Chapter NR 110

SEWERAGE SYSTEMS

History: Chapter NR 110 as it existed on November 30, 1974 was repealed and a new chapter NR 110 was created effective December 1, 1974.

NR 110.01 Applicability. This chapter is applicable to all new or modified sewerage systems, excluding only industrial waste treatment facilities. This chapter also applies to sewerage systems employing land disposal of sewage effluent, except those systems defined as plumbing within the purview of s. 145.01 (1) (b), Stats.

Note: The authority to enact these rules is contained in ch. 144, Stats. Pursuant to s. 144.67 Stats., any person who violates this chapter shall forfeit not less than $10 nor more than $5,000 for each violation. Each day of continued violation is a separate offense.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.02 Severability. Should any section, paragraph, phrase, sentence, clause or word of this chapter be declared invalid or unconstitutional for any reason, the remainder of this chapter shall not be affected thereby.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.03 Definitions. For purposes of this chapter:

(1) "Approved areawide waste treatment management plan" means a plan or element thereof developed pursuant to Section 208 of the Federal Water Pollution Control Act Amendments of 1972 as amended by the Clean Water Act Amendments of 1977 (33 USC 1251 et seq.) and approved by the state of Wisconsin.

(2) "Approval" means the written approval of the department for any project requiring approval pursuant to s. 144.04, Stats., and NR 108.03, Wis. Adm. Code.

(3) "Cost-effective analysis" means a systematic comparison of alternative means of meeting state water quality standards, effluent limitations or other treatment standards in order to identify the alternative which will minimize the total resources costs over the planning period. These resources costs include monetary costs and environmental as well as other non-monetary costs.

(4) "Department" means the department of natural resources.

(5) "Excessive infiltration/inflow" means the quantities of infiltration/inflow which can be economically eliminated from a sewerage system by rehabilitation, as determined in a cost-effectiveness analysis that compares the cost of correcting the infiltration/inflow conditions to the total costs for transportation and treatment of the infiltration/inflow.

(6) "Industrial user" means:

(a) Any nongovernmental, nonresidential user of a municipally owned sewerage system which discharges more than the equivalent of 25,000 gallons per day (gpd) of sanitary wastes and which is identified in the Standard Industrial Classification Manual, 1972, United States Office of Management and Budget, as amended and supplemented as of October 1, 1978 under one of the following divisions:

Division A. Agriculture, Forestry, and Fishing

Division B. Mining

Division D. Manufacturing

Division E. Transportation, Communications, Electric, Gas, and Sanitary Services

Division I. Services.

1. In determining the amount of a user's discharge, domestic wastes or discharges from sanitary conveniences may be excluded.

2. After applying the sanitary waste exclusion in sub. 1 above, discharges in the above divisions that have a volume exceeding 25,000 gpd or the weight of biochemical oxygen demand (BOD) or suspended solids (SS) equivalent to that weight found in 25,000 gpd of sanitary waste are considered industrial users. Sanitary wastes, for purposes of this calculation of equivalency, are the wastes discharged from residential users. The municipality shall, with the department's approval, define the strength of the residential waste discharges in terms of parameters including biochemical oxygen demand (BOD) and suspended solids (SS) per volume of flow as a minimum. Dischargers with a volume exceeding 25,000 gpd or the weight of BOD or SS equivalent to that weight found in 25,000 gpd of sanitary waste are considered as industrial users.

(b) Any nongovermental user of a municipally owned sewerage system which discharges wastewater to the sewerage system which contains toxic pollutants or poisonous solids, liquids, or gases in sufficient quantity either singly or by interaction with other wastes, to contaminate the sludge of any municipal system, or injure or interfere with any sewage treatment process, constitutes a hazard to humans or animal, creates a public nuisance, or creates any hazard in or has an adverse effect on the waters receiving any discharge from the treatment works;

(c) All commercial users of an individual system constructed with grant assistance under NR 128.07.

(7) "Infiltration" means water other than wastewater that enters a sewerage system (including sewer service connections) from the ground through such sources as defective pipes, pipe joints, connections, or manholes. Infiltration does not include, and is distinguished from, inflow.

(8) "Inflow" means water other than wastewater that enters a sewerage system (including sewer service connections) from sources such as roof leaders, cellar drains, yard drains, area drains, foundation drains, drains from springs and swampy areas, manhole covers, cross connections between storm sewers and sanitary sewers, catch basins, cooling towers, storm waters, surface runoff, street wash waters, or drainage. Inflow does not include, and is distinguished from, infiltration.

(9) "Interceptor sewer" means a sewer whose primary purpose is to transport wastewaters from collector sewers to a treatment facility.

(10) "Municipality" means any city, town, village, county, utility district, town sanitary district, public inland lake protection and rehabilitation district or metropolitan sewage district.

(11) "Owner" means the state, county, town, town sanitary district, city, village, firm, company, institution, association, utility district, school district, metropolitan sewerage district, or individual owning or operating a sewerage system.

(12) "Planning area" means that area under study as part of a facilities plan.

(13) "Planning period" means the period over which sewerage system alternatives are evaluated for cost-effectiveness. The planning period begins with the initiation of the operation of the proposed facilities.

(14) "Reviewable project" means any construction or installation project for which department approval is required, pursuant to s. 144.04, Stats., including any new sewerage system; and, any improvements, extensions, or alterations of existing sewerage systems which may effect the quality or quantity of effluent or the location of any outfall.

(15) "Sewage collection system" means the common sanitary sewers within a sewerage system which are primarily installed to receive wastewaters directly from facilities which convey wastewater from individual structures or from private property, and which include service connection "Y" fittings designed for connection with those facilities. The facilities which convey wastewater from individual structures, from private property to the public sanitary sewer, or its equivalent, are specifically excluded from the definition of "sewerage collection system"; except that pumping units and pressurized lines for individual structures or groups of structures may be included as part of a "sewage collection system" when such units are cost effective and are owned and maintained by the sewerage system owner.

(16) "Sewage treatment facilities" means sewerage systems defined in sub. (17) below exclusive of interceptor sewers and sewage collection systems.

(17) "Sewerage system" means all structures, conduits and pipes, by which sewage is collected, treated, and disposed of, except plumbing inside and in connection with buildings served, and service pipes, from building to street main.

(18) "Sewer service area" means that area served or anticipated to be served by a sewage collection system.

(19) "Staging period" means the period of time during which reserve capacity will be provided in the sewerage system for future domestic, commercial, and industrial flows.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74; r. and recr. Register, December, 1978, No. 276, eff. 1-1-79.

NR 110.04 Alternative requirements. (1) If the owner of a proposed reviewable project feels that compliance with the design requirements of this chapter is impracticable, the reasons therefore shall be fully communicated in writing to the department prior to the submission of final plans. This communication must set forth alternative requirements for which department approval is sought and all pertinent facts, data, reports and studies supporting the imposition of such alternative requirements.

(2) If the department determines that compliance with the design requirements of this chapter would be impracticable in specific cases, it may approve alternative requirements which, in its opinion, are in substantial compliance with the requirements of this chapter.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.05 Sewer extensions. (1) It is the purpose of this section to condition department approval of requests for sanitary sewer extensions upon consistency with and enhancement of the goal of abatement of pollution of the waters of the state.

(1m) For the purpose of this rule, the following definitions will apply.

(a) "Sewer extension" shall mean: 1) an extension of sanitary sewers to serve areas not previously served; 2) relief sewers; and 3) interceptor sewers. Excluded from this definition shall be combined sewer relays, sanitary sewer relays, sewer system rehabilitation and other such improvements made in a previously existing sewer system to replace inadequate structures.

(b) "Dry weather flow" is that flow which occurs in the absence of wet weather flow conditions, and includes infiltration resulting from seasonal high ground water.

(c) "Wet weather flow" is that flow which can be attributed to precipitation or snowmelt, including but not limited to rain, sleet, snow, hail, melting snow, or stream flooding.

(2) Requests for sanitary sewer extensions may be approved if the sewer will be tributary to:

(a) A sewerage system which experiences no dry weather or wet weather by-passing; and

(b) A sewage treatment plant which discharges an effluent in compliance with the monthly average effluent limitations for biochemical oxygen demand (BOD) and total suspended solids contained in chapters NR 210 or 214, as appropriate, or with more stringent BOD and total suspended solids effluent limitations required to achieve water quality standards derived from chapters NR 102-104.

(c) In determining whether a discharged effluent is in compliance with the monthly average effluent limitations for biochemical oxygen demand (BOD) and total suspended solids contained in chapters NR 210 or 214, as appropriate, or with more stringent BOD and total suspended solids effluent limitations required to achieve water quality standards derived from chapters NR 102-104, the following procedure will apply:

1. Compliance will be determined by staff review of up to the previous 12 months of discharge monitoring data. If 12 months of data are not available, the review will be based on the data that are available.

2. More than a total of 3 violations of the monthly average limitations for BOD or suspended solids in the previous 12 months (or the equivalent ratio for the number of months of data available) shall cause denial, subject to the following additional considerations:

a. Recognition of the inherent inaccuracy of the BOD and suspended solids tests may be given by utilization of a factor of 1.3X for BOD and 1.2X for suspended solids for purposes of determining compliance with the limit as specified in the permit.

b. The department may grant approval if, in its judgment, it determines that the plant has in recent months been in compliance, thus demonstrating a trend toward better operation.

c. Consideration may be given in those instances where effluent violations have been caused by algae growth in a treatment facility utilizing lagoons as the principal treatment device.

d. The department may grant approval if, in its judgment, it determines that noncompliance with the effluent limitations has been caused by operating difficulties associated with plant startup for those sewage treatment facilities which have recently been constructed or undergone major modification or expansion.

(3) (a) Requests for sanitary sewer extensions shall be denied if the sewer will be tributary to:

1. A sewerage system which contains any bypass (es) or overflow (s) which operate during dry weather; or

2. A sewage treatment plant which discharges an effluent not in compliance with the monthly average effluent limitations for biochemical oxygen demand (BOD) and total suspended solids contained in chapters NR 210 or 214, as appropriate, or with more stringent BOD and total suspended solids effluent limitations required to achieve water quality standards derived from chapters NR 102-104.

(b) Requests for sewer extensions otherwise prohibited by this subsection may be approved if the owner of the treatment works, or the owner of the sewerage system, submits to the department an acceptable

program to assure provision of the appropriate effluent quality, with no dry weather bypass (es) or overflow (s), by July 1, 1982. The program must include a time schedule for completion of the necessary construction or upgrading. It must also include proof of financial ability and commitment to complete the program in accordance with the time schedule.

(4) Requests for sanitary sewer extensions shall be denied if the sewer will be tributary to a sewerage system which contains any bypass (es) or overflow (s) that operate under wet weather conditions, with the following exception:

(a) The request may be approved if the owner of the treatment works, or the owner of the sewerage system within which the bypassing occurs, submits to the department an acceptable program for correction of the bypass (es) or overflow (s), including a time schedule for completion of the corrective work, and proof of financial ability and commitment to complete the work in accordance with the schedule.

(b) In the event the applicant submits a program for correction which includes a time schedule extending beyond July 1, 1982, the following procedure will be employed:

1. The department will make a tentative determination as to the acceptability of the program and the time schedule;

2. Written notice of that tentative determination will be mailed to each member of the natural resources board;

3. If, within 15 days of the date of mailing of that notice, 4 members of the natural resources board notify the department in writing of their intention to take jurisdiction over the request, the applicant will be notified and the matter will be placed on the agenda of the natural resources board for the following month;

4. If the natural resources board takes jurisdiction over the matter as described, the final decision as to approval or denial of the request will be made by the natural resources board;

5. If the natural resources board does not take jurisdiction over the matter, the tentative determination of the department will be deemed approved by the natural resources board and that decision will be made final by notification to the applicant.

(5) Variances from the requirements of subsections (3) and (4) may be granted by the department to allow sewer extensions otherwise prohibited by this rule upon determination by the department of any of the following:

(a) That construction of the subdivision, commercial establishment, institutional facility or industrial plant had commenced prior to May 24, 1976, as evidenced by the issuance of a building permit;

(b) That the area to be served was developed prior to May 24, 1976 and that the sewer extension will eliminate use of existing private waste disposal systems which pose a threat to the public health or safety, provided that connections to the sewer are allowed only for the existing development;

(c) That the sewers to be installed will result in the elimination of existing dry weather overflow(s) or bypass(es), or will result in the abandonment of an existing inadequate sewage treatment plant;

(d) That the proposed extension is a revision to a sewer previously approved by the department, providing that the revision results in no increase in the anticipated waste discharge to the sewer system;

(e) That the facilities to be served are intended primarily to provide educational, humanitarian, or charitable community services;

(f) That the program, time schedule, and the commitment to proceed are established in a court-approved stipulation, order, or judgment.

(6) As a condition of any approval granted under subsection (3), (4) or (5) of this rule, the department may require than an applicant for a sewer extension restrict the number of connections made to such sewer in accordance with a prescribed schedule.

(7) Failure of the owner of the treatment works, or the owner of the sewerage system, to comply with any element of an acceptable program, time schedule, financial commitment, or other condition of approval established pursuant to this rule, shall cause denial of all subsequent requests for sewer extensions which would be tributary to the treatment works or sewerage system, except in those cases in which the department determines that a revision or modification of that element of an acceptable program, time schedule, financial commitment, or other condition of approval established pursuant to this rule is necessary because of the happening of an event over which the applicant has little or no control.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74; emerg. r. and recr. eff. 5-24-76; r. and recr. Register, September, 1976, No. 249, eff. 10-1-76.

NR 110.06 Construction plans for reviewable projects. (1) All construction plans for reviewable projects submitted to the department shall be in conformance with chapter NR 108 and shall bear a suitable title block which includes the name of the owner, the scale and the date. The north point shall be shown on each plan. All plans shall be clear and legible. Blueprints will not be accepted. The datum used shall be indicated and shall be related to U.S.G.S. datum.

(2) Detailed construction plans shall contain appropriate plan views, elevations, necessary sections and supplemental views which together with the specifications provide all necessary information for construction of the project. Manufacturers' drawings shall not be accepted.

(3) All construction plans shall be in conformance with an approved facilities plan as required in NR 110.08 (1).

Note: Applicable state and local codes, including those of the department of industry, labor and human relations, the public service commission and the department of health and social services, should be consulted for other requirements.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74; r. and recr. Register, December, 1978, No. 276, eff. 1-1-79.

NR 110.07 Specifications for reviewable projects. (1) Complete technical specifications for all reviewable projects shall accompany the construction plans. Where feasible the specifications shall contain provisions for maintaining the same degree of wastewater treatment during construction as that which existed prior to the start of construction.

(2) The specifications accompanying the detailed construction drawing shall include, wherever applicable:

(a) All construction information not shown on the plans;

(b) The complete requirements for all mechanical and electrical equipment;

(c) The type and operating characteristics of all equipment;

(d) The laboratory fixtures and equipment;

(e) The construction materials to be used;

(f) The identification of the chemicals to be used; and

(g) The instructions for testing materials and equipment to meet design standards.

(3) Specifications reproduced from manufacturers' data and bearing the manufacturers' labels will not be accepted.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74; r. and recr. Register, December, 1978, No. 276, eff. 1-1-79.

NR 110.08 Facilities plans for reviewable projects. (1) APPLICABILITY. A facilities plan shall be included with each reviewable project submitted to the department for approval. Facilities plans or sewage treatment facilities shall be submitted and approved by the department prior to submittal of the construction plans.

(2) CONTENT. The facilities plan shall contain all of the information required by NR 110.09 (1)-(6), NR 110.10 (1) and (2), or NR 110.11 (1) whichever are applicable. The level of detail necessary to fulfill this requirement may vary depending upon the size and complexity of the project.

(3) WISCONSIN ENVIRONMENTAL POLICY ACT REVIEW. (a) Facilities plans, other than those excluded in NR 150.03 (2) (d) 17., Wis. Adm. Code (1978), shall be screened by the department to determine whether it is required to prepare an environmental impact statement in accordance with chapter NR 150 (1978).

(b) For a proposal which a federal agency and the department determine to be a major and significant action, the requirements of NR 150.10 (1978) shall apply.

(4) CONFORMANCE WITH APPROVED AREAWIDE WASTE TREATMENT MANAGEMENT PLANS. All approvable sewerage system facility plans must be in conformance with approved areawide waste treatment management plans unless the department determines that such plans conflict with the department's responsibilities to protect, maintain, and improve the quality and management of the waters of the state, ground and surface, public and private. In the absence of an approved areawide waste treatment management plan, no determination of such conformance is required.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74; r. and recr. Register, December, 1978, No. 276, eff. 1-1-79.

