MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY
GUIDANCE FOR THE DESIGN OF
PUBLICLY OWNED WASTEWATER FACILITIES
AND DWSIRLF FUNDED DRINKING WATER FACILITIES
February 1, 1999

Comment: When revising, remember to change footer date to agree with this date!

Owner

Loan or Project Number

Design Engineer (Miss. P.E. required)

DEQ Project Manager

Description	Approval Date
Contract 1	
Contract 2	
Contract 3	

REVIEW/APPROVAL

List of relevant chapters used for review and included herewith:

Chapters 10,

REVIEWED/COMMENTS

Project Manager/Date   Engineering Coordinator/Date

APPROVAL (DWSIRLF RECOMMENDATION FOR DOH APPROVAL)

Project Manager/Date   Engineering Coordinator/Date

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CHAPTER 10
GENERAL

10. INTRODUCTION

10.1 Acknowledgment

The technical guidance in this document has primarily been taken from Recommended Standards for Wastewater Facilities 1990 Edition ("Ten States' Standards"). The Department gratefully acknowledges the Great Lakes - Upper Mississippi River Board of State Sanitary Engineers for allowing the use of the Board's guidance.

10.2 Applicability

This document, Guidance for the Design of Publicly Owned Wastewater Facilities ("Guidance"), should be used as a guide in the design and preparation of plans and specifications for publicly owned wastewater facilities, insofar as this guidance is applicable to normal situations for an individual project. Plans, specifications, and contract documents should conform to the applicable items in the Guidance, whether or not the facilities receive funding from a State Revolving Fund (SRF).

This document is not a regulation or a standard and has therefore not been adopted by the Commission on Environmental Quality. However, owners, consulting engineers, and other parties involved in the construction of any wastewater collection or treatment facility in the State should be aware of, and must comply with, the Commission's "Wastewater Regulations for National Pollutant Discharge Elimination System (NPDES) Permits, State Operating Permits, Water Quality Based Effluent Limitations and Water Quality Certification (Wastewater Regulations)", and all other applicable laws and regulations. This guidance does not supersede any other existing laws, ordinances, regulations, or standards. If such conflicts arise, the designer should contact the Department and the other appropriate agencies for instruction on how to proceed.

It should be recognized that simply complying with the items herein does not ensure that a design is correct, or even adequate, but only minimally acceptable to the Department. High quality projects will routinely exceed the minimum standards stipulated herein, and such quality will likely be reflected in the performance, value and satisfaction obtained from such a design. Further, the Department neither warrants nor assumes any responsibility for any design of any project governed by this Guidance. It is the owner's and/or design engineer's responsibility to ensure that such project designs and specifications are correct and adequate. Should anything contained herein appear to conflict with good design practice, such instance should be brought to the Department's attention immediately for resolution.

Plans, specifications and contract documents that vary from this guidance may be submitted and approved (as specified by applicable regulations) when properly justified by the consulting engineer and/or supported by reference to Metcalf and Eddy, WPCF manuals of practice, EPA publications, or other appropriate publications. Although the words "shall" and "must" are used extensively, they are to be interpreted in the context of this section (10.2 Applicability) of the Guidance.

It is recognized that this Guidance does not completely address every conceivable situation concerning the design, inspection, testing, or contracting of publicly owned water or wastewater facilities construction. Therefore, when any issue arises which is not explicitly covered by the Guidance, the Department may require additional documentation or justification of the reasonableness or adequacy of the plans, specifications and contract documents. The Department may withhold completion of review or approval until such documentation, justification, or document changes are submitted and determined acceptable.

Many of the non-technical items in the Guidance apply only to facilities that receive funding from a Clean Water State Revolving Fund Loan. **CWSRF-only review items are contained in Section 11 or are identified with an asterisk (*)**. These items may also be used, but will not be reviewed by the Department, on non-CWSRF projects. In addition, these same items will usually apply to projects funded by the Drinking Water Systems Improvements Revolving Loan Funds (DWSIRLF). Typically, the technical review of DWSIRLF projects will not be performed herein. All DWSIRLF designs shall also conform to the technical requirements of the DOH, which are contained in their Recommended Minimum Design Criteria For Community Public Water Supplies (Criteria), or its successor.

In all cases, Chapter 10 of this document shall be applied. Other chapters shall be used as applicable to the particular project, and shall be listed on the title sheet of this Guidance.

*11. GENERAL CONTRACT DOCUMENTS FOR CWSRF/DWSIRLF ONLY

The items listed in Section 11 apply to CWSRF and DWSIRLF projects but may not apply to non-SRF projects.

11.1 Information to Bidders

___ The contract documents shall include an "Information to Bidders" section provided by the Department, or equivalent. The following items shall be included (a, b, h, i and j reviewed by Program Support Section):

a. Advertisement for Bids, which must include:

1. The Rural Minority Business Development Center (RMBDC) and the Contract Procurement Center closest to the project as locations where contract documents may be examined. Other agencies may be stipulated by the Department as well;

2. The statement that "Minority and women's business enterprises are solicited to bid as prime contractors and encouraged to make inquiries regarding potential subcontracting opportunities, equipment, material and supply needs," and;

3. The statement that "Any contracts awarded under this Invitation for Bids are expected to be funded in part by the Clean Water State Revolving Fund Loan or Drinking Water Systems Improvements Loan Fund Program from the State of Mississippi. Neither the State of Mississippi nor any of its departments, agencies or employees is or will be a party to the invitation for bids or any

resulting contract. The procurement is subject to Section IV, Appendix D of the CWSRF or DWSIRLF Loan Program Regulations."

b. Instructions for Bidders, which must include:

1. The RMBDC and the Contract Procurement Center closest to the project area as agencies that may be contacted for sources of minority and women-owned firms. Other agencies may be stipulated by the Department as well.

2. The minority and women business fair share objectives and must inform bidders that documentation of efforts to utilize minority and women-owned firms must be maintained by all bidders.

___ c. Bid Form

___ d. Bid Bond Form

___ e. Agreement

___ f. Payment Bond Form

___ g. Performance Bond Form

___ h. EEO Forms

___ i. Debarment Certification Form

___ j. MBE/WBE Documentation Requirements

___ k. Notice of Award Form

___ l. Notice to Proceed Form

___ m. Change Order Form

11.2 General Conditions

___ The contract documents shall include a set of general conditions which describes the general responsibilities of all parties. The general conditions may be provided by one or more of the following sources:

a. "General Conditions" provided by the Department.

b. <u>Standard General Conditions of the Construction Contract</u> published by the NSPE and the ASCE.

c. General conditions developed by the consulting engineer which are substantially equivalent to the "General Conditions" provided by the Department.

In every case, the general conditions shall:

___ i. Allow the loan recipient to retain a certain percentage of the progress payments otherwise due the contractor until the building of the project is substantially complete, in accordance with State law;

___ ii. Require the contractor to obtain and maintain the appropriate insurance coverage, including flood insurance if applicable, and;

___ iii. Include an arbitration clause or acceptable procedure regarding the handling of claims, disputes and other matters in question arising out of, or related to, the agreement or the breach thereof, in accordance with state law.

11.3 Supplemental General Conditions

The contract documents shall include the "Supplemental General Conditions" verbatim, as provided by the Department. Attached to the SGC's shall be a list of qualified minority and women business enterprises for the contractors' use. (Reviewed by PSS)

11.4 Biddability and Constructability

___ a. All bid items shall be covered by an appropriate measurement and payment paragraph and vice versa.

___ b. Quantities shown on the plans shall agree with those listed on the bid form.

___ c. All requirements shall be clear and concise.

___ d. All work shall require methods and materials which, insofar as practical, appear to be cost effective, logical, and reasonably accomplishable by a competent contractor.

___ e. The contract time shall be counted in calendar days, and normal weather shall be assumed and allowed for in the original contract time.

___ f. There shall be no conflicts or confusion between the plans and the specifications or any sections thereof.

11.5 SRF Eligibility

___ a. All bid items shall be noted and separated on the bid form as "Eligible" or "Ineligible", with such determinations being made in accordance with CWSRF or DWSIRLF regs., Appendix A. It is emphasized that SRF eligibility shall conform to the "existing community" (1972) rule for conventional gravity collector sewers. Related work that is included in a line item bid or items included in a lump sum bid, etc. are subject to the eligibility review as well, possibly necessitating segregation of the bid items for eligibility/allowability purposes.

___ b. Sewer rehabilitation eligibility shall conform to Chapter 20B.

___ c. Liquidated damages shall be at least $200 per calendar day, unless otherwise approved.

___ d. Specifications shall include technical data useful and identified for the purpose of establishing CWSRF/DWSIRLF Project Performance Standards.

___ e. The bid form shall identify, by defined asterisks or other notation, potential subcontracting opportunities, material and supply needs that can be made available to minority and women business enterprises. For lump sum type contracts or bid items, a written notification identifying the subcontracting opportunities may be inserted with the bid form in lieu of using asterisks. (Reviewed by PSS)

11.6 Comparison of Facilities Plan to Plans and Specifications

The quantities in the plans and specifications must generally agree with the facilities plan.

Gravity Sewer Lines

Facilities Plan		Plans and Specifications	
Size, in.	Length, ft.	Size, in.	Length, ft.
________	________	________	
________	________	________	
________	________	________	
________	________	________	
________	________	________	
________	________	________	

Force Mains, Pressure Sewers, and Water Lines

Size, in.	Length, ft.	Size, in.	Length, ft.
________	________	________	
________	________	________	
________	________	________	
________	________	________	
________	________	________	
________	________	________	

Pumping Stations and Wells

Location or ID Number	Capacity, gpm @TDH	Location or ID Number	Capacity, gpm @ TDH
________	________	________	
________	________	________	
________	________	________	
________	________	________	
________	________	________	

Treatment Units and Water Tanks/Enclosed Reservoirs

Description, Size, Etc.	Description, Size, Etc.
____________________	____________________
____________________	
____________________	
____________________	
____________________	
____________________	
____________________	

Other

____

____________________ ____________________

11.7 Environmental Impact and Other Submittals

a. Have the steps, if any, that were reasonable and included in the facilities plan been taken to ensure that the facility is visually compatible with its present and future surroundings?

( )YES ( )NO

b. Have adequate provisions have been made for minimizing erosion during construction?

( ) YES ( )NO

c. Does the facilities plan or FONSI require mitigative measures or special construction methods?

( )YES ( )NO

If yes, list them and indicate whether they are included in the plans/specs.

____

____

d. Has the loan recipient obtained any Section 10 or Section 404 Permits, and all other Intergovernmental Review Agency approvals/clearances required for the project? (Any such permits/approvals/clearances must be obtained by the Priority System deadlines).

( )Yes ( )NO ( )NA

e. Has a solid waste disposal application been submitted to the Department?

( )Yes ( )NO ( )NA

f. Have the accepted VE recommendations been incorporated?

( )Yes ( )NO ( )NA

g. Has an NPDES or state operating permit application been received?

( )Yes ( )No ( )NA

Has the permit been issued? ( )Yes ( )No ( )NA

The permit must be issued prior to approval of P/S for treatment facilities unless allowed by CB (CWSRF) or MPCB/EPD (Non-SRF) Chief.

12. PLANS

12.1 General

___ All plans shall bear a suitable title showing the name of the owner, whether a municipality, district, association, or institution. They shall show the scale in feet, a graphical scale, the north point, and date. The plans shall be signed, sealed, and dated by the Mississippi Registered Professional Engineer responsible for their development in a manner consistent with the requirements of the State Board of Registration for Professional Engineers and Land Surveyors, as they apply generally to the practice of engineering. Nothing herein is to be construed as allowing any such work to be performed other than by or under the direct supervision of a Registered Mississippi Professional Engineer.

___ The plans shall be of professional quality, clear and legible (suitable for microfilming). They shall be drawn to a scale which will permit all necessary information to be plainly shown. Generally, the size of the plans should not be larger than 30 inches x 42 inches. Datum used should be indicated. Locations and data of test borings and wells, when made, shall be shown on the plans.

___ The plans for wastewater treatment facilities and for drinking water treatment facilities that include unit processes that require a wastewater permit shall include a drawing which shows adjacent zoning, the surrounding property lines and that the required 150 foot buffer zone will exist for facilities with wastewater permits. The buffer zone is not required where the adjoining property is zoned for commercial or industrial use, where the adjoining property, dwelling, or commercial establishment is used for commercial or industrial use, or for collectors, interceptors, or pump stations, or where written waivers from affected property owners are submitted *and a variance is granted by the Permit Board*. Refer to the CWSRF or DWSIRLF regulations, Appendix N, NPDES and Siting Criteria Regulations.

___ Detail 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. They shall also include: dimensions and relative elevations of structures, the location and outline form of equipment, location and size of piping, water levels, and ground elevations.

12.2 Plans of Sewers

12.2.1 General Plan

A complete plan of existing and proposed sewers shall be submitted for projects involving new sewer systems and additions to existing systems. Plans and specifications for service lines and connections only, or for simple rehabilitation/replacement of existing, previously approved sewers need not be submitted unless required under the CWSRF program. Combined sanitary and storm sewers are not allowed. This plan shall show the following:

12.2.1.1 Geographical Features

___ a. Topography and elevations - Existing or proposed streets and all ditches, streams, rivers and water surfaces shall be clearly shown. Contour lines at suitable intervals should be included.

___ b. Boundaries - The boundary lines of the municipality or the sewer district and the area to be sewered shall be shown.

12.2.1.2 Sewers

___ The plan shall show the location and size of all existing and proposed sanitary sewers draining to the treatment works concerned.

___ An adequacy of treatment review and form from the MPCB or EPD is necessary for any new or increased flows to a treatment facility.

12.2.2 Detail Plans

___ Detail plans shall be submitted. 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. Plan views should be drawn to a corresponding horizontal scale and preferably be shown on the same sheet. Plans and profiles shall show:

___ a. Location of streets and sewers.

___ b. Line of ground surface; size, material and specified type(s) 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 or otherwise identified.)

Where there is any question of the sewer being sufficiently deep to serve any user, the engineer shall state that all sewers are sufficiently deep to serve adjacent users without back-ups of wastewater into the residence or business and without problems related to insufficient gravity flow from the residences/businesses.

___ c. Locations of all special features such as inverted siphons, concrete encasements, elevated sewers, etc.

___ d. All known existing structures and utilities, both above and below ground, which might interfere with the proposed construction, particularly water mains, gas mains, storm drains, and telephone, TV and power conduits.

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

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

Typical and special sewer joints, connections, etc.

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

12.3 Plans of Pumping Stations

12.3.1 Location Plan

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

___ a. Any municipal, district, association, etc., boundaries within the tributary area.

___ b. The location of the pumping station and force main, and pertinent elevations.

12.3.2 Detail Plans

Detail plans shall be submitted showing the following, where applicable:

___ a. Topography of the site.

___ b. Existing pumping station.

___ c. Proposed pumping station, including provisions for future pumps or ejectors.

___ d. Test borings, wells, and groundwater elevations, where applicable.

___ e. 100-year flood elevation.

12.4 Plans of Treatment Plants

12.4.1 Location Plan

___ A plan shall be submitted showing the treatment plant in relation to the remainder of the system.

___ Sufficient topographic features shall be included to indicate its location with relation to ditches, streams, rivers, and water surfaces and the point of discharge of treatment effluent.

12.4.2 General Layout

Layouts of the proposed treatment plant shall be submitted, showing:

___ a. Topography of the site.

___ b. Size and location of plant structures.

___ c. Schematic flow diagram(s) showing the flow through various plant units, and showing utility systems serving the plant processes.

___ 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 water, sewage, supernatant liquor, and sludge.

___ f. Test borings, wells, and groundwater elevations, where applicable.

12.5 Detail Plans

Detail 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 operating capacity of all pumps, blowers, motors, and other mechanical devices.

___ d. Maximum hydraulic flow in profile.

___ e. Adequate description of any features not otherwise covered by specifications or engineer's report.

13. SPECIFICATIONS

___ Complete technical specifications for the construction of sewers, water lines, tanks, wells, pumping stations, treatment plants, and all other appurtenances, shall accompany the plans.

___ The specifications shall be signed, sealed, and dated by the Mississippi Registered Professional Engineer responsible for their development in a manner consistent with the requirements of the State Board of Registration for Professional Engineers and Land Surveyors, as they apply generally to the practice of engineering. Nothing herein is to be construed as allowing any such work to be performed other than by or under the direct supervision of a Mississippi Registered Professional Engineer.

___ 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 for the quality of materials, workmanship and fabrication of the project. They shall also include: the type, size, strength, operating characteristics, and rating of equipment; allowable infiltration; the complete requirements for all mechanical and electrical equipment, including machinery, valves, piping, and jointing of pipe; electrical apparatus, wiring, instrumentation, and 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; and performance tests for the completed works and component units. It is suggested that these performance tests be conducted at design load conditions wherever practical.

14. REVISIONS TO APPROVED PLANS

Any revisions, changes, addenda, etc. to reviewed and/or approved plans or specifications shall be made in accordance with this Guidance, the Commission's "Wastewater Regulations," "CWSRF Regulations," applicable Regulations of the Mississippi State Department of Health, and "DWSIRLF Regulations," as applicable, in accordance with Section 10.2. Such revisions shall be submitted to the Department for review and approval. If such is by change order, see the Department's guidance and checklist for change order review, in addition to this document. Record drawings clearly showing such alterations shall be submitted to the Department at the completion of the work.

15. OPERATION DURING CONSTRUCTION

___ Specifications shall contain requirements for keeping existing wastewater or drinking water facilities in operation during construction of the project. Should it be necessary to take existing facilities out of operation, a plan which will avoid or minimize pollution effects on any receiving stream and provide for alternative service for wastewater or drinking water facilities shall be reviewed and approved in advance by the Department and shall be adhered to during construction.

16. ENVIRONMENTAL INFORMATION

16.1 Discharge Point

a. Do the discharge point and design flow shown on the plans match the point and flow used to determine the WLA? ( )Yes ( )No ( )NA

*b. Do the discharge point and design flow on the plans match the point and flow in the facilities plan? ( )Yes ( )No ( )NA

16.2 Flood Information

a.

Unit	Minimum Design Elev., ft.	100-yr. Flood Elev., ft.
Treatment Plant		
Pump Station(s)	________	
	________	
	________	
	________	

b. Are all units operational and not subject to inundation during a 100-yr. flood?

( )Yes ( )No

*c. Will the project affect a designated flood plain?

( )Yes ( )No

If so will E.O. 11988/12148 be followed (mitigation of effect of the project on the Floodplain, FEMA comments)?

( )Yes ( )No

16.3 Other

a. What provisions have been made to prevent sewage bypassing during construction?
*See SGC Attachment 1 (a).

b. If a wastewater project is not being funded with a CWSRF loan, has the municipal information sheet been submitted?

( )Yes ( )No ( )NA

c. Have sites been permitted for stormwater runoff where required?

( )Yes ( )No ( )NA

Sites requiring permits are:

(1) Wastewater treatment facilities designed to treat 1.0 MGD or more, or;

(2) Construction activities where five (5) acres or more of land are disturbed,

For either:

(1) Incorporated municipalities with a total population of 100,000 or more;

(2) Counties with unincorporated areas of 100,000 or more total population, or;

(3) The state or federal government.

CHAPTER 20
DESIGN OF CONVENTIONAL GRAVITY SEWERS

21. DESIGN CAPACITY

In general, sewer capacities should be designed for the estimated ultimate tributary population, or for the design population identified in the facilities plan, except in considering parts of the systems that can be readily increased in capacity. Similarly, consideration should be given to the maximum anticipated capacity of institutions, industrial parks, etc.

