CR 82-39

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

BOX 7921
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STATE OF WISCONSIN)
)
DEPARTMENT OF NATURAL RESOURCES) ss

Filed 11-26-82
9:00 am.

TO ALL TO WHOM THESE PRESENTS SHALL COME, GREETINGS:

I, Carroll D. Besadny, Secretary of the Department of Natural Resources and custodian of the official records of said Department, do hereby certify that the annexed copy of Natural Resources Board Order No. WQ-5-82 was duly approved and adopted by this Department on September 22, 1982. I further certify that said copy has been compared by me with the original on file in this Department and that the same is a true copy thereof, and of the whole of such original.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the official seal of the Department at General Executive Facility #2 in the City of Madison, this 19th day of November, 1982.

Carroll D. Besadny

Carroll D. Besadny, Secretary

(SEAL)

3-1-83

ORDER OF THE STATE OF WISCONSIN NATURAL RESOURCES BOARD REPEALING, RENUMBERING, AMENDING, REPEALING AND RECREATING, AND CREATING RULES.

IN THE MATTER of repealing ss. NR 110.27, 110.28, 110.29 and 110.30; renumbering s. NR 110.03(11),(12), (14) through (18), (21), (23), (25) through (32) and (34); amending NR 110.03(29) and (34), 110.08(1) and (2), 110.09(1)(b)4. and (2)(h); repealing and recreating NR 110.10(2), 110.13 through 110.26; and creating NR 110.03(3) through (10), (13), (19), (20), (22), (24) and (33), 110.06(4), 110.08(6) and 110.09(2)(n), (o), (p), (q) and (5)(d) of the Wisconsin Administrative Code pertaining to the design of sewage systems	WQ-5-82

Analysis Prepared by Department of Natural Resources

NR 110 of the Wisconsin Administrative Code regulates the planning and design of sewerage systems in Wisconsin. The Department is proposing major changes to the technical sections of the code to reflect technical advances which have been made since the last major revision in 1974, and to reorganize the technical sections for easier use and interpretation. Specific changes which have been made to the rule include administrative and technical provisions for the construction of sewage treatment facilities in floodplains, inclusion of specific administrative and technical requirements for the operation of sewerage systems during emergency periods, the inclusion of administrative and technical requirements allowing the bypassing of sewage treatment facilities, inclusion of standards for the construction of rotating biological contactor treatment systems, additional requirements for the location and design of sewage treatment lagoons, and the addition of requirements for the design and construction of land disposal systems.

Pursuant to the authority vested in the State of Wisconsin Natural Resources Board by ss. 23.11(1), 144.04, and 227.014(2), Stats., the State of Wisconsin Natural Resources Board hereby repeals, renumbers, amends, repeals and recreates, and creates rules interpreting s. 144.04, Stats., as follows:

Section 1 - NR 110.03(3) through (20) are renumbered to be NR 110.03, (11), (12), (14), (15), (16), (17), (18), (21), (23), (25), (26), (27), (28), (29), (30), (31), (32) and (34) respectively.

Section 2 - NR 110.03(3), (4), (5), (6), (7), (8), (9), (10), (13), (19), (20), (22), (24) and (33) are created to read:

(3) "ASCE" means the American Society of Civil Engineers. Copies of ASCE publications referenced in this chapter are available for inspection at the offices of the department of natural resource, the secretary of state' office and the office of the revisor of statutes. ASCE publications may be obtained from the American Society of Civil Engineers, 345 East 47th Street, New York, N.Y. 10017.

(4) "ASTM" means the American Society for Testing and Materials. Copies of ASTM standards referenced in this chapter 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. ASTM standards may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Penn. 19103.

(5) "Average design flow" means the anticipated average daily wastewater discharge to a sewage treatment facility.

(6) "AWWA" means the American Water Works Association. Copies of AWWA standards referenced in this chapter 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. AWWA standards may be obtained from the American Water Works Association, 6666 West Quincy Avenue, Denver, Colo. 80235.

(7) "Bypass or overflow" means the discharge of wastewater directly or indirectly to the waters of the state during dry or wet weather flow conditions caused by intentional or inadvertent diversion of all or a portion of the wastewater flow from a sewerage system.

(8) "Bypass or overflow structure" means the physical structures, hydraulic control mechanisms, and piping which allow a bypass or overflow to occur.

(9) "Controlled diversion" means the discharge of untreated or partially treated wastewater around the entire sewage treatment facility, or treatment processes therein, which is recombined with the treated effluent prior to the effluent sampling location.

(10) "Controlled diversion structure" means the physical structures, hydraulic control mechanisms, and piping which allow a controlled diversion to occur.

(13) "Dry land access" means a sewage treatment facility service road which has a minimum elevation of at least one foot above the regional flood elevation.

(19) "Lagoon" means those sewage treatment facilities where the wastewater containment structure is constructed primarily of earthern materials.

(20) "Maximum design flow" means the largest anticipated recurrent wastewater discharge to a sewage treatment facility.

(22) "NEC" means the 1981 National Electrical Code. Copies of the National Electrical Code 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. Copies may be obtained for personal use from the National Fire Protection Association, 470 Atlantic Avenue, Boston, Mass. 02210.

(24) "Peak design flow" means the largest anticipated infrequent wastewater discharge to a sewage treatment facility .

(33) "WPCF" means the Water Pollution Control Federation. Copies of WPCF publications referenced in this chapter 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. WPCF publications may be obtained from the Water Pollution Control Federation, 2626 Pennsylvania Avenue, N.W., Washington, D.C. 20037.

Section 3 - NR 110.03(29) as renumbered is amended to read:

12/6/82 (29) ~~(30)~~ "Sewage treatment facilities" means sewerage systems defined in sub. ~~(17) below~~ (30) (29) exclusive of interceptor sewers and sewage collection systems.

per Carol Turner

Section 4 - NR 110.03(34) as renumbered is amended to read:

(34) "WPDES permit" means the Wisconsin pollutant discharge elimination system permit ~~required by s. NR 200.03 Wis. Adm. Code~~ issued by the department under ch. 147, Stats., for the discharge of pollutants.

Section 5 - NR 110.06 (4) is created to read:

(4) If the construction of a proposed project requires, or may require, any permit under ss. 30.12, 30.19, 30.195, or 30.20, Stats., application for the necessary permits shall be made to the department at the same time the project plans and specifications are submitted for review. Failure to apply for the necessary permits shall be cause for denial or rejection of the plans and specifications.

Section 6 - NR 110.08(1) is amended to read:

(1) APPLICABILITY. A facilities plan shall be ~~included with~~ prepared for each reviewable project submitted to the department for approval. Facilities plans ~~or~~ for sewage treatment facilities or new sewage collection systems shall be submitted to and approved by the department prior to submittal of the construction plans and specifications. The department may accept construction plans and specifications for review prior to facilities plan approval provided that all substantive issues of the facilities plan review have been resolved.

Section 7 - NR 110.08(2) is amended to read:

(2) CONTENT. The facilities plan for municipally owned sewage treatment facilities, sewage collection systems, and interceptors shall contain all of the information required by ss. NR 110.09(1) through (6), 110.10(1) and (2), or 110.11(1), whichever are applicable. The following facilities planning requirements do not apply to nonmunicipally o ed facilities: s. NR 110.09(1)(b)3, 5 and 8, and (2)(b) through (e) and (j) through (m). The level of detail necessary to fulfill ~~this requirement~~ the requirements of this subsection may vary depending ~~upon~~ on the size and complexity of the project.

Section 8 - NR 110.08(6) is created to read:

(6) COST EFFECTIVENESS. A cost-effectiveness analysis shall be performed as part of the evaluation of alternatives in each facilities plan. The cost-effectiveness analysis shall be prepared in accordance with s. NR 110.09(2). Except as provided for in s. NR 110.09(2)(j)4.c., the most cost-effective alternative shall be selected for implementation.

Section 9 - NR 110.09(1)(b)4. is amended to read:

4. A cost-effectiveness analysis of alternatives for the sewerage system prepared in accordance with ~~NR 110.09~~ sub. (2). ~~Except as provided in NR 110.09(2)(j)4.c., the~~ The most cost-effective alternatives shall be selected for implementation in accordance with s. NR 110.08(6).

Section 10 - NR 110.09(2)(h) is amended to read:

(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~~ treatment, handling and disposal operations including a discussion of current quantities being produced, a description of current sludge quality including a sludge analysis, a description of any problems associated with the existing operations, and a description of industrial contributions that may affect the quantity and quality of sludge;

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

3. ~~An identification~~ A brief description of alternative technologies applicable to the proposed facility improvements, such as, thickening, stabilization, dewatering, storage, transportation, and ultimate disposal ~~techniques~~;

4. A cost-effectiveness analysis of the feasible alternatives~~, and~~ including an assessment of the environmental impacts as specified in sub. (3);

5. ~~A summary describing the selected plan and its anticipated environmental impacts.~~ An evaluation of the storage requirements either at the sewage treatment facility or at an offsite location. The evaluation shall include an estimate of the maximum period of time necessary to store sludge, and a description of the location, accessibility, soils, necessary local permits, depth to groundwater, distance to residential homes, type of facility, topography and any other appropriate information.

6. An estimate of the amount of land required for each alternative shall be made. Land requirements for landfilling of sludge shall be based upon accepted landfill design practices. Department approval in accordance with ch. NR 180, is required for construction of sludge landfills and prior to disposal of sludge at an existing licensed landfill.

7. A discussion of the procedures and timing for abandonment of the existing sludge facilities, if appropriate. This shall include, but not be limited to, the types of sludge wastes to be disposed of during abandonment, ultimate disposal location, possible construction scheduling, quantity of wastes, quality of wastes and any special problems associated with the disposal of these wastes; and

8. A summary describing the selected plan and its anticipated environmental impacts. Those actions necessary for implementing and operating the sludge management plan shall be presented. This shall include, but not be limited to, the estimated sludge treatment and disposal costs, operator time, discussion of applicable federal and state laws, necessary local permits, public participation programs, training of operators and any other actions necessary to provide for an environmentally sound sludge management program.

Section 11 - NR 110.09(2)(n) through (q) are created to read:

(n) A flood analysis for the selected treatment facility site if the site is in, or suspected to be in, a floodplain. The analysis shall meet the requirements of s. NR 116.07. The analysis shall determine the limits of the floodplain and the floodway, the regional flood elevation, and the effects on floodstage of constructing the sewage treatment facility, including dry land access and flood protection. The flood velocities at the sewage treatment facility site, and the duration of the regional flood shall also be determined. If a dry land access waiver is requested in accordance with s. NR 110.15(3)(c), the flood analysis shall also include the information necessary to support the request.

(o) An assessment of the location of the sewage treatment facilities relative to commercial establishments and to buildings which are occupied or intended for residential use, and from land which is being actively developed for commercial or residential use. The location of sewage treatment facilities shall comply with the provisions of s. NR 110.15(3)(d).

(p) An assessment of the location of land disposal systems relative to public water supply wells. The location and horizontal separation from the proposed land disposal site and any public water supply well shall be shown. The assessment shall discuss the hydrogeologic conditions of the area, the direction of groundwater movement, the depth of the public well casing, and any other appropriate information. The department will determine whether the separation distance between the land disposal system and the public well is sufficient to protect the public health and quality of the public water supply.

(q) Soil boring logs if the selected treatment alternative includes lagoons or land disposal of effluent. The borings shall supply accurate information about the soil conditions, and groundwater and bedrock elevations at the proposed treatment facility site.

Section 12 - NR 110.09(5)(d) is created to read:

(d) The department may waive the requirements of pars. (a) through (c) if the owner can demonstrate to the department's satisfaction the obvious existence or nonexistence of excessive infiltration or inflow, or both. The information necessary for this demonstration may include infiltration and inflow estimates, per capita design flows, ratio of total flow to dry weather flow, cubic meters of infiltration per centimeter diameter per kilometer of pipe per day (gallons of infiltration per inch diameter per mile per day), bypassing, and other hydrological and geological factors. The department may require the information be expanded to meet the requirements of pars. (a) through (c) if this demonstration is inconclusive.

Section 13 - NR 110.10(2) is repealed and recreated to read:

(2) STAGING OF INTERCEPTORS. (a) 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.

(b) The staging period for interceptor construction and interceptor pipe sizes shall be cost-effective. A 20 year staging period shall be analyzed. Other staging periods, not to exceed 40 years, may also be evaluated.

The cost-effectiveness analysis shall consider the following factors:

1. Cost.

a. Capital cost (present and future).

b. Operation and maintenance cost.

c. Salvage value.

2. Primary environmental impacts.

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

b. Destruction of flora and fauna.

c. Noise, erosion and sedimentation.

d. Destruction of, or impact on, wetlands and floodplains.

3. Secondary impacts.

a. Pressure to rezone or otherwise stimulate unplanned development.

b. Pressure to accelerate growth for quicker recovery of the nonfederal share of the interceptor investments.

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

4. Other nonmonetary impacts including implementation capability, operability, performance reliability and flexibility.

(c) 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.

Section 14 - NR 110.13 through 110.26 are repealed and recreated to read:

NR 110.13 SEWER DESIGN CRITERIA. (1) GENERAL DESIGN CONSIDERATIONS. (a) Separation of sewers. New systems, or extensions to existing systems, which will serve presently unsewered areas shall be designed to exclude storm and other clear water sources from the sanitary sewer system.

(b) Design basis. 1. Sewage collection systems, exclusive of interceptors, shall be designed in accordance with s. NR 110.10(1).

2. Interceptors shall be designed in accordance with s. NR 110.10(2)(a).

3. Extensions to existing sewage collection systems may be designed assuming an average design flow rate of 378 liters (100 gallons) per capita per day.

(c) Design capacity. Sewers shall be designed to carry, when running full, the peak design flows expected from domestic, commercial, industrial and

other sources, and infiltration and inflow. Peak design flow shall be established using existing sewage flow or water use records, and records of infiltration and inflow. Where peak flow records are not available, the peak design flow shall be determined by applying one of the following peak flow factors to the average design flow:

1. 250% of the average design flow for interceptors, main (trunk) sewers, and sewage outfall pipes; or,

2. 400% of average design flow for submain and branch sewers.

(d) Protection of water supplies. 1. Sanitary sewers which shall be laid less than 60 meters (200 feet) from a public water supply well shall be approved on a case-by-case basis. When sanitary sewers are proposed to be laid within 60 meters (200 feet) of a public water supply well the location of the well shall be shown on the design plans.

2. Sanitary sewers shall be isolated from private water supply wells in conformance with s. NR 112.07. When sanitary sewers are proposed to be laid within 15 meters (50 feet) of a private water supply well the location of the well shall be shown on the design plans.

3. Horizontal and vertical separation of sewers from public water mains shall comply with the requirements of ss. NR 111.73(4) and 111.77. Horizontal and vertical separation of sewer from private water laterals shall comply with the requirements of s. H62.13(2)(d).

4. Cross-connections with public and private water supply systems are prohibited.

(2) DESIGN REQUIREMENTS. (a) Diameter. 1. Conventional gravity sewer may not be less than 20 centimeters (8 inches) in diameter.

