control weir to vary the brush depth submergence in order to vary the amount of oxygen transfer.
- e. Clarifiers following ditches should have both mechanical sludge scrapers and scum skimmers with baffle to prevent solids/scum carryover due to no primary clarifiers. They should also have a positive means of sludge return to the ditch or wasting, along with a means of sludge return measurement.
- f. The entire ditch shall be lined with an impervious material to prevent erosion and scouring by the liquid velocity in the ditch. Provisions shall also be made to prevent surface runoff from entering the ditch.

### 82.33 Aeration Equipment

82.331 General - Oxygen requirements generally depend on maximum diurnal organic loading, degree of treatment, and level of suspended solids concentration to be maintained in the aeration tank mixed liquor. Aeration equipment shall be capable of maintaining a minimum of two mg/l of dissolved oxygen in the mixed liquor at all times and providing thorough mixing of the mixed liquor.

In the absence of experimentally determined values, the design oxygen requirements for all activated sludge processes shall be 1.1 lbs oxygen/lb. maximum daily BOD applied to the aeration tanks at working conditions, with the exception of the extended aeration process, for which the value shall be 1.5 to include endogenous respiration requirements. In addition, the oxygen demands due to recycle flows (heat treatment supernatant, filtrate from

dewatering operations, elutriates, etc.) must be considered due to the high concentrations of BOD and ammonia associated with such flows.

In the case of nitrification, the oxygen requirement for oxidizing ammonia must be added to the above requirement for carbonaceous BOD removal and endogenous respiration requirements. The nitrogenous oxygen demand (NOD) shall be taken as 4.6 times the maximum daily ammonia content of the influent to the aeration tank.

Careful consideration should be given to maximizing oxygen utilization per unit power input. Unless flow equalization is provided, the aeration system should be designed to match the diurnal organic load variation while economizing on power input.

82.332 Diffused Air Systems - The design of the diffused air system to provide oxygen requirements shall be performed by either of the two methods described in (a) or (b) and augmented as required by considerations of items (c) through (g).

- a. Having determined the oxygen requirements per Section 82.331, air requirements for a diffused air system shall be determined by use of any of the well-known equations incorporating such factors as tank depth, alpha factor of waste, beta factor of waste, certified aeration device transfer efficiency, minimum aeration tank dissolved oxygen concentrations, critical wastewater temperature, and altitude of plant.

In the absence of experimentally determined alpha and beta factors, wastewater transfer efficiency shall be assumed to be 50 percent of clean water efficiency for plants treating primarily (90 percent or greater) domestic wastewater. Treatment plants where the waste contains higher percentages of industrial wastes shall use a correspondingly lower percentage of clean water efficiency and shall have calculations submitted to justify such a percentage. The design transfer efficiency should be included in the specifications.

- b. Minimum air requirements for all activated sludge processes (excluding nitrogenous oxygen demand) except extended aeration (assuming equipment capable of transmitting to the mixed liquor the amount of oxygen required in Section 82.331) shall be considered to be 1,500 cu. ft. per pound of maximum daily BOD aeration tank loading at standard conditions of pressure, temperature, and humidity. For the extended aeration process, the value shall be 2,050 cu. ft. per pound of maximum daily BOD aeration tank loading at standard conditions of pressure, temperature, and humidity. These requirements include mixing but do not include oxygen demand for nitrification. Refer to Section 82.331.
- c. To the air requirements calculated above shall be added the air required for channels, air lifts, aerobic digesters, or other air-use demand.
- d. The specified capacity of blowers or air compressors, particularly centrifugal blowers, should take into account that the air intake

temperature may reach 104°F or higher, and the pressure may be less than normal. The specified capacity of the motor drive should also take into account that the intake air may be 22°F or less and may require oversizing of the motor or a means of reducing the rate of air delivery to prevent overheating or damage to the motor.

- e. All blowers and electrical controls shall be located in a building or a heated, walk-in enclosure.

The blowers shall be provided in multiple units, so arranged and in such capacities as to meet the maximum air demand with the single largest unit out of service. The design shall also provide for varying the volume of air delivered in proportion to the load demand of the plant. The use of timers to conserve energy is acceptable, provided necessary minimum dissolved oxygen level is maintained in the aeration tank. Aeration equipment shall be easily adjustable in increments and shall maintain solids in suspension within these limits. Step type proportioning is acceptable.

- f. Diffuser systems shall be capable of providing for the diurnal peak oxygen demand or 200 percent of the design average oxygen demand, whichever is larger. The air diffusion piping and diffuser system shall be capable of delivering normal air requirements with minimal friction losses.

Air piping systems should be designed such that total air loss from blower outlet (or silencer outlet where used) to the diffuser inlet does not exceed 0.5 psi at normal operating conditions.

The spacing of diffusers should be in accordance with the oxygen requirements through the length of the channel or tank, and should be designed to facilitate adjustment of their spacing without major revision to air header piping. Diffusers should be located one to two feet from the bottom of the tank when operating.

All plants employing less than four independent aeration tanks shall be designed to incorporate removable diffusers that can be serviced and/or replaced without dewatering the tank. However, use of fixed diffusers may be approved on a case-by-case basis if it is demonstrated that the built-in design and/or operational flexibility can keep the facility in compliance when one of the tanks is out-of-service or not in operation due to maintenance.

- g. Individual assembly units of diffusers shall be equipped with control valves, preferably with indicator markings for throttling, or for complete shutoff. Diffusers in any single assembly shall have substantially uniform pressure loss.

Air filters shall be provided in numbers, arrangements, and capacities to furnish at all times an air supply sufficiently free from dust to prevent damage to blowers and clogging of the diffuser system used.

### 82.333 Mechanical Aeration Systems

- a. Oxygen Transfer Performance - The mechanism and drive unit shall be designed for the expected conditions in the aeration tank in terms of the power performance. Certified on-line testing shall verify mechanical aerator performance based on similar geometrical tank design. Refer to applicable Section 82.332a. In the absence of specific design information, the oxygen requirements shall be calculated using a transfer rate not to exceed two lbs. of oxygen per horsepower per hour in clean water at standard conditions. Design transfer efficiency shall be included in the specifications.
- b. Design Requirements - The design requirements of a mechanical aeration system shall accomplish the following:
  1. Maintain a minimum of two mg/l of dissolved oxygen in the mixed liquor at all times throughout the tank or basin.
  2. Maintain all biological solids in suspension.
  3. Meet maximum oxygen demand and maintain process performance with the largest unit out of service.
  4. Provide for varying the amount of oxygen transferred in proportion to the load demand on the plant.
  5. Provide that motors, gear housing, bearings, grease fittings, etc., be easily accessible and protected from inundation and spray as necessary for proper functioning of the unit.
- c. Winter Protection - Where extended cold weather conditions occur, the aerator mechanism and associated structure shall be protected from freezing due to splashing. Due to high heat loss, subsequent treatment units shall be protected from freezing.

### 83. Rotating Biological Contactors

#### 83.1 General

- 83.11 Applicability - The Rotating Biological Contactor (RBC) process may be used where wastewater to be treated is amenable to aerobic biological treatment. This process may be used to accomplish carbonaceous and/or nitrogenous oxygen demand reductions.
- 83.12 Winter Protection - Wastewater temperature affects RBC performance. Year-round operating requires that RBCs be covered to protect the biological growth from cold temperatures and the excessive loss of heat from the wastewater with the resulting loss of performance.

Enclosures shall be constructed of a suitable corrosion-resistant material. Windows or simple louvered mechanisms which can be opened in the summer and closed in the winter shall be installed to provide adequate ventilation. To minimize condensation, the enclosure should be adequately insulated and/or heated.

83.2 Pretreatment - Effective treatment, through the use of primary clarifiers equipped with scum and grease collecting devices, must be provided ahead of RBC units unless substantial justification is submitted for other pretreatment devices which provide for effective removal of grit, debris and excessive oil or grease prior to the RBC units. Bar screening or comminution is not suitable as the sole means of pretreatment.

### 83.3 Design Considerations

83.31 Process Loading and Reliability - To assure continued and reliable performance, the following items shall be considered in designing RBC process.