___ Combined wastewater and stormwater sewers shall not be approved.

In determining the required capacities of sanitary sewers the following factors should be considered:

___ a. Maximum hourly domestic sewage flow;

b. Additional maximum sewage or waste flow from industrial plants;

___ c. Inflow and groundwater infiltration;

d. Topography of area;

___ e. Location of sewage treatment plant;

f. Depth of excavation; and

___ g. Pumping requirements.

22. DESIGN FLOW

22.1 Per Capita Flow

___ New sewer systems shall be designed on the basis of an average daily per capita flow of sewage of 70 to 120 gallons per day. This range is assumed to consist of 70 gpd of domestic sewage plus 0 to 50 gpd of infiltration. The amount of infiltration will depend on the type, size, and length of the sewer system. Different figures for domestic sewage and infiltration may be used if supported by water use records and flow data. Commercial and industrial flows shall be included as necessary.

22.2 Peak Design Flow

Sanitary sewers shall be designed on a peak design flow basis using one of the following methods. Use of other values for peak design flow will be considered if justified on the basis of adequate documentation.

a. The ratio of peak to average daily flow as determined from the following formula: $Q_p/Q_a = \frac{18+P}{4+P}$ where P = the population in thousands, or;

___ b. Values established from an infiltration/inflow study acceptable to the Department.

23. DETAILS OF DESIGN AND CONSTRUCTION

23.1 Minimum Size

___ No gravity sewer conveying raw sewage shall be less than 8 inches (20 cm) in diameter. House laterals (service lines) shall be no less than 4 inches in diameter. Exceptions are given in Chapter 20A.

23.2 Depth

___ In general, sewer shall be sufficiently deep to be protected from surface loading and to receive sewage from basements and to prevent freezing. The minimum depth shall be 3 feet. Shallower depths may be allowed if structural design or other conditions warrant.

23.3 Slope

23.3.1

___ All sewers shall be designed and constructed to give mean velocities, when flowing full, of not less than 2.0 feet per second (0.61 m/s), based on Manning's formula using an "n" value of 0.013. The following are the minimum slopes which should be provided; however, slopes greater than these are desirable:

Sewer Size (diameter)	Minimum Slope in Feet Per 100 Feet (m/100 m)(%)
8 inch (20 cm)	0.34
9 inch (23 cm)	0.29
10 inch (25 cm)	0.25
12 inch (30 cm)	0.20
14 inch (36 cm)	0.16
15 inch (38 cm)	0.15
16 inch (41 cm)	0.14
18 inch (46 cm)	0.12
21 inch (53 cm)	0.10
24 inch (61 cm)	0.08
27 inch (69 cm)	0.066
30 inch (76 cm)	0.058
36 inch (91 cm)	0.045

23.3.2

___ Slopes slightly less than those required for the 2.0 fps (0.61 m/s) velocity, when flowing full, may be permitted. Such decreased slopes will only be considered where the depth of flow will be at least 0.3 of the pipe diameter for design average flow. Whenever such decreased slopes are selected, the design engineer must furnish with his report his computations of the anticipated flow velocities of average and daily or weekly peak flow rates. The pipe diameter and slope shall be selected to obtain the greatest practical velocities to minimize settling problems. The operating authority of the sewer system will give written assurance to the Department that any additional sewer maintenance required by reduced slopes will be provided.

___ A decreased slope will also be considered when the sewer is being laid between existing manholes and the depth cannot be changed due to the depth of the collection system downstream.

23.3.3

___ Sewers shall be laid with uniform slope between manholes.

23.3.4

___ Where velocities greater than 15 fps (4.6 m/s) are attained, special provision shall be made to protect against displacement by erosion and shock.

23.3.5

___ Sewers on 20 percent slopes or greater shall be anchored securely with concrete anchors or equal, spaced as follows:

a. Not over 36 feet (11 m) center to center on grades 20% and up to 35%;

b. Not over 24 feet (7.3 m) center to center on grades 35% and up to 50%; and

c. Not over 16 feet (4.9 m) center on grades 50% and over.

23.4 Alignment

___ Sewers 24 inches (61 cm) or smaller shall be laid with straight alignment between manholes. The alignment shall be checked by either using a laser beam or lamping.

Curvilinear alignment of sewers larger than 24 inches may be considered on a case by case basis provided that compression joints are specified and ASTM or the specific pipe manufacturer's maximum allowable joint deflection limits are not exceeded. When curvilinear sewers are proposed, minimum slopes indicated in paragraph 23.3.1 must be increased (including manholes) accordingly to provide a recommended minimum velocity of 2.0 fps when flowing full.

23.5 Changes in Pipe Size

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

Sewer extensions should be designed for projected flows even when the diameter of the receiving sewer is less than the diameter of the proposed extension. The Department may require a schedule for future downstream sewer relief.

23.6 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, corrosion and similar problems. For new pipe materials for which ASTM or other generally acceptable industry standards have not been established, the design engineer shall provide complete pipe 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.

All sewers shall be designed to prevent damage from superimposed live and dead loads. Proper allowance for loads on the sewer shall be made because of soil and potential groundwater conditions, as well as the width and depth of trench. Where necessary to withstand extraordinary superimposed loading, special bedding, concrete cradle or special construction may be used. See ASTM D2321 or C12 when appropriate.

23.7 Installation

23.7.1 Standards

Installation specifications shall contain appropriate requirements based on the criteria, standards and requirements established by 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, nor create excessive side fill pressures or ovalation of the pipe, nor seriously impair flow capacity.

23.7.2 Trenching

__ a. The width of the trench shall be ample to allow the pipe to be laid and jointed properly and to allow the bedding, haunching, and 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 4 inches (10 cm) below and on each side of all pipe(s).

23.7.3 Bedding

a. Bedding equal to Classes A, B, or C, or crushed stone as described in ASTM C12 shall be used for all rigid pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load.

b. Material equal to Classes I, II, or III, as described in ASTM D2321 shall be used for all flexible pipe bedding, haunching and initial backfill provided the proper strength pipe is used with the specified bedding to support the anticipated load.

c. All water entering the excavation or other parts of the work shall be removed until all the work has been completed. No sanitary sewer shall be used for the disposal of such water.

23.7.4 Backfill

__ a. Backfill shall be of a suitable material removed from excavation except where other suitable material is specified. Debris, frozen material, large clods or stone, organic matter, or other unstable materials shall not be used for backfill within 2 feet (0.61 m) of the top of the pipe.

__ b. Backfill shall be placed in such a manner as not to disturb the alignment of the pipe.

23.7.5 Deflection Test

__ a. Deflection tests shall be performed on all flexible pipe. The test shall be conducted after the final backfill has been in place at least 30 days.

__ b. No pipe shall exceed a deflection of 5%.

c. If the deflection test is to be run using a rigid ball or mandrel, it shall have a diameter equal to 95% of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices.

23.8 Joints and Infiltration

23.8.1 Joints

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

23.8.2 Leakage Tests

Leakage tests shall be specified. These may include appropriate water or low pressure air testing. The leakage outward or inward (exfiltration or infiltration) shall not exceed 200 gallons per inch of pipe diameter per mile per day (0.19 m^3/cm of pipe dia./km/day) for any section of the system between consecutive manholes. An exfiltration or infiltration test shall be performed with a minimum positive head of 2 feet (0.61 m). The air test, if used, shall, as a minimum, conform to the test procedure described in an appropriate ASTM or equivalent standard. The testing methods selected should also take into consideration the range in groundwater elevations projected (if more than the minimum positive head of two feet), and the situation during the test.

24. MANHOLES

24.1 Location

__ Manholes shall be installed: at the end of each line; at all changes in grade, size, or alignment; at all intersections; and at distances not greater than 400 feet (120 m) for sewer 15 inches (38 cm) and smaller, and 500 feet (150 m) for sewer 18 inches (46 cm) to 30 inches (76 cm), except that distances up to 600 feet (180 m) may be approved in cases where adequate modern cleaning equipment for such spacing is provided. Greater spacing may be permitted in larger sewers. Cleanouts may be used only for special conditions and shall not be substituted for manholes nor installed at the end of the laterals greater than 150 feet (46 m) in length.

24.2 Drop Type

__ A drop pipe should be provided for a sewer entering a manhole at elevations of 24 inches (61 cm) or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches (61 cm), the invert should be filleted to prevent solids deposition.

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

The entire outside drop connection shall be encased in concrete, or other reasonable stabilization methods such as ductile iron pipe and granular backfill shall be used.

24.3 Diameter

___ The minimum diameter of manholes shall be 48 inches (1.22 m); larger diameters are preferable for large diameter sewers. 40 inch diameter is acceptable for rehabilitated manholes. A minimum access diameter of 22 inches (56 cm) shall be provided.

24.4 Flow Channel

___ The flow channel through manholes should be made to conform in shape and slope to that of the sewers.

24.5 Watertightness

Manholes shall be of the pre-cast concrete or poured-in-place concrete type and shall be waterproofed. Plastic, fiberglass, or similar manholes are also acceptable, if properly installed. Brick, masonry, or other similar types shall not be used.

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

Watertight manhole covers shall be used wherever the manhole tops may be flooded by street runoff or high water up to the 100 year flood elevation. Watertight covers may also be necessary in certain cases where sudden surcharging occurs and where such use would not cause an overflow elsewhere. Locked manhole covers may be desirable in isolated easement locations or where vandalism may be a problem.

___ The specifications shall include a requirement for inspection of manholes for watertightness prior to placing into service.

24.6 Electrical

___ Electrical equipment installed or used in manholes shall conform to paragraph 32.3.5.

25. INVERTED SIPHONS

___ Inverted siphons should have not fewer than 2 barrels, with a minimum pipe diameter of 6 inches (15 cm) and shall be provided with necessary appurtenances for convenient flushing and maintenance. The inlet and discharge structures shall have adequate clearances for rodding; and in general, sufficient head shall be provided and pipe sizes selected to secure velocities of at least 3.0 fps (0.92 m/s) for average flows. The inlet and outlet details shall be so arranged that the normal flow is diverted to 1 barrel, and that either barrel may be taken out of service for cleaning. The vertical alignment should permit cleaning and maintenance.

26. SEWERS IN RELATION TO STREAMS

26.1 Location of Sewers on Streams

26.1.1 Cover Depth

__ 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 the following cover requirements must be met:

a. One foot (0.3 m) of cover is required where the sewer is located in rock;

b. Three feet (0.9 m) of cover is required in other material. In major streams, more than three feet (0.9m) of cover may be required, and;

c. In paved stream channels, the top of the sewer line should be placed below the bottom of the channel pavement.

Less cover will be approved only if the pipe is properly protected and the proposed sewer crossing will not interfere with any anticipated future modifications to the stream channel. Reasons for specifying less cover should be given.

26.1.2 Horizontal Location

Sewers located along streams shall be located outside of the stream bed and sufficiently removed therefrom (minimum 30 feet recommended) to provide for future possible stream widening and to prevent pollution by siltation during construction. Department approved BMPs shall be used where needed.

26.1.3 Structures

__ The sewer outfalls, headwalls, manholes, gate boxes, or their structures shall be located so they do not interfere with the free discharge of flood flows of the stream.

26.1.4 Alignment

Sewers crossing streams should be designed to cross the stream as nearly perpendicular to the stream flow as possible. Sewer systems shall be designed to minimize the number of stream crossings.

26.2 Construction

26.2.1 Materials

Sewers entering or crossing streams shall be constructed of cast or ductile iron pipe with mechanical joints; otherwise they shall be encased and constructed so they will remain watertight and free from changes in alignment under flood/high flow conditions. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel, or other materials which will not cause siltation.

26.2.2 Siltation and Erosion

Construction methods that will minimize siltation and erosion in accordance with the Department's list of approved BMPs shall be employed. The design engineer shall include in the project specifications the method(s) to be employed in the construction of sewers in or near streams to provide adequate control of siltation and erosion. Specifications shall require that cleanup, grading, seeding, and planting or restoration of all work areas shall begin immediately. Exposed areas shall not remain unprotected. Excavated material shall be properly stockpiled (on the uphill side of the trench) so as to minimize environmental impacts. All such work shall be specified to meet the regulatory requirements.

27. 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 jointing 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, or no less than 3 feet from the stream bottom.

28. PROTECTION OF WATER SUPPLIES (refer also to Recommended Standards for Water Works)

28.1 Water Supply Interconnections

__ There shall be no physical connections between a public or private potable water supply system and a sewer, or appurtenances thereto which would permit the passage of any sewage or polluted water into the potable supply. No water pipe shall pass through or come in contact with any part of a sewer or manhole.

28.2 Relation to Water Works Structures

__ While no general statement can be made to cover all conditions, it is generally recognized that sewers shall meet the requirements of the appropriate water works reviewing agency with respect to minimum distances from public water supply wells or other water supply sources and structures.

28.3 Relation to Water Mains

__ **Sections 28.3.1, 28.3.2, 28.3.3, and 37.9 herein shall be included in the specifications.**

28.3.1 Horizontal Separation

__ Sewers shall be laid at least 10 feet (3.0 m) horizontally from any existing or proposed water main. The distance shall be measured edge to edge. In cases where it is not practical to maintain a ten foot separation, the Department may allow deviation on a case-by-case basis, if supported by data from the design engineer. Such deviation may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation so the bottom of the water main is at least 18 inches (46 cm) above the top of the sewer.

28.3.2 Crossings

__ Sewers crossing water mains shall be laid to provide a minimum vertical distance of 18 inches (46 cm) between the outside of the water main and the outside of the sewer. The crossing shall be arranged 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. Where a water main crosses under a sewer, either the water main or the sewer shall be ductile iron or shall be encased in ductile iron or concrete for a minimum of one full joint length on each side of the crossing, and the requirements of Section 28.3.3 shall be met, regardless of the clearance distances.

28.3.3 Special Conditions

When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to water pipe, and shall be pressure tested at 150 p.s.i. to assure watertightness prior to backfilling.

CHAPTER 20 A
DESIGN OF ALTERNATIVE SEWERS

21A. DEFINITION

Alternative sewers include small diameter gravity sewers (SDG), grinder pump pressure sewers (GP/PS), septic tank effluent pump sewers (STEP), vacuum sewers, and combinations of the above. Any small diameter sewers shall be used only in conjunction with grinder pumps, septic tanks, or other acceptable solids reduction devices.

22A. REFERENCES

Alternative sewers may be designed in accordance with:

a. <u>Alternative Sewer Systems</u> (1986) WEF Manual of Practice No. FD-12;

b. <u>Small Diameter Gravity Sewers, an Alternative for Unsewered Communities</u> (1986)EPA/600/2-86/022;

c. <u>Alternative Wastewater Collection Systems</u> (1991) EPA/625/1-91/024, or;

d. Other appropriate references.

23A. DESIGN

23A.1

__ The requirements of Section 28 and all subsections shall apply to alternative sewers.

23A.2

__ New alternative sewer systems shall be designed on the basis of an average daily per capita flow of sewage of 70 to 120 gpd, as described in Section 22.1.

The peaking factor for inflow is likely to be smaller than that given in Section 22.2.a.

23A.3

__ The requirements of Section 23.2 (Depth) shall apply.

23A.4

__ Septic tanks shall be used in SDG and STEP systems and shall have a capacity of at least 1000 gallons. If multiple customers are connected to a single tank, a larger tank will be necessary. Tanks shall be completely buried and shall utilize an effluent (scum) baffle; it is recommended that all openings except the influent line be screened. A removable top or other access for cleaning shall be provided. Tanks shall be concrete, plastic, fiberglass, or other acceptable material. Masonry, brick, bare steel, etc. shall not be used. Only new tanks are recommended; existing tanks should not be used for new SDG projects. If new tanks are not installed at each service, all of the existing tanks proposed to be reused shall be opened, cleaned, inspected, baffled and renovated to ensure that they meet all of the requirements of a new tank. Multiple connections to a single septic tank, STEP pump or grinder pump, etc. will be allowed if the sizing and design are acceptable considering the number of users and any other project specific concerns.

The tanks shall be owned and maintained by the local sewer authority (city, town, district, county, etc.), rather than the individual users.

23A.5

Septic tank effluent is very corrosive. All concrete and metal surfaces (including pump stations) which will be exposed to septic tank effluent should be protected from corrosion.

23A.6

__ Variable grade sewers need not be laid on grade, but unnecessary undulations shall be avoided. The use of negative grades is prohibited. Sewers shall be designed based on appropriate criteria from the WEF or other acceptable source. Air and vacuum release devices should be provided at high points as needed to prevent air locking. The hydraulic grade line for each variable grade sewer shall be calculated and plotted on the profile view of the plans.

23A.7

__ SDG sewers shall be at least 3 inches in diameter; a 4 inch minimum is recommended.

23A.8

__ SDG sewers shall have cleanouts at the end of each line and at reasonable distances within the line. The cleanout openings shall not be buried.

23A.9

__ GP/PS and STEP systems shall have redundant backflow prevention devices to preclude the possibility of wastewater from the system entering a building.

23A.10

__ The requirements of Chapter 30 and all subsections shall apply to GP/PS and STEP systems; however, Section 37.1 does not apply to STEP systems.

23A.11

__ If a GP/PS or STEP system will have any closed loops, the design flow and direction of flow in each part of the loop shall be given (either in the P/S or in a separate letter).

CHAPTER 20B
SEWER REHABILITATION

Sewer rehabilitation should be done in accordance with Existing Sewer Evaluation and Rehabilitation (1983; Water Environment Federation Manual of Practice No. FD-6), Sewer System Infrastructure Analysis and Rehabilitation (1991; EPA/625/6-91/030), or other appropriate references.

*___ All cost-effective repairs that are identified in the SSES shall be shown in the P/S.

*___ If there are any repairs in the P/S that are not cost-effective, they shall be identified as ineligible.

*___ The types of repairs shown in the P/S shall match those listed in the SSES.

___ All known bypasses and overflows within the design return storm event shall be included in the P/S for elimination.

*___ Such repairs, if they are the cost effective solution and identified in the approved facilities plan, are allowable.

CHAPTER 30
SEWAGE PUMPING STATIONS

31. GENERAL

31.1 Flooding

___ Sewage pumping structures and electrical and mechanical equipment shall be protected from physical damage by the 100 year flood. Sewage pumping stations shall remain operational and accessible and shall not be inundated by the 100 year flood.

31.2 Accessibility

The pumping station shall be readily accessible by maintenance vehicles during all weather conditions.

___ The pumping station shall be inaccessible to the general public (by a locked fence or enclosure, by being built underground, etc.).

31.3 Grit

Where it is necessary to pump sewage prior to grit removal, the design of the wet well and pump station piping shall receive special consideration such as grit removal facilities to avoid operational problems from the accumulation of grit.

32. DESIGN

32.1 Type

Sewage pumping stations may be wet/dry well, suction lift, or submersible. Screw type lift stations may also be allowed. All equipment shall be designed specifically for the handling of raw or pretreated sewage, as appropriate.

32.2 Structures

32.2.1 Separation

Dry wells, including their superstructure, shall be completely separated from the wet well.

32.2.2 Equipment Removal

Provision shall be made to facilitate removal of pumps, motors, and other mechanical and electrical equipment.

32.2.3 Access

Suitable and safe means of access for persons wearing self-contained breathing apparatus shall be provided to dry wells, and to wet wells containing either bar screens or mechanical equipment requiring inspection or maintenance.

For built-in-place pump station dry wells, a stairway with rest landings shall be provided at vertical intervals not to exceed 12 feet (3.7 m). For factory-built pump station dry wells over 15 feet (4.6 m) deep, a rigidly fixed landing shall be provided at vertical intervals not to exceed 10 feet (3.0 m). Where a landing is used, a suitable and rigidly fixed barrier shall be provided to prevent an individual from falling past the intermediate landing to a lower level. Where acceptable to the Department, an elevator may be used in lieu of landings in a factory-built station, provided emergency access is included in the design.

Reference should be made to applicable safety codes which, if they are more stringent than provided herein or in the specifications, shall govern.

The provisions of Section 46.5 also apply.

32.2.4 Construction Materials

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 sewage.

32.3 Pumps and Pneumatic Ejectors

32.3.1 Multiple Units

Multiple pumps or pneumatic ejectors shall be provided. A minimum of three (3) pumps should be provided for stations handling flows greater than 1 MGD (3800 m^3/d).

Units should be designed to fit actual flow conditions and shall be of such capacity that with any one unit out of service the remaining units will have capacity to handle maximum anticipated sewage flows.