2. Gravity sewers with diameters less than 20 centimeters (8 inches) which are intended to transport septic tank effluent will be evaluated on a case-by-case basis.

(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. 1. Conventional gravity sewers shall be laid with uniform slope between manholes. All sewers shall be designed and constructed to give average velocities of not less than 60 centimeters per second (2.0 feet per second) when flowing full. The minimum slopes shown in Table 1 shall be provided. Slopes less than 0.4% may be permitted for 20 centimeter (8 inch) sewers. In such cases, however, the slope may not be less than 0.3%. The department will approve these sewers only when the owner demonstrates that physical circumstances warrant the lesser slope. Furthermore, approval will not be granted until the department has received written assurance from the operating authority that the authority will provide the additional maintenance which may result from the sedimentation due to decreased velocities.

Table 1

Sewer Size	Minimum Slope (ft./100 ft.)
(20 cm) 8"	0.40
(25 cm) 10"	0.28
(30 cm) 12"	0.22
(38 cm) 15"	0.15
(46 cm) 18"	0.12
(53 cm) 21"	0.10
(61 cm) 24"	0.08

2. Gravity sewers with a diameter less than 20 centimeters (8 inches) shall be laid at uniform slopes between manholes and shall be designed to provide sufficient flow velocities to prevent sedimentation of septic tank solids.

(d) Alignment. 1. Sewers with diameters less than 91 centimeters (36 inches) shall be laid with straight alignment between manholes.

2. The department may approve curvilinear sewers with diameters of 91 centimeters (36 inches) or larger on a case-by-case basis.

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

(f) Velocity. Where velocities of greater than 4.6 meters per second (15 feet per second) are attained, special provision shall be made to protect against displacement or erosion.

(g) Anchoring. Sewers on slopes of 20% or greater shall be anchored securely with concrete anchors or the equivalent, spaced as follows:

1. Not over 11 meters (36 feet) center to center on grades 20% to 35%;

2. Not over 7.3 meters (24 feet) center to center on grades 35% to 50%; and

3. Not over 4.9 meters (16 feet) center to center on grades greater than 50%.

(h) Trench width. The width of the trench shall be sufficient to allow the pipe to be laid and jointed properly and to allow the backfill to be placed and compacted as needed. The trench sides shall be kept as nearly vertical as possible. When wider trenches are dug, appropriate bedding class and pipe strength shall be used. Ledge rock, boulders, and large stones shall be removed to provide a minimum clearance of 10 centimeters (4 inches) below and on each side of the pipe.

(i) Bedding. 1. Bedding classes A, B, or C, as described in ASTM C12 (1981) or WPCF Manual of Practice (MOP) No. 9 (ASCE MOP No. 37) (1976) shall be used for all rigid pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load.

2. Bedding classes I, II, or III, as described in ASTM D2321 (1980) shall be used for all flexible pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load.

(j) Backfill. Debris, frozen material, large clods or stones, organic matter, or other unstable materials may not be used for backfill within 60 centimeters (2 feet) of the top of the pipe. Backfill shall be placed in such a manner as not to disturb the alignment of the pipe.

(k) Construction quality testing. 1. Groundwater infiltration into sanitary sewer systems shall be minimized. Tests for infiltration shall be specified in the construction specifications. This may include appropriate water or low pressure air testing. The leakage outward or inward (exfiltration or infiltration) may not exceed 0.19 cubic meters per centimeter pipe diameter per kilometer per day (200 gallons per inch of pipe diameter per mile per day) for any section of the system. An exfiltration or infiltration test shall be performed with a minimum positive head of 60 centimeters (2 feet). The air test, if used, shall, at a minimum, conform to the test procedure described in ASTM C828 (1980), entitled "Tentative Recommended Practice for Low-Pressure Air Test of Vitrified Clay Pipe Lines". The testing methods selected should take into consideration the range in groundwater elevations projected and the situation during the test.

2. Deflection tests shall be performed for all polyvinyl chloride pipe installations. The deflection test shall be performed using a rigid ball or mandrel, and shall be performed without mechanical pulling devices. If deflection testing occurs within 30 days of placement of the final backfill, deflection may not exceed 5%. Maximum deflection may not exceed 7.5% when testing occurs more than 30 days after placement of the final backfill.

(3) MANHOLES. (a) Location. Manholes shall be installed at the end of each line, at all changes in grade, size or alignment, and at all pipe intersections.

(b) Manhole spacing. 1. Manholes shall be located at intervals not greater than 120 meters (400 feet) for sewers with diameters of 38 centimeters (15 inches), or less, and not greater than 150 meters (500 feet) for sewers with diameters of 46 centimeters (18 inches) to 76 centimeters (30 inches). Distances up to 180 meters (600 feet) may be approved in cases where the sewer system owner has cleaning equipment which can reach this length.

2. Manhole spacing for sewers with a diameter greater than 76 centimeters (30 inches) shall be determined on a case-by-case basis.

(c) Drop pipe. An outside drop pipe shall be provided for a sewer entering a manhole where the invert elevation of the entering sewer is 60 centimeters (2 feet) or more above the spring line of the outgoing sewer. The entire drop connection shall be encased in the concrete. Inside drop connection may be approved on a case-by-case basis.

(d) Diameter. The minimum diameter of manholes shall be 1.1 meters (42 inches).

(e) Construction. Manholes shall be constructed of precast concrete, monolithic concrete, brick or block, or other approved materials. Fiberglass manholes may be approved on a case-by-case basis. Fiberglass manholes may be approved for use in high traffic areas provided the top section of the manhole is not made of fiberglass.

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

(g) Water tightness. Solid watertight 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 block shall be waterproofed on the exterior with plastic coatings supplemented by a bituminous waterproof coating or other approved coatings. Inlet and outlet pipes shall be joined to the manhole with a gasketed flexible watertight connection or any watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place.

(h) Cleanouts. For sewers with diameters 20 centimeters (8 inches), or greater, cleanouts and lampholes may not be used as substitutes for manholes. The department may allow cleanout instead of manholes when the sewer diameter is less than 20 centimeters (8 inches).

(i) Manholes for sewers with diameters less than 20 centimeters (8 inches). Manholes shall be located at pipe intersections. The spacing of these manholes shall be determined on a case-by-case basis.

(4) INVERTED SIPHONS. Inverted siphons may not have less than 2 barrels with a minimum pipe size of 15 centimeters (6 inches) and shall be provided with the necessary appurtenances for convenient flushing and maintenance. The

manholes shall have adequate clearance for rodding. Sufficient head shall be provided and pipe sizes selected to secure velocities of at least 91.5 centimeters per second (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.

(5) MATERIAL SPECIFICATIONS FOR SEWER CONSTRUCTION.

(a) 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 (ABS) composite, and fiberglass reinforced-PVC composite. Other pipe material will be considered on its merit and may be approved by the department. Where an approval is issued for a restricted or experimental use, the department may require a construction inspection report and annual reports including television inspection of the system as a condition of its approval.

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

(c) 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.

(d) Material selection. Pipe material selection shall recognize the design conditions of the sewer installation. Factors which shall be considered include depth of cover, soil types, loading on pipe, and corrosivity.

(e) 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 ASTM C428 (1981);

2. Cast iron pipe and fittings shall be of the commercial grade known as "extra heavy" and shall meet the requirements of AWWA C100 (1977);

3. Concrete pipe shall meet the requirements of ASTM C14 (1981), C76 (1982), or C655 (1981);

4. Vitrified clay pipe shall meet the requirements of ASTM C700 (1978);

5. Steel pipe shall meet the requirements of AWWA C200 (1980);

6. Ductile iron pipe and fittings shall meet the requirements of ASTM A746 (1977) or AWWA C100 (1977);

7. Polyvinyl chloride sewer pipe shall meet the requirements of ASTM D3033 (1980), D3034 (1981), or ASTM F679 (1980);

8. ABS composite sewer pipe shall meet the requirements of ASTM D2680 (1980).

(f) 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 or mechanical joints meeting the requirements of AWWA C100 (1977).

3. Rubber gasket joints for concrete sewer pipe shall meet ASTM C443 (1979).

4. Resilient joints for vitrified clay sewer pipe shall meet ASTM C425 (1977).

5. Steel pipe joints shall meet the requirements of AWWA C200 (1980).

6. Ductile iron pipe joints shall meet the requirements of AWWA C100 (1977).

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

8. ABS composite sewer pipe shall be joined by solvent weld joints or by type OR mechanical-seal joints meeting the requirements of ASTM D2680 (1980).

(g) Pressure sewer pipe and joints. All pressure sewer pipe 10 centimeters (4 inches) or larger shall meet the following minimum requirements:

1. Asbestos cement pipe and joints shall meet the requirements of AWWA C400 (1980).

2. Cast iron pipe and joints shall meet the requirements of AWWA C100 (1977).

3. Ductile iron pipe and joints shall meet the requirements of AWWA C100 (1977).

4. Steel pipe and joints shall meet the requirements of AWWA C200 (1980).

5. Concrete pipe and joints shall meet the requirements of AWWA C300 (1974).

6. Polyvinyl chloride pipe and joints shall meet the requirements of AWWA C900 (1981) (minimum class 150) or ASTM D2241 (1980) (minimum class 250). Solvent weld joints may not be used.

7. Fiberglass reinforced-polyvinyl chloride composite pipe and joints shall meet the requirements of AWWA C950 (1981)(minimum class 250). Eight and 10-inch pipe shall have a minimum category 3 stiffness as defined in ASTM D2996. Four and 6-inch pipe shall have a minimum category 2 stiffness as defined in ASTM D2996 (1977).

(h) Small diameter pressure sewer pipe and joints. All pipe and joints 8 centimeters (3 inches) in diameter or smaller to be used in grinder pumps shall meet the following minimum requirements:

1. Polyethylene pipe and joints which meet the requirements of ASTM D2239 (1974)(minimum class 160) may be approved on a case-by-case basis depending on the expected system pressure relative to the pipe working strength. Solvent weld, butt fusion, or elastomeric joints will be acceptable.

2. ABS pipe and joints shall meet the requirements of ASTM D2282 (1977)(minimum class 160). Solvent weld or elastomeric joints will be acceptable.

3. Polyvinyl chloride pipe and joints shall meet the requirements of ASTM D2241 (1980)(minimum class 160). Solvent weld or elastomeric joints will be acceptable.

NR 110.14 SEWAGE LIFT STATIONS DESIGN CRITERIA. (1) GENERAL.

(a) Applicability. Lift stations may be approved when gravity sewers are not feasible or economical to transport the same design quantities of sewage.

(b) Design report. A design report shall be submitted with plans and specifications for sewage lift stations. The design report shall comply with the facilities planning requirements of s. NR 110.11, as well as detailing the calculations of the lift station design capacity.

(2) DESIGN CONSIDERATIONS. (a) Location. 1. Lift stations may be constructed in floodplains provided the floodproofing requirements of ss. NR 116.16 and 116.17, are met.

2. Where practical, lift stations shall be located off the traffic way of streets and alleys.

3. When a lift station will be constructed within 46 meters (150 feet) of a public or private water supply well, the location of the well shall be shown on the engineering plans. In the case of a private well, the department shall require a private well variance be obtained in accordance with ss. NR 112.04 and 112.07, before approval of the lift station shall be granted.

(b) Design capacity. 1. Pumping rates for lift stations integral to collection systems shall be determined in the same manner as the flows for the sewers contributary to the lift station and in accordance with the provisions of s. NR 110.11(1)(d).

2. Pumping rates for lift stations which operate as part of sewage treatment facilities shall be determined in the same manner as the design flow for the treatment facility in accordance with s. NR 110.15(4)(c).

3. Where possible, the pumping rate shall be designed to approximate the influent flow rate to the lift station. For main pumping stations, pump stations associated with treatment facilities, or in cases where large fluctuations of flow are known to occur, the use of variable speed pumps, or multiple constant speed pumps may be required by the department.

(3) GENERAL DESIGN REQUIREMENTS. (a) Structural features.

1. The pump chamber shall be completely separate from the wet well.

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

3. 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 6 meters (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 1.5 meters (5 feet) and a suitable barrier shall be provided to prevent an individual from falling past the intermediate landing to the lower level.

4. A sump pump shall be provided in pump chambers. The sump pump discharge line shall be equipped with a check valve and shall discharge at an elevation as high as practical in the wet well. A siphon break shall be provided in the discharge line at the high point in the wet well. Pump seal water shall be piped to the sump pit.

5. All floors and walkways should be sloped to a point of drainage.

6. All wet wells shall be designed such that with any combination of influent flow and pumping rate, the pump cycle will not be less than 5 minutes. The total detention time in the wet well, at average design flow, may not exceed 30 minutes.

7. The wet well floor shall have a minimum slope of 1 to 1 to the hopper bottom. The horizontal area of the hopper bottom may not be greater than necessary for proper installation and function of suction pipe intake or pump inlet.

8. There may be no connection between any potable water supply and sewage lift station which might cause contamination of the potable supply.

9. Exteriors of steel lift stations shall be provided with a cathodic protection against corrosion.

(b) Ventilation. 1. All lift stations shall be vented to the atmosphere. Where the pump chamber is below the ground surface, mechanical ventilation must be provided.

2. Mechanical ventilation shall also be provided in wet wells and submersible lift stations where routine entrance is required to inspect or maintain equipment. Portable ventilation equipment should be available for wet wells and submersible pumping stations which are not equipped with mechanical ventilation.

3. There may be no interconnection between wet well and pump chamber ventilation systems. Switches for operation of ventilation equipment shall be marked and conveniently located. All intermittently operated ventilating equipment shall be interconnected with the respective pit lighting system. Consideration should be given also to automatic controls where intermittent operation is used.

4. The fan wheel for ventilating hazardous areas should be fabricated from nonsparking material.

5. Mechanical ventilation for wet wells and submersible lift stations shall 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.

6. Mechanical ventilation for pump chambers shall 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.

(c) Auxiliary equipment. The following auxiliary equipment shall be installed in lift stations:

1. All pump chambers shall be equipped with automatic heaters. The department may waive this requirement if it can be demonstrated that the heat output from the pump motors is sufficient to keep equipment in the chamber from freezing.

2. The installation of dehumidifiers should be considered for all pump chambers.

3. Running time meters shall be installed for each pump in all lift stations. Where the department determines that flow measurement is necessary for the proper operation of the collection system or treatment system, suitable devices for measuring, totalizing, and recording flow shall be installed.

(d) Electrical equipment. Electrical systems and components including motors, lights, cables, conduits, switchboxes, and control circuits, which will be located in raw sewage wet wells, or in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present, shall comply with the national electrical code requirements for class 1, group D, division 1 locations. In addition, equipment located in the wet well shall be suitable for use under corrosive conditions. Each flexible cable shall be provided with a watertight seal and separate strain relief. A fused disconnect switch or equivalent circuit breaker located above ground shall be provided for all pumping stations. When such equipment is exposed to weather, it shall be weatherproofed.

(e) Duplicate units. At least 2 pumps or pneumatic ejectors shall be provided in each lift station. Each pump or ejector shall be capable of pumping the design pumping rate as determined by sub. (2)(b). If 3 or more pumps are provided, they must be designed to meet expected flow conditions and must be capable of pumping the design pumping rate as determined by sub. (2)(b), with one unit out of service. Where the pumping station will serve not more than 25 residential units, a single pump or ejector may be used, provided that the station is designed to permit the installation of a future duplicate pump or ejector with no structural changes.