- a. Design loadings applied to the first RBC stage should not exceed five to six lbs. total BOD/day/1,000 sq. ft. or two and one-half lbs. soluble BOD/day/1,000. Soluble BOD loading should be verified by influent sampling whenever possible. Organic loading considerations during design must include contributions from in-plant sidestreams, septage dumps, etc.
- b. When peak to average flow ratio is 2.5 to 1 or less, average conditions can be used for design. For higher flow ratios, flow equalization should be considered.
- c. If periodic high loadings are expected, supplemental aeration in the first stage should be considered.
- d. Manufacturer's literature indicates that organic removal and nitrification rates diminish at wastewater temperatures below 55° F. Appropriate temperature correction factor should be used to determine needed additional media surface for temperatures below 55° F.
- e. High influent hydrogen sulfide (H<sub>2</sub>S) concentrations can impede RBC performance because of the acceleration of the nuisance growth. When higher than normal influent or side stream H<sub>2</sub>S concentrations are anticipated, appropriate modifications in the design should be considered.
- f. High density media should not be used in first and second stages.
- g. A means of removing excess biofilm growth, such as by air or water stripping, chemical additions, rotational speed control/reversal, etc.; should be provided.
- h. Need for additional media surface should be evaluated when ammonia nitrogen levels are required in the effluent. Manufacturer's literature should be consulted in determining this.
- i. First-stage dissolved oxygen (DO) monitoring should be provided. The RBC unit should be designed to maintain a positive DO level in all stages.
- j. To the extent possible, RBCs should not be installed in buildings. However, when RBCs are installed in buildings, adequate ventilation, humidity control, need for removal of shaft and media, and heating requirements must be considered.

- k. Design should clearly show the effect of varying loadings to the various stages of the process to assure compliance with effluent limits and prevent structural damage to shafts and media caused by organic loadings exceeding process capability.
- l. RBC system should be such that effluent limits are met with some units out of service. This may be necessary for recoating shafts for corrosion control, media replacement or repair, bearing replacement, etc. that would mandate such needs.

If such process reliability needs are not or cannot be met through flexibility in the design flow, then added standby units should be provided to insure process continuity and prevent mechanical/structural failure with short-term overload.

- m. Careful consideration should be given to providing power factor correction for all RBC mechanical and air driven systems.
- n. The use of high-efficiency motors for mechanically driven RBC units to lower the energy consumption should be considered.

83.32 Mechanical Reliability and Structural Integrity - Some of the early generation RBCs had suffered failures to shafts, drives, bearings, and media. The following shall be considered for achieving reliable RBC performance.

- a. The load-bearing capacity for each shaft that considers the maximum anticipated biofilm growth, the capacity to strip excess biofilm, and an adequate margin of safety should be specified in the contract documents.
- b. The manufacturer should be required to provide adequate assurance that the shaft and media support structures are protected from structural failures for the design life of the facility. Structural designs should be based on appropriate American Welding Society (AWS) stress category curves modified as necessary to account for expected corrosive environment. All fabrication during construction should conform to AWS welding and quality control standards.
- c. Load cells should be provided for all first and second stage shafts. Load cells for all of the shafts in an installation are desirable.
- d. The design should consider impact of stress reversals on the plastic media over the design life. The specifications should require the manufacturer to provide adequate assurance that the premature media failures, including collapse, wobbling on shaft, accordian action, shifting within cage, etc., will not occur.
- e. Bearings and drive systems must be designed for a ten year life using appropriate anti-friction bearing Manufacturer's Association criteria and the American Gear Manufacturer's Association criteria. RBC shaft bearings must be of the self-aligning type designed to effectively retard the entrance of foreign material into the lubricant.
- f. The design life of such components as gear boxes, chains, motors, v-belts, fiber glass cover, etc. should be carefully reviewed and compared to available field experience.

- g. The specifications should require that provisions be made to protect the plastic media from direct exposure to sunlight (ultraviolet degradation) during delivery and construction.

83.33 Operation and Maintenance - Adequate flexibility in process operation and ease of maintenance should be provided by considering inclusion of the following items.

- a. Variable rotational speeds in first and second stages.
- b. Multiple treatment trains.
- c. Removable baffles between all stages.
- d. A suitably sized drain line with a shut-off valve for each unit or flow train to allow dewatering of the basin.
- e. Positive influent flow control to each unit or flow train; for example, a flow splitter box to control the flow to each unit or flow train.
- f. Positively controlled alternate flow distribution systems, such as step feed.
- g. Positive air flow metering and control to each shaft when supplemental aeration or air drive units are used.
- h. Recirculation of secondary clarifier effluent.
- i. Ease of access to shaft, media and other mechanical equipment needing inspection/maintenance and possible periodic removals/replacement.
- j. Use of self-aligning, moisture resistant bearings.

#### 84. Intermittent Sand Filters

Secondary treatment by sand filters is generally considered feasible only for institutional or relatively small community treatment plants. The use of subsurface or covered sand filters is not recommended except for private installations where flows do not exceed 10,000 gallons per day.

##### 84.1 Loading on Sand Filters

- 84.11 Primary Effluent - With acceptable primary treatment of normal wastewater, loading shall not exceed 2.3 gallons per square foot of filter area per day.
- 84.12 Trickling Filter and Activated Sludge Effluent - Loading shall not exceed 10 gallons per square foot of filter area per day.
- 84.13 Septic Tank Effluent on Surface Filters - For the effluent of septic tanks treating normal domestic wastewater from small community installations, institutions, motels, etc., the loading shall not exceed 2.3 gallons per square foot of filter area per day. For summertime operations extending not longer than 90 days per year, this loading may be increased to 2.9 gallons per square foot per day, provided the septic tank is cleaned at least once each year. However, in no case may the BOD load reaching the filter exceed 140 pounds per acre per day.

84.14 Septic Tank Effluent on Subsurface Filters - For the effluent of septic tanks treating normal domestic wastewater from private installations, the flow shall not exceed 10,000 gallons per day, and the loading shall not exceed 1.5 gallons per square foot of filter area per day.

#### 84.2 Media

84.21 Gravel Base - Clean, graded gravel, preferably placed in at least three layers, should be placed around the underdrains and to a depth of at least six inches over the top of the underdrains. Suggested gradings for the 3 layers are 1 1/2 inches to 3/4 inch, 3/4 inch to 1/4 inch, and 1/4 inch to 1/8 inch.

84.22 Sand - At least 24 inches of clean sand should be provided. For open filters dosed by flooding, the effective size shall be 0.3 to 0.6 mm; for filters dosed by rotary distributors, the effective size shall be 0.5 to 1.0 mm. The uniformity coefficient shall not be greater than 3.5.

#### 84.3 Dosing

84.31 General - Facilities for dosing of the filter media shall be provided to assure an adequate rest period between two subsequent applications.

84.32 Duplicate Units - Two or more filters are necessary to provide for maintenance and adequate rest periods between doses.

84.33 Volume - The dosing tank volume shall be such that any open filter bed will be covered to a depth of two to four inches by each dose. Subsurface filter dosing should be done such that pipes are filled to 60-75 percent depth per dose.

84.34 Siphons or Pumps - Siphons or pumps shall have a discharge capacity at minimum head at least 100 percent in excess of the maximum rate of inflow to the dosing tank, and at average head, at least 90 gallons per minute per 1,000 square feet.

84.35 Discharge Lines - The discharge lines to the beds shall have sufficient capacity to permit the full rated discharge of the siphons or pumps.

#### 84.4 Distribution

84.41 Arrangement - Troughs or piping may be used for distribution of the settled wastewater over the filter surface and should be so located that the maximum lateral travel is not more than 20 feet. Provisions should be made for adjustment of the flow.

84.42 Splash Slabs - Splash slabs are needed at each point of discharge.

84.43 Drain - A drain opening from troughs or discharge piping is essential.

84.5 Underdrains - Open joint or perforated pipe underdrains of durable material may be used. They should be sloped to the outlet and spaced not to exceed 10-foot centers.

84.6 Earthen Base - The earthen base of the filters should be sloped to the trenches in which the underdrains are laid. An impervious liner shall be installed on the pervious earth based to prevent seepage to the groundwater table.