32.3.2 Protection Against Clogging

All units shall be designed specifically for the handling of the types of sewage they will be subjected to.

Pumps handling sanitary sewage from 30 inch (76 cm) or larger diameter sewers shall be preceded by readily accessible bar racks to protect the pumps from clogging or damage. Bar racks should have clear openings not exceeding 2 2 inches (6.4 cm). Where a bar rack is provided, a mechanical hoist shall also be provided. Where the size of the installation warrants, mechanically cleaned and/or duplicate bar racks shall be provided.

Appropriate protection from clogging should also be considered for small pumping stations.

32.3.3 Pump Openings

Except where grinder pumps or septic tank effluent pumps are used, pumps shall be capable of passing spheres of at least 3 inches (7.6 cm) in diameter, and pump suction and discharge piping shall be at least 4 inches (10.2 cm) in diameter. See Section 37.2 for the size of force mains.

32.3.4 Priming

__ The pump shall be so placed that under normal operating conditions it will operate under a net positive suction head, except as specified in Sections 33 and 34.

32.3.5 Electrical Equipment

__ Electrical systems and components (e.g., motors, lights, cables, conduits, switchboxes, control circuits, etc.) in raw sewage wet wells, or in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present, shall be designed for safe use under such conditions to the extent practicable. In addition, equipment located in the wet well shall be suitable for use under corrosive conditions. Each cable shall be provided with watertight seal (and separate strain relief for flexible cables). 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 weatherproof equipment (NEMA 3R or 4). Lightning arresters and phase protection (for 3-phase motors) shall be provided. GFCI protection shall be provided for all outlets.

__ For each location requiring electrical power, the consulting engineer shall provide a written description of the type of power needed (voltage, amperage, phase, etc.) and shall give his written assurance (either in the P/S or in a separate letter) that the proper power will be available and when it will be available at each site. Phase protection and phase loss warning shall be provided for 3-phase power. Phase protection shall prevent automatic equipment restarting attempts upon power restoration until all three phases are restored.

32.3.6 Intake

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

32.3.7 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 located above the maximum high water level in the wet well. A connection to the pump suction is also recommended as an auxiliary feature. Water ejectors connected to a potable water supply shall not be provided. All floor and walkway surfaces should have an adequate slope to a point of drainage. Pump seal water shall be piped to the sump. Shallow valve pits, etc. may be gravity drained to the wet well as allowed in Section 34.4.

32.3.8 Pumping Rates

The pumps and controls of main pumping stations, and especially pumping station to the treatment works or operated as part of the treatment works, should be capable of discharging sewage at approximately its rate of delivery to the pump station. Wet well sizes, influent flow rates, and pumping capacity shall all be balanced to ensure sufficient capacity without excessive pump run time or detention time in the wet well. See Section 32.6.2. Hydraulic surges detrimental to the proper operation of downstream facilities shall be avoided.

__ Design pumping rates should be established in accordance with Section 23 or Section 43.3.1, as appropriate. A minimum force main velocity of 2 fps shall be maintained.

32.4 Controls

32.4.1 Type

__ Control systems shall be of the transducer, air bubbler, encapsulated float or flow measuring type. Float-tube control systems or existing stations being upgraded may be approved. The electrical equipment shall comply with Section 32.3.5.

32.4.2 Location

The control system shall be located away from the turbulence of incoming flow and pump suction.

32.4.3 Alternation

__ Provisions should be made to automatically alternate the pumps in use.

__ Provisions shall be made for simultaneous operation of multiple units when flow conditions warrant. Generally, when multiple pumps are operating and the water level is falling, the pumps should not be sequenced off, but all on pumps should remain on until the lowest control level is reached, then all pumps should switch off together.

32.5 Valves

32.5.1 Suction Line

Suitable shutoff valves shall be placed on the suction line of each pump except on submersible and vacuum-primed pumps.

32.5.2 Discharge Line

__ Suitable shutoff and check valves shall be placed on the discharge line of each pump discharging into a pressurized header. The check valve shall be located between the shutoff valve and the pump. Check valves shall be suitable for the material being handled. Except for pre-manufactured stations, check valves shall not be placed on the vertical portion of discharge piping. Valves shall be capable of withstanding normal pressure and water hammer.

All shutoff and check valves shall be operable from floor level and accessible for maintenance. External levers should be provided on swing check valves.

32.5.3 Location

__ Valves shall not be located in the wet well, except as provided in Section 34.4.

32.6 Wet Wells

32.6.1 Divided Wells

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

32.6.2 Size

The wet well size and control setting shall be appropriate and in accordance with the pump manufacturer's recommendations to avoid heat buildup in pump motor due to frequent starting and to avoid septic conditions due to excessive detention time. No more than ten (10) pump starts per hour should be allowed. For duplex stations, the design wet well volume in gallons may be calculated as 15 min. x influent (gpm) / 8. Also see Section 32.3.8.

32.6.3 Floor Slope

The wet well floor shall have a minimum slope of one to one to the hopper bottom. The horizontal area of the hopper bottom shall be not greater than necessary for proper installation and function of the inlet.

32.7 Ventilation

__ Adequate ventilation shall be provided for all pump stations.

There shall be no interconnection between the wet well and dry well ventilation systems.

32.7.1 Ventilation in Pump Stations Less Than 350 gpm or Any Submersible Type Not Requiring Entry.

__ At a minimum, passive screened vent pipes shall be provided. Mechanical ventilation as described below is recommended.

32.7.2 Ventilation in Pump Station of 350 gpm or Larger

Where the pump pit is below the ground surface, mechanical ventilation is required, so arranged as to independently ventilate the dry well and the wet well if screens or mechanical equipment requiring maintenance or inspection are located in the wet well. In pits over 15 feet (4.6 m) deep, multiple inlets and outlets are desirable. Damper 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 systems, which shall override any automatic controls. Consideration should be given also to automatic controls where intermittent operation is used. The fan wheel should be fabricated from non-sparking material. Consideration should be given to installation of automatic heating and/or dehumidification equipment.

32.7.2.1 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 rather than exhausted from the wet well.

32.7.2.2 Dry Wells

Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least 6 complete air changes per hour; if intermittent, at least 30 complete air changes per hour. Air should be forced in, rather than exhausted.

32.8 Flow Measurement

__ Suitable devices for measuring sewage flow and/or run time should be considered at all pump stations.

32.9 Water Supply

__ There shall be no physical connection between any potable water supply and a sewage 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 PUMPS

Suction lift pumps shall be of the self-priming or vacuum-priming type and shall meet the applicable requirements of Section 32. Suction lift pump stations using dynamic suction lifts exceeding the limits outlined in the following sections may be approved upon submission of factory certification of pump performance and detailed calculations indicating satisfactory performance under the proposed operating conditions. Such detailed calculations must include static suction lift as measured from "lead pump off" elevation to center line of pump, friction and other hydraulic losses of the suction piping, vapor pressure of the liquid, altitude correction, required net positive suction head, and a safety factor of at least 6 feet (1.8 m).

__ The pump equipment compartment shall be above grade or offset and shall be effectively isolated from the wet well to prevent the humid and corrosive sewer atmosphere from entering the equipment compartment. Wet well access shall not be through the equipment compartment. 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 (6.7 m).

__ Suction lift pumps shall be equipped with an air release valve in the discharge piping. Drainage from the air release valve shall be piped back to the wet well at elevation higher than the maximum wet well water level.

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 (7.6 m) in total length. Priming lift at the "lead pump on" elevation shall include a safety factor of at least 4 feet (1.2 m) from the maximum allowable priming lift for the specific equipment at design operating conditions.

33.2 Vacuum-Priming Pumps

__ Vacuum-priming pump stations shall be equipped with multiple 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 sewage.

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 sewage use, including totally submerged operation during a portion of each pumping cycle and shall meet the requirements of the National Electrical Code for such units. An effective method to detect shaft seal failure or potential seal failure shall be provided, and the motor shall be of squirrel-cage type design without brushes or other arc-producing mechanisms.

34.2 Pump Removal

__ Submersible pumps shall be readily removable and replaceable without entering, dewatering, or manually disconnecting any piping in the wet well.

34.3 Electrical

34.3.1 Power Supply and Control

__ Electrical supply, control and alarm circuits shall be designed to provide strain relief and to allow disconnection from outside the wet well. Terminals and connectors shall be protected from corrosion by location outside the wet well or by the use of watertight seals. If located outside, weatherproof equipment shall be used.

34.3.2 Controls

__ The motor control center shall be located outside the wet well, be readily accessible, and be protected by a conduit seal or other appropriate measures meeting the requirements of the National Electrical Code to prevent the atmosphere of the wet well from gaining access to the control center. The seal shall be so located that the motor may be removed and electrically disconnected without disturbing the seal.

34.3.3 Power Cord

__ Pump motor power cords shall be designed for flexibility and serviceability under conditions of extra hard usage and shall meet the requirements of the National Electrical Code standards for flexible cords in wastewater pump stations. Ground fault circuit interruption protection shall be used to de-energize the circuit in the event of any failure in the electrical integrity of the cable. Power cord terminal fittings shall be corrosion-resistant and constructed in a manner to prevent the entry of moisture into the cable, shall be provided with strain relief appurtenances, and shall be designed to facilitate field connecting.

34.4 Valves

__ Valves required under Section 32.5 shall be located in a separate valve pit. Accumulated water shall be drained to the wet well or to the soil. Sewage leaking into the valve pit shall not be drained to the soil. If the valve pit is drained to the wet well, an effective method shall be provided to prevent sewage from entering the pit during surcharged wet well conditions. Check valves that are integral to the pump may be located in the wet well provided that the valve can be removed in accordance with Section 34.2.

35. ALARM SYSTEMS

__ **Alarm systems SHALL be provided for all pumping stations. The alarm shall be activated in cases of POWER FAILURE, high water elevation, pump failure, phase loss, or any cause of pump station malfunction**. Alarms for major pumping stations should be telemetered, including identification of the alarm conditions, to a municipal facility that is manned 24 hours a day. If such a facility is not available and 24-hour holding capacity is not provided, the alarm should be telemetered to city offices during normal working hours and to the home of the person(s) in responsible charge of the lift station during off-duty hours.

36. EMERGENCY OPERATION

Pumping stations and collection systems shall be designed to prevent or minimize bypassing of raw, diluted, or partially treated sewage. For use during possible periods of extensive power outages, mandatory power reductions, or uncontrolled storm events, consideration should be given to providing storage/detention tanks or basins, which shall be made to drain to the station wet well. Where such overflows affect public water supplies, shellfish production, or water used for culinary or food processing purposes, a storage/detention basin or tank shall be provided having 24-hour detention capacity at the anticipated overflow rate.

36.1 Overflow Prevention Methods

__ A satisfactory method shall be provided to prevent or minimize overflows in the event of pumping station failure. The following methods should be evaluated on an individual basis (the choice should be based on least cost and least operational problems of the methods providing an acceptable degree of reliability):

a. Storage capacity, including trunk sewers, for retention of 24-hour design return wet weather flows (storage basins must be designed to drain back into the wet well or collection system after the flow recedes);

b. Other methods meeting the requirements of Section 46.1.1

36.2 Equipment Requirements

36.2.1 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.

36.2.1.1 Engine Protection

___ The engine must be protected from operating conditions that would result in damage to equipment. Unless continuous manual supervision is provided, protective equipment shall be capable of shutting down the engine and activating an alarm on site and as provided in Section 35. Protective equipment shall monitor for conditions of low oil pressure and overheating, except that oil pressure monitoring is not required for engines with splash lubrication. Oil level monitoring for such engines is recommended.

36.2.1.2 Size

___ The engine shall have adequate rated power to start and continuously operate under all connected loads.

36.2.1.3 Fuel

Reliability and ease of starting, especially during cold weather conditions, should be considered in the selection of the type of fuel.

___ Above ground liquid fuel tanks exceeding 660 gallon single tank capacity or 1320 gallon total capacity require a Spill Prevention Control and Countermeasure (SPCC) Plan and containment in accordance with 40 CFR 112. It is recommended that all above ground liquid fuel tanks have spill containment devices with a minimum capacity equal to the largest tank's volume plus an allowance for precipitation.

___ Underground fuel tanks require compliance with state and federal regulations contained in 40 CFR 280.

36.2.1.4 Engine Ventilation

___ The engine shall be located above grade with adequate ventilation of fuel vapors and exhaust gases.

36.2.1.5 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.

36.2.1.6 Protection of Equipment

Emergency equipment shall be protected from damage at the restoration of regular electrical power. In addition, emergency generating equipment shall be provided with a means of disconnecting such equipment from the regular incoming power source during emergency operating conditions in order to protect others who may be in contact with the failed power system. In the case of automatic systems, such disconnect shall also be automatic. In the case of manual systems, the load transfer switch or connection shall be designed such that it is impossible to connect the auxiliary power source to the primary power source.

36.2.2 Engine-Driven Pumping Equipment

Where permanently-installed or portable engine-driven pumps are used, the following requirements in addition to general requirements shall apply.

36.2.2.1 Pumping 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.

36.2.2.2 Operation

__ Unless continuous manual supervision is provided, the engine and pump shall be equipped to provide automatic start-up and operation of pumping equipment. Provisions shall also be made for manual start-up. Where manual start-up and operation is justified, storage capacity must meet the requirements of Section 36.2.2.3.

36.2.2.3 Portable Pumping Equipment

__ Where part or all of the engine-driven pumping equipment is portable, sufficient storage capacity to allow time for detection of pump station failure and transportation and hookup of the portable equipment shall be provided. This is likely to be 24 hours. A riser from the force main with quick-connect coupling and appropriate valving shall be provided to hook up portable pumps.

36.2.3 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.

36.2.3.1 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 safe and proper operation of the lift station. The operation of only one pump during periods of auxiliary power supply must be justified. Such 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 capacity to start all pumps simultaneously with auxiliary equipment operating.

36.2.3.2 Operation

___ Unless continuous manual supervision is provided, 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 of Section 36.2.3.3.

36.2.3.3 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. FORCE MAINS

37.1 Velocity

___ At design average flow a velocity of at least 2 fps (0.61 m/s) shall be maintained.

37.2 Size

___ Except where grinder pumps or septic tank effluent pumps are used, force mains shall be at least 4 inches in diameter. See Section 32.3.3 for pump sizes.

37.3 Depth

The requirements of Section 23.2 shall apply.

37.4 Air and Vacuum Relief Valves

Automatic air relief valves shall be placed as needed (at high points) in the force main to prevent air locking. Vacuum relief valves may also be necessary.

37.5 Termination

___ Force mains should enter the gravity sewer system at a point not more than 2 feet (60 cm) above the flow line of the receiving manhole.

37.6 Design Pressure

___ The force main and fittings, including reaction blocking, shall be designed to withstand normal pressure and pressure surges (water hammer).

37.7 Special Construction

__ Force main construction near streams or used for aerial crossings shall meet applicable requirements of Section 27 and 28.

37.8 Design Friction Losses

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

Smooth plastic or smooth lined iron or steel - 130 to 140
Unlined iron or steel - 100
All other - 120 (maximum)

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.

37.9 Separation from Water Mains

__ The requirements of Section 28.3 shall be met for all sewage force mains.

37.10 Identification

__ 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.

37.11 Leakage

Force main leakage tests shall be specified, including the testing methods and leakage limits.

CHAPTER 40
SEWAGE TREATMENT WORKS

41. PLANT LOCATION

The following items shall be considered when selecting a plant site:

a. Proximity of residential areas;

b. Direction of prevailing winds;

c. Vehicular access by all weather roads;

d. Area available for expansion;

e. Local zoning requirements;

f. Requirement for a 150 foot buffer zone;

g. Local soil characteristics, geology, hydrology, and topography available to minimize pumping;

h. Access to receiving stream;

i. Classification, vulnerability, and downstream uses of the receiving streams; and

j. 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;

k. Existence of nearby wetlands, flood plains, threatened or endangered species, scenic rivers, or areas of archaeological or cultural importance.

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

41.1 Flood Protection

The treatment works structures, electrical and mechanical equipment shall remain fully operational and accessible and shall be protected from physical damage by the 100 year flood (excepting hurricane flood surges). This applies to new construction and to major modifications at existing facilities.

42. QUALITY OF EFFLUENT

The required degree of wastewater treatment shall be based on the effluent requirements and water quality standards established by the Department and/or appropriate Federal regulations. Only treatment processes which are known, demonstrated, or reasonably expected to be capable of consistently meeting such standards under normal operating conditions shall be approved.

43. DESIGN

43.1 Type of Treatment

As a minimum, the following items shall be considered in the selection of the type of treatment:

a. Present and future effluent requirements, including the status and vulnerability of the receiving stream;

b. Location of and local topography of the plant site;

c. Space available for future plant construction;

d. The effect on industrial wastes likely to be encountered;

e. Ultimate disposal of sludge;

f. System capital costs;

g. System operating and maintenance costs, including basic energy requirements;

h. Process complexity governing operating personnel requirements; and

i. Environmental impact on the receiving stream and on present and future adjacent land use.

43.2 Required Engineering Data for New Process Evaluation

The policy of the Department is to encourage rather than obstruct the development of any methods or equipment for treatment of wastewaters. The lack of inclusion in these standards of some types of wastewater treatment processes or equipment should not be construed as precluding their use. The Department may approve other types of wastewater treatment processes and equipment under the condition that the operational reliability and effectiveness of the process or device shall have been demonstrated with a suitably-sized unit operating at similar design load and effluent conditions, to the extent required.

43.2.1 Test Data

The Department may require the following:

a. Monitoring observations, including test results and engineering evaluations, demonstrating the efficiency of such processes.

b. Detailed description of the test methods.

c. Testing, including appropriately-composited samples, under various ranges of strength and flow rates (including diurnal variations) and waste temperatures over a sufficient length of time to demonstrate performance under climatic and other conditions which may be encountered in the area of the proposed installations.

d. Other appropriate information.

The Department may require that appropriate testing be conducted and evaluations be made under the supervision of a competent process engineer other than those employed by the manufacturer or developer.

43.2.2 Design by Analogy

Data from similar municipalities may be utilized in the case of new systems; however, thorough investigation that is adequately documented shall be provided to the reviewing authority to establish the reliability and applicability of such data.

43.3 Design Loads

43.3.1 Hydraulic Design

43.3.1.1 New Systems

a. Undeveloped Areas

The design for sewage treatment plants to serve new sewer systems being built in currently undeveloped areas shall be based on an average per capita flow of 70 to 120 gpd, as described in Section 23.1.

b. Existing Developed Areas

Consideration shall be given in the design for a sewage treatment plant to serve a new sewerage system for a municipality or sewer district for higher flow rates if the existence of a large percentage of older building is likely to contribute significant infiltration/inflow to the new sanitary sewer system.

43.3.1.2 Existing Systems

__ Where there is an existing system, the volume and strength of existing flows shall be determined. The determination shall include both dry-weather and wet-weather conditions for at least a one-year period. Samples shall be taken and composited so as to be accurately representative of the strength of the wastewater. At least one year's flow data should be taken as the basis for the preparation of hydrographs for analysis to determine the following types of flow conditions of the systems:

a. the annual average daily flow - as determined by averaging flows over one year, exclusive of inflow due to rainfall;

b. the minimum daily flow - as determined by observing twenty-four hour flows during dry weather (low rainfall period) when infiltration/inflow are at a minimum;

c. wet-weather peak flows - as determined by observing twenty-four hour flows during a period of one year when infiltration/inflow are at a maximum;

d. wet-weather flows of 7-day duration, as determined by observing for a period of one year the daily flows during the immediate 7-day period following rainfall sufficient to cause ground surface runoff;

e. peak hourly flows - as determined by observing the maximum hydraulic load to the plant; and

f. industrial waste flows - as determined by flow data, including water use records, for each of industries tributary to sewer system.

The plant design flow selected shall meet the appropriate effluent and water quality standards that are set forth in the discharge permit.

43.3.2 Organic Design

43.3.2.1 New System Minimum Design

__ Domestic waste treatment design shall be on the basis of at least 0.17 pounds (0.08 kg) of BOD_5 per capita per day and 0.20 pounds (0.09 kg) of suspended solids per capita per day, unless information is submitted to justify alternate designs.