(f) Pumps. 1. Except where grinder pumps are used, pumps shall be capable of passing spheres of at least 7.6 centimeters (3 inches) in diameter, and pump suction and discharge piping shall be at least 10 centimeters (4 inches) in diameter. The department may allow the use of pumps with a lesser solids handling ability provided the use of the pump is justified and that a comminutor, mechanically cleaned bar screen, or other clogging protection is provided.

2. All pumps shall be nonclogging. 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. Bar screens and comminutors shall be installed in accordance with s. NR 110.16.

3. Each 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.

(g) Piping. 1. Each pump shall be equipped with individual suction piping. Suction piping shall be as straight as possible.

2. When suction elbows are used, the bell shall be placed above the floor of the wet well at a distance which is not greater than 1/2 nor less than 1/3 the diameter of the bell.

3. Suitable shutoff valves shall be placed on the suction and discharge lines of each pump. A check valve shall be placed on each discharge line between the shutoff valve and the pump. Check valves shall be placed in horizontal sections of pipe.

4. Valves may not be located in wet wells.

(h) Controls. 1. Control systems shall be of the air bubbler type, the encapsulated float type, or the flow measuring types.

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

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

4. All lift stations shall be equipped with an alarm system. The alarm system shall include audible and visual signals. The alarm system shall be activated in cases of power failure, pump failure, and at a predesignated high water level. It is also recommended that alarm systems be activated in the event of unauthorized entry or other lift station malfunction. The department may require that alarm systems be telemetered to responsible authorities for large or main lift stations.

(i) Force mains. 1. At the design pumping rate, a velocity of at least 61 centimeters per second (2 feet per second) shall be maintained.

2. An automatic air relief valve shall be placed at high points in the force main to prevent air locking.

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

4. Friction losses through force mains shall be based on the Hazen and Williams formula or other acceptable method. When the Hazen and Williams formula is used, the department recommends a "C" value between 100 and 125 be used for all pipe except plastic pipe. A "C" value between 120 and 140 is recommended for plastic pipe. The "C" value used for design shall be noted on the project plans or in the project specifications. When initially installed, force mains may have a significantly higher "C" value. The higher "C" value should be considered when calculating maximum power requirements.

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

(b) Lift. The total dynamic suction lift may not exceed 6.0 meters (20 feet).

(c) Compartment separation. The pump equipment compartment shall be above grade or offset and shall be isolated from the wet well in a manner which will prevent the humid and corrosive sewer atmosphere from entering the equipment compartment. Wet well access may not be through the equipment compartment.

(5) SUBMERSIBLE PUMPS. (a) Construction. Submersible pumps and motors shall be designed specifically for raw sewage use, and for total submergence during operation.

(b) Pump removal. Submersible pumps shall be readily removable and replaceable without dewatering the wet well or disconnecting any piping in the wet well. Removal of one submersible pump from the lift station may not interrupt the operation of other pumps in the station.

(c) Electrical equipment. 1. Electrical supply, control, and alarm circuits shall be designed to provide strain relief and to allow disconnection from the outside of the wet well. Terminals and connectors shall be protected from corrosion by being located outside the wet well or through the use of a watertight seal. If located outside, weatherproof equipment shall be used.

2. The motor control center shall be located outside the wet well and be protected by a conduit seal or other appropriate measures meeting the requirements of the national electrical code to prevent the atmosphere of the wet well from gaining access to the control center. The seal shall be so located that the motor may be removed and electrically disconnected without disturbing the seal.

3. Pump motor power cables shall be designed for flexibility and serviceability. Ground fault interruption protection shall be used to break the circuit in the event of any failure in the electrical integrity of the cable. Power cord terminal fittings shall be corrosion-resistant and constructed in a manner to prevent the entry of moisture into the cable, shall be provided with strain relief appurtenances, and shall be designed to facilitate field connecting.

(d) Explosion prevention. In order to prevent the ignition of explosive gases in submersible lift stations, one of the following requirements must be met:

1. Low water level controls shall be set such that the pump will remain totally submerged at all times. The lift station shall be equipped with a low water alarm meeting the requirements of sub. (3)(h)4., and which is distinguishable from the high water warning; or

2. The pump motor shall be rated for compliance with the national electrical code requirements of class 1, group D, division 1 locations.

(6) GRINDER PUMPS. (a) Applicability. The department may approve the use of grinder pumps in lift stations if the following requirements are met.

1. No more than 12 residential units may ultimately be served by one lift station; and

2. The total motor horsepower requirement for each pump shall be 2 horsepower or less.

(b) Duplicate units. Grinder pump lift stations serving more than 3 residential units shall be equipped with duplicate pumping units.

(c) Construction. Grinder pump lift stations shall meet the submersible pump requirements of sub. (5).

(7) EMERGENCY OPERATION. (a) General. 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 a ground surface and to prevent sewage backups into basements.

(b) Lift station requirements. One of the following provisions shall be made to insure continued operation of lift stations:

1. An on-site generator, with automatic switching and starting equipment may be installed. The generator shall have sufficient capacity to meet the total electrical demands of the pumps, controls, and auxiliary equipment; or

2. An on-site gasoline or diesel engine driven pump, with automatic switching and starting equipment may be installed. The pump shall have a capacity equal to or greater than the lift station design pumping rate; or

3. A portable generator may be available for use at the lift station. The generator shall have sufficient capacity to meet the total electrical demands of the pumps, controls, and auxiliary equipment. Electrical connections shall be accessible without maintenance personnel having to enter the lift station; or

4. A portable pump with a pumping capacity equal to or greater than the lift station design pumping rate may be available for use at the lift station. Connections for the portable pumping equipment shall be accessible without maintenance personnel having to enter the lift station; or

5. The lift station electrical system may be connected to 2 independent electrical transmission routes which receive power from the same electrical grid network which supplies power to the lift station service area; or

6. The lift station may be equipped with a holding facility which has a capacity to hold the daily design flow for a minimum period of 24 hours.

(c) Grinder pump lift stations. 1. Emergency operation of grinder pump lift stations shall be provided by one of the methods described in par. (b).

2. Emergency operation provisions for grinder pump lift stations may be waived for those stations which serve homes with private water supply systems provided it is demonstrated to the department that the lift station wet well has the capacity to hold the residual water volume of the private water supply system.

NR 110.15 GENERAL REQUIREMENTS FOR SEWAGE TREATMENT FACILITIES.

(1) DESIGN REPORT. A design report shall be submitted with plans and specifications for all sewage treatment facilities. This report shall summarize the design hydraulic loading, design biochemical oxygen demand (BOD), suspended solids and other appropriate pollutant loading, the sizing of treatment units, pump capacities, design calculations for major treatment units, and explain any deviations from the preliminary facilities planning design information which is required by s. NR 110.09(1)(b).

(2) EFFLUENT QUALITY. (a) Design. Sewage treatment facilities shall be designed to achieve compliance with the monthly and weekly average effluent limitations for biochemical oxygen demand (BOD) and total suspended solids contained in ch. NR 210, or other WPDES permit requirements, as appropriate, or with any more stringent water quality related effluent limitations required to achieve appropriate water quality standards derived from chs. NR 102-104, or from any federally promulgated water quality standard for any waters of the state.

(b) Treatment during construction. During construction of new facilities, treatment shall be maintained at a level not less than that which existed prior to the start of construction.

(c) Treatment during maintenance. During periods of major maintenance, the minimum degree of treatment shall be primary settling and effluent disinfection. All facilities discharging to class I, II or III trout streams, or other critical stream segments as determined by the department, shall be designed to the effluent quality needed to comply with the facility's WPDES permit.

(d) Emergency operation. Emergency power shall be provided in accordance with sub. (5)(d). Sufficient emergency power shall be provided so that:

1. All facilities shall, as a minimum, be able to maintain primary settling and effluent disinfection under all design flow conditions.

2. All facilities discharging to class I, II or III trout streams, or other critical stream segments as determined by the department, shall be able to operate all units critical to meeting the effluent limits as set forth in the WPDES permit for a minimum emergency period of 24 hours under all design flow conditions.

(e) Bypasses. 1. Bypassing of wastewater treatment facilities will be permitted, during periods of extreme and unanticipated high flows, in order to:

a. Prevent loss of life, or severe property damage at treatment works; or

b. Prevent reduction or loss of treatment capacity resulting from total washout of treatment media.

2. Bypass structures shall be designed and constructed in accordance with sub. (5)(h).

3. In lieu of a bypass structure, the department encourages the design and construction of a controlled diversion structure.

4. Bypass structures will not be permitted at the headworks of aerated lagoon or stabilization pond treatment systems.

5. Bypassing to surface waters will not be permitted for treatment facilities which dispose effluent by land application.

(3) PLANT LOCATION. (a) Flood protection. 1. All sewage treatment facilities shall be located such that they are not subject to flooding.

2. Any sewage treatment facility located in a floodplain, or suspected to be in a floodplain, will not be approved until the flood analysis requirements of s. NR 110.09(2)(n) are met.

3. A sewage treatment facility may be located in the flood fringe providing the requirements of par. (c) and ss. NR 116.14, 116.15, 116.16 and 116.17, are met.

4. All sewage treatment facilities which are located in a floodplain shall be floodproofed to an elevation of at least 2 feet above the regional flood elevation.

5. Location of a land disposal system in a floodplain will be evaluated on a case-by-case basis.

(b) Floodway construction. 1. No new sewage treatment facility shall be located in a floodway as defined in ss. NR 116.03 and 116.11. A change in the zoning classification of a treatment facility site from floodway to flood fringe in accordance with the procedures specified in s. NR 116.21(6), will be acceptable only if the rezoning is complemented by the construction of a dry land access as defined in par. (c). When the facility site is rezoned from floodway to flood fringe, the dry land access requirement will not be waived.

2. Any existing sewage treatment facility which is located in a floodway shall meet the requirements of subd. 1. if the expansion or upgrading of the facility is greater than 50% of the value of the facility. Value is defined in par. (c).

3. Any existing sewage treatment facility which is located in a floodway will not have to comply with the requirements of subd. 1. if the expansion or upgrading of the facility is less than 50% of the value of the facility. In this instance, the dry land access requirements of par. (c) will not apply.

(c) Accessibility. 1. Sewage treatment facilities shall be accessible at all times. Sewage treatment facilities located in a flood fringe shall be accessible by dry land access. Dry land access is defined as a service road which has a minimum elevation of at least one foot above the regional flood elevation.

2. The dry land access requirement may be waived by the department if one of the following criteria is met:

a. The physical characteristics of the treatment site and the surrounding area pose practical difficulties for construction of dry land access, and the isolation of the sewage treatment facility during the regional flood is less than 24 hours for mechanical treatment facilities, or 5 days for lagoon systems. The duration of the regional flood shall be calculated using the methods described in s. NR 116.07; or

b. The physical characteristics of the treatment site and the surrounding area pose practical difficulties for construction of dry land access, and the treatment facility access is inundated by less than one foot of water during the regional flood. In these instances, the access roads shall be stabilized and delineated; or

c. The construction costs of the expansion or upgrading of an existing treatment facility are less than 50% of the value of the existing facility. The value of the existing facility shall be calculated by subtracting the 20-year total present worth of expanding or upgrading the existing facility from the 20-year total present worth of the most cost-effective treatment alternative located at another site which is not in a floodplain.

(d) Isolation. 1. In order to minimize any potential odor, noise, and nuisances caused by sewage treatment facilities, and to enhance plant security and reliability, sewage treatment facilities shall be isolated from commercial establishments and from buildings occupied or intended for residential use, and from land which is actively being developed for commercial or residential use. The following separation distances shall be maintained:

a. 150 meters (500 feet) for mechanical treatment facilities, effluent holding and polishing ponds;

b. 150 meters (500 feet) for seepage cells, ridge and furrow systems, and overland flow systems;

c. 230 meters (750 feet) for aerated lagoons;

d. 305 meters (1,000 feet) for off site sludge holding facilities and spray irrigation systems; and

e. 460 meters (1,500 feet) for stabilization lagoons.

2. The department may waive the requirements of subd. 1. if the requirements prevent implementation of the cost-effective treatment alternative at an existing sewage treatment facility site. When a waiver is requested, the owner shall demonstrate to the department that:

a. The owner has made reasonable attempts to obtain an agreement from any affected property owner which states that the property owner has been informed of the potential nuisances which may results from the operation of the sewage treatment facilities and that the property owner does not object to the construction and operation of the sewage treatment facilities; and

b. The treatment facility owner has enacted a zoning ordinance which prohibits future construction within the applicable separation distances, or has purchased sufficient land surrounding the sewage treatment facility to prevent future encroachment.

3. The department may waive the requirements of subd. 1. if the requirements prevent construction of the cost-effective treatment alternative at a new site. When a waiver is requested the owner shall demonstrate that:

a. The treatment facility has obtained from the affected property owners the agreements described in subd. 2.a. or that the proposed sewage treatment facility site is the only reasonably available site or, the costs associated with using another site would place an unreasonable or excessive financial burden on the communty; and

b. The treatment facility owner has enacted a zoning ordinance which prohibits future construction within the applicable separation distances, or has purchased sufficient land surrounding the proposed treatment facility site to prevent future encroachment.

(4) DESIGN OF SEWAGE TREATMENT FACILITIES. (a) Conformance with facilities plan. The design capacity for municipally owned sewage treatment facilities shall be in accordance with s. NR 110.09(2)(j). Privately owned domestic sewage 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 s. NR 110.09(2)(j)4. justifies a lesser design staging period.

(b) Organic loading. 1. The domestic design biochemical oxygen demand and suspended solids loading for upgrading or expanding existing sewage treatment facilities, or for the construction of new sewage treatment facilities to replace an existing facility shall be based on actual sewage and operating records from the existing facilities. The design shall include an appropriate growth increment.

2. When actual operating data is not available, the design loading shall be based on a contribution of 0.08 kilograms (0.17 pounds) of biochemical oxygen demand per capita per day and 0.09 kilograms (0.20 pounds) of suspended solids per capita per day. When garbage grinders are used in areas tributary to a sewage treatment facility, the design basis shall be increased to 0.10 kilograms (0.22 pounds) of biochemical oxygen demand per capita per day, and 0.22 kilograms (0.25 pounds) of suspended solids per capita per day.

3. Sewage treatment facilities which will receive industrial or commercial wastewater shall be designed to include these waste flows.

(c) Hydraulic loading. The design wastewater flow rate shall be estimated in accordance with s. NR 110.09(2)(j). When flow or water use records do not exist, the maximum design flow rate shall be estimated by multiplying the average design flow rate by the appropriate peaking factor shown in Table 2.

Table 2

Community Size (population)	Peaking Factor
Under 1,000	4 - 5
1,000 - 10,000	3.0 - 3.5
10,000 - 100,000	2.0 - 2.5
Over 100,000	1.5 - 2.0

(5) DESIGN FEATURES. (a) Design of conduits. All piping and channels shall be designed to carry the peak design flow rate. The incoming sewer should be designed for unrestricted flow. Bottom corners of the channels must be filleted. Conduits shall be designed to avoid creation of pockets and corners where solids can accumulate. Suitable gates shall be placed in channels to seal off unused sections in which solids might accumulate. The use of shear gates or stop planks may be used in place of gate valves or sluice gates.