NR 110.09 Sewage treatment facilities projects. (1) FACILITIES PLANS FOR SEWAGE TREATMENT FACILITIES PROJECTS. (a) Facilities plans consist of those necessary plans and studies which directly relate to the construction of the proposed facilities. Facilities planning shall demonstrate the need for the proposed facilities. Through a systematic evaluation of feasible alternatives facilities planning shall also demonstrate that the selected alternative is the most cost-effective means of meeting established effluent limitations and water quality standards. The most cost-effective alternative is that which will result in the minimum total resources costs over the planning period. The planning period of the facilities plan shall be 20 years. The total resources costs include monetary costs, environmental and social considerations, and other nonmonetary factors. The interest (discount) rate to be used in calculating present worth shall be obtained from the department when beginning facilities planning.

(b) Facilities planning shall include the following information in such detail as the department deems appropriate for the specific project:

1. A description of the sewerage system for which construction drawings and specifications are to be prepared. This description shall include preliminary engineering data, cost estimates for design and construction of the sewerage system, and a schedule for completion of design and construction. The preliminary engineering data shall include, to the extent appropriate, information such as a schematic flow diagram, unit processes, design data regarding detention times, flow rates, sizing of units, and so forth. This is commonly referred to as the Unit Equipment and Design Report.

2. A description of the selected complete sewerage system of which the proposed facilities will be a part using maps, diagrams and plans as appropriate. This description shall include:

a. The delineation of a sewer service area for the complete sewerage system based on a 20-year population projection and density assumptions;

b. A description of the collection system including existing and proposed trunk sewers and interceptors;

c. A description of the existing and proposed sewerage treatment system including ultimate disposal of wastewater and sludge;

d. A planning area map showing individual systems, if individual systems are to be a part of the cost-effective solution proposed for state or EPA funding.

3. Infiltration/inflow documentation in accordance with NR 110.09 (5) and (6).

4. A cost-effectiveness analysis of alternatives for the sewerage system prepared in accordance with NR 110.09 (2). Except as provided in NR 110.09 (2) (i) 4. c. the most cost-effective alternatives shall be selected for implementation.

5. For facilities plans for state funded projects, parallel cost estimates shall be provided for the facilities necessary to transport and/or treat

the fundable capacity, as well as a cost estimate for the total proposed sewerage system.

Note: See NR 128.05 and NR 128.06 for requirements regarding fundable capacity for state funded projects.

6. An identification of effluent discharge limitations including water quality related effluent limitations, and where a Wisconsin Pollution Discharge Elimination System (WPDES) permit has been issued, a copy of the permit for the proposed sewerage system.

7. Required comments or approvals of relevent state, interstate, regional, and local agencies.

8. An estimate of the anticipated cost to the average user of the system. This cost shall be presented at the public hearing required under NR 110.09 (4).

9. A brief summary of the public hearing required under NR 110.09 (4) or any other public meeting or hearing held during the planning process including a summary of the views expressed.

10. A brief statement demonstrating that the authorities who will be implementing the plan have the necessary legal, financial, institutional, and managerial resources available to insure the construction, operation, and maintenance of the proposed treatment works.

11. A description of potential opportunities for recreation, open space, and access to bodies of water analyzed in planning the proposed sewerage system and the recommended actions. The facility plan shall also describe measures taken to coordinate with federal, state and local recreational programs and with recreational elements of applicable approved areawide waste treatment management plans.

(2) CONTENT OF THE COST-EFFECTIVENESS ANALYSIS. The cost-effectiveness analysis shall include:

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

(b) An evaluation of alternative flow and waste reduction measures, including non-structural methods;

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

(d) An evaluation of the capability of each alternative to meet secondary treatment standards or applicable water quality related effluent limitations. The sewerage system design must be based upon achievement of not less than secondary treatment standards as defined by ch. NR 210;

(e) An identification of and provision for applying technologies included under each of the following waste treatment management techniques:

1. Biological or physical-chemical treatment and discharge to receiving waters;

2. Systems employing the reuse of wastewater and recycling of pollutants;

3. Land application techniques;

4. Systems including revenue generating applications; and

5. On-site and non-conventional systems.

(f) All construction of publicly-owned sewerage systems and privately owned domestic sewerage systems discharging to surface waters shall be based upon application of secondary treatment as a minimum. Where application of secondary treatment would not provide for attainment of water quality standards,the facilities plan shall provide for attaining the applicable standards by designing to meet appropriate water quality related effluent limitations. Sewerage systems discharging to the ground water shall comply with the applicable discharge requirements of ch. NR 214. The alternative of treating combined sewer overflows shall also be considered.

(g) An evaluation to determine the cost-effective means of disposing of treated effluent.

(h) An evaluation of the most cost-effective means of treating, handling, and disposing of sludge. This evaluation shall include at a minimum the following items:

1. A description of the current sludge handling system;

2. An analysis of the anticipated quantity and qualitative characteristics of the sludge from the proposed facility;

3. An identification of alternative stabilization, dewatering, storage, transportation, and disposal techniques;

4. A cost-effectiveness analysis of the feasible alternatives, and;

5. A summary describing the selected plan and its anticipated environmental impacts.

(i) An adequate assessment of the expected environmental impacts of the alternatives (including sites) in accordance with NR 110.09 (3). This assessment shall be an integral part of the analysis of alternatives for cost-effectiveness. The assessment shall be revised as necessary to include information developed during subsequent project steps.

(j) An analysis of the most cost-effective design staging and sizing. The staging and sizing of treatment works shall be based upon the following:

1. Population projections. Population projections for facilities planning shall be in conformance with those contained in applicable approved areawide waste treatment management plans and rules adopted pursuant to ss. 16.96, 144.24 (4) (b), Stats. If such projections are not available, the engineer shall project future population growth based on trends in the recent past.

2. Wastewater flow estimates. a. In determining total average daily flow for the design of sewerage systems, the flows to be considered include the average daily base flows (ADBF) expected from residential

sources, commercial sources, institutional sources, and industries the system will serve plus allowances for future industries and nonexcessive infiltration/inflow.

b. The estimation of existing and future ADBF from combined residential, commercial, and institutional sources, shall be based upon one of the following methods:

i. Preferred method. Existing ADBF shall be estimated based upon a fully documented analysis of water use records adjusted for consumption and losses or on records of wastewater flows for extended dry periods less estimated dry weather infiltration. Future flows for the sewerage system design shall be estimated by determining the existing per capita flows, subtracting any projected per capita water conservation flow reduction and multiplying this figure by the future projected population to be served. Seasonal population can be converted to equivalent full-time residents using the following multipliers:

Day-use visitor (0.1-0.2).

Seasonal visitor (0.5-0.8).

The preferrred method shall be used wherever water supply records or wastewater flow data exist. Allowances for future increases of per capita flow over time will not be approved.

ii. Optional method. Where water supply and wastewater flow data are lacking, existing and future ADBF shall be estimated by multiplying a gallon per capita per day (gpcd) allowance not exceeding those in the following table by the estimated total of the existing and future resident populations to be served. The tabulated ADBF allowances include estimates for commercial and institutional sources as well as residential sources. The department may approve exceptions to the tabulated allowances where large commercial and institutional flows (more than 25 percent of total estimated ADBF) are documented.

Description	Gallons per capita per day (gpcd)
Non-SMSA cities and towns with projected total 10-yr population of 5,000 or less	60-70
Other cities and towns	65-80

3. Industrial flows. a. The sewerage system total design flow capacity may include allowances for industrial flows. The allowances may include capacity needed for industrial flows which the existing sewerage system presently serves. However, these flows shall be carefully reviewed and means of reducing them shall be considered. Capacity needs for existing flows from industrial users and for future flows from all industries intending to increase their flows or relocate in the area must be documented.

b. While many uncertainties accompany forecasting future industrial flows, there is still a need to allow for some unforeseeable future industrial growth. Thus, design capacity of the treatment works may include

(in addition to the existing industrial flows and future documented industrial flows) a nominal flow allowance for future nonidentifiable industries or for unplanned industrial expansions, provided that areawide waste treatment management plans, land-use plans and zoning provide for such industrial growth. This additional allowance for future unplanned industrial flow shall not normally exceed 5% (or 10% for towns with less than 10,000 population) of the total design flow of the treatment works exclusive of the allowance or 25% of the total industrial flow (existing plus documented future), whichever is greater.

4. Staging of sewage treatment facilities. For municipally owned projects the design capacity of new, upgraded or expanded sewage treatment facilities shall not exceed that necessary for wastewater flows projected during the initial staging period. Privately owned domestic waste treatment facilities shall provide design capacity for estimated flows 20 years from the estimated time of start-up of the facilities unless the cost-effectiveness staging analysis in NR 110.09 (2) (i) 4. is done to justify a lesser design staging period. The staging period for municipally owned waste treatment facilities shall be determined by either of the following methods:

a. First method. The owner shall analyze at least three alternative staging periods (10 years, 15 years and 20 years) and the least costly (i.e., total present worth or average annual cost) staging period shall be selected.

b. Second method. The staging period shall not exceed the period which is appropriate according to the following table.

Staging Periods for Treatment Facilities

Flow Growth Factors (20 yrs)	Maximum Initial Staging Period
1. Design flow less than 1.3 times initial flow	20 years
2. Design flow 1.3 to 1.8 times initial flow	15 years
3. Design flow greater than 1.8 times initial flow.	10 years

c. A municipality may stage the construction of a treatment plant for a shorter period than the maximum allowed under this subdivision. A shorter staging period might be based upon environmental factors (secondary impacts, compliance with other environmental laws, energy conservation, water supply), an objective concerning planned modular construction, the utilization of temporary treatment plants, or attainment of consistency with locally adopted plans including comprehensive and capital improvement plans. However, the staging period may in no case be less than 10 years, because of associated cost penalties and the time necessary to plan and construct later stages.

(k) An evaluation of the costs, cost-savings, and effects of flow reduction measures unless the existing average daily base flow from the area is less than 70 gpcd, or the current population of the municipality is under 5,000, or the area is exempted by the department for having an effective existing flow reduction program. A flow reduction program shall be adopted by municipalities which shall include those measures determined to be cost effective.

(l) An analysis of innovative and alternative treatment processes and techniques that reclaim and reuse water, productively recycle wastewater constituents, eliminate the discharge of pollutants or recover energy. Where certain categories of alternative technologies may not be generally applicable because of prevailing climatic or geological conditions, a detailed analysis of these categories of alternative technologies is not required. However, the reason for such a rejection must be fully substantiated in the facilities plan.

(m) An analysis of the primary energy requirements (operational energy inputs) for each system considered. The alternative selected shall propose adoption of measures to reduce energy consumption or to increase recovery as long as such measures are cost effective.

(3) CONTENT OF AN ENVIRONMENTAL ASSESSMENT. An adequate environmental assessment must be an integral, though indentifiable, part of any facilities plan submitted to the department under NR 110.09 (1). The information submitted in the environmental assessment will be used by the department for determining whether or not an environmental impact statement is necessary. The analyses that constitute an adequate environmental assessment shall include:

(a) *Description of the existing environment without the project.* This shall include for the delineated planning area a description of the present environmental conditions relevant to the analysis of alternatives or determinations of the environmental impacts of the proposed action. This description shall include, but not be limited to, discussions of the following topics where applicable to a particular study: surface and ground water quality; water supply and use; general hydrology; air quality; noise levels; energy production and consumption; land use trends; population projections, wetlands, floodplains, coastal zones and other environmentally sensitive areas; historic and archaeological sites; other related federal or state projects in the area; and plant and animal communities which may be affected, especially those containing threatened or endangered species.

(b) *Description of the future environment without the project.* The future environmental conditions with the no project alternative shall be forecast, covering the same areas listed in par. (a) above.

(c) *Evaluation of alternatives.* This discussion shall include a comparative analysis of feasible options and a systematic development of wastewater treatment alternatives. The alternatives shall be screened with respect to capital and operating costs; significant primary and secondary environmental effects; physical, legal or institutional constraints; and whether or not they meet regulatory requirements. Special attention should be given to long term impacts, irreversible impacts and

induced impacts such a development. The reasons for rejecting any alternatives shall be presented in addition to any significant environmental benefits precluded by rejection of an alternative. The analysis should consider, when relevant to the project:

1. Flow and waste reduction measures, including infiltration/inflow reduction;

2. Alternative locations, capacities, and construction phasing of facilities;

3. Alternative waste management techniques, including treatment and discharge, wastewater reuse and land application;

4. Alternative methods for disposal of sludge and other residual waste, including process options and final disposal options;

5. Improving effluent quality through more efficient operation and maintenance;

(d) *Environmental impacts of the proposed action.* Primary and secondary impacts of the proposed action shall be described, giving special attention to unavoidable impacts, steps to mitigate adverse impacts, any irreversible or irretrievable commitments of resources to the project and the relationship between local short term uses of the environment and the maintenance and enhancement of long term productivity. The significance of land use impacts shall be evaluated, based on current population of the planning area; design year population for the service area; percentage of the service area currently vacant; and plans for staging facilities. Special attention should be given to induced changes in population patterns and growth, particularly if a project involves some degree of regionalization.

(e) *Steps to minimize adverse effects.* This section shall describe structural and nonstructural measures, if any, in the facilities plan to mitigate or eliminate significant adverse effects on the human and natural environments. Structural provisions include but are not limited to changes in facility design, size, and location; nonstructural provisions include but are not limited to staging facilities as well as developing and enforcing land use regulations and environmentally protective regulations.

(f) *Documentation.* Sources of information used to describe the existing environment and to assess future environmental impacts should be documented. In addition to the department, these sources should include regional, state and federal agencies with responsibility or interest in the types of impacts listed in par. (a) above. In particular, the following agencies should be consulted:

1. Local, and regional land use planning agencies and areawide waste treatment management planning agencies for assessments of land use trends and population projections, especially those affecting size, timing, and location of facilities;

2. The HUD Regional Office if a project involves a flood risk area identified under the Flood Disaster Protection Act of 1973 (Pub. L. 93-234);

3. The state coastal zone management agency, if a coastal zone is affected;

4. The secretary of the interior or secretary of agriculture, if a wild and scenic river is affected;

5. The secretary of the interior or secretary of commerce, if a threatened or endangered species is affected;

6. The fish and wildlife service (department of the interior), the department of commerce, and the U.S. army corps of engineers, if a wetland is affected.

(4) PUBLIC HEARING. Municipalities shall hold at least one public hearing before a facilities plan is adopted. A copy of the facilities plan should be available for public review before the hearing and at the hearing, since these hearings provide an opportunity for public comment on the issues associated with the facilities plan.

(5) CONTENT OF AN INFILTRATION/INFLOW ANALYSIS. (a) The infiltration/inflow analysis shall demonstrate whether or not excess infiltration/inflow exists in the sewer system. The analysis shall indentify the presence, flow rate, and type of infiltration/inflow conditions, which exists in the sewer systems.

(b) For determination of the possible existence of excessive infiltration/inflow, the analysis shall include an estimate of the cost of eliminating the infiltration/inflow conditions. These costs shall be compared with estimated total costs for transportation and treatment of the infiltration/inflow. This determination shall be made at several levels of infiltration/inflow removal.

(c) If the infiltration/inflow anaylsis demonstrates the existence or possible existence of excessive infiltration/inflow and the specific sources of excessive infiltration/inflow have not been adequately identified, a sewer system evaluation survey shall be conducted in accordance with NR 110.09 (6). A detailed plan for the sewer system evaluation survey shall be included in the infiltration/inflow analysis. The plan shall outline the tasks to be performed in the survey and their estimated costs.

(6) CONTENT OF A SEWER SYSTEM EVALUATION SURVEY. (a) The sewer system evaluation survey shall determine the location, estimated flow rate, method of rehabilitation and cost of rehabilitation versus cost of transportation and treatment for each defined source of infiltration/inflow.

(b) The report shall summarize the results of the sewer system evaluation survey. In addition, the report shall include:

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

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

(7) CONSTRUCTION PLANS AND SPECIFICATIONS FOR SEWAGE TREATMENT PLANT PROJECTS. In addition to the requirements of chapter NR 108 and

NR 110.06 and NR 110.07 above, the following requirements shall be adhered to for submission of plans for sewage treatment plants.