__ Where garbage grinders are widely used in areas tributary to a domestic treatment plant, the design basis should be increased to 0.22 pounds (0.10 kg) of BOD_5 per capita per day and 0.25 pounds (0.11 kg) of suspended solids per capita per day.

__ Domestic waste treatment plants that will receive industrial wastewater flows shall be designed to include these industrial waste loads.

43.3.2.2 Existing Systems

__ When an existing treatment works is to be upgraded or expanded, the organic design shall be based upon the actual strength of the wastewater as determined from the measurements taken in accordance with paragraph 43.3.1.2 above, or upon the basis in paragraph 43.3.2.1 above, whichever is higher, with an appropriate increment for growth.

43.3.3 Shock Effects

The shock effects of high concentrations and diurnal peaks for short periods of time on the treatment process, particularly for small treatment plants, shall be considered.

43.4 Conduits

__ All piping and channels should be designed to carry the maximum expected 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 or stop planks is permitted where they can be used in place of gate valves or sluice gates. Non-corrodible materials shall be used for these control gates.

43.5 Arrangement of Units

__ Component parts of the plant should be arranged for greatest operating and maintenance convenience, flexibility, economy, continuity of maximum effluent quality, and ease of installation of future units. Unless otherwise noted, all process unit drains, backwash, overflow, supernatant drawoff, waste sludge, etc. shall be properly disposed of, or routed to an appropriate point in the treatment process, or to the head of the plant. In no case shall any such waste be discharged, through the effluent line or otherwise, to the environment.

43.6 Flow Division Control

Flow division control facilities shall be provided as necessary to insure organic and hydraulic loading control of plant process units and shall be designed for easy operator access, change, observation, and maintenance. 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 performed in accordance with the recommendations of the manufacturer and 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 without causing a violation of the permit. 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. Dual or multiple unit processes are strongly recommended to facilitate adequate treatment during such repairs, and may be required to protect sensitive receiving waters.

44.2.1 Unit Bypass During Construction

Final plan documents shall include construction requirements in accordance with Section 15, 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. In no case shall any untreated or partially treated water be discharged, through the effluent line or otherwise, to the environment. 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 or access 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 sewage treatment works because of the possible presence of hydrogen sulfide and other corrosive gases, greases, oils, and similar constituents frequently present in sewage. This is particularly important in the selection of metals and paints. Contact between dissimilar metals should be avoided to minimize galvanic action.

All earthen basins receiving wastewater or sludge shall comply with the following Sections: 101 and all subsections, 102 and all subsections, 103, 103.6, 104.1.1-104. 1.5, 104.1.7 and all subsections, 104.2 and all subsections, 104.3.1, 104.3.2, 104.3.4, 104.3.6, 104.4.2 105.1-105.3, and 105.5.

All electrical equipment shall comply with Section 32.3.5.

44.5 Painting

The use of paints containing lead or mercury should be avoided. In order to facilitate identification of piping, particularly in large plants, it is suggested that the different lines be color-coded. The following color scheme is recommended for purposes of standardization. Items with a – are required colors.

Raw sludge line - brown with black bands
Sludge recirculation suction line - brown with yellow bands
Sludge draw off line - brown with orange bands
Sludge recirculation discharge line - brown
– 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
– Sulfur Dioxide - yellow with red bands
Sewage (wastewater) line - gray
Compressed air line - green
Water lines for heating digesters or building - blue with a 6-inch (152 mm) red band spaced 30 inches (762 mm) apart
– The contents shall be stenciled on the piping in a contrasting color.

A direction of flow stencil is also recommended.

44.6 Operating Equipment

A complete outfit of tools, accessories, and spare parts necessary for the plant operator's use should be provided. Readily-accessible storage space and workbench facilities should be provided, and consideration be given to provision of a garage for a large equipment storage, maintenance, and repair.

44.7 Erosion Control During Construction

Effective site erosion control shall be provided during construction.

44.8 Grading and Landscaping

Upon completion of the plant, the ground should be graded and grassed. All-weather walkways should be provided for access to all units. Where possible, steep slopes should be avoided to prevent erosion and accidents. 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 stormwater runoff. Provision should be made for landscaping, particularly when a plant must be located near residential areas.

45. PLANT OUTFALLS

45.1 Entrance Impact Control

The outfall sewer shall be designed to discharge to the receiving stream in a manner acceptable to the Department and COE and any other appropriate authority. Consideration should be given in each case 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; and
d. Appropriate effluent sampling in accordance with Section 45.3.

45.2 Protection and Maintenance

The outfall sewer shall be so constructed and protected against the effects of floodwater, tide, ice, erosion, or other hazards as to reasonably insure its structural stability and freedom from stoppage. 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. ESSENTIAL FACILITIES

46.1 Power Supply and Electrical Equipment

The requirements of Section 32.3.5 shall apply.

46.1.1 Emergency Power Facilities - General

All plants shall be provided with an alternative source of electric power to allow continuity of operation during power failures, except as noted below. Methods of providing alternate sources include:

a. The connection of at least 2 independent public utility sources such as substations - a power line from each substation is recommended, and will be required unless documentation is received and approved by the Department verifying that a duplicate line is not necessary to minimize water quality violations;

b. Portable or in-place internal combustion engine equipment which will generate sufficient electrical or mechanical energy; and

c. Portable pumping or aeration equipment when only emergency pumping or aeration is required.

Power-providing equipment shall conform to Section 36.2, as applicable.

46.1.2 Power for Aeration

__ Standby generating capacity normally is not required for aeration equipment used in the activated sludge process. In cases where long-term (4 hours or more) power outages (such as hurricanes and ice storms) have occurred, auxiliary power for minimum aeration of the activated sludge will be required. Full power generating capacity may be required by the Department on certain critical stream segments.

46.1.3 Power for Disinfection

__ Continuous disinfection, where required, shall be provided during all power outages.

46.2 Water Supply

46.2.1 General

An adequate supply of potable water under pressure shall 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 works which, under any conditions, might cause the contamination of potable water supply. The chemical quality should be checked for suitability for its intended uses such as in heat exchangers, chlorinators, etc.

46.2.2 Direct Connections

Only 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; and
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 unit.

46.2.3 Indirect Connections

Where a potable water supply is to be used for any purpose in a plant other than those listed in Section 46.2.2, a backflow preventer or 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 6 inches (15.2 cm) above the maximum flood line or the spill line of the tank, whichever is higher.

__ A sign shall be permanently posted at every hose bib, faucet, hydrant, or sill cock located on the water system beyond the backflow preventer or break tank to indicate that the water is not safe for drinking. Hoses used at such outlets should be restricted to non-potable uses and should be color coded to not be confused with potable water hoses.

46.2.4 Separate Non-Potable Water Supply

__ Where a separate non-potable water supply is to be provided, a backflow preventer or 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. Hoses used at such outlets should be restricted to non-potable uses and should be color coded to not be confused with potable water hoses.

46.3 Sanitary Facilities

__ Toilet, shower, lavatory, and locker facilities should be provided in sufficient numbers and convenient locations to serve the expected plant personnel.

46.4 Floor Slope

__ Floor surfaces should be sloped adequately to a point of drainage, except where materials containment is necessary.

46.5 Stairways

__ Stairways should be installed wherever possible in lieu of ladders. A flight of stairs should consist of not more than a 12 foot (3.7 m) continuous rise without a platform.

46.6 Flow Measurement

Effluent flow measurement facilities shall be provided at all plants. Indicating, totalizing, and recording flow measurement devices shall be provided for all mechanical plants and for all HCR systems or when required by permit conditions. Flow measurement facilities for lagoon systems shall not be less than pump-calibration time clocks or calibrated flume or weir.

__ Influent flow measurement facilities are recommended.

47. SAFETY

__ Applicable regulations of the Occupational Safety and Health Administration (OSHA) should be considered in the design, construction, and operation of the wastewater facilities. If any of the following items conflict with OSHA regulations, the OSHA regulations shall prevail.

Adequate provision shall be made to effectively protect the operator and visitor from hazards. The following shall be provided as necessary to fulfill the particular needs of each plants:

__ a. Enclosure of the plant site with a fence designed to discourage the entrance of unauthorized persons and animals;

__ b. Hand rails and guards around and/or grating over tanks, trenches, pits, stairwells, and other hazardous structures;

c. First aid equipment;

__ d. "No Smoking" signs in hazardous areas;

e. Protective clothing and equipment, such as air pacs, goggles, full face shields, gloves, hard hats, safety harnesses, fire extinguishers, chemical spill kits, etc.;

__ f. Portable blower and sufficient hose;

__ g. Portable lighting equipment, complying with the NEC requirements, and;

__ 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. A positive means of locking out each mechanical device.

47.1 Hazardous Chemical Handling

__ 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.

47.1.2 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 to 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.

47.1.3 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 unloading. These facilities are to be as close as practicable and shall be no more than 25 feet (7.6 m) from points of hazardous chemical exposure and are to be fully useful during all weather conditions.

47.1.4 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.

47.1.5 Piping, Labeling, Coupling Guards, Location

__ All piping containing or transporting corrosive or hazardous chemicals shall be identified with labels every ten feet and with at least two labels in each room, closet, or pipe chase. Color-coding as detailed in Section 44.5 shall also be used, but is not an adequate substitute for labeling. All connections (flanged or other type), except those adjacent to storage or feeder areas, shall have guards which will direct any leakage away from space normally 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.

47.1.6 Protective Equipment

__ Other safety or protective clothing and equipment, such as chlorine repair kits and respirators, should be provided as appropriate.

47.1.7 Warning System and Signs

__ Facilities shall be provided for automatic shutdown of pumps and sounding of alarms when failure occurs in pressurized chemical discharge line.

__ Warning signs requiring use of goggles shall be located near chemical unloading stations, pumps, and other points of frequent hazard.

47.1.8 Dust Collection

__ Dust collection equipment shall be provided where necessary to protect personnel from dusts injurious to the lungs or skin and to prevent polymer dust from settling on walkways.

48. LABORATORY

Note: Section 48 has been extracted and modified from the Michigan Water Pollution Association publication entitled: ("Recommended Guidelines for Wastewater Treatment Plant Laboratory Facilities, 1970").

All Class IV and mechanical Class III treatment works shall include a laboratory for making the necessary analytical determinations and operating control tests, except in individual situations where the omission of a laboratory is approved by the Department. The laboratory shall have sufficient size, bench space, equipment and supplies to perform all self-monitoring analytical work required by discharge permits, and to perform the process control tests necessary for good management of each treatment process included in the design.

48.1 Location

__ The laboratory should be located on ground level, easily accessible to all sampling points, with environmental control as an important consideration. It shall be located away from vibrating machinery or equipment which might have adverse effects on the performance of laboratory instruments or the analyst or shall be designed to prevent adverse effects from vibration.

48.2 Materials

48.2.1 Floors

__ Floor surfaces should be fire resistant, highly resistant to acids, alkalies, solvents, and salts, and not be slippery when wet. Floor drains should be installed as appropriate, and shall connect to the sanitary sewer.

48.2.2 Doors

Two exit doors should be located to permit a straight egress from the laboratory, preferably at least one to outside the building. Panic hardware should be used. They should have large glass windows for easy visibility of approaching or departing personnel.

Automatic door closures should be installed; swinging doors should not be used.

__ Flush hardware should be provided on doors if cart traffic is anticipated. Kick plates are also recommended.

48.3 Cabinets and Bench Tops

__ Water, gas, air, and vacuum service fixtures; traps, strainers, overflow, plugs, and tailpieces; and all electrical service fixtures shall be supplied with the laboratory furniture.

__ Strong, stable cabinets and bench tops should be provided. The top material should be resistant to attacks from normally used laboratory reagents. Overhangs and drip grooves should be provided.

__ Separate storage cabinets for acids and solvents should be provided.

The solvent storage cabinets should be vented top and bottom.

48.4 Hoods

__ Fume hoods to promote safety and canopy hoods over heat-releasing equipment shall be installed as appropriate.

48.4.1 Fume Hoods

48.4.1.1 Location

__ Fume hoods should be located where air disturbance at the face of the hood is minimal. Air disturbance may be created by persons walking past the hood; by heating, ventilating or air-conditioning systems; by drafts from opening or closing a door; etc.

__ Safety factors should be considered in locating a hood. If a hood is situated near a doorway, a secondary means of egress shall be provided. Bench surfaces should be available next to the hood so that chemicals need not be carried long distances.

48.4.1.2 Design and Materials

__ The selection of fume hoods, their design and materials of construction, shall be appropriate to the variety of analytical work to be performed and the characteristics of the fumes, chemicals, gases, or vapors that will or may be released by the activities therein.

__ Fume hoods are not appropriate for operation of heat-resisting equipment that does not contribute to hazards, unless they are provided in addition to those needed to perform hazardous tasks.

48.4.1.3 Fixtures

__ One cup sink should be provided inside each fume hood.

__ All switches, electrical outlets, and utility and baffle adjustment handles should be located outside the hood. Light fixtures should be explosion-proof.

48.4.1.4 Exhaust

24-hour continuous exhaust capability should be provided. Exhaust fans should be explosion-proof. Exhaust velocities should be checked when fume hoods are installed.

48.4.1.5 Alarms

__ A buzzer for indicating exhaust fan failure and a static pressure gauge should be placed in the exhaust duct. A high temperature sensing device located inside the hood should be connected to the buzzer.

48.4.2 Canopy Hoods

___ Canopy hoods should be installed over the bench-top areas where hot plate, steam bath, or other heating equipment or heat-releasing instruments are used. The canopy should be constructed of heat and corrosion resistant material.

48.5 Sinks

___ The laboratory should have a minimum of three appropriately designed sinks (not including cup sinks). At least two of them should be double-well with drainboards. The sinks should be constructed of material highly resistant to acids, alkalies, solvents, and salts, and should be abrasion and heat resistant, non-absorbent, and light in weight. Traps should be made of glass or plastic and easily accessible for cleaning.

48.6 Ventilation and Lighting

___ Laboratories should be separately air conditioned, with external air supply for 100% makeup volume. In addition, separate exhaust ventilation should be provided. Ventilation outlet locations should be remote from ventilation inlets. Dehumidifiers should be considered.

___ Good lighting, free from shadows, shall be provided.

48.7 Gas and Vacuum

___ Natural gas should be supplied to the laboratory. Digester gas should not be used.

___ An adequately-sized line source of vacuum should be provided with outlets available throughout the laboratory.

48.8 Balance and Table

___ An appropriate analytical balance and table should be provided and appropriately located.

48.9 Equipment, Supplies, and Reagents

___ The laboratory should be provided with all of the equipment, supplies, and reagents that are needed to carry out all of the facility's analytical testing requirements. Permit, process control, and industrial waste monitoring requirements shall be considered when specifying equipment needs. References such as <u>Standard Methods</u>, the <u>U.S.E.P.A. Analytical Procedures Manual</u> and 40 CFR Part 136 should be consulted prior to specifying equipment items.

48.10 Power Supply Regulation

__ To eliminate voltage fluctuation in sensitive equipment, electrical lines supplying the laboratory should be controlled with a constant voltage, harmonic neutralized type of transformer.

48.11 Water Still

__ An all-glass still, with at least one gallon (3.79 1) per hour capacity, should be installed complete with all utility connections. A deionization unit capable of producing 1 gph (3.79 lph) of CAP/ASTM Type I water may be used instead of a still.

48.12 Handicapped Access

Applicable requirements of the Americans with Disabilities Act of 1990 (ADA) must be considered in the design, construction, and operation of the wastewater facilities.

The design engineer shall state or confirm in writing that the facility's design conforms with the ADA.

49. FIRE PROTECTION

__ Treatment facilities should have adequate fire protection. A reference is NFPA 820, Recommended Practice for Fire Protection in Wastewater Treatment Plants by the National Fire Protection Association (NFPA), Quincy, MA, phone 1-800/344-3555.

CHAPTER 50
SCREENING, GRIT REMOVAL, AND FLOW EQUALIZATION

51. SCREENING DEVICES

51.1 Bar Racks and Screens

51.1.1 When Required

Protection for influent pumps and other equipment shall be provided by either coarse bar racks or bar screens. Protection for grinding/shredding equipment should be provided by coarse bar racks.

51.1.2 Location

51.1.2.1 Indoors

Screening devices, installed in a building where other equipment or offices are located, should be accessible only through a separate outside entrance.

51.1.2.2 Outdoors

Screening devices installed outside should be protected from freezing by a temporary protective enclosure or other means as necessary.

51.1.2.3 Access

Screening areas shall be provided with stairway access, adequate lighting and positive fresh air ventilation, and a convenient and adequate means for removing the screenings.

51.1.3 Design and Installation

51.1.3.1 Bar Spacing

Clear openings between bars should be no less than one inch (2.54 cm) for manually cleaned screens. Clear openings for mechanically cleaned screens may be as small as 5/8 of an inch (1.59 cm). Maximum clear openings should be 1 : inches (4.45 cm).

51.1.3.2 Slope

Manually cleaned screens, except those for emergency use, should be placed on a slope of 30 to 45 degrees from the horizontal.

51.1.3.3 Velocities

__ At normal operating flow conditions, approach velocities should be no less than 1.25 fps (38 cm/s), to prevent settling; and no greater than 3.0 fps (91 cm/s) to prevent forcing material through the openings.

51.1.3.4 Channels

Dual channels shall be provided and sized 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.

51.1.3.5 Invert

__ The screen channel invert should be 3.0 to 6.0 inches (7.6 - 15.2 cm) below the invert of the incoming sewer.

51.1.3.6 Flow Distribution

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

51.1.3.7 Flow Measurement

__ Flow measurement devices shall be provided and 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.

51.1.4 Safety

51.1.4.1 Railings and Gratings

__ Manually cleaned screen channels shall be protected by guard railings and deck gratings, with adequate provisions for removal or opening to facilitate raking.

Mechanically cleaned screen channels shall be protected by guard railings and deck gratings. Consideration should also be given to temporary access arrangements to facilitate maintenance and repair.

51.1.4.2 Mechanical Devices

__ Mechanical screening equipment shall have adequate removal enclosures to protect personnel against accidental contact with moving parts and to prevent dripping in multi-level installations.

51.1.5 Control Systems

51.1.5.1 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 preset high water elevation.

51.1.5.2 Electrical Fixtures and Controls

Electrical fixtures and controls in screening areas where hazardous gases may accumulate shall meet the requirements of Section 32.3.5.

51.1.5.3 Manual Override

__ Automatic controls shall be supplemented by a manual override.

51.1.6 Disposal of Screenings

__ Facilities shall be provided for removal, handling, storage, and disposal of screenings in a legal and sanitary manner. Separate grinding of screenings and return to the sewage 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 for both the platform and the storage areas. Such drainage shall be returned to the influent flow at the head of the plant.

51.1.7 Auxiliary Screens

__ Where a single screen is used, an auxiliary manually cleaned screen shall be provided. Where two or more screens are used, the design shall provide for taking any unit out of service without sacrificing the capability to handle the peak design flow. At least one of the screens shall be designed to allow manual cleaning.

51.2 Fine Screens

51.2.1 General

__ Fine screens (about 1/16 inch) may be used in lieu of primary sedimentation providing that subsequent treatment units are designed on the basis of anticipated screen performance. Fine screens should not be considered equivalent to primary sedimentation. Where fine screens are used, additional provision for the removal of floatable oils and greases shall be considered.

51.2.2 Design

__ Tests should be conducted to determine BOD_5 and suspended solids removal efficiencies at the design peak hydraulic and peak organic loadings.
A minimum of two fine screens shall be provided, each unit being capable of independent

operation at peak design flow.

___ Fine screens shall be preceded by a mechanically cleaned bar screen or other protective device. Grinding/shredding devices shall not be used ahead of fine screens. Freeze protection should be provided, as appropriate.

51.2.3 Electrical Fixtures and Control

___ Electrical fixtures and controls in screening areas where hazardous gases may accumulate shall meet the requirements of Section 32.3.5.