84.7 Curbs - Provision should be made to prevent soil from washing onto the beds.

84.8 To assure effective winter operation, filter covers shall be a design consideration.

85. Wastewater Treatment Ponds

85.1. General - The use of wastewater treatment ponds should be considered in those instances where the required level of wastewater treatment is compatible with pond technology and where adverse environmental impacts can be avoided. It must be recognized that wastewater treatment ponds are not an answer to all wastewater treatment problems in Pennsylvania. Availability of land at a reasonable cost often determines their viability. Each proposal to use ponds will be evaluated in light of the effects of the proposed discharge on water quality (both surface and groundwater), including ability to meet the effluent requirements on a consistent basis and any other considerations necessary to protect the public health. Applicants are encouraged to investigate the use of pond systems as a possible alternative to other biological, physical and/or chemical treatment processes. The wastewater treatment pond alternative should be evaluated early in the project development stage for cost-effective and environmental considerations.

85.2. Engineer's Report - The engineer's report shall contain pertinent information on location, geology, soil conditions, area for expansion and any other factors that will affect the feasibility and acceptability of the proposed project. The following information must be submitted in addition to that required in Chapter 10.

85.21 Supplementary Field Survey Data

85.211 The location and direction of all residences, commercial developments, parks, recreational areas and water supplies, within one-half mile of the proposed pond shall be included in the engineer's report.

85.212 Land use zoning adjacent to the proposed pond site shall be included.

85.213 A description, including maps showing elevations and contours of the site and adjacent area, shall be provided. Due consideration shall be given to additional treatment units to meet any applicable discharge standards and/or increased waste loadings in determining land requirements. Current U.S. Geological Survey and Soil Conservation Service maps may be considered adequate for preliminary evaluation of the proposed site.

85.214 The location, depth and discharge point(s) of any field tile in the immediate area of the proposed site shall be identified.

85.215 Data from soil borings conducted by a soil testing laboratory to determine subsurface soil characteristics and groundwater characteristics, including elevation and flow of the proposed site and their effect on the construction and operation of a pond, shall be provided. At least one boring shall be a minimum of 25 feet in depth or into bedrock, whichever is shallower. If bedrock is encountered, structure and corresponding geological formation data should be provided. The boring shall be filled and sealed. The permeability characteristics of the pond bottom and pond seal materials shall also be studied. (Refer to Section 85.53)

85.22 Location

- 85.221 Distance from Habitation - A pond site should be located as far away as practicable from habitation or any area which may be built up within a reasonable future period, taking into consideration site specifics such as topography, prevailing winds, forests, etc.
- 85.222 Prevailing Winds - If practicable, unaerated ponds shall be located so that local prevailing winds will be in the direction of uninhabited areas.
- 85.223 Surface Runoff - Adequate provisions must be made to divert storm water around the ponds to prevent excess hydraulic loading and protect pond embankments from erosion.
- 85.224 Hydrology - Construction of ponds in close proximity to public and/or private groundwater supplies subject to contamination shall be avoided. A minimum separation of four feet between the top of the pond seal and the maximum high water table should be maintained.
- 85.225 Geology - Ponds shall not be located in areas which may be subject to sink holes or solution channeling generally occurring in areas underlaid by limestone or dolomite.

A minimum separation of 10 feet between the pond bottom and any bedrock formations is recommended.

### 85.3 Pond Types and Classification

- 85.31 Pond Types - The wastewater treatment ponds are basically grouped into the following two types based on discharge method.
- a. Flow through ponds in which the pond discharges relatively continuously throughout the year; and
  - b. Controlled discharge ponds in which the pond is designed to retain the wastewater without discharge for a long period and discharge it over a short period.
- 85.32 Pond Classification - The wastewater treatment ponds are broadly classified as aerobic, anaerobic and facultative.

Aerobic ponds are characterized by having dissolved oxygen distributed throughout their contents practically all of the time. The required oxygen may be supplied by algae during daylight, and by mechanical or diffused aeration.

Anaerobic ponds usually are without any dissolved oxygen throughout their entire depth. The treatment depends on fermentation of sludges at the bottom. This process can be quite odorous and is generally not utilized for treating domestic wastewater.

Facultative ponds are the most common type used in treating domestic wastewater. The upper layer of these ponds is aerobic, while the bottom layer is anaerobic. Algae supply most of the required oxygen to the upper layer. Aeration of upper layer to dissolve and mix oxygen in the wastewater may also be required.

### 85.4 Basis of Design

- 85.41 Loading for Controlled Discharge Facultative Treatment Pond Systems - Pond design for BOD loading should range from 15 to 35 pounds per acre per day (at the mean operating depth) in the primary cells and a minimum of 90 days detention time between the two foot and the maximum operating depth of the entire pond system. The mean operating depth can be calculated as the maximum operating depth plus minimum operating depth divided by two. The detention time and organic loading rate shall depend on climatic condition and effluent requirements.
- 85.42 Loading for Flow-Through Facultative Treatment Pond Systems - Pond design for BOD loading should vary from 15 to 35 pounds per acre per day for the primary cells. The major design considerations for BOD loading must be directly related to the climatic conditions.

Design variables such as pond depth, multi-units, detention time and additional treatment units must be considered with respect to applicable standards for BOD, total suspended solids (TSS), fecal coliforms, nutrients, dissolved oxygen (DO), and pH.

A detention time of 90-120 days for the entire pond system should be provided; however, this must be properly related to other design considerations. It should be noted that the major factor in the design is the duration of the cold weather period (water temperature less than 5°C).

- 85.43 Aerated Treatment Pond Systems - These ponds are of the flow-through type. The minimum detention time for aerated pond system design may be estimated using the following formula; however, for the development of final design parameters, it is recommended that actual experimental data be developed.

$$t = \frac{E}{2.3K(1)x(100 - E)}$$

t = detention time, days

E = percent of BOD to be removed in aerated pond

K(1) reaction coefficient, aerated lagoon, base 10. For complete treatment of normal domestic sewage, the K(1) value may be assumed to be 0.20/day at 20°C. or 0.06/day at 0°C.

The reaction rate coefficient for wastewater to be treated, which may include domestic and non domestic wastewater, must be determined experimentally for various conditions which might be encountered in the aerated ponds. Conversion of the reaction rate coefficient at temperatures other than 20°C. shall be based on empirical data.

Raw wastewater strength should consider the impact of any recirculated wastewater. Also, additional storage time should be considered for sludge storage and, in northern climates, ice cover.

Oxygen requirements generally will depend on the BOD loadings, the degree of treatment, and the concentration of suspended solids to be maintained. Aeration equipment shall be capable of maintaining a minimum dissolved oxygen level of two mg/l in the ponds at all times. Sizing of the aeration equipment shall be based on the larger of the following: (1) mixing requirements; (2) oxygen requirements using

summertime kinetics, including allowance for nitrification. Aerated ponds should be designed to achieve complete mixing. Suitable protection shall be provided for electrical controls.

- 85.44 Industrial Wastes - Consideration shall be given to the type and effects of industrial wastes on the treatment process. In some cases it may be necessary to pretreat industrial or other discharges.

Industrial wastes shall not be discharged to ponds without assessment of the effects such wastes may have upon the treatment process or discharge requirements in accordance with state and federal laws.

- 85.45 Number of Cells - At a minimum, a pond system should consist of three cells designed to facilitate both series and parallel operations. The maximum size of a pond should be 40 acres. Two-cell systems may be utilized in very small installations having a flow of 50,000 gpd or less.

All systems should be designed with piping flexibilities to permit isolation of any cell without affecting the transfer and discharge capabilities of the total system. In addition, the ability to discharge the influent waste load to a minimum of two cells and/or all primary cells in the system should be provided.

- 85.451 Controlled Discharge Facultative Treatment Pond Systems - For controlled discharge systems, the area specified as the primary pond(s) should be equally divided into two cells, and the third cell or secondary pond volume should be a minimum of one-third the total volume of the entire system.

In addition, design should permit for adequate elevation difference between primary and secondary ponds to permit gravity filling of the secondary pond from the primary pond. When this is not feasible, pumping facilities shall be provided.

- 85.452 Flow-Through Facultative Treatment Pond Systems - At a minimum, primary pond(s) shall provide adequate detention time to maximize BOD removal. Secondary pond(s) should then be provided for additional detention time with depths up to eight feet to facilitate solids reduction. Design should also consider recirculation within the system.

- 85.453 Aerated Treatment Pond Systems - For a total aerated pond system, a minimum of three cells employing a tapered mode of aeration is recommended. When utilizing wastewater by method of spray irrigation, aerated ponds are recommended, followed by an unaerated storage pond.