(a) *Overall plan.* A plan shall be submitted which shows the sewage treatment plant in relation to the remainder of the system. Sufficient topographic features shall be included to indicate its location with respect to streams and the point of discharge of treated effluent.

(b) *Layout.* A general layout plan shall be submitted which includes:

1. A contour map of the site;

2. The size and location of plant structures;

3. A schematic flow diagram indicating the various plant units;

4. Piping details including piping arrangements for bypassing individual units;

5. The materials handled and the direction of flow through each pipe;

6. The hydraulic profiles for sewage and sludge flows;

7. Soil conditions at the site.

(c) *Detailed plans.* Detailed construction plans shall be submitted which include:

1. The location, dimensions, elevations and details of all existing and proposed plant units;

2. The elevation of high and low water level in the receiving stream;

3. An adequate description of all features not covered in the specifications.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74; r. and recr. Register December, 1978, No. 276, eff. 1-1-79.

NR 110.10 Sewage collection system projects. (1) FACILITIES PLANS FOR SEWER PROJECTS. For sewer projects the facilities plan shall include the following information:

(a) *Description.* A brief description of the project; including its geographic location and any necessary reference maps or exhibits;

(b) *Topography.* A brief description of the topography of the general area with specific reference to the area serviced by the proposed sewer;

(c) *Soil investigations.* A description of the extent of soil investigations, including information on rock likely to be encountered. In addition, that portion of the proposed sewer which is below high ground water level shall be indicated;

(d) *Flooding.* A designation of any portion of the proposed sewer which is located within the floodway or floodplain as defined in chapter NR 116 All projects shall conform to the requirements of chapter NR 116;

(e) *Wetlands.* A statement indicating whether the proposed sewer will pass through a wetlands area, and the approximate acreage of the wetland;

(f) *Population.* Population growth rate (annual) based on the most recent data for the municipality;

(g) *Sewer service area.* If the sewer project is tributary to a treatment plant for which a service area that has been delineated as a part of an approved areawide waste treatment management plan, indicate the location of the sewer on a map of the service area;

(h) *Downstream overflows.* A statement indicating the number and location of overflows and bypasses in the sewer system;

(i) *Description of treatment facilities.* A brief description of the type of treatment facility indicating the ability of the facility to handle the sewage of the proposed project during both wet and dry weather conditions;

(j) *Costs.* A discussion of the estimated capital costs and where an entire sewerage system is being installed, the estimated annual cost to the user of the system;

(k) *Basis of design.* The following data shall be provided for the proposed project:

1. Design period;

2 Population densities per acre and total population served;

3. Area served by proposed sewers in acres;

4. Per capita sewage contribution expressed as an average and maximum value, include basis for this determination;

5. Infiltration;

6. Industrial waste contribution;

7. Design flow rates as expressed as average and maximum values;

8. Size of pipe, grade, velocity and maximum capacity.

(l) *Environmental assessment.* The department may require the submittal of an environmental assessment meeting the requirements of NR 110.09 (3) for large or complex sewer projects, for those projects which are proposed to be constructed in environmentally sensitive areas, or for projects which involve significant public controversy.

(2) STAGING OF INTERCEPTORS. Since the location and length of interceptors will influence growth, interceptor routes and staging of construction shall be planned carefully and shall be consistent with approved areawide waste treatment management plans, growth management plans and other environmental laws.

(a) Interceptor pipe sizes shall be based upon a staging period of 20 years. A larger pipe size corresponding to a longer staging period not to exceed 40 years may be allowed if the owner can demonstrate, wherever areawide waste treatment management plans have been approved, that the larger pipe would be consistent with projected land use patterns in such plans and would reduce overall (primary plus secondary) environmental impacts. These environmental impacts include:

1. Primary impacts.

a. Short-term disruption of traffic, business and other daily activities.

b. Destruction of flora and fauna, noise, erosion and sedimentation.

2. Secondary impacts.

a. Pressure to rezone or otherwise stimulate unplanned development.

b. Pressure to accelerate growth for quicker recovery of the non-federal share of the interceptor investments.

c. Effects on air quality and environmentally sensitive areas by cultural changes.

(b) The estimation of peak flows in interceptors shall be based upon the following considerations:

1. Daily and seasonal variations of pipe flows, the timing of flows from the various parts of the tributary area and pipe storage effects.

2. The feasibility of off-pipe storage to reduce peak flows.

3. The use of an appropriate peak flow factor that decreases as the average daily flow to be conveyed increases.

(3) CONSTRUCTION PLANS AND SPECIFICATIONS FOR SEWER PROJECTS. In addition to the requirements of chapter NR 108 and NR 110.06 and NR 110.07 plans and specifications for proposed sewer projects shall include a plan and profile view of all proposed construction. The plans and profiles shall show:

(a) *Location.* The location of existing or proposed streets and sewers;

(b) *Streams and water surfaces.* The location and 100 year flood elevation of all streams and water surfaces relevant to the project;

(c) *Elevations.* The line of the ground surface, the invert and surface elevation at each manhole and the grade of the sewer between each adjacent manhole. Basement elevations shall be noted on the plans or the designing engineer shall state that all sewers are sufficiently deep to serve adjacent basements except where otherwise noted on the plans. Where gravity basement drainage to the proposed sewer will not be possible for existing buildings, the buildings' owners shall be so advised prior to construction of the sewers;

(d) *Pipe size and material.* The pipe size, material, pipe strength and bedding class shall be shown on the plans or in the specifications;

(e) *Manhole spacing.* The length of sewer between the manholes shall be shown on the plans;

(f) *Special features.* The locations of all special features including inverted siphons, concrete encasements, elevated sewers, and other features as appropriate;

(g) *Existing structures.* The location of all known existing structures and utilities which might interfere with the proposed construction, particularly all water mains, gas mains, storm drains, and other pertinent structures;

(h) *Special drawings.* Special detail drawings made to a scale to clearly show the nature of the design shall be furnished to show the following:

1. Stream crossings with elevations of the stream bed and of normal and extreme high and low water levels;

2. Details of all special sewer joints and cross-sections;

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

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74; r. and recr. Register, December, 1978, No, 276, eff. 1-1-79.

NR 110.11 Sewage lift stations. (1) FACILITIES PLANS FOR SEWAGE LIFT STATIONS. The facilities plan shall include the following:

(a) *Contributory area.* A description of the extent of the existing and proposed contributory area with reference to a general system map as well as description of the areas of probable future expansion of the contributory area.

(b) *Location.* The location of the proposed lift station, force main and point of discharge to the existing sewer system. In addition the report shall discuss the capacity available in the existing downstream sewer to handle the additional flow.

(c) *Flooding.* A statement indicating whether the proposed lift station is in a floodway or floodplain as defined in chapter NR 116. All projects shall conform to the requirements of chapter NR 116.

(d) *Basis for design.* The design data for the proposed project including the following:

1. Design period;

2. Population densities per acre and total population served;

3. Area served in acres;

4. Per capita sewage contribution expressed as an average and as a maximum value;

5. Infiltration;

6. Industrial waste contributions;

7. Design flow rates expressed as average and maximum values; and

8. Design head conditions.

(e) *Essential features.* A description of the essential features of construction and operation of the proposed stations.

(f) *Costs.* Discussion of the estimated capital costs, estimated annual maintenance cost, and estimated annual cost to the average user of the system;

(g) *Environmental assessment.* The department may require the submittal of an environmental assessment meeting the requirements of NR 110.09 (3) for large or complex lift station projects, for those

projects constructed in environmentally sensitive areas or for projects which could involve significant public controversy.

(2) CONSTRUCTION PLANS AND SPECIFICATIONS FOR SEWAGE LIFT STATIONS. In addition to the requirements of chapter NR 108 and secs. NR 110.06 and 110.07, the following requirements shall be adhered to for submission of construction plans and specifications for sewage lift stations:

(a) *Location plan.* A location plan shall be submitted showing the tributary area, the municipal boundaries within the tributary area and the location of the lift station and force main, and all pertinent elevations;

(b) *Detailed plans.* The detailed lift station plans shall show the following, where applicable:

1. The location and the topography (using a contour map) of the property to be used;

2. The station details and all appurtenant equipment including pumps, sump pumps, heaters, ventilation equipment, valving, access ladder, intermediate landings, and wet well;

3. The elevation of high water at the site, including the maximum elevation of sewage in the collection system in the event of power failure at the station.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74; r. and recr. Register, December, 1978, No. 276, eff. 1-1-79.

NR 110.12 Owner approval requirement. If the engineer submitting plans to the department for approval is not an employe of or has not been retained by the owner of the sewerage system for which the plans are submitted, written acceptance of the final plans by the owner shall be required prior to submission of the plans to the department.

Note: For example, if an engineer is retained by a developer to design sewer extensions which will be connected to a municipal system and which will eventually be owned by the municipality, the plans must be accepted by the municipality before the department issues an approval.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.13 Sewer design criteria. (1) SEPARATE SANITARY SEWERS REQUIRED. New systems or extensions to existing systems shall be designed to exclude storm and other clear water sources from the sanitary sewer system. Combined sewers shall be approved as a replacement for existing structurally inadequate combined sewers only when separate sewers cannot be constructed in specific areas. Existing combined sewers shall be eliminated or the pollutional discharges from such sewers shall be controlled as soon as practical and in accordance with applicable state and federal enforcement actions.

Note: In instances where continued use of combined sewers is proposed and a definite program for treating the combined sewage can be established and found to be cost-effective, the department may waive the requirements of this subsection and approve such plans.

(2) DESIGN CAPACITY. Sewage collection systems, exclusive of interceptors, shall provide design capacity for the estimated ultimate tributary population. Interceptors shall provide design capacity for the anticipated flow 20 years after beginning operation unless a different

staging period is determined to be more environmentally sound in accordance with NR 110.10 (2) (a).

(3) DESIGN FACTORS. In determining the required capacities of sanitary sewers the following factors shall be considered:

(a) The maximum hourly quantity of sewage;

(b) The maximum waste quantity and flow rate from industrial plants;

(c) The extent of groundwater infiltration.

(4) DESIGN BASIS. (a) New sewer systems shall be designed on the basis of an average daily per capita flow of sewage of not less than 100 gallons per day. This figure is assumed to include normal infiltration. Sewers shall be designed to carry, when running full, not less than the following daily per capita contributions of sewage, exclusive of sewage or other wastes from industrial plants and other establishments having high peak flow rates:

1. Submain sewers—400 gallons.

2. Main, trunk and outfall sewers—250 gallons.

(b) When deviations from the foregoing per capita rates are proposed, sufficient justification and a brief description of the procedure used for sewer design shall be submitted.

(5) CONSTRUCTION DETAILS. (a) *Diameter.* No sewer shall be less than 8 inches in diameter.

(b) *Depth.* Sewers shall be designed deep enough to prevent freezing and, where economically feasible, to provide gravity basement drainage for sanitary wastes.

(c) *Slope.* Sewers shall be laid with uniform slope between manholes. All sewers shall be designed and constructed to give average velocities when flowing full of not less than 2.0 feet per second based on Kutter's or Manning's formula using an "n" value of 0.013. The following are the minimum slopes which shall be provided:

Sewer Size	Minimum Slope (ft./100 ft.)
8″	0.40
10″	0.28
12″	0.22
15″	0.15
18″	0.12
21″	0.10
24″	0.08

(d) *Alignment.* Sewers shall normally be laid with straight alignment between manholes.

Note: For 36″ diameter sewers or larger, the department may approve curvilinear sewers.

(e) *Increasing size.* When a sewer joins a larger one, the invert of the smaller sewer shall be laid at the proper elevation to maintain the same energy gradient.

(f) *Velocity.* Where velocities of greater than 15 feet per second are attained, special provision shall be made to protect against displacement or erosion.

(g) *Bedding and backfill.* The specifications shall provide for proper bedding and backfill for all sewer installations.

(6) MATERIALS. Materials used in the construction of sanitary sewers shall be restricted to the following: asbestos cement, cast iron, concrete, vitrified clay, steel, ductile iron, polyvinyl chloride, Acrylonitrile-Butadiene-Styrene (A.B.S.) Composite, or other materials approved by the department for restricted or experimental use. Where a restricted or experimental use approval is issued, the department may require a construction inspection report and annual reports including television inspection of the system as a condition of its approval.

(a) *Quality.* All material used for sanitary sewer construction shall be free from defects that impair service.

(b) *Labeling.* Each length of pipe and fitting used in a sanitary sewer shall be stamped or indelibly marked with the manufacturer's name or mark.

(c) *Nonpressure pipe.* All nonpressure sewer pipe shall have sufficient strength to withstand the loads which will exist. The following are minimum standards for nonpressure pipe:

1. Asbestos cement pipe and fittings shall meet the requirements of A.S.T.M. C428 (1972);

2. Cast iron pipe and fittings shall be of the commercial grade known as "extra heavy" and shall meet the requirements of A.W.W.A. C-100 (November 10, 1967);

3. Concrete pipe shall meet the requirements of A.S.T.M. C14 (1971), C76 (1972) or C655 (1970);

4. Vitrified clay pipe shall meet the requirements of A.S.T.M. C700 (1971) or A.A.S.H.O.-M65 (1961);

5. Steel pipe shall meet the requirements of A.W.W.A. C-200 (January 23, 1966);

6. Ductile iron pipe and fittings shall meet the requirements of A.W.W.A. C-100 (November 10, 1967);

7. Polyvinyl chloride sewer pipe shall meet the requirements of A.S.T.M. D3033 (1972) or D3034 (1973);

8. A.B.S. Composite sewer pipe shall meet the requirements of A.S.T.M. D2680 (1972);

Note: Other pipe material will be considered on its merits and may be approved by the department.

9. Copies of the technical references cited above are available for inspection at the offices of the department of natural resources, the secretary of state's office and the office of the revisor of statutes and may be obtained for personal use from the American Society for Testing and Material, 1916 Race Street, Philadelphia, Penn., 19103, and from the

American Water Works Association, 6666 West Quincy Ave., Den ver, Colo., 80235.

(d) *Joints for nonpressure pipe.* The method of making joints and the materials used shall be included in the specifications. Sewer joints shall be designed to minimize infiltration and to prevent the entrance of roots. Joint material shall be of such a composition as not to be adversely affected by the sewage.

1. Asbestos cement pipe joints shall consist of an asbestos cement sleeve and 2 neoprene or rubber type gaskets.

2. Cast iron pipe joints shall consist of rubber gasket joints, mechanical joints or lead joints meeting the requirements of A.W.W.A. C-100 (November 10, 1967).

3. Rubber gasket joints for concrete sewer pipe shall meet A.S.T.M. C443 (1972).

4. Resilient joints for vitrified clay sewer pipe shall meet A.S.T.M. C425 (1971).

5. Steel pipe joints shall meet the requirements of A.W.W.A. C-200 (January 23, 1966).

6. Ductile iron pipe joints shall meet the requirements of A.W.W.A. C-100 (November 10, 1967).

7. Polyvinyl chloride sewer pipe shall be jointed by solvent weld joints or by elastomeric joints which have been approved by the department.

8. A.B.S. Composite sewer pipe shall be jointed by solvent weld joints.

9. Copies of technical references cited above are available for inspection at the offices of the department of natural resources, the secretary of state's office and the office of the revisor of statutes and may be obtained for personal use from the American Society for Testing and Material, 1916 Race Street, Philadelphia, Penn., 19103, and from the American Water Works Association, 6666 West Quincy Ave., Denver, Colo., 80235.

(e) *Infiltration limits and testing.* Groundwater infiltration into the sanitary sewer system shall be minimized. Leakage tests shall be included in the specifications. Results from groundwater infiltration tests shall not exceed the following limits:

1. Water exfiltration or infiltration shall not exceed 200 gallons per inch of pipe diameter per mile per day for the total system under construction. Leakage between adjacent manholes shall not exceed 500 gallons per inch diameter per mile per day; or

2. A low pressure air test may be substituted for the water exfiltration or infiltration test. The air test, if used, shall conform to the test procedure reported on by Ramseier and Riek in the Journal of Sanitary Engineering Division of the proceedings of the American Society of Civil Engineers, April 1964. Copies of the report by Ramseier and Riek which appeared in the Journal of Sanitary Engineering Division, April 1964, are available for inspection at the office of the department of natural resources, the secretary of state's office and the office of the revisor of

statutes and may be obtained for personal use from the Journal of Sanitary Engineering Division, 345 East 47th Street, New York, New York 10017.