(b) Arrangement of units. Component parts of the facility shall be arranged for greatest operating and maintenance convenience, flexibility, economy, continuity of effluent quality, and ease of installation of future units.

(c) Flow measurement. Equipment for flow measurement and recording shall be provided for the total waste flow. Equipment for measuring flow streams within the treatment facility should be provided to aid facility operation.

(d) Emergency operation. One of the following provisions shall be made to insure continued operation of the sewage treatment facility in accordance with sub. (2)(d).

1. An emergency power generator may be provided. The generator shall have sufficient generating capacity to meet the treatment facility power demands needed to comply with sub. (2)(d); or

2. The sewage treatment facility electrical system may be connected to 2 independent electrical transmission routes which receive power from the same electrical grid network which supplies power to the treatment facility service area; or

3. The sewage treatment facility may be equipped with holding facilities which have a capacity to detain the maximum daily design flow for a minimum period of 24 hours.

(e) New processes, methods and equipment. The department encourages the development of new process, methods, or equipment for the treatment of sewage. 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 written certification that the use or design of the equipment is in accordance with the manufacturer's guidelines. Furthermore, the department may require the posting of a performance bond by the manufacturer.

(f) Disinfection. Disinfection shall be provided in accordance with WPDES permit requirements.

(g) Unit bypasses. Unit bypasses shall be located and arranged to allow for proper maintenance of the treatment facility while complying with the provisions of sub. (2)(c). In all cases, it must be possible for each treatment unit to be independently removed from service.

(h) Total treatment facility bypasses. Total treatment facility bypasses may be permitted in accordance with sub. (2)(e). Design of treatment facility bypass structures shall meet the following requirements:

1. Design of a treatment facility bypass structure shall require the deliberate and conscious effort of the treatment facility operator to place the bypass into operation. Automatic bypasses are prohibited.

2. Bypass structures shall be used to conduct only those wastewater flows above the peak flow rate which the treatment plant can safely handle without threatening loss of life, severe property damage, or the washout of treatment media.

3. The means for measuring and sampling bypassed sewage shall be provided at all bypass structures.

(i) Painting. 1. The use of paints containing lead is prohibited. In order to facilitate the identification of piping, pipes shall be painted as follows:

a. Sludge line----brown;

b. Gas line----orange;

c. Potable water line----blue;

d. Chlorine line----yellow;

e. Sewage line----gray;

f. Compressed air line----green;

g. Nonpotable water line----blue with 15 centimeter (6 inch) red bands spaced 76 centimeters (30 inches) apart.

2. 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.

3. Existing treatment facilities which do not comply with the provisions of this subsection shall bring the facility into compliance at the time of any major upgrading or expansion of the facility.

(j) Valve Identification. All valves shall be identified in the plans and specifications and labeled during construction.

(k) Operational Considerations. All necessary tools and accessories for the facility operator's use shall be provided. Storage space and a work area shall also be provided. All equipment shall be located as to provide sufficient clearance for proper and convenient maintenance. All tanks, wet wells, channels and pipe systems shall be equipped with drains, valves, or sumps to facilitate draining for maintenance and repair.

(l) Laboratory space and equipment. A treatment facility owner shall either include a laboratory for making the necessary analytical determinations and operating control tests, or contract with a neighboring facility or independent laboratory to have the analytical and operating control tests done.

(m) Floor slope. Floor surfaces shall be sloped adequately to a point of drainage.

(n) Erosion control during construction. Effective site erosion control shall be provided during construction. Project specifications shall detail erosion control methods. Manner of spoil material disposal shall also be detailed.

(o) Construction materials. Materials shall be selected that are compatible with the wastewater characteristics. Dissimilar metals should be avoided to minimize galvanic action.

(p) Sanitary facilities. Toilet, shower, lavatory, and locker facilities should be provided in sufficient numbers and convenient locations to serve the expected facility personnel. Toilet, shower, and lavatory facilities shall be provided in the following instances:

1. Any sewage treatment facility equipped with laboratory facilities;

2. Any sewage treatment facility equipped with a potable water supply; or

3. Any sewage treatment facility which has one or more full time operating personnel.

(q) Safety. 1. Sewage treatment facilities shall be enclosed with a fence to discourage entry of animals or unauthorized persons.

2. Hand rails shall be installed around all treatment tanks and in other areas of the facility where the potential of falling exists.

3. The department recommends the following safety measure be considered in the design of wastewater treatment facilities:

a. Provision of first aid equipment;

b. Posting of "No Smoking" signs in hazardous areas;

c. Provision of protective clothing and equipment such as gas masks, goggles, gloves, hard hats, and safety harness;

d. Portable blower and hose;

e. Portable lighting equipment; and

f. Nonpotable water supply bibs which are labeled.

4. The safety and health rules set forth in ch. Ind. 1000, and appropriate federal and local safety codes shall be adhered to in the operation of wastewater treatment plants.

5. Specific safety requirements for hazardous chemical handling are found in s. NR 110.22(4).

6. Specific safety requirements for chlorination facilities are found in s. NR 110.23(2)(g).

(6) WATER SUPPLY. (a) Potable supply. Any sewage treatment facility which has a laboratory shall be provided with a potable water supply.

(b) Plumbing. Sewage treatment facility plumbing systems shall be designed in accordance with ch. H62.

(c) Connection to public water systems. Connection of a sewage treatment facility plumbing system to a public water system shall comply with the requirements of s. NR 111.25 and ch. H62.

(d) On-site wells. Construction of wells for supplying water to a sewage treatment facility shall comply with the requirements of the approval obtained under s. NR 112.26(3).

NR 110.16 SCREENING DEVICES. (1) GENERAL DESIGN CONSIDERATIONS. (a) Applicability. All wastewater treatment plants shall be provided with protection for pumps and other equipment by installing coarse screens, bar racks, mechanically cleaned bar racks or comminutors.

(b) Location. 1. Screening devices installed in a building where other equipment or offices are located shall be separated from the rest of the building and provided with separate outside entrances.

2. Screening devices shall be provided with convenient access.

3. Screening devices may not be located such that changes in backwater elevations will interfere with the accuracy of upstream flow measuring equipment.

(c) Ventilation. Screening areas shall be ventilated.

(d) Channels. 1. The channel preceding and following the screen shall be shaped to minimize settling of solids. Fillets shall be installed as necessary.

2. The screen channel invert must be at least 8 centimeters (3 inches) below the invert of the incoming sewer.

3. Where multiple screening units are installed the channels shall be equipped with the necessary gates to direct flow from any one screening unit. Methods for dewatering each channel shall be provided.

4. Entrance channels shall be designed to distribute flow uniformly to the screening units.

(e) Handling screenings. Adequate facilities must be provided for removal, handling and storage 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 for both the platform and the storage areas.

(2) DESIGN REQUIREMENTS FOR SCREENING DEVICES. (a) Bar screens.

1. Clear spacing between bars may not be less than 2.5 centimeters (1 inch), nor more than 5 centimeters (2 inches).

2. Bar screens must be placed on a slope of 30 to 45 degrees with the horizontal with the exception of those installed for emergency use.

3. Approach velocities may be no less than 38 centimeters per second (1.25 feet per second) at design average flow conditions to prevent settling, and no greater than 91 centimeters per second (3 feet per second) at maximum design daily flow to prevent forcing material through the openings.

(b) Mechanical screens. 1. Maximum clean spacing between bars may not exceed 5 centimeters (2 inches).

2. Approach velocities may be no less than 38 centimeters per second (1.25 feet per second) at average design flow conditions to prevent settling, and no greater than 91 centimeters per second (3 feet per second) at maximum daily flow to prevent forcing material through the openings.

3. All mechanical units which are operated by timing devices shall be provided with auxiliary controls which will set the cleaning mechanism in operation at a preset high water elevation.

4. Automatic controls shall be supplemented by a manual override. Manual overrides shall be located in view of the equipment.

5. Electrical fixtures and controls in screening areas where hazardous gases may accumulate shall meet the requirements of the national electrical code for class 1, group D, division 1 locations.

(c) Comminutors. 1. Comminutors shall be designed to comminute the maximum design flow rate.

2. Comminutor channels shall be designed to contain the upstream water depth associated with the head loss which occurs at maximum design flow without surcharging the incoming sewer or other treatment processes. The expected head loss shall take into account the effects of clogging during operation.

3. Comminutor channels shall be equipped with drains.

4. A screened bypass channel shall be provided so that the comminutor may be removed from service for maintenance.

5. Bypass channels will not be required where 2 comminutors are installed. Each comminutor shall be capable of comminuting the maximum design flow.

6. Control switches or a disconnecting device for the comminutor shall be located in view of the comminutor.

7. Electrical fixtures and controls in comminutors areas where hazardous gases may accumulate shall meet the requirements of the national electrical code for class 1, group D, division 1 locations.

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

(2) DESIGN CONSIDERATIONS. (a) Location. Where practical, grit chambers should precede influent pumps. When installed, grit chambers shall precede all major treatment units.

(b) Protection. All grit chambers shall be preceded by a bar rack, coarse screen or comminutor.

(c) Housed facilities. 1. Enclosed grit removal areas shall be ventilated. Fresh air shall be introduced continuously at a rate of 12 air changes per hour, or intermittently at a rate of 30 air changes per hour.

2. All electrical work in enclosed grit removal areas where hazardous gases may accumulate shall meet the requirements of the national electrical code for class 1, group D, division 1 locations.

(d) Number of units. Grit removal facilities shall have at least 2 hand-cleaned units, or a mechanically cleaned unit with a bypass.

(e) Grit handling. 1. All facilities not provided with positive velocity control shall include means for grit washing to further separate organic and inorganic materials.

2. Grit removal facilities located in deep pits shall be provided with mechanical equipment for hoisting or transporting grit to ground level. Impervious, nonslip, working surfaces with adequate drainage shall be provided for grit handling areas. Storage areas for wasted grit shall be provided.

(f) Basis of design. Design of grit chambers shall be based on the size and specific gravity of the grit particle to be removed. If this information is not obtained from actual field measurements, then the design shall assume removal of all particles retained on a 65 mesh (0.21 mm) sieve and having a minimum specific gravity of 2.65. The design requirements of sub. (3) are based on these assumptions.

(3) DESIGN REQUIREMENTS. (a) General requirements.

1. Inlet turbulence into grit chambers shall be minimized.

2. Drains or other means for dewatering each grit unit must be provided.

3. An adequate supply of water under pressure shall be provided for cleaning grit equipment.

(b) Velocity controlled grit chambers. Positive hydraulic control shall be provided to maintain a channel velocity of 30 centimeters per second (one foot per second) through the expected flow range. Positive hydraulic control shall be provided by one of the following:

1. A flow channel with a parabolic cross-section;

2. A proportionate weir; or

3. A Parshall flume.

(c) Aerated grit chambers. 1. Air rates should be in the range of 4.6 to 12.4 liters per second per meter (3 to 8 cubic feet per minute per foot) of tank length.

2. The detention time at the maximum design flow rate should not exceed 3 minutes.

3. Inlets and outlets shall be designed to prevent short circuiting.

4. The design of the grit chamber shall be such to avoid producing dead spaces.

(d) Short-term sedimentation tanks. 1. Inlets shall be designed to distribute flow evenly across the tank.

2. Tanks shall be deep enough to prevent turbulent flow.

3. An additional depth of 15 to 25 centimeters (6 to 10 inches) shall be provided for raking mechanisms.

4. Surface area of the sedimentation tank shall be designed not to exceed a surface settling rate of 1,900 cubic meters per day per square meter (46,000 gallons per day per square foot).

NR 110.18 SETTLING TANKS. (1) DESIGN CONSIDERATIONS.

(a) Multiple settling tanks. 1. Multiple settling tanks shall be provided at all sewage treatment plants with an average design flow which exceeds 1,890 cubic meters per day (0.5 million gallons per day).

2. Control appurtenances such as valves, gates, splitter boxes, and flow measuring devices, shall be provided to divide inflow equally to each settling tank.

(b) Servicing. 1. All settling tanks shall be provided with easy access for maintenance.

2. Each settling tank shall be capable of being independently dewatered and isolated for servicing. Provisions shall be made to protect empty settling tanks from the hydrostatic uplift due to high groundwater.

(c) Safety. Operator safety shall be considered in the design of settling tanks. Safety features such as machinery covers, life lines, stairways, walkways, handrails and slip-resistant surfaces shall be provided if appropriate.

(d) Electrical controls. Electrical fixtures and controls in enclosed settling tanks shall meet the requirements of the national electrical code for class 1, group D, division 1 locations. The fixtures and controls shall be located to provide convenient and safe access for operation and maintenance.

(e) Imhoff tanks. Imhoff tanks will not be approved by the department.

(2) DESIGN REQUIREMENTS. (a) Inlets. 1. Settling tank inlets shall be designed to dissipate the inlet velocity, to distribute the flow equally and to prevent short-circuiting. Either channel shall be designed to maintain a velocity of at least 30 centimeters per second (one foot per second) at one-half of average design flow or some other means of preventing solid deposition shall be used. 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. Inlet velocities in rectangular settling tanks may not exceed 15 centimeters per second (0.5 foot per second).

3. Inlet velocities in center feed circular settling tanks may not exceed 91 centimeters per second (3 feet per second).

(b) Tank features. 1. The side water depth of mechanically cleaned settling tanks shall be as shallow as practical but not less than 2.1 meters (7 feet). Final clarifiers for activated sludge may not be less than 3 meters (10 feet) in depth. Final clarifier for fixed film treatment systems may not be less than 2.1 meters (7 feet).

2. The tops of troughs, beams, and similar construction features which are submerged shall have a minimum slope of 1.4 vertical to one horizontal. A slope of one to one shall be provided on the underside of such features to prevent the accumulation of scum and solids.

3. Effluent weirs shall be adjustable.

(c) Sludge and scum removal. 1. Scum baffles shall be provided ahead of outlet weirs on all primary and final settling tanks.

2. Sludge hoppers shall have a minimum side wall slope of 1.7 vertical to one horizontal. Hopper wall surfaces should be made smooth with rounded corners to aid in sludge removal. The department will not approve increasing the depth of sludge hoppers for the purpose of sludge thickening in settling tanks.

3. Each sludge hopper shall have an individually valved sludge withdrawal line at least 15 centimeters (6 inches) in diameter. Head available for withdrawal of sludge shall be at least 76 centimeters (30 inches), or greater as necessary, to maintain a velocity of 91 centimeters per second (3 feet per second) in the withdrawal pipe.

4. A sludge well or other appropriate equipment shall be provided for viewing and sampling sludge.

5. Provisions for cleaning sludge piping shall be made.

6. The department may approve the use of glass lined pipe for sludge. Glass lined pipe may not be less than 10 centimeters (4 inches) in diameter.

7. Suitable mechanical sludge and scum collection equipment shall be provided in all settling tanks. Provisions for separate scum washing shall be made for treatment facilities which do not have primary settling facilities.