- 85.46 Pond Shape - The shape of all cells shall be such that there are no narrow or elongated portions. Round, square, or rectangular ponds with a length not exceeding three times the width are considered most desirable. No islands, peninsulas, or coves shall be permitted. Dikes shall be rounded at corners to minimize accumulations of floating materials. Common dike construction whenever possible is strongly encouraged.

- 85.47 Additional Treatment - Consideration should be given in the design stage to the utilization of additional treatment units as may be necessary to meet applicable discharge standards.

## 85.5 Pond Construction Details

## 85.51 Embankments and Dikes

- 85.511 Material - Dikes shall be constructed of relatively impervious material and compacted to at least 90 percent Standard Proctor Density to form a stable structure. Vegetation and other unsuitable materials shall be removed from the area where the embankment is to be placed.
- 85.512 Top Width - The minimum dike top width shall be 10 feet to permit access of maintenance vehicles.
- 85.513 Maximum Slopes - Inner and outer dike slopes shall not be steeper than three horizontal to one vertical (3:1).
- 85.514 Minimum Slopes - Inner slopes should not be flatter than four horizontal to one vertical (4:1). Flatter slopes can be specified for larger installations because of wave action but have the disadvantage of added shallow areas being conducive to emergent vegetation. Outer slopes shall be sufficient to prevent surface runoff from entering the ponds.
- 85.515 Freeboard - Minimum freeboard shall be three feet. For systems having maximum monthly average flow of 50,000 gpd or less, 2 feet may be acceptable.
- 85.516 Design Depth - The minimum operating depth should be sufficient to prevent growth of aquatic plants and damage to the dikes, bottom, control structures, aeration equipment, and other appurtenances due to freezing and erosion. In no case shall the minimum operating depth be less than two feet.
- a. Controlled Discharge and Flow-Through Facultative Treatment Ponds - The maximum water depth shall be six feet in primary cells. Greater depths in subsequent cells are permissible although supplemental aeration or mixing may be necessary.
  - b. Aerated Treatment Pond Systems - The design water depth shall be 10-15 feet. This depth limitation may be altered depending on the aeration equipment, waste strength and climatic conditions.
- 85.517 Erosion Control - A justification including detailed discussion of the method of erosion control which encompasses all relative factors such as pond location and size, seal material, topography, prevailing winds, run off, etc., shall be provided.
- a. Seeding - The dikes shall have a cover layer of at least four inches of fertile topsoil to promote establishment of an adequate vegetative cover wherever riprap is not utilized. Prior to prefilling (in accordance with Section 85.534), adequate vegetation shall be established on dikes from the outside toe to the expected low operating water level elevation. Perennial-type, low-growing, spreading grasses that minimize erosion and can be mowed are most satisfactory for seeding of dikes. In general, alfalfa and other long-rooted crops should not be used for seeding since the roots of this type are apt to impair the water holding efficiency of the dikes.

- b. Additional Erosion Protection - Riprap or some other acceptable method of erosion control is required at a minimum around all piping entrances and exits. For aerated cells, the design should ensure erosion protection on the slopes and bottoms in the areas where turbulence will occur. Additional erosion control may also be necessary on the exterior dike slope to protect the embankment from erosion due to severe flooding of a water course.
- c. Alternate Erosion Protection - Alternate erosion control on the interior dike slopes may be necessary for ponds which are subject to severe wave action. In these cases, riprap or acceptable equal shall be placed from one foot above the high water mark to two feet below the low water mark (measured on the vertical).

85.52 Pond Bottom - Soil used in constructing the pond bottom (not including seal) and dike cores shall be relatively incompressible and tight. Soil should have an optimum moisture content and be compacted at or up to four percent above the specified Standard Proctor Density, but no less than 90 percent Standard Proctor Density. The pond bottom shall be as level as possible at all points and shall be at least four feet above the high groundwater table.

#### 85.53 Pond Sealing

85.531 General Requirements - Ponds shall be sealed in such a manner that seepage losses through the pond sides and bottom are minimized. Sealing methods using on-site soils, bentonite, or other types of synthetic liners may be approved if it can be demonstrated that the proposed sealing method will be sufficiently impermeable and will remain structurally sound during all anticipated working conditions.

The use of on-site soils should be demonstrated and documented through soil borings and testing during the design phase.

To insure an adequate seal, it must be demonstrated that the coefficient of permeability,  $K$ , of the pond sides and the bottom will not exceed  $1 \times 10^{-7}$  centimeters per second.

A construction procedure and testing program which will insure the adequacy of the sealing method must be incorporated into the specifications. Standard ASTM procedures, or their equivalent, shall be utilized where applicable.

Upon completion of construction, a written completion certification that the seal has been adequately constructed and tested in accordance with project specifications shall be submitted by the engineer to the Department.

85.532 Liner Materials - Bentonite and other forms of synthetic liners shall be designed and constructed in accordance with manufacturers' recommendations. The project engineer shall confirm the physical-chemical compatibility of the lining material with the wastewater being treated (with particular emphasis on any industrial wastes which may be present).

Flexible membrane liners shall have a minimum thickness of .030 inches or 30 mills.

85.533 Groundwater Monitoring and Leak Detection - A means of monitoring ambient groundwater quality before and during pond operation shall be provided. A minimum of one groundwater observation point shall be located in close proximity to the pond system to intercept the groundwater table at a location downgradient from the pond system (in each major groundwater flow direction).

The following types of groundwater observation points may be acceptable depending upon local conditions.

- a. New or existing wells
- b. Springs
- c. Well points or lysimeters
- d. Rock-lined test pits or trenches

Leak-detection mechanisms such as underdrain systems or soil-resistivity sensing devices will be acceptable as alternatives to the above-mentioned groundwater observation points.

85.534 Prefilling - Prefilling the pond should be considered in order to protect the liner, to prevent weed growth, to reduce odor and to maintain the moisture content of the seal. However, the dikes must be completely prepared as described in Sections 85.517a and/or 85.517b before the introduction of water.

#### 85.54 Influent Lines

85.541 Material - Generally accepted material for underground sewer construction should be given consideration for the influent line to the pond. Unlined corrugated metal pipe should be avoided, however, due to corrosion problems. Other materials selected shall be suited to local conditions. In material selection, consideration must be given to the quality of the wastes, exceptionally heavy external loadings, abrasion, soft foundations and similar problems.

85.542 Manhole - A manhole or vented cleanout wye shall be installed prior to entrance of the influent line into the primary cell(s) and shall be located as close to the dike as topography permits. Its invert shall be at least six inches above the maximum operating level of the pond and provide sufficient hydraulic head without surcharging the manhole.

85.543 Flow Distribution - Flow distribution structures shall be designed to effectively split hydraulic and organic loads equally to primary cells.

85.544 Placement - Influent line(s) for unaerated aerobic or facultative ponds should be located along the bottom of the pond so that the top of the pipe is just below the average elevation of the pond seal; however, the pipe should have adequate seal below it.

Influent line(s) for aerated ponds may go directly through the dike and end at the toe of the inner slope.

85.545 Point of Discharge - All primary cells of unaerated ponds shall have individual influent line(s) which terminate at the midpoint of the width and at approximately two-thirds the length away from the outlet structure so as to minimize short-circuiting. Consideration should be given to multi-influent

discharge points for large primary cells (20 acres or larger) to enhance distribution of load on the cell.

All aerated cells shall have influent lines which distribute the load within the mixing zone of the aeration equipment. Consideration of multi-inlets should be closely evaluated for any diffused aeration systems.

85.546 Influent Discharge Apron - The influent line(s) shall discharge horizontally into a shallow saucer-shaped depression.

The end of the discharge line(s) shall rest on a suitable concrete apron large enough such that the terminal influent velocity at the end of the apron does not cause soil erosion. A minimum size apron of two feet square shall be provided.

#### 85.55 Control Structures and Interconnecting Piping

85.551 Structure - Where possible, facilities design shall consider the use of multi-purpose control structures to facilitate normal operational functions such as drawdown and flow distribution, flow and depth measurement, sampling, pumps for recirculation, chemical addition and mixing, and minimization of construction sites within the dikes.