(f) *Pressure sewer pipe and joints.* All pressure sewer pipe shall meet the following minimum requirements:

1. Asbestos cement pipe and joints shall meet the requirements of A.W.W.A. C-400 (January 31, 1972).

2. Cast iron pipe and joints shall meet the requirements of A.W.W.A. C-100 (November 10, 1967).

3. Ductile iron pipe and joints shall meet the requirements of A.W.W.A. C-100 (November 10, 1967).

4. Steel pipe and joints shall meet the requirements of A.W.W.A. C-200 (January 23, 1966).

5. Concrete pipe and joints shall meet the requirements of A.W.W.A. C-300 (January 27, 1964).

Note: Other pipe material or joints will be considered on their merit and may be approved by the department.

6. Copies of the technical references cited above are available for inspection at the office of the department of natural resources, the secretary of state's office and the office of the revisor of statutes and may be obtained for personal use from the American Water Works Association, 6666 West Quincy Ave., Denver, Colo., 80235.

(7) MANHOLES. (a) *Location.* Manholes shall be installed at the following locations: 1) at the end of each line; 2) at all changes in grade, size or alignment; 3) at all intersections; and 4) at intervals not greater than 400 feet for sewers 15 inches or less, and 500 feet for sewers 18 inches to 30 inches. Lampholes shall be used only for special conditions.

Note: For sewers greater than 30 inches, the interval between manholes shall be determined on a case by case basis.

(b) *Drop pipe.* A drop pipe shall be provided for a sewer entering a manhole where the invert elevation of the entering sewer is 24 inches or more above the spring line of the outgoing sewer.

Note: For large diameter sewers, the use of drop pipes will be evaluated on a case by case basis.

(c) *Diameter.* The minimum diameter of manholes shall be 42 inches.

Note: Larger diameters are preferable.

(d) *Construction.* Manholes shall be constructed of precast concrete, monolithic concrete, segmented brick or block or other approved materials.

(e) *Flow channel.* The flow channel through manholes shall be made to conform to the shape and slope of the sewers.

(f) *Water tightness.* Solid manhole covers shall be used wherever the manhole tops may be flooded by street runoff or high water. Where groundwater conditions are unfavorable, manholes of brick or segmented block shall be waterproofed on the exterior with plaster coatings

supplemented by a bituminous waterproof coating or other approved coatings.

(8) INVERTED SIPHONS. Inverted siphons shall have not less than 2 barrels with a minimum pipe size of 6 inches and shall be provided with the necessary appurtenances for convenient flushing and maintenance. The manholes shall have adequate clearance for rodding and, in general, sufficient head shall be provided and pipe sizes selected to secure velocities of at least 3.0 feet per second at average flows. The inlet and outlet details shall be arranged so that the normal flow is diverted to one barrel, and so that either barrel may be removed from service for cleaning.

(9) PROTECTION OF WATER SUPPLIES. (a) *Cross-connections.* There shall be no physical connection between a public or private potable water supply system and a sewer or appurtenance thereto which would permit the passage of any sewage or polluted water into the potable supply. Water main bleeders into sanitary sewer manholes are prohibited.

(b) *Separation from wells.* Sewers shall be laid at least 200 feet from a public water supply well and at least 50 feet from a private water supply well. All wells located within the distances referred to above shall be indicated on the plans.

Note: In the event these distances cannot be maintained, the department shall be notified and may approve alternate specifications.

(c) *Horizontal separation.* Sewers shall be laid at least 8 feet horizontally from any existing or proposed water main. The distance shall be measured center to center. Should local conditions prevent a horizontal separation of 8 feet, a sewer may be laid closer to a water main provided that:

1. The bottom of the water main is at least 18 inches above the top of the sewer and the minimum horizontal separation is 3 feet measured edge to edge; and

2. A profile of the rock surface as determined from exploration shall be shown on the plan when rock excavation is the reason for the variance from the 8-foot separation.

Note: Rock which can be removed by normal excavation methods will not be grounds for a variance from this provision.

(d) *Vertical separation.* Whenever sewers cross under water mains, the sewer shall be laid at such an elevation that the top of the sewer is at least 6 inches below the bottom of the water main. Whenever sewers cross over water mains, the sewer shall be laid at such an elevation that the bottom of the sewer is at least 18 inches above the top of the water main.

Note: When the elevation of the sewer cannot be varied to meet the above requirements, the department may grant a variance from this requirement, provided that the water main is reconstructed for a minimum distance of 8 feet on each side of the sewer. The purpose of this reconstruction is to insure that one full length of water main is centered on the sewer so that both joints will be as far from the sewer as possible. Structural support of the pipes may be required at some locations.

(e) *Exception.* When it is impossible to obtain the proper horizontal and vertical separation separation set forth in NR 110.13 (9) (c) and (d), the sewer shall be constructed of materials and with joints that are equivalent to water main standards of construction and pressure tested

to assure watertightness. All force mains, however, shall be constructed to meet, at a minimum, the requirements set forth in NR 110.13 (9) (c) 1.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74; am. (2), Register, December, 1978, No. 276, eff. 1-1-79.

NR 110.14 Sewage lift station design criteria. (1) LOCATION. Sewage lift stations shall be accessible at all times and shall be so located as not to be subject to flooding.

Note: The department recommends that sewage lift stations not be in the traffic lane of a street.

(2) DESIGN BASIS. The following items shall be provided where applicable:

(a) *Pump chamber.* The pump chamber shall be completely separate from the wet well.

(b) *Pump removal.* Provision shall be made to facilitate removing pumps and motors.

(c) *Access.* A safe means of access shall be provided to pump chambers and to wet wells containing equipment requiring inspection or maintenance. If a pump chamber is over 20 feet deep, an offset shall be made in the entrance ladder with an intermediate landing at approximately mid-depth. Where an intermediate landing is used, the diameter of the landing area shall be at least 5 feet and a suitable barrier shall be provided to prevent an individual from falling past the intermediate landing to the lower level.

(d) *Duplicate units.* At least 2 pumps or pneumatic ejectors shall be provided for each installation. Where the pumping station will serve not more than 25 homes, a single unit may be used, provided that the station is designed to permit the installation of a future duplicate pump with no structural changes. Each pumping unit shall be capable of handling the expected maximum flow. If three or more pumps are provided, they must be designed to fit expected flow conditions and must be capable of handling the maximum flow with one unit out of service.

(e) *Protection against clogging.* Where a potential for clogging exists, protection in the form of bar screens, mechanically cleaned bar screens, basket screens, comminutors or other suitable means shall be provided.

(f) *Pump openings.* Pumps must be capable of passing spheres of at least 3 inches in diameter. With proper protection against clogging, pumps capable of passing 2½-inch spheres may be used on small installations. Pump suction and discharge openings shall be at least 4 inches in diameter.

(g) *Priming.* The pump shall be located so that under normal operating conditions it will operate under a positive suction head. Self-priming or vacuum primed pumps are excepted from this requirement.

(h) *Electrical equipment.* Electrical equipment in enclosed places where gas may accumulate shall comply with the hazardous application conditions of the electrical code.

(i) *Intake.*

Note: The department recommends that each pump have an individual intake and that intakes be designed with suction elbows with flared opening. In addition, the department recommends that the intake be placed ½ the diameter of the bell above the floor.

(j) *Dewatering.* A sump pump shall be provided in pump chambers to remove leakage or drainage with the discharge at an elevation as high as practical in the wet well. A siphon break shall be included at the high point in the wet well.

(k) *Pumping rate.* The pumping rates for stations discharging to sewage treatment plants must approximate the rate of delivery to the station.

(l) *Controls.*

Note: There are no requirements for alternate use of pump in lift stations; however, the department recommends that in small lift stations, provision be made to alternate the pumps in use.

(m) *Valves.* Suitable shutoff valves shall be placed on suction and discharge lines of each pump. A check valve shall be placed on each discharge line between the shutoff valve and the pump.

Note: It is recommended that the check valve preferably be on a horizontal section of pipe.

(n) *Wet well size.* The effective capacity of the wet well shall provide a holding period not to exceed 10 minutes for the design average flow.

(o) *Wet well floor slope.* The wet well floor shall have a minimum slope of 1 to 1 to the hopper bottom. The horizontal area of the hopper bottom shall be kept to a practical minimum.

(p) *Ventilation.* 1. Adequate ventilation shall be provided for all pump stations. Where the pump chamber is below the ground surface, mechanical ventilation is required. Mechanical ventilation shall also be provided in all wet wells where equipment requiring inspection or maintenance is located. There shall be no interconnection between wet well and pump chamber ventilation systems. Switches for operation of ventilation equipment shall be marked and conveniently located.

Note: Consideration should be given to the use of automatic controls where intermittent ventilation is used. Heating and/or dehumidification equipment shall be provided where needed.

Note: Ventilation is not normally required in submersible pump lift stations.

2. Ventilation for wet wells must provide at least 12 complete air changes per hour if ventilation is continuous and at least 30 complete air changes per hour if ventilation is intermittent. Air shall be forced into the wet well rather than exhausted.

3. Ventilation for pump chambers should provide at least 6 complete air changes per hour if ventilation is continuous and at least 30 complete air changes per hour if ventilation is intermittent.

(q) *Flow measurement.* Suitable devices for measuring sewage flow shall be installed.

(r) *Water supply.* There shall be no connection between any potable water supply and sewage lift station which might cause contamination of the potable supply.

(3) SUCTION LIFT PUMPS. (a) *Priming.* Suction lift pumps shall be of the self-priming or vacumm primed type.

Note: It is recommended that in general the total suction lift not exceed 15 feet.

(b) *Capacity.* The capacity of suction lift pumps shall not exceed 500 gallons per minute.

Note: Larger units may be approved by the department if sufficient justification is presented.

(4) SUBMERSIBLE PUMPS. (a) *Type.* Submersible pumps shall be readily removable and replaceable without dewatering the wet well and with continuity of operation of the other unit or units.

(b) *Installation.* The low water level in the station shall be set at a level such that the pump and motor will be continuously below the minimum sewage level in the wet well or the pump shall be rated as explosion proof by the board of fire underwriters.

(5) ALARMS. (a) Alarm systems shall be provided at all stations. The alarm shall be activated in case of power failure, high water in the wet well or high water in the dry well. In the event a telephone line to a remote location is used as the means of alarm, the alarm shall be activated in the event of a failure in the telephone line.

(b) The alarm shall be either a suitable audible or visual alarm and shall be so located as to be readily seen or heard.

(6) EMERGENCY OPERATION. (a) Provisions for emergency operation of lift stations shall be provided to prevent the discharge of raw or partially treated sewage to a surface water or to the ground surface and to prevent sewage backup into basements.

(b) Power must be available from at least two independent sources or, in the alternative, emergency power generating equipment or portable pumping equipment must be available.

Note: It is recommended that a point of connection to the discharge force main be installed at a point where portable pumping units can be connected.

(7) FORCE MAINS. (a) *Velocity.* A velocity in excess of two feet per second shall be maintained in force mains.

(b) *Air relief valve.* An air relief valve shall be placed at high points in the force main to prevent air locking.

(c) *Termination.*

Note: The department recommends that force mains enter gravity sewer manholes at a point not more than 2 feet above the spring line of the outgoing sewer.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.15 General requirements for sewage treatment works. (1) QUALITY OF EFFLUENT. (a) For purposes of design, the minimum allowable level of treatment shall be that level of treatment which results in the removal of 90% of the 5-day biochemical oxygen demand (BOD,) and 90% of the suspended solids (SS).

Note: Higher levels of treatment may be required depending on the characteristic of the waste being treated, the low flow in the receiving stream or the water quality standards of the receiving stream.

(b) Existing treatment plants capable of removing at least 85% of the BOD_5 and SS and capable of producing an effluent quality of less than 30 mg/1 of BOD_5 and SS on a monthly average will be allowed to remain in service for the design life of the plant if water quality standards can be met in the receiving water.

(c) All effluents discharged to a receiving surface water, except from stabilization ponds, shall be properly disinfected in accordance with NR 111.23.

(2) DESIGN CAPACITY. The design capacity for municipally owned sewage treatment facilities shall be in accordance with NR 110.09 (2) (j). Privately owned domestic waste treatment facilities shall provide design capacity for the estimated population 20 years from the time of start-up of the facility unless the cost-effective staging analysis in NR 110.09 (2) (j) 4. justifies a lesser design staging period.

(3) PLANT LOCATION. (a) Sewage treatment processes, except for lagoon systems, shall be located on sites not less than 500 feet from the nearest inhabited dwelling. Aerated lagoon treatment system shall be located not less than 750 feet from inhabited dwellings and stabilization ponds shall be located not less than 1,500 feet from inhabited dwellings.

(b) Existing treatment facilities which when constructed met the above distance requirement but which have since been encroached upon by residential, commercial or industrial development, shall be subjected to the above requirement at the time of expansion of the facility.

Note: The department may waive this requirement on a case-by-case basis. However, it is recommended that the municipality consider either the purchase of sufficient lands surrounding the plant site or the use of zoning to prevent encroachment of residential, commercial or industrial developments.

(c) All treatment plants and ponds shall be located such that they are not subject to flooding. No plant or pond shall be located in a floodway. If the plant or pond is located in a floodplain, it shall conform to chapter NR 116. The plant or pond shall be accessible at all times.

(4) NEW PROCESSES, METHODS AND EQUIPMENT.

Note: It is the policy of the department to encourage the development of new methods or equipment for treatment of sewage wastes. However, where new processes, methods or equipment are proposed and where limited data is available which demonstrates the performance of the equipment, the department may require the posting of a performance bond by the manufacturer.

(5) SEWAGE FLOW. Unless satisfactory justification is given for using a different value, new sewage treatment systems shall be designed for an average daily flow of 100 gallons per capita, and for anticipated daily flows from industrial waste contributors. Modifications or expansions of existing treatment systems shall be based on gaugings of the present sewage flow, plus allowance for estimated future increase.

(6) BOD_5 AND SS. Unless satisfactory justification is given for using different values, sewage treatment systems shall be designed based on a BOD_5 contribution of 0.17 pounds per capita per day and SS contribution of 0.20 pounds per capita per day and anticipated industrial waste contributions.

(7) DESIGN LOADING. The design of treatment units shall be based on an average rate of sewage flow per 24 hours except where significant

deviation from normal diurnal flow pattern exists. Industrial waste design flows shall be determined from the observed rate of flow during the significant period of discharge. The following factors shall be evaluated in determining the design flow of the sewage treatment plant:

(a) Peak flow rates occurring over significant time periods;

(b) Data from similar municipalities in the case of new systems;

(c) Wet weather flows. Excessive clear water must be eliminated at its source and must not be included in the plant design;

(d) Recirculation.

(8) DESIGN OF CONDUITS. All piping and channels shall be designed to carry the maximum flows. The incoming sewer shall be designed to operate without surcharge. Pockets, corners and other dead areas where solids can accumulate must be eliminated.

(9) ARRANGEMENT OF UNITS. All treatment units shall be arranged to provide operating convenience and flexibility, and to facilitate installation of future units.

(10) BY-PASSES. Complete plant by-passes shall not be provided. By-passing of individual units for maintenance purposes is permissible. During periods of maintenance, the minimum degree of treatment shall be solids settling and effluent disinfection.

(11) TREATMENT DURING CONSTRUCTION. During construction of new facilities, treatment shall be maintained at the same level as that which existed prior to the start of construction.

(12) CONSTRUCTION MATERIALS. Materials shall be selected that are compatible with the characteristics of the sewage wastes.

Note: Dissimilar metals should be avoided to minimize galvanic action.

(13) PAINTING. (a) The use of paints containing lead is prohibited. In order to facilitate the identification of piping, the following color scheme shall be utilized:

1. Sludge line—brown;

2. Gas line—red;

3. Potable water line—blue;

4. Chlorine line—yellow;

5. Sewage line—gray;

6. Compressed air line—green;

7. Nonpotable water line—blue with 6-inch red bands spaced 30 inches apart.

(b) In addition to the color code, each pipe shall be adequately labeled with a minimum of 2 labels in each room, crawl space or compartment.

(14) OPERATING EQUIPMENT. All necessary tools and accessories for the plant operator's use shall be provided. Storage space and a work area shall also be provided.

(15) EMERGENCY POWER. A standby power source shall be provided at each sewage treatment plant in the form of connection to 2 independent power sources or by providing an emergency power generator. Sufficient emergency power shall be supplied to provide a minimum treatment equivalent to solids settling and effluent disinfection at all times.