(d) Design parameters. 1. Operating design parameters for settling facilities may not exceed the values given in Table 3.

Table 3

Location	Flow Basis	Surface Settling Rate -$m^3/m^2.d$- (gal/ft^2.d)	Solids Loading -$kg/m^2.h$- (lb/ft^2.h)	Weir Overflow Rate -m /m.d- (gal/ft.day)
Primary	Average design	40 (1000)	-	125 (10,000)
	Maximum Hourly	60 (1500)	-	-
Intermediate	Maximum Hourly	60 (1500)	-	-
Final (following)				
- Trickling filter/RBC	Average design	-	5.0 (1.0)	125 (10,000)
	Maximum Hourly	49 (1200)	8.0 (1.6)	- -
- Activated Sludge	Average design	-	7.0 (1.4)	125 (10,000)
	Maximum Hourly	49 (1200)	10.0 (2.0)	-
- Separate Stage Nitrification	Average design	-	7.0 (1.4)	125 (10,000)
	Maximum Hourly	33 (800)	10.0 (2.0)	
- Extended Aeration	Average design	-	6.0 (1.2)	125 (10,000)
	Maximum Hourly	40 (1000)	10.0 (2.0)	-

2. For treatment plants with an average design flow greater than 3,785 cubic meters per day (one million gallons per day), the department may approve an overflow rate of 188 cubic meters per meter per day (15,000 gallons per foot per day).

3. The design parameters shown in Table 3 may be waived by the department if the settling tank design is based on settling tests of wastes currently received at the existing treatment facility, or if the effluent from the sewage treatment facility is to be disposed on land.

NR 110.19 TRICKLING FILTERS. (1) APPLICABILITY. (a) Surface water discharge. New trickling filters shall be used in conjunction with other treatment units which, in combination, will produce an acceptable level of treatment as defined in s. NR 110.15(2)(a). Existing trickling filters may be used as a treatment unit in plant expansion if the effluent quality requirements of s. NR 110.15(2)(a) are met.

(b) Land disposal. Trickling filter treatment systems are an acceptable means of treatment prior to land disposal of effluent.

(2) DESIGN REPORT. A design report must be submitted in accordance with s. NR 110.15(1). The report shall show the empirical equations and the assumptions used for designing the trickling filter and the additional treatment units.

(3) DESIGN REQUIREMENTS. (a) Recirculation. Recirculation shall be provided for intermediate and high-rate filters to increase treatment efficiency and to provide wetting of the biological growth. The recirculation rate shall be variable. The recirculation rate to average influent flow ratio should not exceed 4:1.

(b) Dosing cycle. The interval between dosing cycles may not exceed one hour.

(c) Flooding. Filter structures should be designed to allow flooding of the filter.

(d) Primary treatment. Trickling filters shall be preceded by primary treatment facilities.

(4) DESIGN LOADING. Hydraulic and organic loadings to trickling filters may not exceed the values given in Table 4. Higher loadings may be approved if justified by pilot studies or if manufactured media is used. Higher loadings may also be used if the trickling filter is intended to act only as a roughing or polishing treatment unit.

Table 4

Filter Type	Recirculation Ratio	Hydrualic Loading $-m^3/m^2.d-$ (mgal/acre-day)	Organic Loading $-kg/m^3.d-$ ($lbs/10^3$ ft ^{3}.d)
Low-rate	-	4	0.3
		(4)	(20)
Intermediate-rate	less than 2:1	10	0.5
		(11)	(30)
High-rate	2:1-to-4:1	40	1.0
		(43)	(60)

(5) HYDRAULIC FEATURES. (a) Dosing equipment. 1. Sewage shall be distributed over the filter by rotary distributors or other suitable devices which will permit uniform distribution to the filter surface area.

2. 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. The dosing rate shall be large enough to insure rotation of the distributor arms.

3. A minimum clearance of 15 centimeters (6 inches) between media and distributor arms shall be provided.

(b) Underdrainage system. 1. An underdrainage system which covers the entire floor of the filter shall be provided. Inlet openings into the underdrains shall have an unsubmerged gross combined area equal to at least 15% of the surface area of the filter.

2. The underdrains shall have a minimum slope of 1%. Effluent channels shall be designed to produce a minimum velocity of 60 centimeters per second (2 feet per second) at the average daily rate of application to the filter.

(6) MEDIA. (a) Type. The media shall be crushed rock, slag or material specially manufactured for use as media in trickling filters.

(b) Quality. 1. Rock and slag media shall be durable, resistant to spalling or flaking, and be relatively insoluble in sewage. Slag media may not contain iron. The top 46 centimeters (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 ASCE Manual of Engineering Practice, Number 13.

2. Manufactured media shall be resistant to ultraviolet degradation, disintegration, erosion, aging, all common acids and alkalies, organic compounds, and fungus or biological attack. Either the media shall be structurally capable of supporting a person's weight or a suitable access walkway shall be provided to allow for distributor maintenance.

(c) Size and grading of rock, slag and similar media. 1. Rock, slag and similar media may 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 a vibrating screen with square openings:

a. Passing 11.4 centimeter (4 1/2-inch) screen - 100% by weight;

b. Retained on 7.6 centimeter (3-inch) screen - 95-100% by weight;

c. Passing 5.1 centimeter (2-inch) screen - 0.2% by weight;

d. Passing 2.5 centimeter (1-inch) screen - 0.1% by weight;

2. The department may approve other rock media gradations provided the gradations are consistent with accepted published engineering practices.

(7) STRUCTURAL FEATURES. (a) Mercury seals. Mercury seals may not be used on trickling filter distributors. Mercury seals shall be removed from existing filters during renovation. Mercury seals removed from existing filters during renovation or destruction of the filter shall be disposed in a location and manner approved by the department.

(b) Depth of media. Rock or slag filter media, or loose synthetic media, shall have a minimum depth of 1.5 meters (5 feet) above the underdrains. Synthetic corrugated filter media should have a minimum depth of 3 meters (10 feet) to provide adequate contact time with the wastewater. Rock or slag filter media depths may not exceed 3 meters (10 feet) and synthetic filter media depths may not exceed 9.1 meters (30 feet) except where special construction is justified through pilot studies.

(c) Covers. Covers shall be provided on all filters to prevent icing and freezing and to increase the treatment efficiency of the filter during winter conditions.

(d) Ventilation. 1. 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% of their cross-sectional area will be submerged under the maximum daily design hydraulic loading. The design of the effluent channels should consider the probability of increased hydraulic loading.

2. Filter covers shall be designed to allow adequate ventilation to maintain the filter in an aerobic state at all times.

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

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

NR 110.20 ROTATING BIOLOGICAL CONTACTORS. (1) GENERAL.

(a) Applicability. Rotating biological contactors may be used when the wastewater is amenable to biological treatment. This treatment process may be used for carbonaceous or nitrogenous oxygen demand reduction, or both.

(b) Manufacturer's warranty. Manufacturers of rotating biological contactor equipment shall guarantee the rotating shafts, and media against failure during the initial 5 years of operation for all proposed rotating biological contactor treatment systems. The guarantee shall include equipment replacement and installation costs.

(2) DESIGN CONSIDERATIONS. (a) Design report. A design report for rotating biological contactors shall be submitted in accordance with s. NR 110.15(1).

(b) Design parameters. The design of rotating biological contactors shall consider:

1. Design flow rate;

2. Influent carbonaceous and nitrogenous biochemical oxygen demand;

3. Rotational velocity;

4. Wastewater temperature; and

5. Percent influent biochemical oxygen demand which is soluble.

(3) DESIGN FEATURES. (a) Primary treatment. Rotating biological contactors shall be preceded by primary treatment.

(b) Contact tanks. 1. Contact tanks shall be sized to maintain a maximum hydraulic detention time of 100 minutes.

2. Tanks shall contain positive liquid level control so that the rotating biological contactors will remain approximately 40% submerged.

3. Contact tanks and rotating shafts shall be enclosed. The enclosure shall be ventilated.

4. Removable baffles shall be provided between contact stages.

(c) Equalization. Equalization facilities shall be provided ahead of rotating biological contactors if the ratio of maximum hourly design flow to average design flow exceeds 2.5:1.

(d) High density media. High density shafts may not be used in the first 2 stages of any rotating biological treatment unit or system.

(e) Rotational speed. 1. Contactors shall be equipped with drive units which will allow variable rotational speed.

2. Maximum rotational speed shall be limited to a peripheral velocity of 49 centimeters per second (1.6 feet per second).

(f) Load monitoring. Each rotating biological shaft shall be equipped with a load monitoring device.

NR 110.21 ACTIVATED SLUDGE. (1) APPLICABILITY. The activated sludge process, and its various modifications, may be used where sewage is amenable to biological treatment.

(2) DESIGN REPORT. A design report shall be submitted in accordance with s. NR 110.15(1).

(3) DESIGN CONSIDERATIONS. (a) Process selection. The choice of activated sludge process will be influenced by the degree of treatment needed to achieve the required effluent limits, the proposed treatment facility size, and the characteristics of the waste to be treated.

(b) Winter protection. Activated sludge processes and aeration equipment which are subject to freezing or icing shall be designed to minimize the degree of freezing and icing.

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

(d) Measuring devices. Devices shall be installed for measuring and displaying flow rates of raw sewage or primary effluent, return sludge, and

air to the aeration facilities. It is recommended that these devices totalize and record, as well as indicate, flows if the average design flow for the treatment plant is greater than 5,680 cubic meters per day (1.5 million gallons per day).

(e) Equalization. Equalization chambers shall be provided when large daily fluctuations of influent flow or organic loading are expected to occur.

(4) AERATION TANKS. (a) Process design. The size of aeration units for any particular adaptation of the activated sludge process shall be determined by pilot plant studies, or calculations based mainly on food to microorganism (F/M) ratio and mixed liquor suspended solids (MLSS) levels. Other factors such as size of treatment plant, diurnal load variations and degree of treatment required shall also be considered. In addition, temperature, pH bicarbonate hardness, and reactor dissolved oxygen shall be considered when designing for nitrification. The calculations used to determine the aeration capacity shall be included in the design report required by s. NR 110.15(1). Designs based on mixed liquor suspended solids levels greater than 5,000 milligrams per liter will not be approved unless adequate data is submitted showing the aeration and settling systems are capable of supporting such levels.

(b) Permissible loadings. In lieu of the design calculation requirements of par. (a), the parameters shown in Table 5 may be used to design aeration tank capacities.

Table 5

Process	F/M mg BOD applied/ mg MLVSS.d	Volumetric Loading kg BOD_5 applied/m^3. d (lbs. BOD_5 applied/1000 ft^3. d)	MLSS mg/l
Conventional	0.2 - 0.5	0.6 (40)	1,000 - 3,000
Step Aeration	0.2 - 0.5	0.6 (40)	2,000 - 3,500
Complete Mix	0.2 - 0.6	0.8 (50)	3,000 - 5,000
Contact-Stabilization	0.2 - 0.6	0.8[a] (50)	1,000 - 3,000[b] 4,000 - 10,000[c]
Extended Aeration	0.05 - 0.15	0.25 (15)	3,000 - 5,000

footnotes: a) total aeration capacity

b) contact tank

c) reaeration tank

(c) Number of units. Multiple aeration tanks shall be provided where the average design flow exceeds 1,890 cubic meters (500,000 gallons) per day.

(d) Aeration tank design features. 1. The dimensions of each aeration tank or return sludge reaeration tank shall be such as to maintain effective mixing and use of air.

2. Liquid depths in aeration tanks may not be less than 3 meters (10 feet). The department may allow liquid depths to exceed 5 meters (16 feet) on a case-by-case basis.

3. Baffling or the placement of aeration equipment shall provide positive control of hydraulic short-circuiting through aeration tanks.

4. Process piping, influent channels and inlet structure shall be arranged to provide operational flexibility.

5. 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 each tank and to maintain a constant liquid level. The hydraulic properties of the system shall permit the maximum design flow to be carried with any single aeration tank unit out of service.

6. Channels and pipes carrying liquids with suspended solids shall be designed to maintain self-cleansing velocities or shall be agitated to keep the solids in suspension at all rates of flow within the design limits.

7. All aeration tanks shall have a freeboard of not less than 46 centimeters (18 inches).

(5) AERATION SYSTEMS. (a) General. The aeration system shall be capable of meeting the oxygen requirements of the activated sludge system, or of maintaining adequate mixing of the mixed liquor suspended solids, whichever is greater.

(b) Oxygen demand. 1. Aeration equipment shall be capable of maintaining a minimum mixed liquor dissolved oxygen concentration of 2 milligrams per liter.

2. In the absence of experimentally determined values, the design oxygen requirements for all activated sludge processes shall be 1.1 kilograms oxygen per kilogram peak BOD_5 (1.1 pounds oxygen per pound peak BOD_5) removed in the aeration tanks, with the exception of the extended aeration process, for which the value shall be 1.8 kilograms oxygen per kilogram peak BOD_5 (1.8 pounds oxygen per pound peak BOD_5).

3. In the absence of experimentally determined values, the nitrogen oxygen demand (NOD) shall be 4.6 kilogram of oxygen per kilogram removed peak total Kjeldahl nitrogen (TKN) (4.6 pounds oxygen per pound removed peak TKN).

(c) Air supply to meet oxygen demands. 1. The design of the aerator system to provide the oxygen requirements calculated in accordance with par. (b) shall be done using standard design equations for diffused and mechanical aeration systems. Calculations shall incorporate such factors as tank depth, alpha factor of the waste, beta factor of the waste, certified aerator oxygen transfer efficiency, minimum aeration tank dissolved oxygen concentration, critical wastewater temperature and altitude of the wastewater treatment facility.

2. In the absence of specific design information, the air requirements shall be calculated using an oxygen transfer efficiency of 7% for diffused aerators, or a transfer rate of 1.2 kilograms oxygen per kilowatt-hour (2 pounds oxygen per horsepower-hour) for mechanical aerators.

(d) Mixing requirements. The following minimum requirements shall be met to insure adequate mixing of mixed liquor suspended solids.

1. Diffused aeration systems shall be capable of delivering a minimum air flow rate of 20 cubic meters per minute per 1,000 cubic meters (20 cubic feet per minute per 1,000 cubic feet) of aeration volume.

2. Mechanical aerators shall deliver a minimum of 15 kilowatts per 1,000 cubic meters (0.6 horsepower per 1,000 cubic feet) of aeration volume.

(e) Other air-use demands. The aeration system shall also be capable of providing the air required for channel aeration, air-lift pumps, aerobic digesters, and any other air-use demand.

(6) AERATION EQUIPMENT. (a) Diffused aeration systems. 1. Multiple blowers shall be provided. The blowers shall be sized to meet the maximum air demand with the largest blower out of service. The design shall also provide for varying the volume of air delivered in proportion to the air demand of the plant.

2. Diffusers and air piping shall be capable of supplying the diurnal peak air demand or 200% of the design average air demand, whichever is larger.

3. The arrangement of diffusers shall permit their removal for inspection, maintenance and replacement without dewatering aeration tanks or channels and without shutting off the air supply to other diffusers in the treatment system. The department may waive this requirement for systems with multiple aeration tanks provided the treatment efficiency of the system can be maintained with one aeration tank out of service.