51.2.4 Servicing

Hosing equipment shall be provided to facilitate cleaning. Provision shall be made for isolating or removing units from their location for servicing.

52. GRINDING/SHREDDING (GS) EQUIPMENT

52.1 GENERAL

___ Provisions for location shall be in accordance with those for screening devices, Section 51.1.2.

52.2 When Required

___ G/S equipment should be used in plants that do not have primary sedimentation or fine screens, and should be provided in cases where mechanically cleaned bar screens will not be used.

___ G/S equipment is not required for SDG, STEP, or GP/PS collection systems.

52.3 Design Considerations

52.3.1 Location

G/S equipment should be located downstream of any grit removal equipment.

52.3.2 Size

G/S equipment capacity shall be adequate to handle peak hourly flow.

52.3.3 Installation

A screened bypass channel shall be provided. The use of the bypass channel should be automatic in case of equipment failure and at depths of flow exceeding the design capacity of the G/S equipment.

___ Each G/S device that is not preceded by grit removal equipment should be protected by a 6.0 inch (15.2 cm) deep gravel trap.

Gates shall be provided in accordance with Section 51.1.3.4.

52.3.4 Servicing

Provision shall be made to facilitate servicing units in place and removing units from their location for servicing.

52.3.5 Electrical Controls and Motors

__ Electrical equipment in G/S equipment chambers where hazardous gases may accumulate shall meet the requirements of Section 32.3.5. Motors in areas not governed by this requirement may need protection against accidental submergence.

53. GRIT REMOVAL FACILITIES

53.1 General

__ Grit removal facilities should be provided as needed for all sewage treatment plants.

__ Grit removal facilities should be located ahead of pumps and grinding/shredding devices. Coarse bar racks should be placed ahead of grit removal facilities.

53.1.1 Housed Facilities

53.1.1.1 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 facilities may also be warranted.

53.1.1.2 Access

Adequate stairway access to above or below-grade facilities shall be provided.

53.1.1.3 Electrical

All electrical work in enclosed grit removal areas where hazardous gases may accumulate shall meet the requirements of Section 32.3.5.

53.1.2 Outside Facilities

__ Grit removal facilities located outside shall be protected from freezing by a temporary protective enclosure or other means.

53.3 Type and Number of Units

A single manually cleaned or mechanically cleaned grit chamber with a bypass is acceptable for small (under 1 MGD) sewage treatment plants serving separate sanitary sewer systems. Minimum facilities for larger (1 MGD or more) plants serving sanitary sewers should be at least one mechanically cleaned unit with a bypass. Facilities other than channel-type are acceptable if provided with adequate and flexible controls for agitation and/or air supply devices and with grit collection and removal equipment.

53.4 Design Factors

53.4.1 General

__ The design effectiveness of a grit removal system shall be commensurate with the requirements of the subsequent process units.

53.4.2 Inlet

Inlet turbulence shall be minimized.

53.4.3 Velocity and Detention

Channel-type chambers shall be designed to limit velocities during normal variations in flow as close as possible to one fps (30 cm/s). 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, and air supply.

53.4.4 Grit Washing

__ The need for grit washing should be determined by the method of final grit disposal.

53.4.5 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.

54. PREAERATION

__ Preaeration of sewage to reduce septicity may be required in special cases.

55. FLOW EQUALIZATION

55.1 General

Flow equalization can reduce the dry-weather variations in organic and hydraulic loadings at any wastewater treatment plant. It should be provided where large diurnal variations are expected.

55.2 Location

__ Equalization basins should be located downstream of pretreatment facilities such as bar screens, grinding/shredding equipment, and grit chambers.

55.3 Type

__ Flow equalization can be provided by using separate basins or on-line treatment units, such as aeration tanks. Except as provided in Section 55.7, 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 equalization basins during the early period of design life.

55.4 Size

__ Equalization basin capacity should be sufficient to effectively reduce expected flow and load variations to the extent deemed to be economically advantageous. With a diurnal flow pattern, the volume required to achieve the desired degree of equalization can be determined from a cumulative flow plot over a representative 24-hour period.

55.5 Operation

55.5.1 Mixing

__ Aeration or mechanical equipment shall be provided if necessary to maintain adequate odor control and mixing. Corner fillets and hopper bottoms with draw-offs should be provided to alleviate the accumulation of sludge and grit.

55.5.2 Aeration

Aeration equipment shall be sufficient to maintain a minimum of 1.0 mg/1 of dissolved oxygen in the mixed basin contents at all times. Air supply rates should be minimum of 1.25 cfm/1000 gallons (0.15 $1/s*m^3$) of storage capacity. The air supply should be isolated from other treatment plant aeration requirements to facilitate process aeration control, although process air supply equipment may be utilized as a source of standby aeration.

55.5.3 Controls

__ Inlets and outlets for all basin compartments shall be suitably 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 should also be provided to measure and indicate liquid levels and flow rates.

55.6 Construction and Materials

__ The basins should be side-line, not in-line.

__ All basins must comply with Section 44.4.

CHAPTER 60
SETTLING

61. GENERAL CONSIDERATIONS

61.1 Number of Units

Multiple units capable of independent operation are desirable and shall be provided in all plants where design flows exceed 100,000 gpd (379 m^3/d). Plants not having multiple units shall include other provisions to assure continuity of treatment.

61.2 Arrangement

Settling tanks shall be arranged in accordance with Section 43.5 and 62.6.

61.3 Flow Distribution

Effective flow measurement devices and control appurtenances (i.e., valves, gates, splitter boxes, etc.) shall be provided to permit proper proportion of flow to each unit.

61.4 Tank Configuration

Consideration should be given to the probable flow pattern in 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 (3 m) unless special provisions are made to prevent short circuiting. The sidewater depth for primary clarifiers shall be as shallow as practicable, but not less than 7 feet (2.1 m). Clarifiers following the activated sludge process shall have sidewater depths of at least 12 feet (3.7 m). Clarifiers following fixed film reactors shall have sidewater depth of at least 10 feet (3.0 m).

62.2 Surface Settling Rates (Overflow Rates)

62.2.1 Primary Settling Tanks

Surface settling rates for primary tanks should not exceed 1000 gpd/ft^2 (41 m^3/m^2*d) at design average flows or 1500 gpd/ft^2 (61 m^3/m^2*d) for peak hourly flows. Clarifier sizing shall be calculated for both flow conditions and the larger surface area determined shall be used. Primary settling of normal domestic sewage can be expected to remove 30% to 35% of the influent BOD. However, anticipated BOD removal for sewage containing appreciable quantities of industrial wastes (or chemical additions to be used) should be determined by laboratory tests and consideration of the quantity and character of the wastes.

62.2.2 Intermediate Settling Tanks

__ Surface settling rates for intermediate settling tanks following series units of fixed film reactor processes shall not exceed 1500 gpd/ft^2 (61 m^3/m^2*d) based on peak hourly flow.

62.2.3 Final Settling Tanks

62.2.3.1 Final Settling Tanks - Fixed Film Biological Reactors

__ Surface settling rates for settling tanks following trickling filters or rotating biological contactors shall not exceed 800 gpd/ft^2 at design average flow or 1200 gpd/ft^2 (49 m^3/m^2*d) based on peak hourly flow.

62.2.3.2 Final Settling Tanks - Activated Sludge

__ The hydraulic design of intermediate and final settling tanks following the activated sludge process shall be based upon the anticipated peak hourly rate for the areas downstream of the inlet baffle. The peak/design average hydraulic loadings shall not exceed: 1200/800 gpd/ft^2 for conventional, step aeration, contact stabilization and the carbonaceous stage of separate-stage nitrification; 1000/700 gpd/ft^2 for extended aeration; and 800/600 gpd/ft^2 for the separate nitrification stage. The solids loadings for all activated sludge processes shall not exceed 20 lb/d/ft^2 (98 kg/m^2*d) at the design average flow or 50 lb/d/ft^2 (244 kg/m^2*d) at the peak rate. Consideration should be given to flow equalization.

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 fps (0.3 m/s) at one-half the design flow. Corner pockets and dead ends should 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 Weirs

62.4.1 General

Overflow weirs shall be adjustable for leveling.

62.4.2 Location

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

62.4.3 Design Rates

__ Weir loadings should not exceed 10,000 gpd/ft (124 m^3/m*d) for plants designed for average flows of less than 1 MGD. Higher weir loadings may be used for plants designed for larger average flows, but should not exceed 15,000 gpd/ft (186 m^3/m*d). If pumping is required, weir loadings should be related to pump delivery rates to avoid short circuiting.

62.4.4 Weir Troughs

__ Weir troughs shall be designed to prevent submergence at maximum design flow, and to maintain a velocity of at least one fps (0.3 m/s) at one-half design flow.

62.5 Submerged Surfaces

__ The top of troughs, beams, and similar submerged construction elements shall have a minimum slope of 1.4 vertical to 1 horizontal; the underside of such elements should have a slope of 1 to 1 prevent the accumulation of scum and solids.

62.6 Freeboard

Walls of settling tanks shall extend at least 6 inches (15 cm) above the surrounding ground surface and shall provide not less than 12 inches (30 cm) freeboard. 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. SLUDGE AND SCUM REMOVAL

63.1 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, should 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.

63.2 Sludge Removal

63.2.1 Sludge Hopper

__ The minimum slope of the side walls shall be 1.7 vertical to 1 horizontal. 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 (0.6 m). Extra depth sludge hoppers for sludge thickening are not acceptable. Cross-collectors serving one or more settling tanks may be used in lieu of multiple sludge hoppers.

63.2.2 Sludge Removal Piping

__ Each hopper shall have an individually valved sludge withdrawal line at least six inches (15 cm) in diameter (8 inches is recommended). The static head available for withdrawal of sludge shall be 30 inches (76 cm) or greater, as necessary to maintain a three fps (0.91 m/s) 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 waste sludge to primary clarifiers.

63.2.3 Sludge Removal Control

__ 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. Air lift type of sludge removal will not be approved for removal of primary sludges. Sludge pump motor control systems shall include time clocks and valve activators for regulating the duration and sequencing of sludge removal.

64. PROTECTIVE AND SERVICE FACILITIES

64.1 Operator Protection

__ All settling tanks shall be equipped to enhance safety for operators. Such features shall appropriately include machinery covers, life lines, stairways, walkways, handrails, slip-resistant surfaces, etc. OSHA guidance shall be followed.

64.2 Mechanical Maintenance Access

The design shall provide for convenient and safe access to routine maintenance items such as gear boxes, scum removal mechanisms, baffles, weirs, inlet stilling baffle areas, effluent channels, etc.

64.3 Electrical Fixtures and Controls

__ Electrical fixtures and controls in enclosed settling basins shall meet the requirements of Section 32.3.5. 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.

CHAPTER 70
SLUDGE HANDLING AND DISPOSAL

71. DESIGN CONSIDERATIONS

71.1 Process Selection

___ The selection of sludge handling and disposal methods should include the following considerations (See Chapter 40 also). In addition to Chapter 60, only items with a – apply to drinking water sludge treatment:

a. – Energy requirements;

b. – Cost efficiency of sludge thickening and dewatering;

c. – Complexity of equipment;

d. – Staffing requirements;

e. Toxic effects of heavy metals and other substances on sludge stabilization and disposal;

f. Sludge digestion or stabilization requirements;

g. Treatment of side-stream flow such as digester and thickener supernatant;

h. – Sludge storage requirements;

i. – A backup method of sludge handling and disposal, and;

j. – Methods of ultimate sludge disposal.

72. – SLUDGE THICKENERS

As the first step of sludge handling, the need for sludge thickeners to reduce the volume of sludge should be considered. Particular attention should be given to the pumping and piping of the concentrated sludge and possible onset of anaerobic conditions in sewage sludge. Sewage sludge should be thickened to at least 5% solids prior to transmission to digesters.

73. ANAEROBIC SLUDGE DIGESTION

73.1 General

73.1.1 Multiple Units

___ Multiple tanks are recommended. Where a single digestion tank is used, an alternate method of sludge processing or emergency storage to maintain continuity of service shall be provided.

73.1.2 Depth

___ For those units proposed to serve as supernatant separation tanks, the depth should be sufficient to allow for the formation of a reasonable depth of supernatant liquor. A minimum sidewater depth of 20 feet (6.1 m) is recommended.

73.1.3 Maintenance Provisions

To facilitate draining, cleaning, and maintenance, the following features are desirable:

73.1.3.1 Slope

The tank bottom should slope to drain toward the withdrawal pipe. For tanks equipped with a suction mechanism for withdrawal of sludge, a bottom slope not less than 1:12 is recommended. Where the sludge is to be removed by gravity alone, 1:4 slope is recommended.

73.1.3.2 Access Manholes

___ At least two 36 inch (91 cm) 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.

73.2 Sludge Inlets and Outlets

___ Multiple recirculation withdrawal and return points, to enhance flexible operation and effective mixing, should be provided, unless mixing facilities are incorporated within the digester. The returns, in order to assist in scum breakup, should discharge above the liquid level and be located near the center of the tank.

Raw sludge discharge to the digester should be through the sludge heater and recirculation return piping, or directly to the tank if internal mixing facilities are provided.

___ Sludge withdrawal to disposal should be from the bottom of the tank. This pipe should be interconnected with the recirculation piping to increase versatility in mixing the tank contents, if such piping is provided.

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

73.3 Tank Capacity

The total digestion tank capacity should be determined by rational calculations based upon such factors as volume of sludge added, its percent solids and character, the temperature to be maintained in the digesters, the degree of extent of mixing to be obtained, and the degree of volatile solids reduction required. Calculations should be submitted to justify the basis of design.

When such calculations are not based on the above factors, the minimum combined digestion tank capacity outlined below will be required. Such requirements assume that a raw sludge is derived from ordinary domestic wastewater, that a digestion temperature is to be maintained in the range of 90E to 100EF (32EC to 38EC), that 40% to 50% volatile matter will be maintained in the digested sludge, and that the digested sludge will be removed frequently from the system.

73.3.1 Completely-Mixed Systems

Completely-mixed systems shall provide for intimate and effective mixing to prevent stratification and to assure homogeneity to digester content. The system may be loaded at a rate up to 80 pounds of volatile solids per 1,000 ft^3 per day (1.28 kg/m^3*d) in the active digestion units. When grit removal facilities are not provided, the reduction of digester volume due to grit accumulation should be considered. (Complete mixing can be accomplished only with substantial energy input.)

73.3.2 Moderately-Mixed Systems

For 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 40 pounds of volatile solids per 1,000 ft^3 per day (0.64 kg/m^3*d) in the active digestion units. This loading may be modified upward or downward depending upon the degree of mixing provided.

73.4 Gas Collection, Piping, and Appurtenances

73.4.1 General

All portions of the gas system shall be designed so 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.

73.4.2 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. Water seal equipment shall not be installed. Gas safety equipment and gas compressors should be housed in a separate room with an exterior entrance.

73.4.3 Gas Piping and Condensate

__ Gas piping shall be of adequate diameter and shall slope to condensate traps at low points. The use of float-controlled condensate traps is not permitted.

73.4.4 Gas Utilization Equipment

__ Gas-fired boilers for heating digesters shall be located in a separate room not connected to the digester gallery. Such separate rooms would not ordinarily be classified as a hazardous location. Gas lines to these units shall be provided with suitable flame traps.

73.4.5 Electrical Fixtures

Electrical fixtures and controls, in places enclosing anaerobic digestion appurtenances, where hazardous gases are normally contained in the tanks and piping, shall comply with Section 32.3.5. Digester galleries should be isolated from normal operating areas, in accordance with Section 73.4.7, to avoid an extension of the hazardous location.

73.4.6 Waste Gas

__ Waste gas burners shall be readily accessible and should be located at least 50 feet (15.2 m) away from any plant structure if placed at ground level, or may be located on the roof of the control building if sufficiently removed from the tank.

__ 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.

__ 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 (3.0 m) above the ground surface, provided that the assembly incorporate a flame trap.

73.4.7 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 Section 32.7.2. The piping gallery for digesters should not be connected to other passages. Where used, tightly fitting, self-closing doors should be provided at connecting passageways and tunnels to minimize the spread of gas.

73.4.8 Meter

__ A gas meter with bypass should be provided to meter total gas production.

73.5 Digester Heating

73.5.1 Insulation

__ Wherever possible digestion tanks should be suitably insulated to minimize heat loss.

73.5.2. External Heating

__ Piping shall be designed to provide for the preheating of feed sludge before introduction to the digesters. Provisions shall be made in the layout of the piping and valving to facilitate cleaning of these lines. Heat exchanger sludge piping should be sized for heat transfer requirements.

73.5.3 Heating Capacity

__ Heating capacity sufficient to consistently maintain the design sludge temperature shall be provided. Where digester tank gas is used for sludge heating, and auxiliary fuel supply is required.

73.5.4 Hot Water Internal Heating Controls

73.5.4.1 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 jacket can be held below a temperature at which caking will be accentuated.

__ Manual control should also be provided by suitable bypass valves.

73.5.4.2 Boiler Controls

__ The boiler should be provided with suitable automatic controls to maintain the boiler temperature at approximately 180EF (82EC) 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.

73.5.4.3 Thermometers

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

73.6 Supernatant Withdrawal

73.6.1 Piping Size

__ Supernatant piping should not be less than 6 inches (15.2 cm) in diameter.

73.6.2 Withdrawal Arrangements

73.6.2.1 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.

73.6.2.2 Supernatant Selector

__ If a supernatant selector is provided, provisions shall be made for at least one other drawoff level located in the supernatant zone of the tank in addition to the unvalved emergency supernatant drawoff pipe. High pressure backwash facilities shall be provided.

73.6.3 Sampling

__ Provisions should be made for sampling at each supernatant drawoff level. Sampling pipes should be at least 1.5 inches (3.81 cm) in diameter, and should terminate at a suitably-sized sampling sink or basin.

73.6.4 Alternate Supernatant Disposal

__ Consideration should be given to supernatant conditioning, where appropriate, in relation to its effect on plant performance and effluent quality.

74. AEROBIC SLUDGE DIGESTION

74.1 Mixing and Air Requirements

__ Aerobic sludge digestion tanks shall be designed for effective mixing by satisfactory aeration equipment. Sufficient air shall be provided to keep the solids in suspensions and maintain dissolved oxygen between 1 and 2 mg/1. A minimum mixing and oxygen requirement of 30 cfm/1,000 ft^3 of tank volume (0.50 1/s*m^3) shall be provided with the largest blower out of service. If diffusers are used, the nonclog type is recommended, and they should be designed to permit continuity of service. If mechanical aerator are utilized, a minimum of 1.0 hp/1,000 ft^3 (26.3 W/m^3) should be provided. Use of mechanical equipment is discouraged where freezing temperatures are normally expected.

74.2 Tanks

__ 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. 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.

74.2.1 Volatile Solids Loading

It is recommended that the volatile suspended solids loading not exceed 100 lb/1,000 ft^3 of volume per day (1.60 kg/m^3*d) in the digestion units. Lower loading rates may be necessary depending on temperature, type of sludge, and other factors.

74.2.2 Solids Retention Time

Required minimum solids retention time for stabilization of biological sludges vary depending on 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 50EF (10EC), additional detention time should be considered.

74.3 Supernatant Separation

Facilities shall be provided for separation and withdrawal of supernatant and for collection and removal of scum and grease.

75.– SLUDGE PUMPS AND PIPING

75.1 SLUDGE PUMPS

75.1.1 Duplicate Units

Duplicate units shall be provided where failure of one unit would seriously hamper plant operation.

75.1.2 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 plunger-type pump should be provided as an alternate to increase reliability of centrifugal pump. Provision for varying pump capacity is desirable.

75.1.3 Minimum Head

A minimum positive head of 24 inches (61 cm) 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 (3.0 m) for plunger pumps.

75.1.4 Sampling Facilities

__ Unless sludge sampling facilities are otherwise provided, quick-closing sampling valves shall be installed at the sludge pumps. The size of valve and piping should be at least 1.5 inches (3.81 cm).