(16) WATER SUPPLY. An adequate supply of potable water shall be provided for use in the laboratory. No connections shall be made which might cause contamination of a potable water supply.

(a) *Direct connections.* Potable water from a public supply may be used directly at points above grade for the following hot and cold supplies: lavatory sink, water closet, laboratory sink, shower, eyewash fountain and drinking fountain. Hot water for any of the above shall not be taken directly from a boiler used for supplying hot water to a sludge heat exchanger or digester heating coils.

(b) *Indirect connections.* Where a potable water supply is to be used for any other purpose than those listed in paragraph (a), a break tank, pressure pump and pressure tank or a backflow preventer shall be provided.

1. Break tank. Potable water shall be discharged to the break tank through an air gap at least 6 inches 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 or sill cock located on the water system beyond the break tank to indicate that the water is not safe for drinking.

2. Backflow preventer. a. Backflow preventers may be used to protect the potable water supply provided that the following conditions are met:

i. Detailed plans and specifications covering the unit and its installation are approved by the department of health and social services, plumbing section, before installation.

ii. The installation is made above grade in a location accessible for testing, inspection and maintenance, and is protected from freezing and flooding.

iii. The unit is installed immediately downstream of the meter prior to any branches off the service line.

b. The following protective devices shall be installed where backflow preventers are used:

i. Chlorinator water supply. A vacuum breaker shall be installed downstream of the last water supply shutoff valve and at an elevation higher than the chlorinator.

ii. Hose bibs and approved yard hydrants. An approved combination backflow-siphon breaker shall be provided.

iii. Sinks or lavatories. A vacuum breaker located 6-7½ feet above the sink or, if located at sink elevation, an anti-hose connection on the faucet shall be required.

iv. Pump bearing lubrication. A vacuum breaker shall be provided downstream of the shutoff valve and above the elevation of the pumps. Additionally, a ⅛″ to ¼″ bleed line shall be installed that will allow free discharge to a storm sewer or to the ground surface.

(c) *Separate potable water supply.* Where it is not possible to provide potable water from a public water supply, a separate potable water supply must be provided.

Note: If a separate well is provided, the well specifications and usage must be approved by the private water supply section of the department.

(d) *Separate nonpotable water supply.* Where a separate nonpotable water supply is provided, a break tank or backflow preventer will not be necessary, but all water outlets must be posted with a permanent sign indicating the water is not safe for drinking.

(17) SANITARY FACILITIES.

Note: It is recommended that a toilet, shower and lavatory be provided.

(18) LABORATORY SPACE AND EQUIPMENT. All treatment works should include a laboratory for making the necessary analytical determinations and operating control tests. Equipment necessary for making the various determinations required by the department should be provided. In lieu of laboratory testing at the plant site, a suitable contract with a neighboring plant or independent laboratory is acceptable.

(19) FLOW MEASUREMENT. Equipment for flow measurement, totalizing and recording shall be provided for the total waste flow.

Note: It is recommended that measurement of other flow streams within the plant be done in aid of plant operation.

(20) FLOOR SLOPE. Floor surfaces shall be sloped adequately to a point of drainage.

(21) SAFETY.

Note: Although safety regulation is beyond the scope of these rules, the department recommends that adequate provision be made to effectively protect the operator and visitors from hazards. It is further recommended that the Safety and Health Rules set forth in chapter Ind 1000, Wis. Adm. Code, and the appropriate federal and local safety codes be adhered to in the operation of the plant. The following are specific measures which might be taken to enhance the safe operation of the plant:

(a) Enclosure of the plant site with a fence to discourage entrance of animals or unauthorized persons.

(b) Installation of hand rails and guards where necessary.

(c) Provision of first aid equipment.

(d) Posting of "No Smoking" signs in hazardous areas.

(e) Provision of protective clothing and equipment such as gas masks, goggles, gloves.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74; r. and recr. (1) (c), Register, March, 1978, No. 267, eff. 4-1-78.

NR 110.16 Screening devices. (1) APPLICABILITY. All sewage treatment plants shall provide protection for pumps and other equipment by installing coarse bar racks or screens, comminutors or mechanically cleaned bar screens. All equipment shall be readily accessible for maintenance. A screening device shall precede grit chambers.

(2) ACCESS. Screening devices shall be provided with convenient access, adequate lighting and ventilation, and convenient and adequate means for removing screenings when necessary.

(3) SEPARATION FROM OTHER EQUIPMENT IN BUILDING. Screening devices installed in a building where other equipment or offices are located shall be separated from the rest of the building, provided with separate outside entrances, and provided with adequate means of ventilation.

(4) DESIGN AND INSTALLATION. (a) *Nonmechanical screens.* Clear openings between bars shall not exceed two inches. Design and installation of bar screens shall be such that they can be conveniently cleaned.

(b) *Mechanical screens.* Clear openings for mechanically cleaned screens may be as small as adequate for conditions.

(c) *Velocities.* For hand raked bar screens the screen chamber should be designed to provide a velocity through the screen of approximately one foot per second at average rate of flow. For mechanically cleaned screens maximum velocities during wet weather periods shall not exceed 2.5 feet per second.

(d) *Invert.* The screen channel invert must be at least 3 inches below the invert of the incoming sewer.

(e) *Slope.* Hand-cleaned screens, except those for emergency use, must be placed on a slope of 30 to 45 degrees with the horizontal.

(5) CHANNELS. The channel preceding and following the screen shall be shaped to minimize settling of solids. Fillets shall be installed as necessary. Channels shall be equipped with the necessary gates to divert flow from any one screening unit. Methods for dewatering each unit must be provided.

(6) SAFETY DEVICES. All mechanical units which are operated by timing devices shall be provided with auxiliary controls which will activiate the cleaning mechanism at predetermined high-water marks or differentials in head.

(7) HANDLING SCREENINGS. Adequate facilities must be provided for removal, handling, storage, and disposal of screenings in a sanitary manner. Hand-cleaned screening facilities must include an accessible platform from which the operator may rake screenings. Suitable drainage facilities must be provided both for the platform and for storage areas.

(8) AUXILIARY SCREENS. Where mechanically operated screening or comminuting devices are used auxiliary hand-cleaned screens shall be provided. Plant design must provide for the automatic diversion of the entire sewage flow through the auxiliary screens should the regular units fail.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.17 Grit removal facilities. (1) APPLICABILITY. Grit removal facilities are recommended for all sewage treatment plants, and are required for plants receiving sewage from combined sewers or from sewer systems receiving substantial amounts of grit.

(2) TYPE AND NUMBER OF UNITS. Grit removal facilities must have at least two hand-cleaned units, or a mechanically cleaned unit with a bypass. Where aerated grit chambers are proposed, detailed design information and necessary supporting documents shall be provided with the plans.

(3) DESIGN FACTORS. (a) *Inlet.* Inlet turbulence shall be minimized.

(b) *Velocity and detention.* Channel-type chambers shall be designed to provide controlled velocities of one foot per second. The detention period shall be based on the size of particle to be removed.

(c) *Grit washing.* All facilities not provided with positive velocity control shall include means for grit washing to further separate organic and inorganic materials.

(d) *Drains.* Drains or other means for dewatering each unit must be provided.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.18 Settling tanks. (1) INLETS. Settling tank inlets shall be designed to dissipate the inlet velocity, to distribute the flow equally and to prevent short-circuiting. Channels shall be designed to maintain a velocity of at least one foot per second at one-half of design flow. Corner pockets and dead ends shall be eliminated and corner fillets or channeling used where necessary. Elimination or removal of floating materials in inlet structures having submerged ports shall be required.

(2) LENGTH OF FLOW. The minimum length of flow from inlet to outlet shall not be less than 10 feet unless special provision is made to prevent short-circuiting.

(3) SCUM BAFFLES. Scum baffles shall be provided ahead of outlet weirs on all primary and final settling tanks. Mechanical scum removal equipment shall be provided in all primary and final settling tanks.

Note: It is recommended that decanting tanks be used.

(4) WEIRS. Overflow weirs shall be adjustable. Weir loadings shall not exceed 10,000 gallons per day per linear foot for plants designed for average flows of 1.0 mgd or less.

Note: Weir loadings not in excess of 15,000 gallons per day per linear foot may be approved by the department for plants designed for flows in excess of 1.0 mgd.

(5) SUBMERGED SURFACES. The tops of troughs, beams, and similar construction features which are submerged shall have a minimum slope of 1.4 vertical to one horizontal.

Note: It is recommended that a slope of one to one on the underside of such features to prevent the accumulation of scum and solids be provided.

(6) MULTIPLE TANKS. Multiple units shall be provided at all plants with a design flow of greater than 0.5 mgd.

Note: The department may waive this requirement if it concludes that the facilities can be effectively operated for a short time with a single unit removed from service.

(7) SERVICING FACILITIES. All settling basins shall be provided with easy access for maintenance.

(8) SURFACE SETTLING RATES. (a) *Primary settling tanks.* Surface settling rates for primary tanks shall not exceed 600 gallons per day per square foot based on the design flow for plants where excess activated sludge or recirculated flows are returned to the primary settling tanks. In other cases, the surface settling rates shall not exceed 1,000 gallons per day per square foot based on the design flow.

(b) *Intermediate settling tanks.* Surface settling rates for intermediate settling tanks shall not exceed 1,000 gallons per day per square foot based on their design flow.

(c) *Final settling tanks.* Surface settling rates for final settling tanks based on their design flow, shall not exceed 600 gallons per day per square foot except as provided in NR 110.20 (5) (b), Wis. Adm. Code.

(9) SLUDGE REMOVAL. Direct pump suction to the sludge hoppers of primary settling tanks shall be provided. A sludge well shall be provided or appropriate equipment installed for viewing and sampling the sludge. Continuous sludge removal from final settling tanks shall be provided. Each sludge hopper shall have an individually valved sludge withdrawal line at least 6 inches in diameter. Head available for withdrawal of sludge shall be at least 30 inches for gravity withdrawal.

(10) DEPTH. The liquid depth of mechanically cleaned settling tanks shall be as shallow as practical but not less than 7 feet. Final clarifiers for activated sludge shall not be less than 10 feet in depth.

(11) SLUDGE HOPPERS. Hoppers shall be accessible for maintenance from the operating level. The minimum slope of the side walls of sludge hoppers shall be 1.7 vertical to one horizontal. Clearance between the end of the sludge draw-off pipe and the hopper walls shall be sufficient to prevent "bridging" of solids. Hopper bottoms shall have a maximum dimension of two feet along the side.

(12) MECHANICAL SLUDGE COLLECTION EQUIPMENT. Suitable mechanical sludge collection equipment shall be provided in all settling tanks except for installations too small to warrant the use of mechanically equipped tanks.

(13) IMHOFF TANKS. Imhoff tanks are not acceptable.

Note: The department will waive this prohibition and approve Imhoff tanks only when plans are accompanied by sufficient justification and detailed design data.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.19 Biological treatment; trickling filters. (1) APPLICABILITY. New trickling filters are not acceptable unless used in conjunction with other treatment units which will produce an overall level of treatment defined as acceptable in NR 110.15 (1). Existing trickling filters may be used as a treatment unit in plant expansion if the overall requirements of NR 110.15 (1) are met. Trickling filters shall be preceded by approved settling tanks equipped with scum collecting devices, or other suitable pretreatment facilities.

(2) DESIGN BASIS. Trickling filters shall be designed to accept an organic loading of less than 50 pounds of BOD_5 per 1,000 cubic feet of media. Filters using manufactured media shall be loaded at less than 75 pounds BOD_5 per 1,000 cubic feet of media.

Note: The department may approve a higher loading rate depending on the use of the filter with respect to other plant units.

(3) DOSING EQUIPMENT. (a) *Distribution.* The sewage shall be distributed over the filter by rotary distributors or other suitable devices which will permit reasonably uniform distribution to the surface area.

(b) *Dosing.* Sewage shall 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 continuous. A piping system which will permit recirculation shall be provided.

(c) *Clearance.* A minimum clearance of 6 inches between media and distributor arms shall be provided.

(4) MEDIA. (a) *Type.* The media shall be crushed rock, slag or any approved specially manufactured material.

(b) *Quality.* The media shall be durable, resistant to spalling or flaking, and be relatively insoluble in sewage. The top 18 inches of natural aggregate shall have a loss of not more than 10% as measured by the 20-cycle, sodium sulfate soundness test, with the balance passing a 10-cycle test. The test shall be done in accordance with A.S.C.E. Manual of Engineering Practice, Number 13 (October 13, 1935). Copies of the A.S.C.E. Manual of Engineering Practice, Number 13, are available for inspection at the office of the department of natural resources, secretary of state's office and the office of the revisor of statutes and may be obtained for personal use from the American Society of Civil Engineers, 33 West 39th Street, New York, New York. Slag media shall be free from iron. Manufactured media shall be structurally stable and chemically and biologically inert.

(c) *Depth.* The filter media shall have a minimum depth of 5 feet above the underdrains and shall not exceed 7 feet in depth except where special construction is justified by studies.

(5) SIZE AND GRADING OF MEDIA. (a) *Rock, slag and similar media.* Rock, slag and similar media shall not contain more than 5% by weight of pieces whose longest dimension is 3 times the least dimension. They shall be free from thin elongated and flat pieces, dust, clay, sand, or fine material and shall conform to the following size and gradings when mechanically graded over vibrating screen with square openings:

1. Passing 4½-inch screen—100% by weight;

2. Retained on 3-inch screen—95-100% by weight;

3. Passing 2-inch screen—0-2% by weight;

4. Passing 1-inch screen—0.1% by weight;

(b) *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 no material shall be dumped directly into the filter. Crushed rock, slag and similar media shall be rescreened or forked at the filter site to removal all fines. Such material shall be placed by hand to a depth of 12 inches above the tile underdrains and all material shall be carefully placed so as not to damage the underdrains. The remainder of the material shall be placed by means of belt conveyors or equally effective methods. Trucks, tractors, or other heavy equipment shall not be driven over the filter during or after construction.

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

(b) *Slope.* The underdrains shall have a minimum slope of 1%. Effluent channels shall be designed to produce a minimum velocity of 2 feet per second at average daily rate of application to the filter.

(c) *Flushing.* Provision shall be made for flushing the underdrains. In small filters, use of a peripheral head channel with vertical vents is acceptable for flushing purposes. Inspection facilities shall be provided.

(d) *Ventilation.* The underdrainage system, effluent channels, and effluent pipe shall be designed to permit free passage of air. The size of drains, channels, and pipe shall be such that not more than 50 percent of their cross-sectional area will be submerged under the design hydraulic loading.

Note: The design of the effluent channels should consider the possibility of increased hydraulic loading.

(7) PROTECTION FROM FREEZING. (a) *Covers.* Covers shall be provided on all filters to prevent icing and freezing during wintertime conditions and to increase the efficiency of removal through the filter during cold weather.

Note: Where it can be demonstrated that freezing is not a problem and efficiencies are maintained at a high level during all weather conditions, the department may waive this requirement. Other means to prevent freezing and improve efficiency will also be considered by the department on their individual merits.

(b) *Ventilation of covered filters.* Adequate ventilation shall be provided to maintain the filter in an aerobic state at all times.

Note: Mechanical power ventilation at all installations is recommended.

(8) SPECIAL FEATURES. (a) *Flooding.*

Note: It is recommended that filter structures be so designed so that they may be flooded.

(b) *Seals.* Mercury seals shall not be used on trickling filter distributors.

(c) *Maintenance.* All distribution devices, underdrains, channels and pipes shall be installed so that they may be properly maintained, flushed or drained.

(d) *Flow measurement.* Devices shall be provided to permit measurement of flow to the filter, including the amount of recirculated flow.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.20 Biological treatment; activated sludge. (1) APPLICABILITY.

Note: The activated sludge process, and its various modifications, may be used where sewage is amenable to biological treatment.

(2) PROCESS SELECTION. All designs shall provide for flexibility in operation.

Note: Choice of the activated sludge process most applicable will be influenced by the proposed plant size, type of waste to be treated, and degree and consistency of treatment required.

(3) WINTER PROTECTION. Measures shall be taken to insure against freezing.

(4) PRETREATMENT. Where primary settling tanks are not used, effective removal of grit, debris, excessive oil or grease, and comminution of solids shall be accomplished prior to the activated sludge process.