(b) Mechanical aerators. 1. Multiple mechanical aeration units shall be designed and located so as to meet the diurnal peak oxygen demand or 200% of the design average oxygen demand, whichever is larger, with one unit out of service.

2. Due to high heat loss, the mechanical aerators shall be protected from freezing.

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

(7) SLUDGE EQUIPMENT. (a) Return sludge rate. The rate of sludge return expressed as a percentage of the average design flow of sewage shall lie within the limits shown in Table 6:

Table 6

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

(b) Return sludge pumps. 1. If motor driven return sludge pumps are used, the maximum return sludge capacity shall be met with the largest pump out of service. A positive head shall be provided on pump suctions. Pumps shall also have at least 7.6 centimeter (3-inch) suction and discharge openings.

2. If air lifts are used for returning sludge from each settling tank hopper, no standby unit will be required provided the design of the air lifts allows rapid and easy cleaning. Air lift pumps shall be designed to provide positive control of the return sludge rate.

(c) Return sludge piping. Suction piping and discharge piping for returning activated sludge shall be at least 10 centimeters (4 inches) in diameter and must be designed to maintain a velocity of not less than 60 centimeters per second (2 feet per second) 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 piping. Waste sludge piping shall comply with the requirements of s. NR 110.26(4)

(e) Waste sludge pumps. Variable speed or multiple constant speed waste sludge pumps shall be provided. The maximum sludge pumping rate shall be at least 200% of the anticipated volumetric sludge production rate. Devices for measuring waste activated sludge flow rates shall be provided.

NR 110.22 PHYSICAL-CHEMICAL TREATMENT. (1) APPLICABILITY. Physical-chemical treatment processes may be used where appropriate to achieve the required effluent limits.

(2) DESIGN REPORT. A design report shall be submitted in accordance with s. NR 110.05(1). The report shall detail any lab testing, pilot plant studies or operating experience used to design the physical-chemical process.

(3) CHEMICAL TREATMENT. (a) Chemical selection. Selection of chemicals used in chemical treatment shall be based on the characteristics of the wastewater and constituents to be removed.

(b) Design basis. 1. Design of chemical treatment processes shall be based on laboratory testing, pilot plant studies or practical operating experience.

2. Design of chemical treatment equipment, reactors, and appurtenances shall consider:

a. The chemical requirements and feed rates;

b. The location of chemical injection into the waste stream;

c. The need for rapid mixing and flocculation basins;

d. The settling characteristics of the chemical sludge;

e. The need for pH adjustment to optimize chemical reactions; and

f. The velocity of waste streams in flow conduits to minimize destruction of floc.

(c) Phosphorus removal. 1. Addition of lime or the salts of aluminum or iron may be used for the chemical precipitation of soluble phosphorus.

2. The addition of polyelectrolytes to aid in the settling of phosphate precipitates should be considered.

3. Chemicals shall be mixed rapidly and thoroughly with the wastewater.

(4) HAZARDOUS CHEMICAL HANDLING. (a) Safety. 1. Eye-wash fountains and safety showers using potable water shall be provided in the laboratory and on each floor level or work location where hazardous chemicals are stored, mixed or slaked, pumped, metered or unloaded. These fountains and showers shall be less than 7.6 meters (25 feet) from points of exposure to hazardous chemicals and shall be fully usable during all weather conditions.

2. Eye-wash fountains shall be supplied with water with a temperature not exceeding 38°C (100°F). This supply shall be separate from the hot water supply and be able to provide 15 to 30 minutes of continuous irrigation of the eyes.

3. Safety showers shall be capable of discharging 1.9 to 3.2 liters per second (30 to 50 gallons per minute) of water with a temperature not exceeding 38°C (100°F) temperature, and at pressures of 1.41 to 3.52 kilograms force per square centimeter (20 to 50 pounds per square inch).

4. The following protective clothing and equipment shall be available for use with all operations or procedures in which their use will minimize the risk of injury to personnel:

a. Chemical worker's goggles or other suitable goggles (safety glasses are insufficient);

b. Face masks or shields for use over goggles;

c. Rubber gloves;

d. Rubber aprons with leg straps;

e. Rubber boots; and

f. Safety harness and line.

5. Warning signs shall be installed where appropriate.

(b) Storage requirements. 1. The materials used for storing of hazardous chemicals shall be selected based on the physical and chemical characteristics of each chemical used.

2. Chemical storage areas shall be enclosed by dikes or curbs which will contain the stored volume in case of a spill until it can be either safely transferred to another storage area or released to the wastewater at a controlled rate which will not damage the treatment facilities, inhibit the treatment processes, or contribute to stream pollution. Liquid polymer shall be similarly contained.

3. Chemical storage and mixing areas shall be separate from other treatment plant functions.

4. Nonslip floor surfaces are desirable in polymer handling areas.

(c) Pumping and piping requirements. 1. The materials used for piping, valves, pumping, metering, splash guards and any other equipment used to convey hazardous chemicals shall be selected based on the physical and chemical characteristics of each chemical used.

2. All piping containing or transporting hazardous chemicals shall be identified with labels every 3 meters (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.

3. All pumps or feeders for hazardous or corrosive chemicals shall have splash guards which will effectively prevent spray of chemicals into space occupied by workers. The splash guards are in addition to guards to prevent injury from moving or rotating machinery parts. All connections except those adjacent to storage or feeder areas shall have guards which will direct any leakage away from space occupied by workers.

4. Exposed pipes containing hazardous chemicals may not be located above shoulder level except where continuous drip collection trays and coupling guards will eliminate the spraying or dripping of these chemicals onto workers.

(5) PHYSICAL TREATMENT. (a) Design. Physical treatment shall be evaluated on a case-by-case basis. The design shall be based on pilot plant studies or operating experience.

(b) Filtration. 1. Selection of type, size, and depth of filter media shall depend on the filtration rate, the type of treatment provided prior to filtration, filter configuration, available hydraulic head, and the desired effluent quality.

2. Multiple filters shall be provided to insure compliance with s. NR 110.15(2)(c).

3. Filtration rates at maximum daily design flow may not exceed 3.4 liters per second per square meter (5 gallons per minute per square foot) with one filter out of service.

4. Provisions shall be made for backwashing each filter. The backwash system shall be capable of providing a variable backwash rate with a maximum rate sufficient to fluidize the filtering material. A minimum backwash period of 10 minutes shall be provided.

5. Air scour for aiding backwashing is recommended.

6. Provision shall be made for chlorinating each filter.

7. Backwash reservoirs shall be provided. Total backwash water storage provided shall equal or exceed the volume required for 2 complete backwash cycles.

8. Spent backwash water shall be individually treated or returned to the head of the treatment facility. The return rate of backwash to the head of the treatment facility may not exceed 15% of the average design flow rate.

(c) Microstraining. 1. Multiple screening units shall be provided to insure compliance with s. NR 110.15(2)(c).

2. The screening rate at maximum daily design flow may not exceed 3.4 liters per second per square meter (5 gallons per minute per square foot) based on submerged area with one screening unit out of service.

3. Provisions shall be made for backwashing each unit. The backwash system shall be capable of delivering at least 1.7 liters per second per meter (8 gallons per minute per foot) of filter length. Backwash shall be delivered at 4.2 kilograms force per square centimeter (60 pounds per square inch).

4. Spent backwash shall be individually treated or returned to the head of the treatment facility. The return rate of backwash to the head of the treatment facility may not exceed 15% of the design average daily flow rate.

(6) RECIRCULATING SAND FILTERS. (a) Applicability. Recirculating sand filters may be approved on a case-by-case basis.

(b) Primary treatment. Recirculating sand filters shall be preceded by a minimum of primary treatment.

(c) Recirculation tanks. 1. Recirculation tanks shall be equipped with a highwater and pump failure alarm.

2. Recirculation tanks shall have a minimum detention time of 24 hours.

(d) Maintenance. Recirculation tanks and sand filters shall be readily accessible for inspection and maintenance.

(7) INTERMITTENT SAND FILTERS. (a) Applicability. Intermittent sand filters may be approved on a case-by-case basis.

(b) Primary treatment. Intermittent sand filters shall be preceded by a minimum of primary treatment.

(c) Loading. 1. The loading rate for installations which operate with significant rest periods may not exceed 41 liters per square meter (one gallon per square foot) per day.

2. The loading rate for filters which operate on a continuous basis may not exceed 20 liters per square meter (0.5 gallons per square foot) per day for total bed area.

(d) General requirements. 1. Duplicate filters shall be provided.

2. Intermittent sand filters shall be sealed in compliance with the provisions of s. NR 110.24(4).

3. Intermittent sand filters shall be underdrained. Underdrains may be constructed of open jointed or perforated clay, concrete or plastic pipe. Underdrain spacing may not exceed 3 meters (10 feet) on center.

(e) Media. 1. Clean graded gravel shall be placed around the underdrains. Depth of the gravel shall be at least 15 centimeters (6 inches) over of the top of the underdrains.

2. At least 60 centimeters (2 feet) of clean sand shall be placed over the gravel. The effective size of the sand shall be 0.3 to 0.6 millimeter (0.01 to 0.02 inches) with a uniformity coefficient of 3.5.

(f) Buried sand filters. 1. Distribution piping shall have a minimum diameter of 10 centimeters (4 inches). Spacing of distribution pipes may not exceed 3 meters (10 feet). Distribution pipes may not be placed directly above underdrains.

2. The distribution piping shall be vented to the atmosphere.

3. Buried sand filters shall be dosed by pumps or siphons. The dosing volume shall be 90% of the volume of the distribution piping. The dosing system and distribution piping shall be sized to handle the average daily design flow.

4. Buried sand filters shall be covered by a minimum of 91 centimeters (36 inches) of soil.

(g) Exposed sand filters. 1. Exposed filters may be used when the filter will be designed to operate during the summer months.

2. Distribution troughs or piping shall be spaced not more than 6 meters (20 feet) on center.

3. Splash pads shall be provided at each point of discharge.

4. Exposed sand filters shall be dosed by pumps or siphons. The dosing volume shall be sufficient to cover the filter with 3 to 6 centimeters (2 to 4 inches) of effluent. The dosing system shall be sized to handle the average daily design flow.

5. Exposed sand filters shall have a freeboard of at least 60 centimeters (2 feet).

NR 110.23 DISINFECTION. (1) GENERAL. (a) Applicability. Disinfection shall be provided in accordance with WPDES permit requirements.

(b) Effluent limitations. 1. When chlorine is used as the disinfectant, the residual concentration in the wastewater treatment facility effluent shall comply with WPDES permit requirements.

2. Effluent bacterial concentrations shall conform with WPDES permit requirements.

(c) Process selection. 1. The selection of the method of disinfection shall be based on a cost effective comparison of disinfection methods.

2. 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 for the design of the system in accordance with s. NR 110.15(1).

(2) DISINFECTION WITH CHLORINE. (a) Storage requirements. 1. If a gas chlorinator and chlorine cylinders are installed in a building used for other purposes, the chlorinator and chlorine cylinders shall be separated from all other portions of the building by being kept in a gas-tight room. Doors to this room shall open only to the outside of the building, and shall be equipped with panic or emergency hardware. Those rooms shall be at or slightly above grade and must permit easy access to all equipment. If one ton or larger cylinders of chlorine are used, the chlorination equipment shall be kept in a room separate from the chlorine cylinders.

2. 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.

3. Chlorinator and chlorine cylinder storage rooms shall be provided with a means of heating so that a temperature of at least 16°C (60°F) can be maintained. The rooms shall be protected against temperatures exceeding 65°C (140°F).

4. Forced, mechanical ventilation of the chlorinator room and the chlorine storage room shall be installed. Ventilation equipment shall be capable of providing 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.

5. The controls for the ventilator and lights shall be such that the ventilator and lights will automatically operate when the door is opened but must be manually switched off even if the door closes. Switches shall also be provided to allow manual operation of the lights and ventilator from outside of the room without opening the door.

6. One ton cylinders shall be used at treatment facilities where the chlorine use rate exceeds 68 kilograms (150 pounds) per day.

(b) Feed equipment. 1. Solution-feed vacuum type chlorinators or positive displacement type hypochlorite feeders shall be used.

2. An ample supply of water shall be supplied for operating the chlorinator.

3. Chlorinators and feed equipment shall be sized to handle the maximum design chlorine demand.

4. Chlorinators shall be equipped to provide control of chlorine application through the full range of design chlorine demand. If necessary, more than one rotometer shall be supplied to ensure control of chlorine application through the design range.

5. Scales or other means of determining chlorine usage shall be provided. Scales shall be of corrosion-resistant material.

6. Evaporators for converting liquid chlorine to a gas may be used if necessary.

(c) Piping and connections. 1. Only piping systems specifically manufactured for chlorine service shall be used.

2. Due to the corrosiveness of wet chlorine, all lines designed to handle dry chlorine shall be protected from the entry of water or air containing water.

(d) Chlorine control systems. In all systems with design flow of greater than 945 cubic meters per day (0.25 million gallons per day), the chlorine feed mechanism shall be provided with either an automatic flow proportional control or an automatic residual control. Chlorine residual analyzers shall be located near the chlorine contact tank. The total response time for automatic residual control systems may not exceed 3 minutes.

(e) Application. 1. 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.

2. A chlorine contact tank shall be provided and shall be sized to provide a detention time of 60 minutes at average design flow or 30 minutes at maximum design flow.

3. Chlorine contact tanks shall be baffled to provide a flow channel with a minimum length to width ratio of 40:1.

4. The department may approve contact tanks which do not comply with the requirements of this paragraph. Such facilities, however, shall be field tested to demonstrate that short circuiting of hydraulic flow through the contact chamber does not occur.

(f) Dechlorination. 1. Dechlorination shall be provided in accordance with WPDES permit requirements.

2. Dechlorination chemicals shall be rapidly mixed with the effluent.

3. Sulfur dioxide dechlorination systems shall be designed in the same manner as chlorination systems.

4. Effluent reaeration shall be provided after dechlorination if necessary to insure adequate dissolved oxygen concentration in the receiving stream.

5. Dechlorinated effluent shall be monitored for chlorine residual and dissolved oxygen in accordance with WPDES permit requirements.

(g) Safety equipment. 1. 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 convenient location. The equipment may not be stored inside any room in which chlorine is used and stored. The equipment shall use compressed air or oxygen, have at least a 30-minute capacity, and be compatible with the units used by the fire department having jurisdiction over the plant.

2. A plastic bottle of ammonium hydroxide shall be provided for the detection of chlorine leaks.

3. Leak repair kits shall be provided when one ton chlorine cylinders are used.

(3) ULTRAVIOLET DISINFECTION. Provisions shall be made to clean ultraviolet units without loss of disinfection. This shall be accomplished by installing multiple ultraviolet units, by providing ultrasonic cleaners, or by providing an effluent holding tank with a capacity of one hour detention at average design flow.

NR 110.24 LAGOONS. (1) DESIGN REPORT. A design report shall be submitted in accordance with s. NR 110.15(1).

(2) BASIS OF DESIGN. (a) Number of cells. A minimum of 2 treatment cells shall be provided for aerated lagoons and stablilization ponds. Where a controlled discharge is required, additional effluent storage cells shall be provided.