__ – Sampling facilities and flow metering should be provided on any discharge outfall line.

75.2 Sludge Piping

75.2.1 Size and Head

Sludge withdrawal piping should have a minimum diameter of 8 inches (20.3 cm) for gravity withdrawal and 6 inches (15.2 cm) 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 2 fps (0.61 m/s) velocity.

75.2.2 Slope

__ Gravity piping should be laid on uniform grade and alignment. The slope of gravity discharge piping should not be less than 3%. Provisions should be made for cleaning, draining, and flushing discharge lines.

75.2.3 Supports

__ Special consideration should be given to the corrosion resistance and continuing stability of supporting systems located inside the digestion tank.

76. – SLUDGE DEWATERING

76.1 Sludge Drying Beds

76.1.1 Area

__ In general, the sizing of the drying bed may be estimated on the basis of 2.0 ft^2/capita (0.19 m^2/capita) when the drying bed is the primary method of dewatering, and 1.0 ft^2/capita (0.09 m^2/capita) if it is to be used as a backup dewatering unit. An increase of bed area by 25% is recommended for paved beds.

76.1.2 Percolation Type

__ The lower course of gravel around the underdrains should be properly graded and should be 12 inches (30.5 cm) in depth, extending at least 6 inches (15.2 cm) 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 (7.6 cm) should consist of gravel 1/8 inch to 1/4 inch (3.18 to 6.35 mm) in size. Artificial media beds are also allowable.

76.1.2.1 Sand

The top course should consist of 6 to 9 inches (15.2 to 22.9 cm) of clean coarse sand. The finished sand surface should be level.

76.1.2.2 Underdrains

Underdrains should be pipe or drain tile at least 4 inches (10.2 cm) in diameter laid with open joints. Underdrains should be spaced not more than 20 feet (6.1 m) apart. The disposal of the underdrain filtrate is covered in Section 76.3.

76.1.3 Partially Paved Type

The partially paved drying bed should be designed with consideration for space requirement to operate mechanical equipment for removing the dried sludge.

76.1.4 Walls

Walls should be watertight and extend 15 to 18 inches (38 to 46 cm) above and at least 6 inches (15 cm) below the surface. Outer walls should be curbed to prevent soil from washing onto the beds.

76.1.5 Sludge Removal

No fewer than two beds should be provided and they should be arranged to facilitate sludge removal. Concrete truck tracks should be provided for all percolation-type sludge beds.

76.1.6 Sludge Influent

The sludge pipe to the drying beds should terminate at least 12 inches (30.5 cm) above the surface and be so arranged that it will drain. Concrete splash plates for percolation-type beds should be provided at sludge discharge points.

76.2 Mechanical Dewatering Facilities

The number of mechanical dewatering facilities should be sufficient to dewater the sludge produced with one largest unit out of service. Unless other standby facilities are available, adequate storage facilities shall be provided. The storage capacity should be sufficient to handle at least three-month sludge production.

76.2.1 Auxiliary Facilities for Vacuum Filters

A back-up vacuum pump and filtrate pump shall be installed for each vacuum filter. It is permissible to have an uninstalled back-up vacuum pump or filtrate pump for every three or fewer vacuum filters, provided that the installed unit can easily be removed and replaced. At least one filter media replacement unit shall be provided.

76.2.2 Ventilation

___ Adequate facilities shall be provided for ventilation of dewatering area. For sewage sludges, the exhaust air should be properly conditioned to avoid odor nuisance.

76.2.3 Chemical Handling Enclosures

Lime-mixing facilities should be completely enclosed to prevent the escape of lime dust. Chemical handling equipment should be automated to eliminate the manual lifting requirement.

___ Polymer handling (for drinking water sludges) - see Sections 47.1.2, 47.1.3, and 47.1.8.

76.3 Drainage and Filtrate Disposal

___ Drainage from beds of filtrate from sludge dewatering units shall be returned to the sewage treatment or sludge handling process at appropriate points.

76.4 Other Dewatering Facilities

If it is proposed to dewater or dispose of sludge by other methods, a detailed description of the process and design data shall accompany the plans in accordance with Section 43.2.

77. MUNICIPAL SLUDGE DISPOSAL ON LAND

___ Sludge to be applied to land must meet the requirement of 40 CFR 257 and 40 CFR 503, including treatment to provide PSRP (Process to Significantly Reduce Pathogens). Plans which include land application of sludge must be forwarded to the OPC Non-Hazardous Waste Branch or EPD, as appropriate, for review.

78.– SLUDGE LAGOONS

a. Section 44.4 shall apply to sludge lagoons.

___ b. Sludge lagoons should not be used for high pH sludge.

c. A sludge storage time of at least 10 years is recommended. Shorter times may be approved, but a plan for ultimate sludge disposal shall be presented in either case.

___ d. There shall be no discharge of sludge lagoon supernatant to the environment. All supernatant shall be discharged to the WWTP upstream of the major biological treatment process.

__ e. For sewage sludges, provisions must be made to prevent odors. Aeration is recommended.

79. OTHER SLUDGE DISPOSAL METHODS

__ When other sludge, disposal methods, such as incineration or landfill are considered, pertinent requirements from the Department shall be followed.

CHAPTER 80
BIOLOGICAL TREATMENT

81. TRICKLING FILTERS

81.1 General

Trickling filters shall be preceded by effective settling tanks equipped with scum and grease collecting devices, or other suitable pretreatment facilities.

81.2 Hydraulics

81.2.1 Distribution

81.2.1.1 Uniformity

The sewage may be distributed over the filter by rotary distributors or other suitable devices which will ensure uniform distribution to the surface area.

81.2.1.2 Head Requirements

For reaction type distributors, a minimum head of 24 inches (61 cm) between low water level in the siphon chamber and center of the arms is required. Similar allowance in design shall be provided for added pumping head requirements where pumping to the reaction type distributor is used.

81.2.1.3 Clearance

A minimum clearance of 6 inches (15 cm) between media and distributor arms shall be provided. Greater clearance is essential where icing may occur.

81.2.2 Dosing

Sewage 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 sewage shall be practically continuous. The piping system shall be designed for recirculation.

81.2.3 Loading Rates

Hydraulic loading rates for trickling filters shall range from 25-100 gpd/ft^2 for low-rate filters, 100-1000 gpd/ft^2 for high-rate filters, and 700-3000 gpd/ft^2 for roughing filters.

Organic (BOD_5) loading rates shall range from 5-25 lb/d/1000 ft^3 for low- rate filters, 25-100 lb/d/1000 ft^3 for high-rate filters, and may exceed 100 lbs/day/1000 ft^3 for roughing filters.

81.2.4 Piping System

The piping system, including dosing equipment and distributor, shall be designed to provide capacity for the peak hourly flow rate, including recirculation required under Section 81.5.5.

81.3 Media

81.3.1 Quality

The media may be crushed rock, slag, or specially manufactured material. The media shall be durable, resistant to spalling or flaking and relatively insoluble in sewage. The top 18 inches (46 cm) should have a loss by the 20-cycle, sodium sulfate soundness test of not more than 10%, as prescribed by ASCE Manual of Engineering Practice, Number 13. The balance should pass a 10-cycle test using the same criteria. Slag media shall be free from iron. 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.

81.3.2 Depth

Rock and/or slag filter media shall have a minimum depth of 5 feet (1.5 m) above the underdrains. Manufactured filter media should have a minimum depth of 10 feet (3 m) to provide adequate contact time with the wastewater. Rock and/or slag filter media depths shall not exceed 10 feet (3 m) and manufactured filter media depths shall not exceed 30 feet (9.1 m) except where special construction is justified through extensive pilot studies.

81.3.3 Size and Grading of Media

81.3.3.1 Rock, Slag and Similar Media

Rock, slag and similar media shall not contain more than 5% by weight of pieces whose longest dimension is three times the least dimension. It 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 4½ inch (11.4 cm) screen - 100% by weight
Retained on 3 inch (7.6 cm) screen - 95-100% by weight
Passing 2 inch (5.1 cm) screen - 0-2% by weight
Passing 1 inch (2.5 cm) screen - 0-1% by weight

81.3.3.2 Manufactured Media

Suitability will be evaluated on the basis of experience with installations handling similar wastes and loadings in accordance with Section 43.2.

81.3.3.3 Handling and Placing of Media

Material delivered to the filter site shall be stored on wood-planked or other approved clean, hard-surfaced areas. All material shall be rehandled at the filter site and not material shall be dumped directly into the filter. Crushed rock, slag and similar media shall be placed by hand to a depth of 12 inches (30 cm) above the title underdrains. 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 manufacturer. Trucks, tractors, and other heavy equipment shall not be driven over the filter during or after construction.

81.4 Underdrainage System

81.4.1 Arrangement

Underdrains with semicircular 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% of the surface area of the filter.

81.4.2 Hydraulic Capacity and Ventilation

The underdrains shall have a minimum slope of 1%. Effluent channels shall be designed to produce a minimum velocity of 2 fps (0.61 m/s) at average daily rates of application to the filter including recirculated flows.

The underdrainage system, effluent channels, and effluent pipe shall be designed to permit free passage of air. The size of drains, channels, and pipe should be such that not more than 50% of their cross-sectional area will be submerged under the design peak hydraulic loading, including proposed or possible future recirculated flows. Consideration shall be given to the use of forced ventilation, particularly for covered filters and deep manufactured media filters.

81.4.3 Flushing

Provision should be made for flushing the underdrains. In small filters, use of peripheral head channel with vertical vents is acceptable for flushing purposes. Inspection facilities should be provided.

81.5 Special Features

81.5.1 Flooding

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

81.5.2 Freeboard

A freeboard of 4 feet (1.2 m) or more should be provided for tall, manufactured media filters to maximize the containment of windblown spray. Otherwise, the freeboard shall be at least 18 inches. In all cases, the freeboard should rise above the top of the distribution arms.

81.5.3 Maintenance

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

81.5.4 Winter Protection

__ Adequate protection such as covers (in severe climate) or windbreaks (in moderate climate) shall be provided to maintain operation and treatment efficiencies when climatic conditions are expected to result in problems due to cold temperatures.

81.5.5 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. The recirculation ratio (R/Q) should be between 0.4 and 4.0. At least two (2) recirculation pumps shall be provided.

81.5.6 Recirculation Measurement

Devices shall be provided to permit measurement of the recirculation rate. Time lapse meters and pump head recording devices are acceptable for facilities treating less than 1 MGD (3785 m^3/d).

81.6 Rotary Distributor Seals

__ Mercury seals shall not be used. Ease of seal replacement shall be considered in the design to ensure continuity of operation.

81.7 Multi-Stage Filters

The foregoing standards also apply to multi-stage filters.

81.8 Unit Sizing

Required volumes of media filters shall be based upon pilot testing in accordance with Section 43.2 with the particular wastewater and media or any of the various empirical design equations that have been verified through actual full scale experience.

81.9 Design Safety Factors

__ Trickling filters are affected by diurnal load conditions. The volume of media 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 average rate. An alternative is flow equalization.

82. ACTIVATED SLUDGE

82.1 Flexibility

All designs shall provide for flexibility in operation. Plants over 1 MGD (3785 m^3/d) shall be designed to facilitate easy conversion to various operation modes.

82.2 Pretreatment

__ Where primary settling tanks are not used, effective removal or exclusion of grit, debris, excessive oil or grease, and grinding/shredding or screening of solids should be accomplished prior to the activated sludge process. Grit removal and grinding/shredding are not required with SDG or STEP collection systems.

__ Where primary settling is used, provision shall be made for discharging raw sewage 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

82.3.1 Capacities and Permissible Loadings

__ 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 operational plants. Mixed liquor suspended solids levels greater than 5000 mg/1 may be allowed, providing adequate data is submitted showing the aeration and clarification system 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; alternatively, the ranges given in Metcalf and Eddy or WPCF MOP 8 may 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 appropriate reviewing agency as justification to approve organic loading rates that exceed those specified in the table.

Permissible Aeration Tank Capacities and Loadings

Process	Aeration Tank Organic Loading - lb. BOD_5/day per 1000 ft^3	F/M Ratio lb. BOD_5/day per lb. MLVSS	MLSS+ mg/liter
Conventional Step Aeration Complete Mix	40	0.2-0.5	1000-3000
Contact Stabilization	50++	0.2-0.6	1000-3000
Extended Aeration Oxidation Ditch	15	0.05-0.1	3000- 5000

+MLSS values are dependent upon the surface area provided for sedimentation and the rate of sludge return as well as the aeration process.

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

82.3.2 Arrangement of Aeration Tanks

82.3.2.1 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 (3 m) or more than 30 feet (9 m) except in special design cases.

b. Short-circuiting

__ The shape of the tank and the installation of aeration equipment should provide for positive control of short-circuiting through the tank.

82.3.2.2 Number of Units

__ Total aeration tank volume should be divided among two or more units, capable of independent operation.

82.3.2.3 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 flow control to any unit and to maintain a reasonably constant liquid level. The hydraulic properties of the system shall permit the maximum instantaneous hydraulic load 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.

82.3.2.4 Freeboard

All aeration tanks shall have a freeboard of not less than 18 inches (46 cm). Additional freeboard or windbreak may be necessary to protect against freezing or windblown spray.

82.3.3 Aeration Equipment

82.3.3.1 General

Aeration equipment shall be capable of maintaining a minimum of 2.0 mg/1 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 should be at least 1.1 lb O_2/lb. peak BOD_5 applied to the aeration tanks (1.1kg O_2/kg peak BOD_5), with the exception of the extended aeration process, for which the value should be at least 1.5.

In the case of nitrification, the oxygen requirement for oxidizing ammonia must be added to the above requirement for carbonaceous BOD removal. The nitrogen oxygen demand (NOD) should be taken as 4.6 times the diurnal peak TKN content of the influent. Also, the oxygen demands due to recycle flows - heat treatment supernatant, vacuum filtrate, elutriates, etc. - must be considered due to high concentrations of BOD and TKN associated with such flows.

Unless flow equalization is provided, the aeration system should be designed to match the diurnal organic load variation while economizing on power input.

82.3.3.2 Diffused Air Systems

The design of diffused air system to provide the oxygen requirements shall be done by either of the two methods described below in (a) and (b), augmented as required by consideration of items (c) through (k):

___ a. Having determined the oxygen requirements per Section 82.3.3.1, air requirements for a diffused air system shall be determined by use of any of the well known equations incorporating such factors as:

1. Tank depth;
2. Alpha factor of waste;
3. Beta factor of waste;
4. Certified aeration device transfer efficiency;
5. Minimum aeration tank dissolved oxygen concentrations;
6. Critical wastewater temperature; and
7. Altitude of plant.

___ In the absence of experimentally determined alpha and beta factors, wastewater transfer efficiency shall be assumed to be 50% of clean water efficiency for plants treating primarily (90% or greater) domestic sewage. 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.

___ b. Normal air requirements for all activated sludge processes except extended aeration (assuming equipment capable of transmitting to the mixed liquor the amount of oxygen required in Section 82.3.3.1) shall be considered to be 1500 ft^3/lb BOD_5 peak aeration tank loading (93.5 m^3/kg BOD_5). For the extended aeration process the value shall be 2050 ft^3 (125 m^3).

___ c. To the air requirements calculated above shall be added air required for channels, pumps, 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 40EC (104EF) 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 -18EC (0EF) 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. 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. Aeration equipment shall be easily adjustable in increments and shall maintain solids suspension within these limits.

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

___ g. Air piping systems should be designed such that total head loss from blower outlet (or silencer outlet where used) to the diffuser inlet does not exceed 0.5 psi (0.04 kgf/cm^2) at average operating conditions.

___ h. 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.

___ i. All plants employing fewer than four independent aeration tanks shall be designed to incorporate removable diffusers that can be serviced and/or replaced without dewatering the tank.

___ j. 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.

___ k. 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.

82.3.3.3 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 testing shall verify mechanical aerator performance.

b. Design Requirements

The design requirements of a mechanical aeration system shall accomplish the following:

___ 1. Maintain a minimum of 2.0 mg/1 of dissolved oxygen in the mixed liquor at all times throughout the tank or basin;

___ 2. Maintain all biological solid in suspension;

___ 3. Meet maximum oxygen demand and maintain process performance with the largest unit out of service; and

4. Provide for varying the amount of oxygen transferred in proportion to the load demand on the plant.

82.4 Return Sludge Equipment

82.4.1 Return Sludge Rate

__ The rate of sludge return expressed as a percentage of the design average flow of sewage should generally be variable between the limits set forth as follows:

	% DAF	
	Minimum	Maximum
Standard Rate	15	75
Carbonaceous Stage of Separate Stage Nitrification	15	75
Step Aeration	15	75
Contact Stabilization	50	150
Extended Aeration	50	150
Nitrification Stage of Separate Stage Nitrification	50	200

__ The rate of sludge return shall be variable to pump sludge at the above rates.

82.4.2 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 suctions. Pumps should have at least 3 inch (7.6 cm) suction and discharge openings.

If air lifts are used for returning sludge from each settling tank hopper, no standby unit will be required provided the design of the air lifts are such to facilitate their rapid and easy cleaning and provided other suitable standby measures are provided. Air lifts should be at least 3 inches (7.6 cm) in diameter.

82.4.3 Return Sludge Piping

__ Discharge piping should be at least 6 inches (15.2 cm) in diameter and should be designed to maintain a velocity of not less than 2 fps (0.61 m/s) when return sludge facilities are operating at normal return sludge rates. Suitable devices for observing, measuring, sampling and controlling return activated sludge flow from each settling tank hopper shall be provided, as outlined in Section 63.2.3.

82.4.4 Waste Sludge Facilities

__ Waste sludge control facilities should have a maximum capacity of not less than 25% of the average rate of sewage flow and function satisfactorily at rates of 0.5% of average sewage flow or a minimum of 10 gpm (0.63 l/s), 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.

83. ROTATING BIOLOGICAL CONTACTORS

83.1 General

Design standards, operating data and experience for the Rotating Biological Contactor (RBC) process are not well established. Therefore, expected performance of RBCs shall be based upon experience at similar full scale installations or thoroughly documented pilot testing with the particular wastewater.

83.2 Required Pretreatment

__ RBCs must be preceded by effective settling tanks equipped with scum and grease collecting devices unless substantial justification is submitted for other pretreatment devices which provide for effective removal of grits, debris, and excessive oil or grease prior to the RBC units. Bar screening/grinding/shredding are not suitable as the sole means of pretreatment.

83.3 Unit Sizing

__ Unit sizing shall be based on experience at similar full-scale installations or thoroughly documented pilot testing with the particular wastewater. In determining design loading rates, expressed in units of volume per day per unit area of media covered by biological growth, the following parameters must be considered:

a. Design flow rate and influent waste strength;

b. Percentage of BOD to be removed;

c. Media arrangement, including number of stages and unit area in each stage;

d. Rotational velocity of the media;

e. Retention time within the tank containing the media;

f. Wastewater temperature; and

g. Percentage of influent BOD which is soluble.

In addition to the above parameters, loading rates for nitrification will depend upon influent total kjeldahl nitrogen (TKN), pH, and the allowable effluent ammonia nitrogen concentration.

83.4 Design Safety Factor

Effluent concentrations of ammonia nitrogen from the RBC process designed for nitrification are affected by diurnal load variations. Therefore, it may be necessary to increase the design surface area proportional to the ammonia nitrogen diurnal peaking rates to meet effluent limitations. An alternative is to provide flow equalization sufficient to insure process performance within the required effluent limitations.

CHAPTER 90
DISINFECTION

91. FORMS OF DISINFECTION

Chlorine is the most commonly used chemical for wastewater disinfection. The forms most often used are liquid (gas) chlorine, solid powdered calcium hypochlorite and liquid sodium hypochlorite. Moist chlorine gas is very corrosive, an irritant, causes blistering, and will support combustion. Calcium hypochlorite is a corrosive and rapid oxidant, unstable and combustible. It may react explosively with common substances, such as petroleum products. It is typically used in strengths of 60% to 65%. It may emit chlorine gas. Sodium hypochlorite is an unstable corrosive, typically used in strengths of 5 **3**% to 15%. It may also emit chlorine gas. Other disinfectants, including chlorine dioxide, ozone, bromine, or ultraviolet disinfection may be accepted by the Department in individual cases. If chlorination is utilized, it may be necessary to dechlorinate in order to meet the effluent permit limits.