As a minimum, control structures shall be: (a) accessible for maintenance and adjustment of controls; (b) adequately ventilated for safety and to minimize corrosion; (c) locked to discourage vandalism; (d) equipped with controls to allow variable water level and flow rate control, complete shut off and complete draining; (e) constructed of non-corrosive materials (metal on metal contact in controls should be of like alloys to discourage electrochemical reaction); and (f) located to minimize short circuiting within the cell and avoid freezing and ice damage.

Recommended devices to regulate water level are valves, slide tubes, or dual slide gates. Regulators should be designed so that they can be preset to stop flows at any pond elevation.

85.552 Piping - All piping shall be of suitable materials. The piping shall not be located within or below the seal. Pipes should be anchored with adequate erosion control.

##### (a) Drawdown Structure Piping

1. Submerged Discharges - For ponds designed for shallow or variable depth operations, submerged discharges are recommended. Discharge pipes shall be located a minimum of 10 feet from the toe of the dike and two feet from the top of the seal and shall employ a vertical withdrawal.
2. Multi-Level Discharges - For ponds that are designed deep enough to permit stratification of pond content, multiple discharges are recommended. There shall be a minimum of three withdrawal pipes at different elevations. The bottom pipe shall conform with submerged discharge. Other pipes

should utilize horizontal entrance. Adequate structural support shall be provided.

3. Surface Discharge - For use under constant discharge conditions and/or relatively shallow ponds under warm weather conditions, surface overflow-type withdrawal is recommended. Design should evaluate floating weir box or slide tube entrance, with baffles for scum control.
  4. Pond Drain - All ponds shall have emergency drawdown piping to allow complete draining by either gravity or pumping for maintenance. These should be incorporated into the above-described structures.
  5. Emergency Overflow - To prevent overtopping of dikes, emergency overflow should be provided with capacity to carry the peak instantaneous flow.
- (b) Hydraulic Capacity - The hydraulic capacity of structures and piping for the flow-through system shall allow for a minimum of 250 percent of the maximum monthly average flow of the system.

The hydraulic capacity for controlled discharge systems shall permit transfer of water at a minimum rate of six inches of pond water depth per day at the available head. The discharge shall be as constant throughout the day as possible.

## 85.6 Miscellaneous

- 85.61 Fencing - The pond area shall be enclosed with an adequate fence to prevent livestock watering and discourage trespassing. Fencing should not obstruct vehicle traffic on top of the dike. A vehicle access gate of sufficient width to accommodate mowing equipment shall be provided. All access gates shall be provided with locks.
- 85.62 Access - An all-weather access road shall be provided to the pond site to allow year-round maintenance of the facility.
- 85.63 Warning Signs - Appropriate permanent signs shall be provided along the fence around the pond to designate the nature of the facility and advise against trespassing. At least one sign shall be provided on each side of the site and one for every 500 feet of its perimeter.
- 85.64 Flow Measurement - Flow measurement requirements are presented in Section 46.7. Effective weather protection shall be provided for the flow recorders.
- 85.65 Pond Level Gauges - Pond level gauges shall be provided.
- 85.66 Service Building - Consideration should be given to including a control building for laboratory and maintenance equipment.

85.67 Groundwater Monitoring - An approved system of wells or lysimeters may be required around the perimeter of the pond site to facilitate groundwater monitoring. The need for such monitoring will be determined on a case-by-case basis.

86. Other Biological Treatment Processes

The use of secondary treatment processes other than those listed above will be considered by the Department on the merit of the process involved (see Section 9.4).

87. Land Treatment

87.1 General - The application of wastewater to the land by spraying and similar application methods is considered to be "ultimate" disposal with no further treatment necessary. The design of land application facilities must be such to achieve that goal. The recycling of wastewater through the land has the additional benefits of recovery and utilization of nutrients and recharging the groundwater system for existing and potential public and domestic use and maintenance of surface water base flow. The Department encourages municipal officials and other applicants to investigate the use of land disposal of wastewater.

87.2 Pretreatment - A minimum of secondary treatment is generally required prior to land application of wastewater unless, in a specific case, the applicant can establish that a lesser degree of pretreatment will not cause any health hazard or groundwater pollution problem.

Where wastewater contains refractory organics, heavy metals and other industrial wastes, additional pretreatment may be required to remove constituents that may not be renovated by the soil and cause water pollution, or health hazards by adversely affecting soil where food may be grown.

87.3 Design Considerations - The design of systems for the application of wastewater to the land is dependent upon and must relate to soil conditions, climate conditions, waste load characteristics, and the groundwater flow system. Each site to be considered as a treatment facility for wastewater must be designed so as not to cause groundwater or surface water pollution. The proposed design must reflect the existing site conditions and wastewater characteristics. The monitoring program must be such as to provide adequate data so that groundwater and surface water can be protected.

For detailed design criteria for projects utilizing land application, see Bureau of Water Quality Protection Publication "Manual for Land Application of Treated Sewage and Industrial Wastewater" (10/97).

88 through 89 - RESERVED FOR FUTURE USE

## 90. ADVANCED WASTEWATER TREATMENT

### 91. High Rate Effluent Filtration

Granular media filters may be used as a tertiary treatment device for the removal of residual suspended solids from secondary effluents. Filters may be necessary where effluent concentrations of less than 15 mg/l of suspended solids and/or one mg/l of phosphorus must be achieved. A pretreatment process such as chemical coagulation and sedimentation or other acceptable process should precede the filter units where effluent suspended solids requirements are less than 10 mg/l.

Care should be given in designing pipes or conduits ahead of filter units, if applicable, to minimize shearing of floc particles. Consideration should be given in the plant design to provide flow-equalization facilities to moderate filter influent quality and quantity.

91.1 Filter Types - Filters may be of the gravity type or pressure type. Pressure filters shall be provided with ready and convenient access to the media for treatment or cleaning. Where greases or similar solids which result in filter plugging are expected, filters should be of the gravity type.

91.2 Filtration Rates - Filtration rates shall not exceed five gpm/sq. ft. based on the design peak hourly flow rate applied to the filter units. The expected design maximum suspended solids loading to the filter should also be considered in determining the necessary filter area.

Total filter area shall be provided in two or more units, and the filtration rate shall be calculated on the total available filter area with one unit out of service.

#### 91.3 Backwash

91.31 Backwash Rates - The backwash rate shall be adequate to fluidize and expand each media layer a minimum of 20 percent based on the media selected. The backwash system shall be capable of providing a variable backwash rate. Minimum and maximum backwash rates shall be based on demonstrated satisfactory field experience under similar conditions. The design shall provide for a minimum backwash period of 10 minutes.

91.32 Backwash Pumps - Pumps for backwashing filter units shall be sized and interconnected to provide the required backwash rate to any filter with the largest pump out of service. Filtered water from a clear well or chlorine tank shall be used as the source of backwash water. Waste filter backwash shall be adequately treated.

91.33 Backwash Surge Control - The rate of return of waste filter backwash water to treatment units shall be controlled such that the rate does not exceed 15 percent of the maximum monthly average flow rate to the treatment units. The hydraulic and organic load from waste backwash water shall be considered in the overall design of the treatment plant. Surge tanks shall have a minimum capacity of two backwash volumes, although additional capacity should be considered to allow for operational flexibility. Where waste backwash water is returned for treatment by pumping, adequate pumping capacity shall be provided with the largest unit out of service.

91.34 Backwash Water Storage - Total backwash water storage capacity in an effluent clearwell or chlorine contact tank shall equal or exceed the volume required for two complete backwash cycles.

91.4 Filter Media Selection - Selection of proper media type and size will depend on required effluent quality, the type of treatment provided prior to filtration, the filtration rate selected, and filter configuration. In dual or multi-media filters, media size selection must consider compatibility among media. Media shall be selected and provided to meet specific conditions and requirements relative to the project under consideration. The selection and sizing of the media shall be based on demonstrated satisfactory field experience under similar conditions. All media shall have a uniformity coefficient of 1.7 or less. The uniformity coefficient, effective size, depth and type of media shall be set forth in the specifications.