(5) SETTLING TANKS. The following requirements are in addition to those set forth in NR 110.18:

(a) *By-pass.* When a primary settling tanks is used, piping shall be provided to allow raw sewage to be discharged directly to the aeration tanks following pretreatment. When a primary settling tank is not used, piping shall be provided to allow raw sewage to be discharged to the final settling tanks to permit a minimum of primary treatment and effluent disinfection.

(b) *Final settling tanks.* 1. Inlets, sludge collection and sludge withdrawal facilities shall be designed as to minimize density currents and assure rapid return of sludge to the aeration tanks.

2. Multiple units capable of independent operation shall be provided in all plants where design flows exceed 500,000 gallons per day, unless other provision is made to assure continuity of treatment.

3. Effective baffling and mechanical scum removal equipment shall be provided for all final settling tanks.

Note: The department recommends that the following design parameters be observed in the design of final settling tanks for the following activated sludge processes, except that due consideration be given to the flow duration and the solids loading rate.

Type of Process	Average Design Flow, MGD	Average Detention Time-Hours	Surface Settling Rates (gal/day/sq.ft.)
Conventional or	to 0.5	3.0	600
Step	0.5 to 1.5	2.5	600
Aeration	1.5 up	2.0	600
Contact	to 0.5	3.6	500
Stabilitation	0.5 to 1.5	3.0	600
	1.5 up	2.5	600

Extended Aeration	to 0.05	4.0	300
	0.05 to 0.15	3.6	300
	0.15 up	3.0	400
Complete Mix	to 0.5	3.5	400
	0.5 to 1.5	3.0	500
	1.5 up	3.0	500

(6) AERATION TANKS. (a) *General.* The size of the aeration tank for any particular adaptation of the process shall be based on such factors as the size of the plant, degree of treatment desired, mixed liquor suspended solids concentration, BOD loading, and mixed liquor solids to BOD loading ratio. Calculations shall be submitted to justify the basis of design of the aeration tank capacity. Pilot plant studies may be considered as a basis for justification of the design of the system. When such calculations are not submitted to justify the capacity of the aeration tank, the minimum tank capacities set forth in paragraph (b) shall be required for the various modifications of the activated sludge process.

(b) Aeration tank capacities and permissible loadings.

Type of Process	Average Design Flow, MGD	Average Aeration Retention Period-Hours	Average Aerator Loading Lb. BOD,/1,000 cubic feet
Conventional or Step Aeration	to 1.5	7.5	30
	1.5 up	6.0	40
Contact Stabilitation	to 1.5	3.0 (in contact zone)	30
	1.5 up	2.0 (in contact zone)	40
Extended Aeration	All	24	12.5
Complete Mix	to 1.5	6.0	40
	1.5 up	4.5	50

Note: Contact Zone = 30-35% of total aeration tank volumes. Balance is in the reaeration zone.

(7) ARRANGEMENT OF AERATION TANKS. (a) *General.* 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. For very small tanks or tanks with special configuration, the shape of the tank and the installation of aeration equipment shall provide for positive control of short-circuiting through the tank.

Note: The department recommends that liquid depths be not less than 10 feet nor more than 15 feet except in special design cases.

(b) *Number of units.* Duplicate units shall be provided where the design flow exceeds 500,000 gallons per day.

(c) *Inlets and outlets.* 1. Controls. Inlets and outlets for each aeration tank unit shall be equipped with valves, gates, stop plates weirs, or other

devices to permit controlling the flow to any unit and to maintain 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.

2. 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.

(d) *Measuring devices.* Devices shall be installed for measuring and displaying flow rates of raw sewage or primary effluent, return sludge, and air to each tank unit. For plants designed for sewage flows of 1.5 mgd or more, these devices must totalize and record, as well as indicate flows. Where the design provides for all return sludge to be mixed with the raw sewage or primary effluent at one location, then the mixed liquor flow rate to each aeration unit shall be measured.

(e) *Freeboard.* All aeration tanks shall have a freeboard of not less than 18 inches.

(8) AERATION EQUIPMENT. (a) *General.* Aeration equipment shall be capable of maintaining a minumum of 2.0 mg/l of dissolved oxygen in the mixed liquor at all times and of providing thorough mixing of the mixed liquor.

(b) *Diffused air systems.* 1. Diffused air systems shall provide a minimum of 1,500 cubic feet of air per pound of BOD, applied to the aeration tank for all processes except extended aeration. For extended aeration, a minimum of 2,000 cubic feet of air per pound of BOD, shall be provided. In any case, the requirements of NR 110.20 (8) (a), Wis. Adm. Code, shall be met.

2. In addition to the requirements of NR 110.20 (8) (b) 1., Wis. Adm. Code, the diffused air system shall provide such additional quantities of air as are required for channels, pumps or other air-use demands.

3. The blowers shall be provided in multiple units, adequately housed and so arranged and with such capacities as to meet the maximum air demand with the single largest unit out of service. The design shall also provide the capability of varying the volume of air delivered in proportion to the load demand of the plant.

4. The air diffusion piping and diffuser system shall be capable of delivering 200% of the normal air requirements. The spacing of diffusers shall be in accordance with the oxygenation requirements through the length of the channel or tank. The arrangement of diffusers shall permit their removal for inspection, maintenance and replacement without dewatering the tank and without shutting off the air supply to other diffusers in the tank.

Note: In large systems, the department may waive the requirement of removable diffusers provided the efficiency of the system can be maintained with one unit out of service.

(c) *Mechanical aeration systems.* 1. A minimum of 1.0 pound of oxygen per pound of BOD_5 applied to the aeration tank shall be provided.

Note: A transfer rate of 2.0 pounds of oxygen per horsepower hour will be allowed. Higher transfer rates may be approved where adequate test data is provided.

2. Multiple mechanical aeration units shall be designed and located so as to meet the maximum air demand with the largest unit out of service. Spare equipment shall be provided at the treatment plant so that any unit can be returned to service with a minimum amount of down time.

(d) *Pure oxygen.* Where pure oxygen is proposed, supporting data from pilot plant installations or similar full-scale installations shall be submitted to justify the proposed aerator loading rate and the amount and type of aeration capacity and equipment proposed.

(9) RETURN SLUDGE EQUIPMENT. (a) *Return sludge rate.* The rate of sludge return expressed as a percentage of the average design flow of sewage must lie within the following limits:

	Minimum	Normal	Maximum
Conventional	15	30	75
Step aeration	20	50	75
Contact stabilization	50	100	150
Extended aeration	50	100	200
Complete mix	20	50	75

(b) *Return sludge pumps.* 1. If motor driven return sludge pumps are used, the maximum return sludge capacity must be met with the largest pump out of service. A positive head shall be provided on pump suctions. Pumps shall also have at least 3-inch suction and discharge openings.

2. If air lifts are used for returning sludge from each settling tank hopper, no standby unit is required provided the design of the air lifts are such as to facilitate their rapid and easy cleaning. Air lifts shall be at least 3 inches in diameter.

(c) *Return sludge piping.* Suction and discharge piping shall be at least 4 inches in diameter and must be designed to maintain a velocity of not less than 2 feet per second when return sludge facilities are operating at normal return sludge rates. Suitable devices for observing, sampling and controlling return activated sludge flow from each settling tank shall be provided.

(d) *Waste sludge facilities.* Waste sludge control facilities shall 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 gallons per minute, whichever is larger. Means for observing, measuring, sampling, and controlling waste activated sludge flow shall be provided. Waste sludge may be discharged to the primary settling tank, concentration or thickening tank, sludge digestion tank, vacuum filters, or any practical combination of these units.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.21 Biological treatment; fixed film contacters. Projects proposing to employ fixed film contacters as a means of treatment will be reviewed on their merits. The department may approve such devices if adequate substantiating design information is provided.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.22 Physical-chemical treatment. Projects proposing to employ physical-chemical processes as a means of treatment will be reviewed on their merits. The department may approve such devices if adequate substantiating design information is provided.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.23 Disinfection. (1) GENERAL. Continuous disinfection shall be provided to reduce the risk of a public health hazard. Exceptions to this requirement are as follows:

(a) Stabilization lagoon treatment systems as described in NR 110.28 are exempt from the disinfection requirement. However, where the department of natural resources determines that short circuiting within such a system might cause a potential risk to public health due to the lack of adequate detention time, requirements for disinfection may be imposed in specific cases. Aerated lagoon treatment systems as described in NR 110.28 are required to disinfect as required by this section.

(b) In areas where it can be shown that the costs exceed the benefits derived from the disinfection of secondary or higher level of treated effluent, the owner may request that the department waive or modify the requirements for disinfection. The owner must submit to the department, for its review, specific data to justify any modification of the disinfection requirements.

(2) TYPES OF DISINFECTION. Chlorine is the most commonly used chemical. However, the department encourages the owner to evaluate the cost-effective application of ozone, bromine, bromine chloride, ultraviolet light, and other chemicals or methods or combinations of methods in individual cases. Where a disinfection process other than chlorine is proposed, supporting data from pilot plant installations or similar full-scale installations shall be submitted as a basis upon which the owner or the owner's representative may design the system.

(3) FEED EQUIPMENT — CHLORINE. (a) *Type.* Solution-feed vacuum type chlorinators or positive displacement type hypochlorite feeders are recommended.

(b) *Capacity.* Required capacity will vary, depending on the uses and points of application of the disinfectant. Caution should be used to not oversize the units.

(4) MEASUREMENT TECHNIQUES. (a) *Residual chlorine.* Residual chlorine concentrations shall be measured in accordance with chapter NR 219 Wis. Adm. Code.

(b) *Bacteriological measurements.* Coliform content of effluents shall be measured in accordance with chapter NR 219 Wis. Adm. Code.

(5) CHLORINE SUPPLY. (a) *Cylinders.* Cylinders must comply with department of transportation regulations concerning placards and labels. Furthermore, only chlorine institute approved valves can be used in this service.

Note: The department recommends consideration of one ton containers of chlorine where the average daily chlorine consumption is over 150 pounds. However, both monetary cost and potential residential exposure to chlorine should be evaluated when making a final decision.

The department recommends that the cylinders be hydrostatically tested for integrity every 5 years.

(b) *Scales.* Scales or other means of determining chlorine usage must be provided at all plants using chlorine gas for disinfection. Scales shall be of corrosion-resistant material.

Note: At large plants, scales of the indicating and recording type ar recommended.

(c) *Evaporators.* Evaporators for converting liquid chlorine to a gas can be used where manifolding of ton units to increase gas flow is impractical or imprudent.

(d) *Leak detection and controls.* A bottle of 56% ammonium hydroxide solution shall be available for detecting chlorine leaks. Where ton containers are used, a leak repair kit approved by the chlorine institute shall be provided.

Note: The department recommends that caustic soda solution reaction tanks be installed where practical for absorbing the contents of leaking one ton cylinders where such cylinders are in use. At large installations the department recommends that automatic gas detection and related alarm equipment be installed.

(6) PIPING AND CONNECTIONS. (a) Only piping systems specifically manufactured for chlorine service are approvable. The specifications of the chlorine institute should be used as guidelines.

(b) Due to the corrosiveness of wet chlorine, all lines designed to handle dry chlorine must be protected from the entrance of water or air containing water.

(7) HOUSING. (a) *Separation.* If gas chlorination equipment and chlorine cylinders are to be in a building used for other purposes, a gas-tight partition shall separate this room from any other portion of the building. Doors to this room shall open only to the outside of the building, and shall be equipped with panic or emergency hardware. Such rooms shall be at least 6" above ground level, and must permit easy access to all equipment. Storage area shall be separated from the feed area where one ton or larger cylinders are used.

(b) *Inspection window.* A clear glass, gas-tight window shall be installed in an exterior door or interior wall of the chlorinator room to permit the chlorinator to be viewed without entering the room.

(c) *Temperature control.* Chlorinator rooms and cylinders in use shall be maintained at a temperature not less than 60°F and not greater than 140°F.

(d) *Ventilation.* Forced, mechanical ventilation shall be installed which will provide one complete air change per minute. 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 and at such a temperature that will not adversely affect the chlorination equipment. The vent hose from the chlorinator shall discharge to the outside atmosphere above grade.

(e) *Electrical controls.* The controls for the fans and lights shall be such that the fans and lights will automatically operate when the door is

opened and can also be manually operated from the outside without opening the door.

(8) SAFETY EQUIPMENT. Respiratory air-pack 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 convenience location, but not inside any room where chlorine is used and stored. The units shall use compressed air or oxygen, have at least 30-minute capacity, and be compatible with the units used by the fire department responsible for the plant.

(9) APPLICATION OF CHLORINE. (a) *Initial mixing.* The chlorine shall be mixed as rapidly as possible. This may be accomplished by either the design of a turbulent flow regime or the use of a mechanical flash mixer.

(b) *Contact time.* After rapid mixing, a contact time of at least one hour at average design flow or 30 minutes at peak daily design flow shall be provided. The hydraulic characteristics of the contact zone must be equivalent to that achieved by a tank with a length to width ratio of 40:1 or more. A tank of this type could be expected to have a dispersion index of 0.02 and a Morril index of less than 2.0.

(c) *Characteristics.* The hydraulic characteristics of a contact zone with a length to width ratio less than 40:1 must be certified at the time of construction by the submission of the results of field test. It is recommended that the basin have provisions for cleaning which will not interrupt the disinfection process.

(10) CHLORINE CONTROL SYSTEMS. In all systems, with design flow of greater than 0.25 MGD the feed mechansim shall be provided with either an automatic flow proportional control or an automatic residual control. The department encourages the consideration of a "compound loop control" at plants with an average design flow of greater than one MGD.

(a) All sample lines should be designed to provide easy cleaning and to minimize biofouling. The department will inspect the chlorine control system on an annual basis to assure that it is being properly operated and maintained.

(11) DECHLORINATION. In instances where chlorine is used, the most practical method of lessening toxicity of residual chlorine present in the effluent will usually be dechlorination of the effluent by the use of sulfur dioxide, sodium biosulfite, sodium thiosulfate, or sodium metabisulfite. In instances where dechlorination of the effluent may be required, alternative forms of disinfection should be evaluated which may result in a lower total system cost. The most common chemical used to dechlorinate wastewater in large treatment plants (greater than one MGD) is sulfur dioxide and in smaller plants sodium metabisulfite. In both instances the following apply. (In certain individual cases, the use of activated carbon may be approved for the purposes of dechlorination.)

(a) *Feed equipment.* When using sulfur dioxide, the feed equipment is essentially the same as that used for the application of chlorine, and similar precautions must be observed. When using sodium metabisulfite, the chemical may be fed either in the dry form or as a

solution and metered with a diaphragm pump. Although similar equipment is used, the same piece of equipment shall not be interchanged with the chlorine application equipment.

(b) *Mixing.* The chemical shall be mixed such that complete dispersion is achieved before the effluent reaches the receiving water.

(c) *Contact time.* When complete mixing has been achieved, no further contact time is necessary.

(d) *Control system.* At the present time it is not practical to continuously monitor the sulfite ion. The most practical method is to intermittently divert a portion of the final effluent to a chlorine residual analyzer (which is suggested for all chlorination-dechlorination systems) for a short period each one-two hours to allow the recorder to measure the residual chlorine. The residual should be essentially zero.

(e) *Sulfur dioxide supply.* The supply system should be designed similar to the chlorine system.

(f) *Safety.* Safety equipment is similar to that used for chlorine.

(g) *Reaeration.* Reaeration of the effluent may be necessary before the discharge to achieve an adequate dissolved oxygen level in the stream. The dissolved oxygen requirements as required in chapter NR 104 Wis. Adm. Code shall be used as a basis for the determination of the need for and capacity of reaeration facilities.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74; r. and recr. Register, March, 1978, No. 267, eff. 4-1-78.

NR 110.24 Phosphorus removal. (1) APPLICABILITY. (a) The department may require removal of excess amounts of phosphorus from any municipal waste discharge where such discharge is causing, or may cause, over-fertilization of surface waters.

(b) Phosphorus removal shall be provided at all municipal waste discharges serving a population equivalent of greater than 2,500 in the Lake Michigan and Lake Superior drainage basins.

(2) DEGREE OF TREATMENT. Phosphorus removal facilities shall be designed to achieve a monthly average phosphorus concentration in the effluent of not more than 1.0 mg/l of total phosphorus. In instances where it can be demonstrated that 1.0 mg/l phosphorus cannot be achieved on a monthly average, the system shall be operated to remove at least 85% of the influent phosphorus on an annual average.