92. FEED EQUIPMENT

92.1 Type

Solution-feed vacuum-type chlorinators are generally preferred for large chlorination installations. The use of tablet chlorinators may be considered and are generally preferred when disinfection at smaller facilities is required. The preferred method of generation of chlorine dioxide is the injection of a sodium hypochlorite solution into the discharge line of a solution-feed gas-type chlorinator.

Ozone dissolution is accomplished through the use of conventional gas diffusion equipment, with appropriate consideration of materials. If ozone is being produced from air, rather than oxygen, gas preparation equipment (driers, filters, compressors) is required.

92.2 Capacity

For normal domestic sewage, the following may be used as guide in sizing chlorination facilities.

Type of Treatment	Dosage
Trickling filter plant effluent	10 mg/1
Activated sludge plant effluent	8 mg/1
Tertiary filtration effluent	6 mg/1
Nitrified effluent	6 mg/1

92.3 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.

92.4 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, and, when necessary, standby power as well. Protection of a potable supply shall conform to the requirements of Section 46.2.

93. CHLORINE SUPPLY

93.1 Containers

___ The use of ton containers should be considered where the average daily chlorine consumption is over 150 pounds (68 kg).

___ In all cases, all chlorine bottles or containers shall always be properly chained or secured and supported to prevent movement, accidents, and leaks.

93.2 Tank Cars

___ At large chlorination installations, consideration should be given to the use of tank cars, generally accompanied by evaporators. Liquid chlorine lines from tank cars to evaporators shall be buried and installed in a conduit and shall not enter below-grade spaces. Systems shall be designed for the shortest possible pipe transportation of liquid chlorine.

93.3 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. At least a platform scale shall be provided. Scales shall be of corrosion-resistant material.

93.4 Evaporators

Where manifolding of several cylinders or ton containers will be required to evaporate sufficient chlorine, consideration should be given to the installation of evaporators to produce the quantity of gas required.

93.5 Leak Detection and Controls for Gas Systems

___ A bottle of 56% 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 the provision of caustic soda solution reaction tanks for absorbing the contents of leaking containers. At large chlorination installations, consideration should be given to the installation of automatic gas detection and related alarm equipment. For ozone installations, similar purpose equipment shall be provided.

94. OZONE GENERATION

__ Ozone may be produced from either an air or an oxygen gas source. Generation units shall be automatically controlled to adjust ozone production to meet disinfection requirements.

95. PIPING AND CONNECTIONS

__ Piping systems should be as simple as possible, specifically selected and manufactured to be suitable for corrosive chlorine or ozone service. Piping should be well supported and protected against temperature extremes.

__ All lines designed to handle dry chlorine shall be protected from the entrance of water or air containing water. Low pressure lines made of hard rubber, saran-lined, rubber-lined, polyethylene, polyvinyl chloride (PVC), or Uscolite materials are satisfactory for wet chlorine or aqueous solutions of chlorine.

For ozonation systems, copper or aluminum alloys should be avoided. Only materials at least as corrosion-resistant to ozone as Grade 304 L stainless steel should be specified for piping containing ozone in nonsubmerged applications. Unplasticized PVC, Type I, may be used in submerged piping, provided the gas temperature is below 140EF (60EC) and the gas pressure is low.

96. HOUSING

96.1 Separation

__ If gas chlorination equipment, chlorine cylinders or ozone generation equipment are to be in a building used for other purposes, a gas-tight room shall separate this equipment from any other portion of the building. 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. Such rooms shall be at ground level, and should permit easy access to all equipment. Storage area should be separated from the feed area. Chlorination equipment should be situated as closed to the application point as reasonably possible.

96.2 Inspection Window

__ A clear glass, gas-tight, window shall be installed in an exterior door or interior wall of the chlorinator or ozone generator room to permit the units to be viewed without entering the room.

96.3 Heat

Rooms containing disinfection equipment shall be provided with a means of heating so that a temperature of at least 60EF (16EC) can be maintained. The room should be protected from excess heat. Cylinders shall be kept at essentially room temperature. The room containing the ozone generation units shall be maintained above 35EF (2EC) at all times.

96.4 Ventilation

__ With chlorination systems, forced mechanical ventilation shall be installed which will provide one complete air change per minute when the room is occupied. For ozonation systems, continuous ventilation to provide at least 6 complete air changes per hour should be installed. The entrance to the air exhaust duct 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 with air and at such temperature that will not adversely affect the chlorination or ozone generation equipment. The vent hose from the chlorinator shall discharge to the outside atmosphere above grade.

96.5 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 point.

97. 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. 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.

98. APPLICATION OF CHLORINE OR OZONE

98.1 Mixing

__ The disinfectant shall be positively mixed as rapidly as possible, with a complete mix being effected in 3 seconds. This may be accomplished by the use of turbulent flow regime, a mechanical flash mixer, or diffused post-aeration.

98.2 Contact Period

__ For a chlorination system, a minimum contact period of 15 minutes at peak hourly flow or maximum rate of pumpage shall be provided after thorough mixing. If dechlorination is required, no contact time is necessary after complete mixing (30 seconds, minimum) of the effluent with the chemical. The required contact time for an ozonation unit varies with the type of dissolving equipment used.

98.3 Contact Tank

__ The chlorine or ozone contact tank shall be constructed so as to reduce short-circuiting of flow to a practical minimum. "Over-and-under" or "around-end" baffling shall be provided to minimize short-circuiting.

__ The tank should 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. Covered tanks are discouraged.

99. EVALUATION OF EFFECTIVENESS

99.1 Sampling

__ Facilities shall be included for sampling the disinfected effluent after contact. In large installations, or where stream conditions warrant, provision should be made for continuous monitoring of effluent residual.

99.2 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 installations.

99A. DECHLORINATION

Dechlorination may be accomplished using sulfur dioxide (SO_2) or other chemicals.

__ There must be no possibility of contact between chlorine gas and sulfur dioxide gas.

__ The housing requirements are generally the same as the chlorine (Section 96). The dechlorination system should be in a separate building from the chlorination system. If in the same building, the chlorination and dechlorination systems shall be in separate gas-tight rooms.

__ If any valves, fittings, pressure gauges, etc. will fit both the chlorination and dechlorination systems, they shall be color coded to prevent cross connections. Preferably, fittings, gauges, etc. will be sized or reverse threaded such that cross connections are impossible.

__ Respiratory equipment shall be available as described in Section 97.

__ Facilities that dechlorinate shall post-aerate as described in Section 115.

99B. ULTRAVIOLET DISINFECTION

99B.1 Introduction

__ Ultraviolet light can effectively disinfect wastewater which has low suspended solids level. Ultraviolet light shall not be used to disinfect wastewater which has a suspended solids level higher than 30 mg/1 and should not be used to disinfect wastewater which has a suspended solids level higher than 15 mg/l.

99B.2 References

__ Ultraviolet disinfection systems shall be designed according to:

a. Wastewater Disinfection (1986)

Water Pollution Control Federation Manual of Practice FD-10.

b. Municipal Wastewater Disinfection (1986) EPA/625/1-86-021

c. Other appropriate references.

CHAPTER 100
WASTEWATER TREATMENT PONDS (LAGOONS)

100. GENERAL

This Chapter deals with generally used variations of treatment ponds to achieve secondary treatment including controlled-discharge, flow-through and aerated pond systems.

101. SUPPLEMENT TO 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.

101.1 Supplementary Field Survey Data

101.1.1 Location of Nearby Facilities

__ The location and direction of all residential areas, commercial developments, parks, and recreational areas shall be included in the engineer's report.

101.1.2 Site Description

__ 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 and/or increased waste loadings in determining land requirements.

101.1.3 Location of Field Tile

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

101.1.4 Soil/Groundwater Study

__ Considering the leakage requirement set forth in Section 104.2.2.1, a soil/groundwater evaluation must be included for newly constructed facilities and additions to such facilities already in place. This does not apply to basins formed with fiberglass, concrete, etc., nor to existing earthen facilities not being enlarged or deepened.

101.1.4.1 Liner Proposed

Where a liner such as bentonite or synthetic material is proposed to meet the leakage limit, the soil/groundwater study may be limited to the following:

a. A general review of the local geology, hydrology, and current and potential groundwater resources, including information from published literature (soil maps and cross sections, etc.) and applicable files and databases at the USGS and the DEQ.

b. A brief description of the proposed liner (material type, thickness, hydraulic conductivity, etc.).

c. A statement that with the proposed liner the leakage limit will not be exceeded.

101.1.4.2 Liner Determined Unnecessary

Where a liner is determined in the report to be unnecessary to meet the leakage limit due to the characteristics of in-situ material, the soil/groundwater study must include the following:

a. The information listed in Section 101.1.4.1.a.

b. A USGS topographic map (1:24,000 scale) with the project site and a one mile radius area of review denoted. The location and depth of all recorded water wells within the area of review must be shown. An effort must be made to determine if residences within the area of review have private wells that may not be listed on inventories maintained at the Office of Land and Water Resources (OLWR) or the USGS.

c. Soil borings of sufficient depth and number to characterize the soil/groundwater conditions below the planned excavation and to demonstrate that an in-situ competent liner is present. These borings must be continuous and extend to a depth of 25 feet below the bottom of the impoundment. Permeability tests (either lab or field) must be conducted on undisturbed samples taken from the interval that will serve as the natural liner. ASTM procedures or acceptable similar methods should be followed for all tests. The table below specifies the minimum number of borings and permeability tests based on impoundment size.

Impoundment Acreage	Minimum # Borings	Minimum # Perm. Tests
$\leq$10	5	3
>10 to 20	7	4
>20 to 30	10	5
>30	15	7

If a shallow aquifer is encountered, groundwater levels from at least 3 temporary piezometers must be monitored to determine flow direction and rate.

Boring logs and cross-sections showing thickness, lateral continuity, and lithology should be submitted as part of the study.

d. Well drillers' logs (available from OLWR) and geophysical logs (available from the

USGS and the Office of Geology) for the water wells within the one-mile radius area of review. Information to be included with the logs are identification number, location, date drilled, depth, use, pumping rate, casing size and screen length.

e. A statement that given the documented conditions the leakage limit will not be exceeded.

102. LOCATION

102.1 Surface Runoff

__ Location of ponds in watersheds receiving significant amounts of stormwater runoff is discouraged. Adequate provision must be made to divert stormwater runoff around the ponds and protect pond embankments from erosion.

102.2 Hydrology

Construction of ponds in close proximity to water supplies and other facilities subject to contamination should be avoided. A minimum separation of 4 feet (1.2 m) between the bottom of the pond and the maximum groundwater elevation should be maintained.

102.3 Geology

__ A minimum separation of 10 feet (3.0 m) between the pond bottom and any bedrock formation is recommended.

103. BASIS OF DESIGN

__ The maximum size of a lagoon cell should be 40 acres.

__ When there are multiple cells, the piping should allow individual cells to be isolated.

103.1 Facultative Lagoon

__ The system shall be designed with at least two cells in series. The first cell shall be loaded no heavier than 40 lb BOD_5/ac/d. The overall loading shall be no heavier than 30 lb BOD_5/ac/d. Loadings shall be determined using the surface area at the 4 foot operating depth.

__ The minimum detention time shall be 30 days overall at the 4 foot operating depth.

103.2 Aerated Lagoon

103.2.1 Partially Mixed Aerated Lagoon

The minimum detention time of the aerated cell shall be 18 days.

__ There shall be a settling area with a minimum detention time of 1 day. A separate settling cell is preferred. The settling area may be a quiescent portion of the aerated cell, in which case the total detention time must be at least 19 days.

__ For mechanical aerators, a minimum aeration capacity of 8 hp per MG of aeration pond volume (at the 4 foot depth) should be provided. This capacity is intended to provide oxygen for BOD conversion and a reasonable amount of energy for mixing. Wastewater that is stronger than domestic wastewater may require more aeration capacity.

__ If less aeration capacity is provided, the aerators shall be able to continuously maintain a minimum DO level of 2 mg/1 in the top two feet of water and in the effluent.

103.2.2 Completely Mixed Aerated Lagoon

The aerators shall be able to completely mix the lagoon contents and to continuously maintain a minimum DO level of 2 mg/1 in all parts of the lagoon and in the effluent.

__ A settling area must be provided. Either a separate settling cell with a 1 day detention time or a clarifier designed according to Chapter 60 may be used.

__ If the settling area will be a portion of the aerated cell, it must be separated with a baffle.

103.3 Hydrograph Controlled Release Lagoon

__ The treatment portion of a hydrograph controlled release (HCR) lagoon system may be (a) a lagoon designed according to Section 103.1 or 103.2, (b) a single-cell facultative lagoon loaded no heavier than 30 lb BOD_5/ac/d, or (c) other methods for producing secondary effluent. The required storage time shall be determined by using procedures approved by the Water Quality Monitoring Branch of the OPC, the minimum storage time shall be 90 days. Detention time in the treatment portion of the system shall not be counted toward the detention in the storage portion. Single-cell HCR systems are not allowed.

103.4 Anaerobic Lagoon

Anaerobic lagoons may be used as pretreatment for high strength wastewaters with enough oil/grease to form a scum cover. Anaerobic lagoons shall not be used for typical domestic wastewater unless there is some positive method of providing a cover or seal.

The lagoon shall be designed so that a complete scum cover can be maintained. The surface area should be relatively small to prevent breakup of the cover by wind. Anaerobic lagoons shall not be used where the influent flow fluctuates widely.

__ Loading should be 175 to 2000 lb BOD_5/ac/d.

The minimum detention time should be 20 days.

103.5 Pretreatment Lagoon

Positive odor control methods (such as aeration) should be included if the loading will exceed 50 lb BOD_5/ac/d.

103.6 Pond Shape

__ The shape of all cells should 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 should be rounded at corners to minimize accumulations of floating materials. Common-wall dike construction, wherever possible, is strongly encouraged.

104. POND CONSTRUCTION DETAILS

104.1 Embankments and Dikes

104.1.1 Material

__ Dikes shall be constructed of structurally stable relatively impervious material and compacted to at least 90% 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.

104.1.2 Top Width

__ The minimum dike width shall be 8 ft (2.4 m) to allow access by maintenance vehicles.

104.1.3 Maximum Slopes

__ Earthen inner and outer dike slopes shall not be steeper than 3 horizontal to 1 vertical (3:1). Paved or other protected slopes not requiring mowing, etc. should not be steeper than 2:1.

104.1.4 Minimum Slopes

Inner slopes should not be flatter than 4 horizontal to 1 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.

104.1.5 Freeboard

__ Minimum freeboard shall be 3 feet (1.0 m). For very small systems, 2 feet (0.6 m) may be acceptable.

104.1.6 Design Depth

__ The minimum operating depth of lagoons shall be not less than 4 feet; exceptions may be made for aerobic lagoons.

__ It should not be possible to drain the lagoon lower than the 2 foot level. If shallower drainage is provided for, the drain shall be relatively inaccessible to prevent draining the pond by accident or vandalism.

104.1.6.1 Facultative Lagoon

__ The maximum operating depth shall be no more than 6 feet in primary cells. Greater depths in subsequent cells are permissible although supplemental aeration or mixing may be necessary.

104.1.6.2 Aerated Lagoon

The design water depth of the aerated cell should be 10 to 15 feet. Shallower depths may be used if the pond bottom is protected against scouring by the aerators.

__ The maximum operating depth of a separate settling cell shall be no more than 6 feet.

104.1.6.3 Hydrograph Controlled Release Lagoon

__ The maximum operating depth of a treatment/storage HCR cell should be no more than 15 feet.

__ The maximum operating depth of an HCR storage cell should be no more than 20 feet.

104.1.6.4 Anaerobic Lagoon

__ The design water depth should be 8 to 20 feet.

104.1.6.5 Pretreatment Lagoon

__ The design water depth should be 6 to 20 feet.

104.1.7 Erosion Control

__ Excessive erosion of the dikes must be prevented.

104.1.7.1 Seeding

__ The dikes shall have a cover layer of at least 4 inches (10 cm), of fertile topsoil to promote establishment of an adequate vegetative cover wherever other erosion control is not utilized. Prior to prefilling (in accordance with 104.2.4), adequate vegetation shall be established on dikes from the outside toe to 2 feet (0.6 m) above the pond bottom on the interior as measured on the slope. Perennial-type, low-growing, spreading grasses that minimize erosion and can be mowed are most satisfactory. In general, alfalfa and other long-rooted crops should not be used since the roots of this type are apt to impair the water holding efficiency of the dikes.

104.1.7.2 Additional Erosion Protection

An acceptable method of erosion control is required as a minimum around all piping entrances and exists. 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 watercourse. Filter material should be used underneath any riprap.

104.1.7.3 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 erosion protection shall be placed from one foot (0.3 m) above the high water mark to two feet (0.6 m) below the low water mark (measured on the vertical).

__ Synthetic liners are very slippery. If they are used, some method shall be provided to allow people or animals that have fallen into the lagoon to climb out without having to swim too far.

104.2 Pond Bottom

104.2.1 Soil

Soil used in constructing the pond bottom (not including seal) and dike cores shall be relatively incompressible and tight and compacted at or up to 4% above the optimum water content to at least 90% Standard Proctor Density.

104.2.2 Seal

__ A seal or liner may be required in accordance with Section 101.1.4.

104.2.2.1 Leakage Limit

__ The water loss from each lagoon cell shall not exceed 500 gpd/ac at a head equal to the maximum operating depth of the cell.

104.2.2.2 Testing Requirements

__ The P/S shall include a requirement that the leakage limit be met and shall include a specific testing method.

If testing will be done by soil borings or other localized testing methods, at least one test per cell shall be done; more should be done as needed. If any individual test fails to meet the leakage limit, the area of the cell represented by that test shall be reworked and retested. Field tests should be corrected for evaporation and precipitation, as appropriate.

104.2.2.3 Applicability

__ The leakage requirement shall apply to all newly constructed or modified cells which will receive wastewater, regardless of the degree of treatment.

__ The leakage requirement will not normally apply to existing cells when the cell will receive minor modifications which will not enlarge or deepen the cell and where the soil is known to be relatively impermeable.

104.2.3 Uniformity

The pond bottom shall be as level as possible at all points. Finished elevations shall not be more than 3 inches (7.5 cm) from the average elevation of the bottom.

104.2.4 Prefilling

__ Prefilling the pond should be considered in order to protect the liner, to prevent weed growth, to reduce odor, and to maintain moisture content of the seal. However, the dikes must be completely prepared as described in Sections 104.1.7.1-2 before the introduction of water.

104.3 Influent Lines

104.3.1 Material

__ Generally accepted material for underground sewer construction shall be used for the influent line to the pond.

104.3.2 Manhole

__ A manhole or vented cleanout wye shall be installed prior to entrance of the influent line into the primary cell and shall be located as close to the dike as topography permits. Its invert shall be at least 6 inches (15 cm) above the maximum operating level of the pond and provide sufficient hydraulic head without surcharging the manhole.

104.3.3 Flow Distribution

Flow distribution structures shall be designed to effectively split hydraulic and organic loads proportionally to parallel primary cells.

104.3.4 Placement

__ Influent lines should be located along the bottom of the pond and shall have adequate seal below them.

104.3.5 Point of Discharge

__ All primary cells shall have individual influent lines which terminate at approximately the center of the cell so as to minimize short-circuiting. Consideration should be given to multi-influent discharge points for primary cells of 20 acres (8 ha) or larger to enhance the distribution of wasteload in the cell.

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

104.3.6 Influent Discharge Apron

__ The influent line may discharge horizontally, directed away from nearby dikes, or vertically. The discharge may be into a shallow, saucer-shaped, depression.

The discharge flow shall remain below the water surface. The end of the discharge line shall rest on a suitable concrete apron large enough to prevent the terminal influent velocity at the end of the apron from causing soil erosion.