91.5 Filter Appurtenances - The filters shall be equipped with wash water troughs, surface wash or air scouring equipment, means of measurement and positive control of the backwash rate, equipment for measuring filter head loss, positive means of shutting off flow to a filter being backwashed, and filter influent and effluent sampling points. If automatic controls are provided, there shall be a manual override for operating equipment, including each individual valve essential to the filter operation. The underdrain system shall be designed for uniform distribution of backwash water (and air, if provided) without danger of clogging from solids in the backwash water. If air is to be used for filter backwash, separate backwash blower(s) shall be provided.

Provision shall be made for periodic chlorination of the filter influent or backwash water to control slime growths. When chemical disinfection is not provided, manual dosage of chlorine compounds may be utilized.

91.6 Access and Housing - Each filter unit shall be designed and installed so that there is ready and convenient access to all components and the media surface for inspection and maintenance without taking other units out of service. Housing for filter units shall be provided. The housing shall be constructed of suitable corrosion-resistant materials. All controls shall be enclosed, and the structure housing filter controls and equipment shall be provided with adequate heating and ventilation equipment to minimize problems with excess humidity.

91.7 Proprietary Equipment - Where proprietary filtration equipment not conforming to the preceding requirements is proposed, data which support the capability of the equipment to meet effluent requirements under design conditions shall be provided. Such equipment will be reviewed by the Department on a case-by-case basis.

## 92. Phosphorus Removal by Chemical Treatment

Addition of lime or the salts of aluminum or iron may be used for chemical removal of soluble phosphorus. The phosphorus reacts with the calcium, aluminum or iron ions to form insoluble compounds. Those insoluble compounds may be flocculated with or without the addition of a coagulant aid such as polyelectrolyte to facilitate separation by sedimentation.

### 92.1 Design Basis

92.1.1 Preliminary Testing - Laboratory, pilot, or full scale studies of various chemical feed systems and treatment processes are recommended for existing plant facilities to determine the achievable performance level, cost-effective design criteria, and ranges of required chemical dosages.

The selection of a treatment process and chemical dosage for a new facility should be based on such factors as influent wastewater characteristics, effluent requirements, and anticipated treatment efficiency.

92.12 System Flexibility - Systems shall be designed with sufficient flexibility to allow for several operational adjustments in chemical feed locations, chemical feed rates, and feeding alternate chemical compounds.

## 92.2 Process Requirements

92.21 Dosage - The design chemical dosage shall include the amount needed to react with the phosphorus in the wastewater, the amount required to drive the chemical reaction to the desired state of completion, and the amount required due to inefficiencies in mixing or dispersion. Excessive chemical dosage should be avoided.

92.22 Chemical Selection - The choice of lime or the salts of aluminum or iron should be based on the wastewater characteristics and the economics of the total system.

When lime is used, it may be necessary to neutralize the high pH prior to subsequent treatment in secondary biological systems prior to discharge in those flow schemes where lime treatment is the final step in the treatment process.

92.23 Chemical Feed Points - Selection of chemical feed points shall include consideration of the chemicals used in the process, necessary reaction times between chemical and polyelectrolyte additions, and the wastewater treatment processes and components utilized. Flexibility in feed location shall be provided to optimize chemical usage.

92.24 Flash Mixing - Each chemical must be mixed rapidly and uniformly with the flow stream. Where separate mixing basins are provided, they should be equipped with mechanical mixing devices. The detention period should be at least 30 seconds.

92.25 Flocculation - The particle size of the precipitate formed by chemical treatment may be very small. Consideration should be given in the process design for the addition of synthetic polyelectrolytes to aid settling. The flocculation equipment should be adjustable in order to obtain optimum floc growth, control deposition of solids, and prevent floc destruction.

92.26 Liquid-Solids Separation - The velocity through pipes or conduits from flocculation basins to settling basins should not exceed 1.5 feet per second in order to minimize floc destruction. Entrance works to settling basins should also be designed to minimize floc shear.

Settling basin design shall be in accordance with criteria outlined in Chapter 60. For design of the sludge handling system, special consideration should be given to the type and volume of sludge generated in the phosphorus removal process.

92.27 Filtration - Effluent filtration shall be considered where effluent phosphorus concentrations of less than one mg/l must be achieved. Refer to requirements under Section 91.

92.3 Feed Systems - All liquid chemical mixing and feed installation should be installed on corrosion-resistant pedestals and elevated above the highest liquid level anticipated during emergency conditions.

In general, the chemical feed equipment shall be designed to meet the maximum dosage requirements for the design conditions. When lime is used as a coagulant, the feed equipment shall be designed as a minimum to meet the chemical dosage requirements of 150 mg/l and

300 mg/l of CaO for single stage lime treatment and two stage lime treatment, respectively. When alum or ferric chloride is used as a coagulant, the feed equipment shall be designed, as a minimum, to meet the dosage requirement of 16 mg/l of alum or 45 mg/l of ferric chloride for each mg/l of phosphorus removal.

Lime feed equipment should be located so as to minimize the length of slurry conduits. All slurry conduits shall be accessible for cleaning.

92.31 Liquid Chemical Feed Systems - Liquid chemical feed pumps should be of the positive displacement type with variable feed rate. Pumps shall be selected to feed the full range of chemical quantities required for the phosphorus mass loading conditions anticipated with the largest unit out of service.

Screens and valves shall be provided on the chemical feed pump suction lines.

An air break or anti-siphon device shall be provided where the chemical solution stream discharges to the transport water stream to prevent an induction effect resulting in overfeed.

Consideration shall be given to providing pacing equipment to optimize chemical feed rates.

92.32 Dry Chemical Feed System - Each dry chemical feeder shall be equipped with a dissolver which is capable of providing a minimum five-minute retention at the maximum feed rate.

Polyelectrolyte feed installations should be equipped with two solution vessels and transfer piping for solution makeup and daily operation.

Make-up tanks shall be provided with an educator funnel or other appropriate arrangement for wetting the polymer during the preparation of the stock feed solution. Adequate mixing should be provided by a large-diameter, low-speed mixer.

#### 92.4 Storage Facilities

92.41 Size - Storage facilities shall be sufficient to insure that an adequate supply of the chemical is available at all times. Exact size required will depend on size of shipment, length of delivery time, and process requirements. Storage for a minimum of 10-day's supply should be provided.

92.42 Location and Containment - The liquid chemical storage tanks and tank fill connections shall be located within a containment structure having a capacity exceeding the total volume of all storage vessels. Valves on discharge lines shall be located adjacent to the storage tank and within the containment structure.

Auxiliary facilities, including pumps and controls, within the containment area shall be located above the highest anticipated liquid level. Containment areas shall be sloped to a sump area and shall not contain floor drains.

Bag storage should be located near the solution make-up point to avoid unnecessary transportation and housekeeping problems.

- 92.43 Accessories - Platforms, stairs, and railings shall be provided as necessary to afford convenient and safe access to all filling connections, storage tank entries, and measuring devices.

Storage tanks shall have reasonable access provided to facilitate cleaning.

#### 92.5 Other Requirements

- 92.51 Materials - All chemical feed equipment and storage facilities shall be constructed of materials resistant to chemical attack by all chemicals normally used for phosphorus removal in accordance with Section 47.

- 92.52 Temperature, Humidity, and Dust Control - Precautions shall be taken to prevent chemical storage tanks and feed lines from reaching temperatures likely to result in freezing or chemical crystallization at the concentrations employed. A heated enclosure or insulation may be required. Consideration shall be given to temperature, humidity, and dust control in all chemical feed room areas.

- 92.53 Cleaning - Consideration shall be given to the accessibility of piping. Piping should be installed with plugging wyes, tees or crosses with removable plugs at changes in direction to facilitate cleaning.

- 92.54 Filling Drains and Draw-Off - Above-bottom drawoff from chemical storage or feed tanks shall be provided to avoid withdrawal of settled solids into the feed system. A bottom drain shall also be installed for periodic removal of accumulated settled solids. Provisions shall be made in the fill lines to prevent back siphonage of chemical tank contents.

- 92.6 Safety and Hazardous Chemical Handling - The chemical handling facilities shall meet the appropriate safety and hazardous chemical handling facilities requirements of Section 47.

93 through 95. RESERVED FOR FUTURE USE

## 100. DISINFECTION

### 101. General

The Department currently requires effective disinfection of wastewater to control disease-producing organisms. The disinfection facilities design shall consider meeting both the bacterial standards and disinfectant residual requirements in the effluent. The disinfection process should be selected after due consideration of waste characteristics, type of treatment provided prior to disinfection, waste flow rates, application and demand rates, pH of wastewater, cost of equipment, construction and operation, chemical availability, and maintenance problems.