1. For aerated lagoons designed to treat domestic wastewater only, the hydraulic detention time of each cell shall be based on the following formula:

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

Where: T = detention time, days

E = BOD removal efficiency, percent

K = Reaction coefficient (log base e), days $^{-1}$

a. For domestic wastewater K = 0.5 at 20°C.

b. The reaction coefficient (K) must be adjusted for temperature according to the formula:

$$K_T = K_{20}\,\theta^{\,T-20}$$

Where K_T = Corrected reaction coefficient

K_{20} = 0.5

θ = 1.07

T = Low design temperature, °C

2. The appropriate summertime and wintertime reaction coefficients for aerated lagoons designed to treat combined domestic and industrial wastewater shall be determined from laboratory or pilot studies, or from operating data of existing full scale aerated lagoons which are treating similar wastewater. The reaction coefficients developed shall be used to calculate the required detention time.

3. In addition to the treatment volume calculated in subd. 1. or 2., quiescent settling zone or cell shall be provided for aerated lagoon systems. Minimum settling time shall be 6 days for surface water discharge, and 3 days for land disposal discharge.

4. Aerated lagoons designed to treat combined domestic and industrial wastewater shall be provided with the means to recirculate final lagoon effluent to the first treatment cell.

(b) Stabilization ponds. 1. Stabilization ponds may be used to treat domestic wastewater. Combined domestic and industrial wastewater may be treated in stabilization ponds only if the treatability of the industrial wastewater is demonstrated through pilot testing.

2. Pond design for BOD_5 loading may not exceed 23 kilograms per hectare (20 pounds per acre) per day.

3. A minimum hydraulic detention time of 150 days shall be provided.

(3) DESIGN REQUIREMENTS. (a) Location. Lagoon systems shall be located in compliance with s. NR 110.15(3)(b) and (c).

(b) Separation from groundwater. 1. For all lagoons not sealed with a synthetic liner, a minimum separation distance of 1.25 meters (4 feet) shall be maintained between the bottom of lagoons and the highest recorded or indicated seasonal groundwater table elevation.

2. For all lagoons sealed with a synthetic liner, a minimum separation distance of 60 centimeters (2 feet) shall be maintained between the bottom of the lagoon and the highest recorded or indicated seasonal groundwater table elevation.

(c) Separation from bedrock. A minimum separation of 3 meters (10 feet) shall be maintained between the bottom of lagoons and bedrock. The department may waive this requirement on a case-by-case basis if it can be demonstrated that a lesser separation distance will not cause groundwater quality problems. Criteria which will be evaluated to waive this requirement include the depth to bedrock, the type of bedrock, the fracture condition of the bedrock, the direction of groundwater movement, the existing groundwater quality, and the downstream uses of the groundwater.

(d) Soil borings. 1. Soil borings shall be conducted at each proposed lagoon site. The drilling logs of the borings shall be submitted as part of the engineering report required by s. NR 110.15(1). Soil borings shall be conducted by an independent soil testing laboratory or engineering firm.

2. Soil borings shall be used to determine subsurface soil characteristics, groundwater table elevation and depth to bedrock. Soils shall be classified according to the unified soil classification system.

3. Soil borings shall be performed in accordance with ASTM D1586 (1974) or ASTM D1587 (1974).

4. A minimum of one soil boring per 4,047 square meters (one acre) shall be taken. The department may require additional borings be taken if the additional borings are needed to properly describe the site soils, bedrock, or groundwater conditions.

5. Each boring shall have a minimum depth of 7.6 meters (25 feet), or to bedrock, whichever is shallower.

(e) Lagoon shape. The shape of lagoons shall be such that there are no narrow or elongated portions. Islands, peninsulas or coves will not be approved. Dikes shall be rounded at corners to minimize accumulations of floating materials. Commonwall dike construction is encouraged. Round, square or rectangular lagoons with a length not exceeding 3 times the width are recommended.

(f) Dikes. 1. The minimum top width of dikes shall be 3.6 meters (12 feet).

2. Maximum dike slopes shall be 3:1 (horizontal to vertical).

3. The minimum allowable interior slope shall be 4:1.

4. A minimum one meter (3 feet) freeboard from operating water surface to the top of dikes shall be provided.

(g) Operating water depth. 1. A minimum liquid depth of 0.6 meters (2 feet) for stabilization ponds and 1.8 meters (6 feet) for aerated lagoons shall be provided.

2. Maximum water depth may not exceed 1.8 meters (6 feet) for stabilization ponds and 4.3 meters (15 feet) for aerated lagoons.

(4) SEALING REQUIREMENTS (a) General. All lagoons shall be sealed to prevent excessive exfiltration.

(b) Exfiltration rate. 1. Loss of water from lagoons may not exceed 10 cubic meters per water surface hectare (1,000 gallons per acre) per day.

2. In circumstances where soil characteristics, groundwater quality, or waste characteristics warrant, the department may require that more stringent exfiltration rates be met.

(c) Materials. 1. Soil materials or synthetic liners approved by the department may be used to seal lagoons.

2. Soil materials or synthetic liners used to seal lagoons shall be compatible with the wastewater characteristics.

(d) Sampling and Testing Standards. 1. Core samples taken to determine soil texture, grain size distribution or permeability shall be taken in accordance with ASTM D1586 (1974), ASTM D1587 (1974), or ASTM D 3550 (1977).

2. Permeability shall be determined using a falling head permeability test. The test shall be performed at the same approximate density as the in-place field condition. Tests on remolded or undisturbed samples are acceptable.

3. Sieve analyses performed to determine grain size distribution shall be performed in accordance with ASTM D422 (1972).

4. Plasticity index shall be determined in accordance with ASTM D424 (1971).

5. Standard proctor densities shall be determined in accordance with ASTM D698 (1978).

(e) Uniform construction. All lagoon seals shall be uniformly constructed across the lagoon bottom and interior dike walls. Seals shall extend up the dike wall to the berm.

(f) Synthetic liners. 1. Synthetic liners shall have a minimum thickness of 0.8 millimeters (30 mils).

2. All synthetic liners shall be installed under the supervision of a qualified manufacturer's representative.

3. Synthetic liners shall be protected by an inorganic soil layer. The soil layer shall have a minimum thickness of 30 centimeters (one foot). The soil shall be uniformly graded and free from large rocks, angular stones, soil

clumps, sticks or other material which may puncture the liner. When a granular, noncohesive soil is used for the cover, a soil fabric shall be placed between the liner and the soil cover. The soil fabric shall be anchored at the dike berm.

4. Synthetic liners shall be securely anchored to the dike berm.

5. Synthetic liners shall be vented.

6. Riprap or other means of erosion control shall be provided to prevent exposure of the synthetic liner due to erosion of the protective soil layer.

7. Prior to constructing the synthetic liner, the underlying soils shall be treated with a herbicide in accordance with manufacturers recommendations.

(g) Soil or soil-bentonite liners. 1. The permeability of soil or bentonite liners may not be greater than 1×10^{-7} cm/sec. (2.83×10^{-4} ft/day).

2. The liner thickness shall be determined according to Darcy's equation, and shall include an appropriate safety factor for construction variability. In no case shall the liner thickness be less than the minimum values shown in Table 7.

3. When the soil or soil-bentonite liner is to be constructed over the existing soil at the lagoon site, 15% of the soil particles of the existing soil must pass a no. 200 sieve. If this requirement cannot be met, a soil filter fabric material shall be placed between the liner and the existing soil.

4. Liners shall be compacted at or above optimum moisture content.

5. A means shall be provided to prevent the liner from desiccating after the completion of construction and prior to placing the system in operation.

6. Liners shall be protected by an inorganic soil layer. The soil layer shall have a minimum thickness of 10 centimeters (4 inches). The cover shall be uniformly graded and free from large rocks, soil clumps, and sticks.

Table 7

Coefficient of Permeability cm/sec (ft/day)	Minimum Liner Thickness Centimeters (Inches) Water Depth Meters (feet)			
	1.8 (6)	3 (10)	3.8 (12)	4.6 (15)
1×10^{-7} (2.83×10^{-4})	22 cm (9 in)	33 cm (13 in)	40 cm (16 in)	48 cm (19 in)
5×10^{-8} (1.42×10^{-4})	14 (6)	19 (8)	23 (8)	27 (11)
1×10^{-8} (2.83×10^{-5})	10 (4)	10 (4)	10 (4)	10 (4)
5×10^{-9} (1.42×10^{-5})	10 (4)	10 (4)	10 (4)	10 (4)
1×10^{-9} (2.83×10^{-6})	10 (4)	10 (4)	10 (4)	10 (4)

(h) Soil liner material specifications. 1. Soil liners shall consist of soils of which more than 50% of the soil particles pass a no. 200 sieve. The soil liner shall have a plasticity index of at least 15.

2. Soil liners shall be compacted to at least 95% of the maximum standard proctor density.

3. Soil liners shall be constructed and compacted in lifts. Each lift may not exceed a compacted thickness of 15 centimeters (6 inches).

4. Frost susceptible soils may not be used to construct the liner. Any soil which is primarily silt, silty sand, or lean clay which has a plasticity index less than 12 shall be considered as frost susceptible.

5. Soil liners constructed of natural in-place soils shall be scarified prior to compaction.

(i) Bentonite liner material specifications. 1. Bentonite shall be mixed with a soil in which at least 30% of the soil particles pass a no. 200 sieve. The soil shall have a plasticity index of at least 15.

2. Bentonite shall be applied at a rate recommended by the manufacturer or independent soil expert. The constructed liner shall have a minimum bentonite content of 5% by dry weight.

3. Ninety percent of the bentonite by weight shall pass a no. 80 sieve.

4. Bentonite shall be thoroughly mixed with the soil material.

5. The bentonite liner shall be compacted to at least 85% of the maximum standard proctor density.

(j) Construction quality testing. 1. All liners shall be tested before placing the lagoons into operation to insure compliance with par. (b). Test results shall be submitted to the department.

2. The method of testing shall be presented to the department with the project plans and specifications.

3. Testing shall be performed in accordance with one of the testing methods of par. (k).

4. All tests shall be performed under the supervision of the design engineer.

(k) Testing methods. 1. All liners may be tested using an in-field full lagoon water balance. The test shall occur over a minimum 14-day period. The manner of determining precipitation, and evaporation rates shall be shown in the project plans and specifications.

2. The integrity of the field constructed seams for synthetic liners shall be tested with compressed air prior to placing the protective soil cover. All faulty seams shall be repaired and retested.

3. Core samples of soil or soil-bentonite liners may be taken and the liner thickness and permeability measured in a laboratory. Core samples shall be taken in accordance with ASTM D1587 (1974). A minimum of 12 samples per wetted hectare (5 samples per wetted acre) must be analyzed. The samples shall be proportionately taken from the lagoon bottoms and dikes. The lagoon liner shall be considered to meet the performance standard of par. (b) if:

a. The average seal thickness of the samples are equal or to greater than the specified design thickness. No sample shall have a thickness more than 1-inch less than the design thickness; and

b. The coefficient of permeability of 90% of the samples must be equal to or less than the design coefficient of permeability.

(5) CONSTRUCTION DETAILS. (a) Material. 1. Embankments and dikes shall be constructed of relatively impervious materials and compacted at near optimum moisture content to 95% of the standard proctor density.

2. Vegetation and other unsuitable materials shall be removed from the area where the embankment is to be placed.

(b) Erosion control. 1. Riprap or other means of preventing erosion shall be used at locations on lagoon bottoms and interior dike walls where erosion or activity of burrowing animals is likely to occur.

2. Riprap or other erosion control methods shall be used on the exterior dike walls for lagoons which are constructed in a flood fringe.

3. Exterior dike walls, berms and interior dike walls above the normal operating water depth, shall be riprapped or seeded with perennial, low growing, spreading grasses.

(c) Fencing. Lagoons shall be enclosed within a fence. A vehicle access gate shall be provided.

(d) Warning signs. Appropriate signs shall be provided along the fence surrounding lagoons to designate the nature of the facility and prohibit trespassing.

(6) AERATION EQUIPMENT. (a) Air requirements. Air shall be provided to the aerated lagoons at a rate of not less than 1.5 kilograms oxygen per kilogram (1.5 pounds of oxygen per pound) of BOD removed.

(b) Surface aeration equipment. 1. The department may approve the use of surface aeration equipment only in those cases in which the equipment can be properly maintained and operated during the winter.

2. Surface aeration equipment shall be so designed and placed to provide optimum mixing of pond lagoon contents and dispersion of oxygen to the waste. Unless sufficient justification is presented to the contrary, surface aerators shall be designed using an oxygen transfer rate of 1.2 kilograms of oxygen per kilowatt-hour (2.0 pounds of oxygen per horsepower-hour).

(c) Subsurface aeration equipment. 1. Flexible tubing containing air release slits shall be provided across the lagoon bottom in accordance with the manufacturer's recommendations. Air tubing shall be securely anchored to prevent floating. To prevent clogging of the air lines, provision shall be made to accommodate cleaning.

2. Air tubing and anchors shall be constructed of materials which resist corrosion.

3. Air shall be supplied to the lagoon system at a rate sufficient to meet the oxygen requirements of par. (a) assuming an oxygen transfer efficiency of 7%.

4. Tubular aeration units shall be provided in sufficient number to supply adequate air to the pond system based on a maximum transfer rate of 0.6 kilograms (1.25 pounds) of oxygen per unit per hour.

5. Where data is presented to the department to justify oxygen transfer rates varying from the requirements of this paragraph the department may approve such design transfer rates.

(d) Aeration systems. 1. Multiple blowers shall be provided. Capacity of the blowers shall be sufficient to meet total air demands with one blower out of service.

2. Diffusers and air piping shall be capable of supplying 200% of the average daily air demand.

(7) HYDRAULIC STRUCTURES. (a) Materials. Influent lines, interconnecting piping, and overflow structures shall be constructed of materials suitable for underground gravity sewer construction.

(b) Capacity. 1. Influent lines to all lagoon systems shall be sized in accordance with s. NR 110.13(4).

2. Overflow structures and interconnecting piping for continuous flow lagoon systems shall be sized in accordance with s. NR 110.13(4).

3. Overflow structures and interconnecting piping for controlled discharge lagoon systems shall be sized to handle the anticipated interlagoon flow rates during periods of discharge.

(c) Influent piping. 1. A manhole shall be installed at the end of the influent line or force main and shall be located as close to the dike as topography permits. Its invert shall be at least 15 centimeters (6 inches) above the maximum operating water level of the lagoon to provide sufficient hydraulic head without surcharging the manhole.

2. Influent lines shall be located such that the top of the pipe is at least 15 centimeters (6 incnes) below the lower surface of the soil, bentonite, or synthetic liner.

3. For circular lagoons, the inlet shall terminate at the center of the lagoon. Influent lines to rectangular or square lagoons shall terminate in the first one third of the lagoon length. Influent and effluent piping shall be located to minimize short-circuiting within the lagoon.

4. The inlet line shall discharge either horizontally onto a concrete pad or by means of an upturned elbow terminating at least 30 centimeters (one foot) above the pond bottom.