104.4 Control Structures and Interconnecting Piping

104.4.1 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 additions and mixing, and minimization of the number 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) contain controls to permit water level and flow rate control, complete shutoff, and complete draining; (e) constructed of non-corrodible materials (metal-on-metal contact in controls should be of similar alloys to discourage electro-chemical reactions); 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.

104.4.2 Piping

__ All piping shall be of cast iron or other acceptable material. The piping shall not be located within or below the seal. Pipes should be anchored with adequate erosion control.

104.4.2.1 Drawdown Structure Piping

a. Submerged Takeoffs

__ For ponds designed for shallow or variable depth operations, submerged takeoffs are recommended. Intakes shall be located a minimum of 10 feet (3.0 m) from the toe of the dike and 2 feet (0.6 m) from the top of the seal, and shall employ vertical withdrawal.

b. Multi-Level Takeoffs

For ponds that are designed deep enough to permit stratification of pond content, multiple takeoffs are recommended. There shall be a minimum of three withdrawal pipes at different elevations. The bottom pipe shall conform to submerged takeoffs. The other should utilize horizontal entrance. Adequate structural support shall be provided.

c. Surface Takeoffs

__ Under constant discharge conditions and/or for relatively shallow ponds under warm weather conditions, surface overflow type withdrawal is recommended. A baffle shall extend at least one foot below the water surface to prevent discharge of floating material. The baffle shall be located to allow accurate flow measurement and to prevent excessive currents.

d. Emergency Overflow

__ To prevent overtopping of dikes, emergency overflow should be provided.

104.4.2.2 Hydraulic Capacity

__ The hydraulic capacity for continuous discharge structures and piping shall allow for a minimum of 250% of the design flow of the system.

105. MISCELLANEOUS

105.1 Fencing

__ The pond area shall be enclosed with an adequate fence to prevent entering of livestock 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.

105.2 Access

__ An all-weather access road shall be provided to the site to allow year-round maintenance.

105.3 Warning Signs

__ Appropriate permanent signs shall be provided along the fence around the pond to designate the nature of the facility and warn against trespassing. At least one sign shall be provided on each side of the site and one for every 500 feet (150 m) of its perimeter.

105.4 Flow Measurement

Flow measurement requirements are presented in Section 46.6. Effective weather protection shall be provided for the recording equipment.

105.5 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.

105.6 Laboratory Equipment

__ For laboratory equipment refer to Chapter 40.

105.7 Pond Level Gauges

__ Pond level gauges shall be provided.

CHAPTER 110
SUPPLEMENTAL TREATMENT PROCESSES

111. PHOSPHORUS REMOVAL BY CHEMICAL TREATMENT

111.1 System Flexibility

__ Systems shall be designed with sufficient flexibility to allow for several operational adjustments in chemical feed location, chemical feed rates, and for feeding alternate chemical compounds.

111.2 Process Requirements

111.2.1 Dosage

__ The required 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 or completion, and the amount required due to inefficiencies in mixing or dispersion. Excessive chemical dosage should be avoided.

111.2.2 Chemical Feed Points

Considerable flexibility in feed location should be provided, and multiple feed points are recommended.

111.2.3 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.

111.2.4 Flocculation

__ The flocculation equipment should be adjustable in order to obtain optimum floc growth, control deposition of solids, and prevent floc destruction.

111.2.5 Liquid - Solids Separation

The velocity through pipes or conduits from flocculation basins to settlings basins should not exceed 1.5 fps (0.46 m/s) 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.

111.2.6 Filtration

___ Effluent filtration shall be considered where effluent phosphorus concentrations of less than 1 mg/1 must be achieved.

111.3 Feed Systems

111.3.1 Location

___ All liquid chemical mixing and feed installations should be installed on corrosion resistant pedestals and elevated above the highest water level anticipated during emergency conditions.

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

111.3.2 Liquid Chemical Feed System

___ 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.

111.3.3 Dry Chemical Feed System

Each dry chemical feeder shall be equipped with a dissolver which is capable of providing a minimum 5-minute retention at the maximum feed rate.

___ Polyelectrolyte feed installations should be equipped with two solution vessels and transfer piping for solution make-up and daily operation.

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

111.4 Storage Facilities

111.4.1 Size

___ Storage for a minimum of 10 days' supply should be provided.

111.4.2 Location

__ 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. Discharge line valves 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.

111.4.3 Accessories

__ Platforms, ladders, and railings should 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.

111.5 Other Requirements

111.5.1 Materials

__ All chemical feed equipment and storage facilities shall be constructed of materials resistant to chemical attack by all chemicals normally used for phosphorus treatment.

111.5.2 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 should be given to temperature, humidity, and dust control in all chemical feed room areas.

111.5.3 Cleaning

__ Consideration shall be given to the accessibility of piping. Piping should be installed with plugged wyes, tees, or crosses at changes in direction to facilitate cleaning.

111.5.4 Drains and Drawoff

__ Above-bottom drawoff from chemical storage and 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.

111.6 Hazardous Chemical Handling

__ The requirements of Section 47.1 shall be met.

112. HIGH RATE EFFLUENT FILTRATION

112.1 General

112.1.1 Applicability

__ Granular media filters may be used as a tertiary treatment device for the removal of residual suspended solids from secondary effluents. Where effluent suspended solids requirements are very low, where secondary effluent quality can be expected to fluctuate significantly, or where filters follow a treatment process where significant amounts of algae will be present, a pre-treatment process such as chemical coagulation and sedimentation or other acceptable process should precede the filter units.

112.1.2 Design Considerations

Consideration should be given in the plant design to providing flow-equalization facilities to moderate filter influent quality and quantity.

112.2 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.

112.3 Filtration Rates

112.3.1 Allowable Rates

__ Filtration rates shall not exceed 5 gpm/ft^2 (3.4 1/m^2*s) based on the maximum hydraulic flow rate applied to the filter units.

112.3.2 Number of Units

__ 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 the largest unit out of service.

112.4 Backwash

112.4.1 Backwash Rate

__ The backwash rate shall be adequate to fluidize and expand each media layer a minimum of 20% based on the media selected. The backwash system shall be capable of providing a variable backwash rate having a maximum of at least 20 gpm/ft^2 (13.6 1/m^2*s) and a minimum backwash period of 10 minutes.

112.4.2 Backwash Pumps

__ Pumps for backwashing filter units shall be sized and interconnected to provide the required rate to any filter with the largest pump out of service. Filtered water shall be used as the source of backwash water. Waste filter backwash shall be recycled for treatment.

112.4.3 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% of the design average daily 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.

112.4.4 Backwash Water Storage

__ Total backwash water storage capacity provided in an effluent clearwell or other unit shall equal or exceed the volume required for two complete backwash cycles.

112.5 Filter Media

112.5.1 Media Specifications

__ The following table provides minimum media depths and the normally acceptable range of media sizes. The uniformity coefficient shall be 1.7 or less. The designer has the responsibility for selection of media to meet specific conditions and treatment requirements relative to the project under consideration.

Minimum Depth and Effective Size of Filter Media

Medium	Criterion	Single Media Filter	Dual Media Filter	Triple Media Filter
Anthracite	Depth	--	20 inches	20 inches
	Eff. Size	--	1.0 - 2.0 mm	1.0 - 2.0 mm
Sand	Depth	48 inches	12 inches	10 inches
	Eff. Size	1.0 - 4.0 mm	0.5 - 1.0 mm	0.6 - 0.8 mm
Garnet or Similar Material	Depth	--	--	2 inches
	Eff. Size	--	--	0.3 - 0.6 mm

112.6 Filter Appurtenances

__ The filters shall be equipped with washwater 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 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. Provision should be made to allow periodic chlorination of the filter influent or backwash water to control slime growths.

112.7 Reliability

__ 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. The need for housing of filter units shall depend on expected extreme climatic conditions at the treatment plant site. As minimum, all controls shall be enclosed. The structure housing filter controls and equipment shall be provided with adequate heating and ventilation equipment to minimize problems with excess humidity.

112.8 Proprietary Equipment

__ Where proprietary filtration equipment not conforming to the preceding requirements is proposed, data which supports the capability of the equipment to meet effluent requirements under design conditions shall be provided. Such equipment will be reviewed on a case-by-case basis at the discretion of the Department in accordance with Section 43.2.

113. INTERMITTENT SAND FILTRATION

113.1 Introduction

The following standards are for single-stage intermittent sand filters that are used to polish lagoon, activated sludge, or trickling filter effluent. Other uses are also allowable. Consideration shall be given to pretreating lagoon effluent for algae reduction. All earthen basin filters shall comply with Section 44.4.

113.2 Filter Size and Number

__ There shall be at least two filters.

__ The filters should be of the same size and shape to provide ease of operation.

113.3 Hydraulic Loading Rate

__ The hydraulic loading rate with the largest filter out of operation should be in the range of 0.4 to 0.6 MGD/ac.

113.4 Media

113.4.1 Sand

Sand is the most commonly used filtration media. Other materials such as crushed shells may be approvable on a case-by-case basis.

__ The effective size should be 0.3 to 1.0 mm. The uniformity coefficient should be no greater than 3.5.

__ The filter media depth should be 24 to 36 inches.

113.4.2 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 gradation for the three layers are bottom: 1 2 to 3/4 inches, middle: 3/4 to 1/4 inch, and top: 1/4 to 1/8 inch.

Other support media may be allowable on a case-by-case basis.

113.5 Underdrain System

__ The filter shall be provided with perforated pipe or similar underdrains. Proprietary systems may be used in lieu of conventional underdrain-gravel bed construction.

__ Underdrains shall be sloped to the outlet and shall be placed on 10 foot maximum centers.

The underdrain shall drain sufficiently between dosings to provide an open air channel.

__ Vertical riser vents shall be provided at both ends of each underdrain pipe and shall be located so as not to be overtopped at maximum dosing depth.

113.6 Influent System

__ The influent system should be able to apply the entire daily hydraulic load in less than six hours.

__ Splash pads or other methods shall be provided to prevent erosion of the filter medium.

113.7 Sand Cleaning

If spent filter medium is stored on-site, it shall be stored in a steel, plastic, concrete, or similar container or in an earthen impoundment which meets the requirements of Section 104.2 and all subsections.

__ There shall be no discharge from the spent filter media holding area or cleaning unit. All discharge fluids shall be sent to the WWTP upstream of the major biological treatment process.

113.8 Surface Runoff

__ The filter and spent medium storage area shall be designed so as to preclude the entry of surface runoff.

114. MICROSCREENING

114.1 General

114.1.1 Applicability

Microscreening units may be used following a biological treatment process for the removal of residual suspended solids. Selection of this unit process should consider final effluent requirements, the preceding biological treatment process, and anticipated consistency of biological process to provide a high quality effluent. Microscreens shall not be used following lagoons or free water surface wetland treatment facilities.

114.1.2 Design Considerations

Pilot plant testing on existing secondary effluent is encouraged. Where pilot studies so indicate, where microscreens follow trickling filters, or where effluent suspended solids requirements are less than 10 mg/1, a pretreatment process such as chemical coagulation and sedimentation shall be provided. Care should be taken in the selection of pumping equipment ahead of microscreens to minimize shearing of floc particles. The process design shall include flow equalization facilities to moderate microscreen influent quality and quantity.

114.2 Screen Material

__ The microfabric shall be a material demonstrated to be durable through long-term performance data. The aperture size must be selected considering required removal efficiencies, normally ranging from 20 to 35 microns. The use of pilot plant testing for aperture size selection is recommended.

114.3 Screening Rate

The screening rate shall be selected to be compatible with available pilot plant test results and selected screen aperture size, but shall not exceed 5 gpm/ft^2 (3.40 l/m^2*s) of effective screen area based on the maximum hydraulic flow rate applied to the units. The effective screen area shall be considered as the submerged screen surface area less the area of screen blocked by structural supports and fasteners. The screening rate shall be that applied to the units with the largest unit out of service.

114.4 Backwash

__ All waste backwash water generated by the microscreening operation shall be recycled for treatment. The backwash volume and pressure shall be adequate to assure maintenance of fabric cleanliness and flow capacity. Equipment for backwash of at least 8 gpm/linear foot (1.66 1/m*s) of screen length, 60 psi (4.22 kgf/cm^2) capacity, respectively, shall be provided. Backwash water shall be supplied continuously by multiple pumps, including one standby, and should be obtained from microscreened effluent. The rate of return of waste backwash water to treatment units shall be controlled such that the rate does not exceed 15% of the design average daily flow rate to the treatment plant. If the hydraulic and organic load from waste backwash water is returned for treatment by pumping, adequate pumping capacity shall be provided with the largest pump out of service. Provisions should be made for measuring backwash flow.

114.5 Appurtenances

Each microscreen unit shall be provided with automatic drum speed controls with provisions for manual override, a bypass weir with an alarm for use when the screen becomes blinded to prevent excessive head development, and means for dewatering the unit for inspection and maintenance. Bypassed flows must be segregated from water used for backwashing. Equipment for control of biological slime growths shall be provided. The use of chlorine should be restricted to those installations where the screen material is not subject to damage by the chlorine.

114.6 Reliability

__ A minimum of two microscreen units shall be provided, each unit being capable of independent operation at the design average flow. A supply of critical spare parts shall be provided and maintained. All units and control shall be enclosed in a heated and ventilated structure with adequate working space to provide for ease of maintenance.

115. POST AERATION

115.1 Initial Dissolved Oxygen Concentration

__ An initial dissolved oxygen (DO) concentration of zero should be assumed. An initial DO concentration higher than 2.0 mg/1 shall not be assumed.

115.2 Maximum Effluent Temperature

__ The post aerator shall be designed to provide the required DO at the maximum effluent temperature.

The actual one-in-ten-year high effluent temperature may be used. Otherwise, a maximum temperature of at least 25EC shall be used.

115.3 Cascade Aeration

115.3.1 Type

__ Cascade aeration shall be of the "step" type, with each step at least six (6) inches high and twelve (12) inches deep (front to rear).

115.3.2 Height

__ The total height shall not be less than eight (8) feet, and shall be calculated with the Barrett formula.

CHAPTER 120
LAND APPLICATION OF WASTEWATER

121. REFERENCES

Land treatment systems should be designed in accordance with:

a. Land Treatment of Municipal Wastewater (1981) EPA 625/1-81-013;

b. Land Treatment of Municipal Wastewater: Supplement on Rapid Infiltration and Overland Flow (1984) EPA 625/1-81-031a;

c. Natural Systems for Wastewater Treatment (1990) Water Environment Federation Manual of Practice FD-16, or;

d. Other appropriate references.

122. OVERLAND FLOW SYSTEMS

Some of the major design criteria from the referenced publications are summarized below. No attempt has been made to be all-inclusive. The referenced publications should be consulted for detailed design and O & M guidance.

122.1 Storage/Pretreatment

A holding pond before the overland flow slope shall be provided to allow for operational flexibility. The minimum detention time shall be 5 days. Otherwise the pond must comply with Section 55, Flow Equalization.

Overland flow shall not be used to treat effluents from facultative, aerobic, partially aerated, HCR, or pretreatment lagoons unless algae removal is provided.

Secondary settling prior to land application should be considered.

122.2 Sizing of Application Field

One of the rational design procedure described in the referenced publications may be used. Otherwise, the following empirical design ranges may be used.

122.2.1 Slope Length

The slope length should be about 150 feet or longer.

122.2.2 Loading Rate

__ Both the application and hydraulic loading rate criteria in the following table must be satisfied. The low end of the ranges should be used when the effluent limits are strict.

Preapplication Treatment	Application Rate, gph per foot of slope width	Hydraulic Loading Rate, in/day
Aerated Lagoon (1 day detention)	6.4 - 11.3	0.8 - 3.3
Primary Sedimentation	5.6 - 9.7	1.0 - 3.5
Secondary	8.9 - 13.7	1.2 - 3.9

122.2.3 Application Period

__ The application period should be 8-12 hrs/day.

122.2.4 Application Frequency

__ The application frequency should be 5-7 days/week.

122.2.5 Continuous Application

__ Overland flow systems shall not be sized based on continuous application; however, it is permissible to operate a system continuously as long as all permit limits (*****and project performance standards) are met.

122.3 Application Field Construction

The soil/groundwater study requirements for earthen impoundments found in Section 101.1.4 also apply to land treatment projects.

__ Slope should be 2-8% with a cross slope of no more than 0.5%.

__ The P/S should require that surface elevations not differ from the design elevations by more than 0.05 ft. There should be no swales or depressions.

A maximum clod size on the prepared surface prior to seeding should be specified.

__ The P/S should forbid driving equipment on the finished slope unless the equipment has high flotation tires to minimize rutting.

122.4 Distribution System

___ The distribution system shall have enough flexibility to allow application of wastewater to parts of the slope while other parts are allowed to dry for maintenance.

___ The distribution system shall be designed so as to minimize the likelihood of damage by equipment during routine maintenance.

122.4.1 Surface Distribution

___ Slotted or perforated pipe may be used. The openings must be uniformly machined.

A sawtooth weir that is similar to a clarifier weir may be used.

___ The pipe or weir should be adjustable to allow leveling and must allow uniform application along its length.

___ The surface distribution system must discharge on to a gravel bed or some other device which will minimize erosion and ensure uniform sheet flow.

122.4.2 Spray or Sprinkler Distribution

___ There must be sufficient downslope distance beyond the spray pattern to allow for adequate treatment.

122.5 Vegetation Selection and Establishment

___ The P/S should require that the slope be finished and planted as early in the growing season as practicable, so as to allow the maximum time for the cover to be established.

___ The P/S should require that the slope be watered with about one inch of water every three days or twice a week after seeding or sodding until the cover is firmly established; and then watered as needed thereafter to maintain the cover in good condition.

___ Watering shall be done carefully to prevent erosion; there should be no runoff. Wastewater, stream water (if permitted), or potable water may be used.

CHAPTER 130
CONSTRUCTED WETLANDS

131. INTRODUCTION

Constructed wetlands are a promising method for advanced treatment. Since there is not yet a consensus on specific design criteria only a few technical requirements are presented.

132. REFERENCES

Constructed wetland systems may be designed in accordance with:

a. Natural Systems for Wastewater Treatment (1990) Water Environment Federation Manual of Practice FD-16;

b. Constructed Wetlands for Wastewater Treatment (1989) Donald A. Hammer, Lewis Publisher, Chelsea, MI;

c. Wastewater Treatment/Disposal for Small Communities (9/1992), EPA/625/R-92/005;

d. Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment (1988) EPA/625/1-88/022, or;

e. Other appropriate references.

133. DESIGN

133.1 General Design Criteria

The flow control structure or effluent structure shall be designed to allow variable depth of flow in the wetland cells.

___ The initial planting shall be dense enough to result in compliance with the permit by the end of the first full growing season, unless otherwise allowed by the permit.

___ Levee construction, cell bottom sealing, pretreatment lagoons, and other earthwork shall conform to Chapter 100.

___ Multiple cells should be provided.

___ Plants used should be proven suitable and planted on maximum three foot centers.

___ Consideration should be given to algae removal.

133.2 Free Water Surface

___ Currently, the loading rates (not accounting for ammonia removal) are about 15-40 ac/MGD. The actual rates used for design will be system-specific.

133.3 Subsurface Flow

___ A minimum of primary pretreatment is required.

___ The organic loading rate shall not exceed 0.1 lb BOD_5/ft^2 of end area/day (at the head of the wetland cells).

Consideration should be given to the cross-sectional area of the channel to prevent hydraulic overloading and plugging by algae. The hydraulic loading rate shall not exceed 350 gpd/ft^2 of end area (at the head of the wetland cells).

A minimum hydraulic detention time of 24 hours shall be provided for secondary treatment; longer times and other performance-enhancing features shall be used to meet more stringent limits.

A maximum long term porosity of greater than 35% shall not be assumed.

___ The bed bottom slope should be 1% - 2%.

Beds should consist of 18 to 24 inches of washed stone or artificial media with specified sizes of 3/4 to 3 inches and less than 5% fines.

___ P/S shall prohibit the operation of vehicles on in-place media.