If chlorination is utilized, it may be necessary to dechlorinate if the chlorine level in the effluent would impair the natural aquatic habitat of the receiving stream.

### 102. Forms of Disinfection

Chlorine is the most commonly used chemical for wastewater disinfection. The forms most often used are liquid chlorine and calcium or sodium hypochlorite. Chlorine tablets which erode in a controlled manner may be used. Other disinfectants, including chlorine dioxide, ozone, bromine, ultraviolet radiation, or hydrogen peroxide, may be accepted by the Department in individual cases.

### 103. Chlorine Disinfection

103.1 Type - Chlorine is available for disinfection in gas, liquid (hypochlorite solution) and pellet (hypochlorite tablet) form. The type of chlorine supply should be carefully evaluated during the facilities planning process. The use of chlorine gas or liquid will be most dependent on the size of the facility and the chlorine dose required. Large quantities of chlorine such as are contained in ton containers and tank cars represent a significant potential hazard to plant personnel and to the surrounding area should the container develop leaks. Both monetary considerations and the potential public exposure to chlorine should be considered when making the final determination.

#### 103.2 Chlorine Containers

103.21 Cylinders - 150 pound cylinders are typically used where chlorine consumption is less than 150 pounds per day. Cylinders should be stored in an upright position with adequate support brackets and chains at 2/3 of cylinder height for each cylinder. The use of one-ton containers should be considered where the average daily chlorine consumption is over 150 pounds.

103.22 Tank Cars - At large installations, consideration should be given to the use of tank cars, generally accompanied by gas evaporators. Areawide public safety shall be evaluated as a part of the consideration. Provision of chlorine supply during tank car switching shall be provided.

The tank car being used for the chlorine supply shall be located on a dead-end, level track that is a private siding. The tank car shall be protected from accidental bumping by other railway cars by a locked derail device or a closed locked switch or both. The area shall be clearly posted "DANGER-CHLORINE". The tank car

shall be secured by adequate fencing with gates provided with locks for personnel and rail access.

The tank car site shall be provided with a suitable operating platform at the unloading point for easy access to the protective housing or the tank car for connection of flexible feedlines and valve operation. Adequate area lighting shall be provided for night-time operation and maintenance.

- 103.23 Liquid Hypochlorite Solutions - Storage containers for hypochlorite solutions shall be of sturdy, non-metallic lined construction and shall be provided with secure tank tops and pressure relief and overflow piping. Storage tanks should be either located or vented outside. Provision shall be made for adequate protection from light and extreme temperatures. Tanks shall be located where leakage will not cause corrosion or damage to other equipment. A means of secondary containment shall be provided to contain spills and facilitate cleanup. Due to deterioration of hypochlorite solutions over time, it is recommended that containers not be sized to hold more than one month's needs. At larger facilities and locations where delivery is not a problem, it may be desirable to limit on-site storage to one week.
- 103.24 Dry Hypochlorite Compounds - Dry hypochlorite compounds should be kept in tightly closed containers and stored in a cool, dry location. Some means of dust control should be considered, depending on the size of the facility and the quantity of compound used.
- 103.25 Scales - Scales for weighing cylinders shall be provided at all plants using chlorine gas. At large plants, scales of the indicating and recording type are recommended. As a minimum, a platform scale shall be provided. Scales shall be of corrosion-resistant material.
- 103.26 Evaporators - Where manifolding of several cylinders or ton containers will be required to evaporate sufficient chlorine gas, consideration should be given to the installation of evaporators to produce the quantity of gas required. However, connection of cylinders or ton containers discharging liquid chlorine to a manifold is not recommended.
- 103.27 Leak Detection and Controls - A bottle of 56 percent ammonium hydroxide solution shall be available for detecting chlorine leaks. Where ton containers or tank cars are used, a leak repair kit approved by the Chlorine Institute shall be provided. Consideration should be given to providing a caustic soda solution reaction tank for absorbing the contents of leaking ton containers where such containers are in use. Consideration should be given to the installation of automatic gas detection and related alarm equipment at large installations.

### 103.3 Feed Equipment

- 103.31 Type - Solution-feed, vacuum-type chlorinators are generally preferred for large chlorination installations. The use of hypochlorite feeders of the positive displacement type may be considered and are generally preferred when intermittent disinfection is required. The preferred method of generation of chlorine dioxide is

the injection of a sodium chlorite solution into the discharge line of the solution-feed gas-type chlorinator, with subsequent formation of the chlorine dioxide in a reaction chamber at a pH of four or less. Erosion feed chlorinators capable of producing a design residual are acceptable, but use should be limited to plants where the flow does not exceed 10,000 gpd or as an emergency measure in larger plants with malfunctioning disinfection equipment.

The feed equipment should at least provide for disinfectant dosages which are proportionate to the effluent flow. Automatic dosage equipment should be provided for larger plants.

- 103.32 Capacity - Disinfection capacity shall be adequate to produce an effluent that will meet the fecal coliform limits specified by the Department for that installation. Required disinfection capacity will vary, depending on the uses and points of application of the disinfection chemical. For domestic wastewater, the following minimum dosing capacity may be used as a guide in sizing chlorination facilities.

<u>Type of Treatment</u>	<u>Chlorine Dosage</u>
Trickling Filter and Rotating Biological Contactor Effluent	12 mg/l
Waste Stabilization Pond Effluent	12 mg/l
Activated Sludge Plant Effluent	8 mg/l
Tertiary Filtration Effluent	6 mg/l
Nitrified Effluent	6 mg/l

- 103.33 Standby Equipment and Spare Parts - Standby equipment of sufficient capacity should be available to replace the largest unit during shutdowns. Spare parts shall be available for all disinfection equipment to replace parts which are subject to wear and breakage.

- 103.34 Chlorinator Water Supply - An ample supply of water shall be available for operating the chlorinator. Where a booster pump is required, duplicate equipment should be provided. Standby power should be provided to insure adequate disinfection in case of a power outage. Protection of a potable water supply shall conform to the requirements of Section 46.2. Adequately filtered plant effluent should be considered for use in the chlorinator.

- 103.4 Piping and Connections - Piping systems should be as simple as possible, specifically selected and manufactured to be suitable for chlorine service, and with a minimum number of joints. Piping should be well supported and protected against temperature extremes.

Due to the corrosiveness of wet chlorine, all lines designed to handle dry chlorine shall be protected at the entrance from water or air containing water. Even minute traces of water added to chlorine results in a corrosive attack. Low pressure lines made of hard rubber, saran-lined, rubber-lined, polyethylene, polyvinylchloride (PVC), or other approved materials are satisfactory for wet chlorine or aqueous solutions of chlorine. Sections of piping that convey liquid chlorine and are isolated with valves at both ends must be provided with a suitable expansion chamber.

## 103.5 Housing

- 103.51 Feed and Storage Room - If gas chlorination equipment or chlorine cylinders are to be in a building used for other purposes, a gas-tight room shall separate this equipment. Such rooms shall be at ground level, and should permit easy access to all equipment. Floor drains from the chlorine room shall not be connected to floor drains from other rooms. Doors to this room shall open only to the outside of the building, and shall be equipped with panic hardware. Storage area should be separated from the feed area and the storage area should have designated areas for "full" and "empty" containers. Chlorination equipment should be situated as close to the application point as reasonably possible.
- 103.52 Inspection Window - A clear glass, gas-tight window shall be installed in an exterior door or interior wall of the chlorinator room to permit the units to be viewed without entering the room.
- 103.53 Heat - Rooms containing chlorination equipment shall be provided with a means of heating so that a temperature of at least 60°F can be maintained. The room shall be protected from excess heat which could melt a fusible metal safety plug. Cylinders shall be kept at essentially room temperature.
- 103.54 Ventilation - With chlorination systems, forced, mechanical ventilation shall be installed which will provide one complete air change per minute when the room is occupied. The entrance to the air exhaust duct or fan from the room shall be near the floor, and the point of discharge shall be so located as not to contaminate the air inlet to any buildings or inhabited areas. Air inlets shall be so located as to provide cross ventilation through the room and at such temperature that will not adversely affect the chlorination equipment. The vent hose from the chlorinator shall discharge to the outside atmosphere above grade and away from public exposure. In areas where public exposure may be extensive or unavoidable, scrubbers may be required on the vent hose discharge.
- 103.55 Electrical Controls - Switches for fans and lights shall be outside of the room at the entrance. A labeled signal light indicating fan operation should be provided at each entrance if the fan can be controlled from more than one location. The controls for the fans and lights shall be such that they will automatically operate when the door is opened and can also be manually operated from the outside without opening the door.
- 103.6 Respiratory Protection - Respiratory air-pac protection equipment, meeting the requirements of the National Institute for Occupational Safety and Health (NIOSH) shall be available where chlorine gas is handled and shall be stored at a convenient location, but not inside any room where chlorine is used or stored. Instructions for using the equipment shall be posted adjacent to the equipment. The units shall use compressed air, have at least 30-minute capacity, and be compatible with the units used by the fire department responsible for the plant.