(3) METHOD OF TREATMENT. Phosphorus removal shall be achieved by use of chemical precipitation or by any other method that has been proven effective by pilot plant testing.

(a) *Chemicals.* The following chemicals are considered acceptable for removing phosphorus: ferrous or ferric chloride, ferrous or ferric sulfate, aluminum sulfate, sodium aluminate, or other suitable metal salts.

Note: Selection of the chemical used should be based on the waste characteristics. Pilot plant work or jar testing is recommended.

(b) *Chemical feed equipment.* Feed equipment shall be selected which allows the use of various chemicals. Alternate points of chemical

application within the flow scheme shall be provided for flexibility of operation and to maximize removal of phosphorus.

(c) *Polymers.* Polymers shall be used if necessary to meet the effluent concentration limits.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.25 Hazardous chemical handling. (1) CONTAINMENT MATERIALS. The materials utilized for storage, piping, valves, pumping, metering, splash guards, and any other equipment used to contain or convey hazardous or corrosive chemicals shall be selected based on the physical and chemical characteristics of each such chemical used. Chlorine shall be handled separately in accordance with the requirements of NR 110.23.

(2) SECONDARY CONTAINMENT. Chemical storage areas shall be enclosed in dykes or curbs which will contain the stored volume until it can be either safely transferred to alternate storage areas or released to the wastewater at controlled rates which will not damage facilities, inhibit the treatment processes or contribute to stream pollution. Liquid polymer shall be similarly contained.

Note: Nonslip floor surfaces are desirable in polymer handling areas.

(3) EYE WASH FOUNTAINS AND SAFETY SHOWERS. (a) Eye wash fountains and safety showers utilizing potable water shall be provided in the laboratory and on each floor level or work location involving hazardous or corrosive chemical storage, mixing or slaking, pumping, metering, or transportation unloading. These facilities shall be as close as practical to possible chemical exposure sites and shall be fully useful during all weather conditions.

(b) The eye wash fountains shall be supplied with water of moderate temperature between 50°F and 90°F, separate from the hot water supply, suitable to provide 15 to 30 minutes of continuous irrigation of the eyes.

(c) The emergency showers shall be capable of discharging 30 to 50 gpm of water at moderate temperature at pressures of 20 to 50 psi.

Note: It is recommended that the eye wash fountains and showers be no more than 25 feet from points of caustic exposure.

(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.

(5) PIPING, LABELING, COUPLING GUARDS, LOCATION. All piping containing or transporting corrosive or hazardous chemicals shall be identified with labels every 10 feet and with at least 2 labels in each room, closet or pipe chase. Color coding may also be used but is not an adequate substitute for labeling. All connections except those adjacent to storage or fedder areas, shall have guards which will direct any leakage away from space occupied by personnel. Pipes containing hazardous or corrosive chemicals shall not be located above shoulder level except where continuous drip collection trays and coupling guards will eliminate the spraying or dripping of such chemicals onto personnel.

(6) PROTECTIVE CLOTHING AND EQUIPMENT. The following items of protective clothing or equipment shall be available for all operations or procedures where their use will minimize injury hazard to personnel and will insure the continuous operation of the facility:

(a) Respirators. (An air supply type is recommended for protection against chlorine).

(b) Chemical workers' goggles or other suitable goggles. Safety glasses are insufficient.

(c) Face masks or shields for use over goggles.

(d) Rubber gloves.

(e) Rubber aprons with leg straps.

(f) Rubber boots. Leather and wool clothing should be avoided near caustics.

(g) Safety harness and line.

(7) WARNING SYSTEMS AND SIGNS. Facilities shall be provided for automatic shutdown of pumps and sounding of alarms when failure occurs in a pressurized chemical discharge line.

Note: The department strongly recommends that warning signs requiring use of goggles be located near chemical unloading stations, pumps and other points of frequent hazard.

(8) DUST COLLECTION.

Note: The department strongly recommends that dust collection equipment be provided to protect personnel from dusts injurious to the lungs or skin and to prevent polymer dust from settling on walkways.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.26 Supplemental treatment facilities. (1) APPLICABILITY. Supplemental treatment facilities shall be required at all treatment plants where conventional secondary treatment facilities will not produce an effluent which will meet the water quality standards of the receiving water.

(2) DESIGN BASIS. Proposals for supplemental facilities will be evaluated on an individual basis. Pilot studies to determine design criteria are recommended. The following methods of supplemental treatment may be approved by the department.

(a) *Filtration.* A loading rate of not more than 5.0 gallons per minute per square foot of filter surface area shall be provided at the design maximum flow. Multiple units shall be provided. Use of air scouring facilities is recommended. A backwash water holding tank shall be provided. The backwash water shall be returned to the treatment process at a rate of not more than 15% of the average design forward flow. Provision shall be made to backwash each filter unit at a rate of at least 15 gpm/ft^2 for a minimum of 10 minutes.

(b) *Microstraining.* A loading rate of not more than 5.0 gallons per minute per square foot of surface area shall be provided at design maximum flow. Multiple units shall be provided.

(c) *Others.* Other methods of supplemental treatment will be considered based on an evaluation of pilot plant studies substantiating the design.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.27 Sludge handling and disposal. (1) ANAEROBIC SLUDGE DIGESTION. (a) *General.* 1. Multiple units.

Note: The department recommends that multiple digestion tanks be used. Where a single digestion tank is used it is desirable to have a lagoon or storage tank for emergency use so that the tank may be taken out of service without interrupting plant operation.

2. Sludge storage. Sludge storage and supernatant separation in an additional unit shall be required, if raw sludge concentration and disposal methods for sludge and supernatant require it.

3. Depth. The proportion of depth to diameter should be such as to allow for the formation of a reasonable depth of supernatant liquor.

4. Maintenance provisions.

Note: To facilitate emptying, cleaning, and maintenance the following features are recommended:

a. The tank bottom should slope to drain toward the withdrawal pipe.

b. At least 2 access manholes should be provided in the top of the tank in addition to the gas dome. One opening should preferably be large enough to permit the use of mechanical equipment to remove grit and sand. Consideration should be given to use of a separate side wall manhole.

c. Nonsparking tools, rubber soled shoes, safety harness, gas detectors for inflammable and toxic gases, and gas masks of the hose or oxygen helmet type should be provided.

(b) *Sludge inlets and outlets.* Multiple sludge inlets and draw-offs and, where used, multiple recirculation suction and discharge points to facilitate flexible operation and effective mixing of the digester contents shall be provided unless adequate mixing facilities are provided within the digester. One inlet shall discharge above the liquid level and be located at approximately the center of the tank to assist in scum breakup. Raw sludge inlet discharge points shall be so located as to minimize short circuiting to the supernantant draw-off.

(c) *Tank capacity.* 1. The total digestion tank capacity shall be calculated based upon such factors as volume of sludge added, its percent solids, and character, the temperature to be maintained in the digesters, the degree or extent of mixing to be obtained, the degree of volatile solids reduction required, and the size of the installation with appropriate allowances for sludge and supernatant storage. Calculations shall be submitted to justify the basis of design.

2. When such calculations are not submitted to justify the design based on the above factors, the minimum combined digestion tank capacity outlined below shall be required. Such requirements assume that the raw sludge is derived from ordinary domestic wastewater, a digestion temperature is to be maintained in the range of 85° to 95°F, 40 to 50% volatile matter in the digested sludge and that the digested sludge will be removed frequently from the process.

a. Completely mixed systems. For digestion systems providing for intimate and effective mixing of the digester contents, the maximum system loading is 80 pounds of volatile solids per 1,000 cubic feet of volume per day in the active digestion units.

b. Moderately mixed systems. For digestion systems where mixing is accomplished only by circulating sludge through an external heat exchanger, the maximum system loading is 40 pounds of volatile solids per 1,000 cubic feet of volume per day in the active digestion units. This loading may be modified upward or downward depending upon the degree of mixing provided. Where mixing is accomplished by other methods, loading rates may be approved on the basis of information submitted justifying the design.

(d) *Gas collection, piping, and appurtenances.* 1. General. All portions of the gas system including the space above the tank liquor storage facilities and piping shall be so designed that under all normal operating conditions including sludge withdrawal, the gas will be maintained under pressure. All enclosed areas where any gas leakage might occur shall be adequately ventilated.

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 shut off valves, are essential. Water seal equipment shall not be installed.

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

4. Gas utilization equipment. Gas burning boilers, engines, and other units using gas as a fuel shall be located in well ventilated rooms, preferably at ground level and shall be isolated in accordance of the provisions of Ind 54.13, Wis. Adm. Code. Gas lines to these units shall be provided with suitable flame traps.

5. Electrical fixtures. Electrical fixtures in enclosed places where gas may accumulate shall comply with the National Fire Code specifications, Volumes 2, 3 and 5 (1973-1974), for hazardous conditions. Copies of the National Fire Code, Volumes 2, 3 and 5 (1973-1974) are available for inspection at the office of the department of natural resources, secretary of state's office and the office of the revisor of statutes and may be obtained for personal use from the National Fire Protection Association, 470 Atlantic Avenue, Boston, Mass., 02210.

6. Waste gas. Waste gas burners shall be readily accessible and shall be located at least 25 feet 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. In remote locations it may be permissible to discharge the gas to the atmosphere through a return-bend screened vent terminating at least 10 feet above the walking surface provided the assembly incorporates a flame trap.

7. Meter. A gas meter with by-pass shall be provided to meter total gas production.

8. Other.

Note: Other applicable state codes which should be considered are those set forth in the Wisconsin State Electrical Code, Volume 2, as set forth in the rules of the department of industry, labor and human relations.

(e) *Digestion tank heating.* 1. Insulation. Wherever possible digestion tanks shall be constructed above groundwater level and shall be suitably insulated to minimize heat loss.

2. Heating facilities. Piping shall be designed to provide for the preheating of feed sludge before introduction to the digesters. Provisions shall be made in the lay-out of the piping and valving to facilitate cleaning of these lines. Heat exchanger sludge piping shall be sized for heat transfer requirements.

3. Heating capacity. Sufficient heating capacity shall be provided to consistently maintain the design sludge temperature. Where digestion tank gas is used for other purposes, an auxiliary fuel may be required.

(f) *Supernatant withdrawal.* 1. Piping size. Supernatant piping may not be less than 6 inches in diameter.

2. Withdrawal arrangements. Piping shall be arranged so that withdrawal can be made from 3 or more levels in the tank. A positive unvalved vented overflow shall be provided.

3. Sampling. Provision shall be made for sampling at each supernatant draw-off level. Sampling pipes shall be at least 1½ inches in diameter.

(2) AEROBIC SLUDGE DIGESTION. (a) *Multiple tanks are recommended.* A single sludge digestion tank may be used in the case of small treatment plants. The tanks shall be designed to provide effective air mixing, reduction of organic matter, supernatant separation and sludge concentration.

(b) *Mixing.* Digestion tanks shall be designed for effective mixing by satisfactory aeration equipment. If diffusers are used, types shall be provided which are designed to permit removal for inspection, maintenance, and replacement without dewatering the tanks.

(c) *Size and number of tanks.* The size and number of aerobic sludge digestion tanks should be determined by calculations based upon such factors as volume of sludge added, its percent solids and character, the degree of reduction of volatile solids required, the size of installation with appropriate allowance for sludge and supernatant storage. Calculations shall be submitted to justify the basis of design. If such calculations are not submitted, a minimum capacity of 3 cubic feet of volume per capita shall be provided.

(d) *Air supply.* Air shall be supplied to aerobic digesters digesting waste activated sludge, as follows:

Population Equivalent	CFM/Cu. Ft. of Tank Volume
100-300	.030
500-700	.025
1,000-5,000	.020
7,500-10,000	.015

Note: Additional air shall be provided if digestion of primary sludge is to take place.

(e) *Supernatant separation.* Facilities shall be provided for effective separation or decantation of supernatant.

(3) SLUDGE PUMPS AND PIPING. (a) *Sludge pumps.* 1. Capacity. Adequate pump capacities shall be provided.

Note: Provision for varying pump capacity is desirable.

2. Duplicate units. Duplicate units shall be provided.

3. Type. Plunger pumps, screw feed pumps or other types of pumps with demonstrated solids handling capability shall be provided for handling raw sludge.

4. Minimum head. A minimum positive head of 24 inches shall be provided at the suction side of centrifugal type pumps. Maximum suction lifts shall not exceed 10 feet for plunger pumps.

Note: The department recommends that a minimum positive head of 24 inches be provided at the suction side of all sludge pumps.

5. 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 shall be at least 1½ inches.

(b) *Sludge piping.* 1. Size and head. Sludge withdrawal piping shall have a minimum diameter of 8 inches for gravity withdrawal and 6 inches for pump suction and discharge lines. Where withdrawal is by gravity, the available head on the discharge pipe shall be at least 4 feet.

2. Slope. Gravity piping shall be laid on uniform grade and alignment. Slope on gravity discharge piping shall not be less than 3%. Provisions shall be made for drainage and flushing discharge lines.

Note: The department recommends that air relief at high points in a pressure sludge line be provided.

(4) SLUDGE DEWATERING. (a) *Sludge drying beds.* 1. Area. At least one square foot of drying bed area per capita shall be provided. If necessary, wet sludge shall be hauled.

2. Percolation type. a. The lower course of gravel around the underdrains shall be properly graded and shall be at least 12 inches in depth, extending at least 6 inches above the top of the underdrains.

Note: It is desirable to place this in 2 or more layers. The top layer of at least 3 inches shall consist of gravel ⅛ inch to ¼ inch in size.

b. The top course shall consist of at least 6 to 9 inches of clean coarse sand. The finished surface shall be level.

c. Underdrains shall be at least 4 inches in diameter laid with open joints. Underdrains shall be spaced not more than 20 feet apart.

3. Impervious types. Paved surface beds may be used if adequate center or side drains are provided. Special consideration shall be given to the total bed area required.

4. Walls. Walls shall be watertight and extend 15 to 18 inches above and at least 6 inches below the surface. Outer walls shall be curbed to prevent soil from washing onto the beds.

5. Sludge removal. Not less than 2 beds shall be provided and they shall be arranged to facilitate sludge removal. Concrete truck tracks shall be provided for all percolation type sludge beds. Pairs of tracks for percolation type beds shall be on 20-foot centers.

6. Sludge influent. The sludge pipe to the beds shall terminate at least 12 inches above the surface and be so arranged that it will drain. Concrete splash plates for percolation type beds shall be provided at sludge discharge points.

(b) *Sludge lagoons.* The use of shallow sludge drying lagoons in lieu of drying beds is permissible subject to the following conditions:

1. Soil and groundwater conditions. The soil must be reasonably porous and the bottom of the lagoons must be at least 3 feet above the maximum groundwater table and at least 5 feet above bedrock. Surrounding areas shall be graded to prevent surface water entering the lagoon.

2. Depth. Lagoons shall not be more than 36 inches in depth.

3. Area. The area required will depend on design conditions. Not less than 2 lagoons shall be provided.

4. Location. Lagoons shall be adequately isolated to avoid creating nuisances.

(c) *Mechanical dewatering facilities.* Provision shall be made to maintain sufficient continuity of service so that sludge may be dewatered without accumulation beyond storage capacity. Vacuum filters, sludge presses or other appropriate mechanical dewatering facilities may be approved where sufficient pilot data is presented to justify the design.

(d) *Drainage and filtrate disposal.* Drainage from beds or filtrate from dewatering units shall be returned to the raw sewage inlet to the treatment plant.

(e) *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.

(5) SLUDGE REDUCTION. (a) *Incineration.* Adequate provisions for residue disposal and air pollution control shall be provided. The appropriate requirements of Wis. Adm. Code chapter NR 154 shall be met.

(b) *Other reduction facilities.* If it is proposed to reduce the quantity of sludge by other methods, a detailed description of the process and design data shall accompany the plans.

(6) SLUDGE MANAGEMENT. (a) *General requirements.* 1. A sludge management plan shall be developed by each owner of a wastewater treatment plant and submitted to the department pursuant to conditions imposed in the WPDES permits. The department shall evaluate the plan for adequacy. If the department determines that the plan described an acceptable sludge management plan, it will issue a letter of approval to the owner.

2. If the plan as submitted is determined by the department to be unacceptable, it shall be returned to the owner of the wastewater treatment plant for revision and resubmittal. At any time after a plan has been found to be unacceptable, the department may issue an order requiring submittal of an acceptable plan.