## 103.7 Application of Chlorine

103.71 Mixing - The disinfectant shall be positively mixed as rapidly as possible, with a complete mix being effected in three seconds. This may be accomplished by either the use of a turbulent flow regime or a mechanical flash mixer.

103.72 Contact Period - A minimum contact period of 15 minutes at peak hourly flow or maximum rate of pumpage, or a minimum contact period of 30 minutes at maximum monthly average flow shall be provided after thorough mixing. For evaluation of existing chlorine contact tanks, field tracer studies should be done to assure adequate contact time. If needed, aeration of effluent to meet the dissolved oxygen requirement shall follow the chlorine contact tank.

103.73 Contact Tank - The chlorine contact tank shall be constructed to reduce short circuiting of flow to a practical minimum. Tanks not utilizing continuous mixing shall be provided with "over-and-under" or "end-around" baffling to minimize short circuiting. A 40:1 length-to-width ratio for baffled tanks is desirable to prevent short circuiting.

The tank shall be designed to facilitate maintenance and cleaning without reducing effectiveness of disinfection. Duplicate tanks, mechanical scrapers, or portable deck level vacuum cleaning equipment shall be provided. Consideration should be given to providing skimming devices on all contact tanks. Covered tanks are discouraged.

103.74 Sampling - Facilities shall be included for sampling the disinfected effluent for residual chlorine. When required by the department, provisions shall be made for continuous monitoring of effluent chlorine residual.

103.75 Testing and Control - Equipment shall be provided for measuring chlorine residual using accepted test procedures.

The installation of demonstrated effective facilities for automatic chlorine residual analysis, recording, and proportioning systems should be considered at all large installations.

Equipment shall also be provided for measuring fecal coliforms using accepted test procedures.

## 104. Dechlorination

104.1 Type - Dechlorination of wastewater effluents may be necessary to reduce the toxicity due to chlorine residuals. The most common dechlorination chemicals are sulfur compounds, particularly sulfur dioxide gas or aqueous solutions of sulfide or bisulfite. Pellet dechlorination systems are also available for small facilities.

The type of dechlorination system should be carefully selected. Consideration should be given to the amount of chemical needed, type of chemical storage required, ease of operation, compatibility with existing equipment, safety, etc.

## 104.2 Feed Equipment

104.21 Type - In general, the same type of feeding equipment used for chlorine gas may be used, with minor modifications, for sulfur dioxide gas. However, the manufacturer should be contacted for specific equipment recommendations. No equipment should be alternately used for two gasses. The common types of dechlorination feed equipment utilizing sulfur compounds include vacuum solution feed for sulfur dioxide gas and positive displacement pump for aqueous solutions of sulfite or bisulfite. The selection of the type of feed equipment utilizing sulfur compounds shall include consideration of operator safety and overall public safety relative to the plant's proximity to populated areas and the security of gas cylinder storage. The selection and design of sulfur dioxide feeding equipment shall take into account that the gas reliquifies quite easily. Special precautions must be taken when using ton containers to prevent reliquification.

Where necessary to meet the operating ranges, multiple units shall be provided for adequate peak capacity and to provide a sufficiently low feed rate on turn down to avoid depletion of the dissolved oxygen concentrations in the receiving waters.

104.22 Dosage - In determining the dosage of dechlorination chemical, consideration shall be given to the residual chlorine in the disinfected waste stream, the final residual chlorine effluent limits, and the particular form of the dechlorinating chemical used. A form of sulfur is most commonly used as a dechlorinating agent. Commonly used forms of the sulfur compounds and their theoretical application rates are:

	Theoretical mg/l Required to Neutralize 1 mg/l Cl <sub>2</sub>
Sulfur dioxide (gas)	0.9
Sodium metabisulfite (solution)	1.34
Sodium bisulfite (solution)	1.46

Theoretical values may be used for initial approximations to size feed equipment with the consideration that under good mixing conditions, 10 percent excess dechlorinating chemical is required above theoretical values.

Excess sulfur dioxide may consume oxygen at a maximum rate of one mg dissolved oxygen for every four mg sulfur dioxide.

The liquid solutions come in various strengths. These solutions may need to be further diluted to provide the proper dosage of sulfite.

104.23 Standby Equipment and Spare Parts - The same requirements apply as for chlorination systems. See Section 103.33 of this chapter.

104.24 Sulfonator Water Supply - The same requirements apply as for chlorination systems. See Section 103.34 of this chapter.

- 104.3 Chemical Containers - Depending on the chemical selected for dechlorination, the storage containers will vary from gas cylinders, liquid in 50 gallon drums, or dry compounds. Dilution tanks and mixing tanks will be necessary to deliver the proper dosage of dry compounds and may be necessary for liquid compounds.
- 104.4 Piping and Connections - Piping system should be as simple as possible, specifically selected and manufactured to be suitable for sulfur compounds, with a minimum number of joints. Piping shall be well supported and protected against temperature extremes.
- 104.5 Housing Requirements - The same requirements apply for housing sulfur dioxide gas equipment as for housing chlorine gas equipment. Refer to Section 103.5 of this chapter for specific details.

When using solutions of the dechlorinating compounds, the solution may be stored in a room that meets the safety and handling requirements under Section 47. The mixing, storage and solution delivery areas must be designed to contain or route solution spillage or leakage away from traffic areas to an appropriate containment unit.

#### 104.6 Application of Chemicals

- 104.61 Mixing Requirements - The dechlorination reaction with free or combined chlorine will generally occur within twenty seconds. Mechanical mixers are required unless the mixing facility will provide the required hydraulic turbulence to assure thorough and complete mixing.
- 104.62 Contact Period - A minimum of 30 seconds of contact time (which includes the mixing time) shall be provided at the peak hourly flow or maximum rate of pumpage. A suitable sampling point shall be provided downstream of the contact zone. Consideration shall be given to a means of reaeration to assure maintenance of dissolved oxygen concentration in the stream following sulfonation.
- 104.63 Safety Equipment - The respiratory air-pac protection equipment shall be provided as described for chlorination facilities in Section 103.6 of this chapter.
- 104.64 Sampling - Facilities shall be included for sampling the dechlorinated effluent for residual chlorine. When required by the Department, provisions shall be made for monitoring the dissolved oxygen concentration following sulfonation.
- 104.65 Testing and Control - There is no control system specifically for sulfur dioxide so chlorine residual measurements control the feed rate. Inherent delays in fluctuating demand and other problems with chlorine residual control may result in over or under sulfonation. Manual or automatic provisions shall be provided for control of sulfonation feed rates based on chlorine residual measurements or effluent flow.

#### 105. Ultraviolet (UV) Radiation Disinfection

Design standards, operating data, and experience for this process are not well established. Therefore, expected performance of the UV units shall be based upon experience at similar full-scale installations or thoroughly documented prototype testing with the particular wastewater. This process should be limited to high quality effluent having a BOD and suspended solids concentrations preferably around

10 mg/l. Presence of mineral content (especially iron salts), organic compounds, color, and turbidity in the treated wastewater will reduce microbial absorption capability of UV energy and decrease the lethal effect on microorganisms. The UV transmittance of an existing effluent should be verified by sampling and analysis.

106. Other Disinfection Processes

The use of disinfection processes other than dechlorination referenced in Section 102 will be considered by the Department on the merit of the process involved. Refer to Section 9.4 on new processes.