3. The owner of the wastewater treatment plant shall be responsible for the implementation of the approved sludge management activities. An owner of a wastewater treatment plant may at any time amend the sludge management plan, subject to the approval of the department. Any proposed amendment shall contain the same type of information required in the original management plan. The amended plan may not be put into effect until it has received approval from the department.

4. The department shall evaluate the management plans on the basis of recommendations in Wisconsin department of natural resources (DNR) technical bulletin no. 88 and any other pertinent information deemed appropriate to the review of sludge management plans.

(b) *Sludge management plan requirements.* The sludge management plan shall include but not be limited to the following:

1. Provision for interim sludge storage when normal disposal sites are unavailable or inaccessible, including:

a. Type of storage

b. Location of storage

c. Capacity of facility

d. Construction details

e. Property interest or contractual agreement allowing use of the facility

f. Future use of the storage facility

g. Evaluation of environmental effects

2. Description of sludge characteristics, including:

a. The type of wastewater treatment provided resulting in sludge generation

b. The type of sludge treatment prior to disposal

c. The physical and chemical characteristics of typical sludge samples taken at intervals specified in the WPDES permit. The parameters analyzed shall include all or parts of the following:

1) Physical (solids fraction, organic fraction, others)

2) pH

3) Nutrient content (nitrogen, phosphorous, potassium, others)

4) Metals content (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn, others)

5) Salt content (chlorides, fluorides, sulfates, others)

6) Biological populations (total coliform, fecal coliform, virus, others)

7) Other parameters such as oils and greases, phenolics, pesticides, toxic substances.

8) Any other parameters deemed necessary by the department on a case-by-case basis.

d. The volume or quantity of sludge generated on a daily, monthly and annual basis.

3. Proposed mode of sludge transportation, including:

a. The transporter of the sludge.

b. The method of transportation.

c. The type of vehicle used for transportation of the sludge.

4. Information about the ultimate disposal site. a. If sludge will be disposed of at one or more licensed landfill sites, the amount to be disposed of at each site, the site names and license numbers, contractual agreements, and indication of approval from the solid waste management section.

b. If sludge will be disposed of on land areas (other than at licensed landfill sites) for each disposal site:

1) Soil test results at the site at intervals specified in the WPDES permits. The parameters analyzed shall include soil, pH, organic matter, available P, exchangeable K and any other parameters deemed necessary by the department on a case-by-case basis. Recommended soil additions such as lime, N, P_2O_5 and K_2O should be specified.

2) Copies of a soils map, plat map and a U.S.G.S. topographic map showing the location of the site.

3) A description of the crops to be grown or dominant vegetation on the disposal site.

4) Data on the geology, hydrology, areas for future expansion and adjacent land use.

5) The ownership of the site.

6) A description of the type of agreement covering use of land.

7) A description of the methods to be used to spread sludge on the land and incorporate it with the soil.

8) The applicator of the sludge.

9) An estimate of the total acreage to which sludge will be applied.

10) The maximum rate of application (tons/acre/year based on nitrogen or cadmium, whichever is lower) and the loading limit (tons/acre based on metal equivalents or cadmium whichever is lower).

11) The anticipated use of the site for 12 months after application of the sludge.

12) Any follow-up monitoring that is requested by the department.

c. The frequency of sludge disposal and the months in which it occurs.

d. Beginning with submission of the first plan, records shall be maintained for each site (other than at licensed landfill sites), including:

1) The amount of sludge applied (tons/acre).

2) The amount of nitrogen applied per year (lbs/acre).

3) The amount of cadmium applied per year (lbs/acre).

4) The total amount of metal equivalents applied (lbs/acre).

5) The location of the site on a plat map and the number of acres the sludge was applied to.

6) The site monitoring results.

7) A description of any adverse environmental, health or social effects that occurred due to sludge disposal.

8) A report of any action not in conformance with the approved plan.

(7) SLUDGE DISPOSAL. Sludge disposal shall be accomplished in accordance with the approved sludge management plans as specified in section NR 110.27(6). The following items shall be considered in the development of the management plan.

(a) *Sanitary landfill.* Burial of sewage sludge in a sanitary landfill shall meet the following requirements:

1. The sludge must be capable of being mixed well with the other refuse in the compaction process.

2. The sludge must be able to support compaction equipment.

3. The sludge must be capable of permanent confinement within the earth excavation.

(b) *Surface application.* Surface application disposal of raw sludge is generally not permitted. Surface application of digested sludge will be evaluated based on the justification provided in the sludge management plan.

(c) *Transportation of sludges.* 1. Liquid. Liquid sludge shall be transported in an enclosed watertight unit from treatment plant to disposal site.

2. Semi-solid cake. Sludge cake shall be transported in a covered watertight unit to prevent leakage of sludge moisture released in transit. Provision shall be taken to prevent spillage of sludge from the vehicle while in transit and to prevent an odor nuisance while in transit.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74; r. and recr. (5), cr. (6) and (7), Register, June, 1977, No. 258, eff. 7-1-77.

NR 110.28 Lagoons. (1) BASIS OF DESIGN. (a) *Stabilization ponds.* 1. Area and loadings. A minimum of 2 cells shall be provided. The primary cell shall be designed on the basis of one acre of water surface for each 100 design population or population equivalent. The secondary cell shall be ¼ to ⅓ the size of the primary cell. Where a controlled discharge is required, the secondary cell may be larger.

2. Industrial wastes. The effects of industrial wastes on the treatment process must be reflected in the design basis of the stabilization ponds. Milk wastes are not permitted in stabilization ponds.

Note: The department may waive this prohibition if adequate supporting data is presented in the plans.

(b) *Aerated lagoons.* 1. For aerated lagoons designed to treat domestic wastes only, a minimum of 2 cells shall be provided. The primary cell shall have a minimum retention time of 18 days and the secondary cell shall have a minimum retention time of 26 days. In the event a three-celled system is desired, the secondary cell shall have a minimum retention time of 18 days and the final cell shall have a minimum retention time of 6 days. Aeration equipment shall be provided in the first 2 cells of all aerated lagoons.

Note: The above detention times were based on the following formulae and assumptions:

$$T = \frac{E}{K(100-E)}$$

where T = detention time, K = reaction coefficient and E = efficiency. For domestic waste K is assumed to equal 0.5 at 20°C. To correct for anticipated wintertime temperature, the formula $KT' = K_{20}\theta^{T'-20}$ was used. In this formula, T' is the anticipated low temperature and θ is a temperature coefficient. For Wisconsin, T' is assumed to be 0° C. and θ is assumed to be 1.07. Where studies indicate a variation from the above criteria will provide an adequate degree of treatment, the department will consider such data in determining whether to waive this requirement.

2. For aerated lagoons designed to treat combined domestic and industrial wastes, laboratory or pilot studies shall be conducted to develop an appropriate reaction coefficient at both anticipated summertime and wintertime temperatures. The reaction coefficient developed shall be used to calculate the required detention time. The laboratory or pilot plant results and engineering calculations shall be submitted to justify the design. A minimum of 2 cells shall be provided with additional volume provided in the second cell to facilitate removal of solids. Provisions shall be made to recirculate final lagoon effluent to the inlet of the treatment system.

(2) POND SHAPE. The shape of all cells shall be such that there are no narrow or elongated portions. No islands, peninsulas, or coves are permitted. Dikes shall be rounded at corners to minimize accumulations of floating materials.

Note: Round, square, or rectangular ponds with a length not exceeding 3 times the width are considered most desirable.

(3) LOCATION. (a) *Distance from habitation.* The location requirements of NR 110.15 (3) shall be adhered to.

(b) *Groundwater pollution.* Lagoons shall be located to minimize the potential of groundwater pollution.

Note: The department recommends that pond bottoms be located a minimum of 3 feet above high groundwater and 5 feet above bedrock. Consideration shall be given to the nature of the subsoil and bedrock in determining the exact depth. The primary cell of a stabilization pond and the first 2 cells of an aerated lagoon shall be adequately sealed to prevent loss of liquid such that the design operating depth can be achieved and maintained.

(4) POND CONSTRUCTION DETAILS. (a) *Material.* Embankments and dikes shall be constructed of relatively impervious materials and compacted to a density of 95% as measured by the standard proctor test.

(b) *Top width.* The minimum embankment top width shall be 12 feet to permit access of maintenance vehicles.

(c) *Maximum slopes.* Embankment slopes steeper than 3 horizontal to one vertical are prohibited.

(d) *Minimum slopes.* Embankment sloped flatter than 4 horizontal to one vertical for the inner slope are prohibited.

(e) *Freeboard.* Minimum freeboard shall be 3 feet.

(f) *Minimum depth.* A minimum normal liquid depth of 2 feet for stabilization ponds and 6 feet for aerated lagoons shall be provided.

(g) *Maximum depth.* A maximum normal liquid depth of 5 feet for stabilization ponds and 14 feet for aerated lagoons shall be provided.

(h) *Seeding.* Embankments shall be seeded from the outside toe to one foot above the high water line on the dikes, measured on the slope. Additional protection for embankments, such as riprap, shall be provided where the dikes are subject to erosion.

(i) *Vegetation control.* A method to prevent vegetation growth over the bottom of the lagoon and up to one foot above the water line on the dikes shall be specified in the plans.

(5) POND BOTTOM. (a) *Uniformity.* The pond bottom shall be as level as possible at all points.

(b) *Vegetation.* The bottom shall be cleared of vegetation and debris.

(6) INFLUENT LINES. (a) *Material.* Influent lines may be constructed with any generally accepted material for underground sewer construction.

(b) *Manholes.* A manhole shall be installed at the terminus of the outfall line or the force main and shall be located as close to the dike as topography permits. Its invert shall be at least 6 inches above the maximum operating level of the pond to provide sufficient hydraulic head without surcharging the manhole.

(c) *Influent lines.* Influent lines shall be located along the bottom of the pond so that the top of the pipe is just below the average elevation of the pond bottom.

(d) *Point of discharge.* For circular or square ponds, the inlet shall be located at the center of the pond. Influent lines to rectangular ponds shall terminate at approximately the third point farthest from the outlet structure. Influent and effluent piping shall be located to minimize short-circuiting within the pond.

(e) *Inlets.* The inlet line shall discharge either horizontally onto a concrete pad or by means of an upturned elbow terminating one foot above the pond bottom.

(7) OVERFLOW STRUCTURES AND INTERCONNECTING PIPING. (a) *Material.* Interconnecting piping and overflows may be constructed of any generally accepted material for underground sewer construction.

(b) *Overflow structure.* Overflow structures shall consist of a manhole or box equipped with multiple-valved pond drawoff lines or an adjustable overflow device so that the liquid level of the pond can be adjusted to permit operation at depths of 2 to 5 feet in stabilization ponds and 6 feet to the design depth in aerated lagoons.

(8) MISCELLANEOUS. (a) *Fencing.* The pond area shall be enclosed with a suitable fence to prevent livestock movement into and discourage trespassing on the pond area. A vehicle access gate of sufficient width to accommodate mowing equipment shall be provided. All access gates shall be provided with locks.

(b) *Warning signs.* Appropriate signs shall be provided along the fence around the pond to designate the nature of the facility and the advice against trespassing.

(c) *Flow measurement.* The capability of installing flow measurement devices on the inlet and outlet of all lagoon systems shall be provided.

(9) AERATION EQUIPMENT. (a) *Air requirements.* Air shall be provided to the aerated lagoons at a rate of not less than 1.5 pounds of oxygen per pound of influent BOD_5.

(b) *Surface aeration equipment.* Surface aeration equipment shall be so designed and placed to provide optimum mixing of pond contents and dispersion of oxygen to the waste. The equipment shall be operated continuously throughout the year. Provisions must be made to prevent ice formation on the aerator during the winter season resulting in shutdown of aeration equipment. Unless sufficient justification is presented to the contrary, surface aerators shall be designed using an oxygen transfer rate of 1.5 pounds of oxygen per horsepower hour.

(c) *Subsurface aeration equipment.* 1. Flexible tubing containing air release slits shall be provided across the pond bottom in accordance with the manufacturer's recommendations. To prevent clogging of the air lines, provision must be made to accommodate cleaning at least 4 times per year or more often if necessary. Air shall be supplied to the pond system at a rate of at least 1,000 cubic feet of air per pound of design BOD_5 with the largest blower unit out of service.

2. Tubular aeration units shall be provided in sufficient number to supply adequate air to the pond system based on a transfer rate of 1.25 pounds of oxygen per unit per hour.

3. Where data is presented to the department to justify oxygen transfer rates varying from the above, the department may approve such design transfer rates.

(10) EFFLUENT HOLDING PONDS. (a) Effluent holding ponds shall be provided following all extended aeration activated sludge sewage treatment plants.

Note: The department may require effluent holding ponds at other locations.

(b) The detention time in the effluent pond shall be at least 30 days based on design flow.

Note: Lesser detention times may be approved by the department on a case by case basis if supported by sufficient design data.

(11) SEEPAGE PONDS.

Note: Seepage ponds should be considered where stream water quality must be maintained at a high level or where no stream exists for discharge of sewage effluent. Soil and groundwater conditions shall be thoroughly evaluated and conditions must be favorable to permit use of a seepage pond. The pond should be sized based on an evaluation of the soil's capability to accept liquid wastes.

History: Cr. Register, November, 1974. No 227, eff. 12-1-74.

NR 110.29 Land disposal of effluent. (1) GENERAL. Land disposal of secondary treated effluent may be approved by the department on a case by case basis. The effect of land disposal on groundwater is of concern; therefore the quality, direction and rate of movement and local use of the groundwater must be thoroughly analyzed in any design report submitted to the department.

(2) DESIGN REPORT. The design report shall be as comprehensive as possible and shall include all necessary maps, diagrams and additional information needed to conduct an evaluation of the proposed system. The following items must be thoroughly considered and discussed in the design report:

(a) Location;

(b) Geology;

(c) Hydrology;

(d) Soils;

(e) Agricultural practice;

(f) Adjacent land use; and

(g) Direction of groundwater movement.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.

NR 110.30 Intermittent sand filters. (1) GENERAL. Intermittent sand filters may be used for treatment of relatively small waste streams. All such installations shall be preceded by gravity settling devices such as in conventional primary clarifiers or septic tanks. Waste from intermittent sand filters shall be disinfected and discharged to an effluent holding pond prior to discharge to a receiving water.

(2) LOADING. The loading on the sand filter shall not exceed one gallon per square foot per day for the total bed area for installations which operate with a significant rest period. The loading shall not exceed 0.5 gallon/ft²/day for the total bed area for installations used on a continuous year round basis.

(3) MEDIA. (a) *Gravel base.* Clean graded gravel placed in 3 layers around the underdrains and to a depth of at least 6 inches over the top of the underdrains shall be provided.

Note: Suggested gradings for the 3 layers are: 1½" to ¾", ¾" to ¼", ¼" to ⅛".

(b) *Sand.* At least 24 inches of clean sand above the gravel base shall be provided. The effective size of the sand shall be 0.3 to 0.6 mm, and the uniformity coefficient shall not exceed 3.5.

(4) DOSING. (a) *Duplicate units.* The filter bed shall be divided into at least 2 separate units to provide for maintenance and adequate rest periods.

(b) *Volume.* The dosing tank volume shall be such that the filter bed will be covered to a depth of 2 to 4 inches by each dose.

(c) *Siphons or pumps.* The siphons or pumps shall have a discharge capacity at minimum head of at least 100% in excess of the maximum rate of inflow to the dosing tank and at average head of at least 90 gpm/ 1,000 ft^2 of filter surface area.

(d) *Discharge lines.* Discharge lines shall have sufficient capacity to permit the full rated discharge of the siphons or pumps.

(5) DISTRIBUTION. (a) *Arrangement.* Troughs or piping used for distribution of the settled sewage over the filter surface shall be located not more than 20′ center to center.

(b) *Splash pads.* Splash pads shall be provided at each point of discharge.

(c) *Drain.* A drain opening from troughs or discharge piping shall be provided.

(6) UNDERDRAINS. Open joint or perforated clay or concrete pipe underdrains may be used. They shall be sloped to the outlet and spaced not to exceed 10 feet center to center.

(7) COVERING. All sand filter installations shall be covered with roofing paper or other suitable material and at least 3 feet of soil unless they are designed to operate only during the summer months in which case the filter may be exposed to the atmosphere.

History: Cr. Register, November, 1974, No. 227, eff. 12-1-74.