(d) Overflow structures. An overflow structure shall be provided and shall consist of either a manhole or box equipped with multiple-valved pond drawoff lines or an adjustable overflow device. The overflow structure shall allow the liquid level of the lagoon to be adjusted to permit operation at depths ranging from 60 centimeters (2 feet) to the maximum design operating depth in stabilization ponds and from 1.2 meters (6 feet) to the maximum design operating depth in aerated lagoons. The department recommends that stop planks not be used in overflow structures to control operating depth.

NR 110.25 LAND DISPOSAL OF EFFLUENT. (1) APPLICABILITY. Land disposal systems shall be reviewed and approved on a case-by-case basis.

(2) ENGINEERING REPORT. An engineering report shall be submitted in accordance with s. NR 110.15(1). The report shall detail the soil types, groundwater conditions, topography, soil permeability and other characteristics of the disposal site. Soil boring logs shall be provided. Wastewater characteristics which may influence design of the disposal system shall also be discussed.

(3) TREATMENT PRIOR TO DISPOSAL. Prior to land disposal, wastewater shall be treated in accordance with WPDES permit requirements.

(4) DESIGN REQUIREMENTS. (a) Application rates. 1. The application rate of wastewater may not exceed the long term infiltrative capacity of the soil.

2. The application rate of wastewater containing heavy metals may not exceed the soil capacity for preventing the movement of the heavy metals through the soil.

(b) Separation from groundwater. 1. A minimum 1.25 meter (4-foot) zone of unsaturated soil shall separate the soil surface of the land disposal system and the highest anticipated groundwater elevation. The highest anticipated groundwater elevation shall be determined by adding the calculated mounding effects of the disposal discharge to the seasonal high groundwater elevation.

2. The separation distance required in subd. (1) may be increased by the department if the disposal site soil types, hydrogeologic conditions, groundwater quality and use, or the wastewater characteristics warrant a greater separation distance.

(c) Separation from water supplies. 1. Land disposal systems shall be separated from private water supply wells by a minimum horizontal distance of 76 meters (250 feet).

2. The minimum horizontal separation distance between a land disposal system and public water supply wells shall be determined during facilities planning in accordance with s. NR 110.09(2)(p). In all cases the department recommends a minimum horizontal separation of 305 meters (1,000 feet) be maintained.

(d) Separation from bedrock. 1. A minimum separation distance of 3 meters (10 feet) shall be maintained between the soil surface of the land disposal system and bedrock.

2. The separation distance required in subd. 1. may be increased by the department if the disposal site soil types, hydrogeologic conditions, groundwater quality and uses, type of bedrock, or wastewater characteristics warrant a greater separation distance.

(e) Storage lagoons. Storage lagoons shall be provided for all land disposal systems which are adversely affected by winter conditions or wet weather. Storage lagoons shall be constructed in accordance with s. NR 110.24(3) and (4).

(f) Multiple seepage cells. 1. Multiple seepage cells shall be provided, or other provisions shall be made to allow loading and resting of seepage cells.

2. Loading rates to multiple seepage cells shall be based on the total seepage area of all cells.

(5) GROUNDWATER MONITORING. (a) Applicability. Groundwater monitoring systems shall be installed in accordance with WPDES permit requirements.

(b) Well location. 1. The upgradient groundwater monitoring well shall be located at the most distant upgradient point of the facility property but not more than 76 meters (250 feet) from the outer edge of the land disposal system.

2. Downgradient groundwater monitoring wells shall be located at least 3 meters (10 feet) and preferably not more than 15 meters (50 feet) from the outer edge of the land disposal system. In no case shall downgradient wells be located beyond the property boundary of the site, unless an easement for access is obtained.

(c) Construction details. 1. For driven point well type construction, a 5 centimeter (2 inch) or larger diameter stainless steel well point shall be connected to new schedule 40 steel pipe.

2. For all other types of drilled well construction, including augering and jetting, a larger upper drillhole having a minimum inside diameter of 10 centimeters (4 inches) shall be provided to ensure adequate and proper sealing of the annular space between the outer drillhole and the monitoring well. Where caving formation exists, a temporary larger outer pipe or hollow stem auger shall be installed to hold the drillhole open. The monitoring well shall have a minimum inside diameter of 5 centimeters (2 inches) and shall be set to the bottom of the drillhole. Either schedule 40 plastic pipe and well screen or schedule 40 steel pipe and stainless steel well screen are acceptable construction materials. Drilling holes or slots in the plastic pipe instead of using well screen is acceptable provided a coarse filter cloth

is wrapped over the holes or slots to prevent the well from filling with soil. A washed and graded sand or gravel pack shall be placed around the well screen to an elevation at least 30 centimeters (one foot) above the top of the screen. Thirty centimeters (one foot) of coarse or graded sand shall be placed on top of the gravel pack. In those cases where the drillhole does not stand open, the larger outer diameter pipe shall be pulled back to expose the gravel pack and coarse sand to the water bearing formation and must be removed during or immediately following grouting. For unconsolidated soils, a minimum vertical annular space of 60 centimeters (2 feet) above the coarse sand and 91 centimeters (3 feet) below the ground surface shall be sealed. Either a clay type soil slurry, fine aggregate cement or bentonite slurry shall be placed in the annular space. The remaining vertical annular space may be filled with native soil, drill cuttings or clay type soil slurry. For compacted heterogeneous soils, a clay type soil slurry, fine aggregate cement or bentonite slurry shall be placed above the coarse sand and extended to the ground surface.

3. The top of groundwater monitoring wells shall extend a minimum of 30 centimeters (one foot) above the ground surface. In the event the monitoring well is located in a floodplain, the top of the monitoring well shall extend to a minimum of 60 centimeters (2 feet) above the regional flood level, or the top of the well shall be sealed to withstand the water head associated with the regional flood level above the top of the well.

(d) Well screens. 1. Inlet screens shall have a length of at least 76 centimeters (30 inches) but not greater than 1.5 meters (5 feet).

2. For a single level groundwater monitoring well system, the monitoring well inlet screens shall be located 1.5 to 3 meters (5 to 10 feet) below the top of the groundwater table.

3. For a multi-level groundwater monitoring well system, the wells installed at the highest elevation shall have the inlet screens located 1.5 to 3 meters (5 to 10 feet) below the top of the groundwater table. The wells installed at the lower elevations shall have their inlet screens located at 3 to 4.5 meter (10 to 15 foot) intervals to provide a representative picture of the groundwater quality on a 3 dimensional basis.

(e) Miscellaneous. 1. A protective post or an outer steel cover shall be provided for each plastic monitoring well extending above ground level.

2. A sign or legible message shall be attached to the well site indicating that water from the well should not be used for drinking purposes.

3. All unsuccessful wells, boreholes or other vertical holes shall be abandoned following pulling of the well pipe and screen by filling completely with a clay type soil slurry, or fine aggregate concrete grout or bentonite slurry.

4. The department may approve any alternative construction methods for installing groundwater monitoring wells on a case-by-case basis.

(f) Sampling technique. The department recommends that bailers be used to draw samples from groundwater monitoring wells.

NR 110.26 SLUDGE HANDLING AND DISPOSAL. (1) DESIGN REPORT. A design report shall be submitted in accordance with s. NR 110.15(1). The report shall show calculations used to design the sludge facilities. Design of sludge handling facilities shall consider such factors as the volume of sludge generated, its percent solids and character, the degree of volatile solids reduction, sludge temperature, the degree or extent of mixing to be obtained, the sludge percent solids and characteristics after processing and the size of the installation with appropriate allowances for sludge and supernatant storage and energy requirements whenever such factors are appropriate for the design of the sludge processing facilities.

(2) GENERAL DESIGN CONSIDERATIONS. (a) Grit removal. When grit removal facilities are not provided, the volume of thickeners, digesters and storage facilities shall be increased to accommodate the additional solids loading.

(b) Sludge thickening. 1. Whenever practical, sludge thickening shall be provided.

2. Thickened sludge should have a minimum solids concentration of 5% prior to transmission to the digesters.

(c) Multiple units. Multiple units shall be provided. A single unit may be allowed, provided an alternate method of sludge processing, emergency storage or ultimate disposal operation exists to insure continuity of service.

(d) Maintenance. 1. Provisions shall be made for draining, cleaning, inspection, and maintenance of all units.

2. Tank bottoms shall be sloped to drain to a sump pump or withdrawal pipe.

3. Access manholes shall be provided. Covered tanks shall have one side wall entrance large enough to permit the use of mechanical equipment to remove grit and sand.

(e) Storage facilities. 1. The construction of sludge storage facilities may be required to improve sludge handling capabilities, provide flexibility in operations, and to avoid environmental or public health hazards due to improper disposal techniques.

2. Construction of these facilities will depend upon treatment plant capabilities, land availability, surface and groundwater protection, health factors, municipal sludge management capabilities and other environmental factors.

(3) GENERAL DESIGN REQUIREMENTS. (a) Flow measurement. Devices for measuring flow to and from sludge digestion facilities shall be provided.

(b) Ventilation. All enclosures which are connected with sludge digestors, or which contain sludge or gas piping or equipment shall be provided with forced ventilation in accordance with s. NR 110.14(3)(b). The piping gallery for digesters may not be connected to other passages unless a tightly fitting self-closing door is provided at connecting passageways.

(c) Safety. Nonsparking tools, rubber soled shoes, safety harness, gas detectors for inflammable and toxic gases and at least 2 self-contained respiratory units should be provided for emergency use whenever inflammable and toxic gases may be present.

(d) Supernatant withdrawal. Sludge thickeners and aerobic digestors shall be designed for effective separation and withdrawal of supernatant and for effective collection and removal of scum and grease.

(e) Sampling. 1. Provisions shall be made for sampling at each supernatant draw-off level and for collecting sludge samples for analysis. Sampling pipes shall be at least 4 centimeters (1 1/2 inches) in diameter and shall terminate in a suitably-sized sink or basin.

2. Unless 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 4 centimeters (1 1/2 inches).

(f) Chemical handling. Chemical handling facilities shall meet the provisions of s. NR 110.22.

(4) SLUDGE PUMPS AND PIPING. (a) Sludge pumps. 1. Sludge pumping systems shall be designed to handle the expected range of sludge flows.

2. Multiple pumps shall be provided.

3. Pumps with demonstrated solids handling capability shall be provided for handling raw and processed sludge.

4. A minimum positive head of 60 centimeters (2 feet) shall be provided at the suction side of centrifugal-type pumps and is desirable for all types of sludge pumps. Maximum suction lifts may not exceed 3.0 meters (10 feet) for plunger pumps.

(b) Sludge piping. 1. Sludge withdrawal piping shall have a minimum diameter of 20 centimeters (8 inches) for gravity withdrawal and 15 centimeters (6 inches) for pump suction and discharge lines. The department may approve the use of glass lined pipe which is at least 10 centimeters (4 inches) in diameter. Where withdrawal is by gravity, the available head on the discharge pipe shall be sufficient to maintain a minimum velocity of 90 centimeters (3 feet) per second.

2. Gravity piping shall be laid on uniform grade and alignment. The slope on gravity discharge piping may not be less than 3%.

3. Provisions shall be made for draining, flushing and cleaning sludge piping.

4. Air relief valves shall be provided at high points in pressure sludge lines.

5. Special consideration shall be given to the corrosion resistance and continuing stability of pipes and supports located inside the digestion tank.

(5) ANAEROBIC DIGESTION. (a) General. 1. Anaerobic digesters which will also serve as supernatant separation tanks shall have a minimum side water depth of 6 meters (20 feet).

2. Multiple sludge inlets and draw-offs shall be provided. Multiple recirculation suction and discharge points to facilitate flexible operations and effective mixing of the digester contents shall be provided unless adequate mixing facilities are provided within the digester. One sludge 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 supernatant draw-off. Sludge withdrawal for disposal shall be from the bottom of the tank. The pipe shall be interconnected with the recirculation piping to increase flexibility in mixing tank contents.

(b) Tank capacity. 1. The total digestion tank capacity shall be calculated based upon the factors indicated in sub. (1). If such calculations are not done, the following minimum requirements shall be met:

a. A minimum detention time of 15 days at design flows shall be provided;

b. Completely mixed digestion systems shall provide for intimate and effective mixing to prevent stratification and to assure homogeneity of digester content. The maximum system loading shall be 1.28 kilograms per cubic meter per day (80 pounds of volatile solids per 1,000 cubic feet of volume per day) in the digester;

c. The maximum system loading for moderately mixed digestion systems in which mixing is accomplished only by circulating sludge through an external heat exchanger shall be 0.64 kilograms per cubic meter per day (40 pounds of volatile solids per 1,000 cubic feet of volume per day) in the digester; and

d. The loading rates indicated in subds. 2., 3., and 4. assume that the raw sludge is derived from ordinary domestic wastewater. The 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.

(c) Temperature. Heating equipment shall have the ability to maintain digestion temperature in the range of 33° to 38°C (90° to 100°F).

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

2. Safety facilities shall be included where gas is produced. Pressure and vacuum relief valves and flame traps, together with automatic safety shut off valves, shall be provided. Waterseal equipment may not be installed. Gas compressors with gas safety equipment should be housed in a separate room with an exterior entrance.

3. The diameter of gas piping shall be based on the volume of gas which will be generated. Gas piping shall slope to condensate traps. The use of float-controlled condensate traps is prohibited.

4. Gas burning boilers, engines and other units using gas as a fuel shall be located in ventilated rooms, preferably at ground level and shall be isolated in accordance with the provisions of s. Ind. 54.13 (14). Gas lines to these units shall be provided with suitable flame traps.

5. Electrical fixtures and controls in enclosed places where gas may accumulate shall comply with the national electrical code requirements for class 1, group D, division 2 locations.

6. Waste gas burners shall be readily accessible and shall be located at least 7.6 meters (25 feet) away from any plant structure if placed at ground level. Waste gas burners may be located on the roof of the control building if sufficiently removed from the tank. All waste gas burners shall be equipped with automatic ignition, such as a pilot light or a device using a photoelectric cell sensor. Consideration should be given to the use of natural or propane gas to insure reliability of the pilot light. If the waste gas burner is in a remote location, the department may approve the discharge of gas to the atmosphere through a return-bend screened vent terminating at least 3 meters (10 feet) above the walking surface, provided the assembly incorporates a flame trap.

7. A gas meter with by-pass shall be provided to meter total gas production. Additional gas meters may be required to measure gas usage.

(e) Digestion tank heating. 1. Whenever possible, digestion tanks shall be constructed above groundwater level. Digestion tanks shall be insulated to minimize heat loss.

2. Piping shall be designed to provide for the heating of feed sludge before introduction to the digesters. Heat exchanger sludge piping shall be sized for heat transfer requirements.

3. 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 supply shall be provided.

4. Consideration should be given to equipping hot water internal heating controls with an automatic mixing valve to temper the boiler water with return water so that the inlet water to the heat jacket can be maintained between 49° to 55°C (120° to 130°F) to prevent excessive caking or encrustation of sludge on the heat jacket. Manual controls shall also be provided.

5. The boiler shall be provided with automatic controls to maintain the boiler temperature at approximately 82°C (180°F). Automatic controls shall also be provided to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level or excessive temperature.

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

(f) Supernatant withdrawal. 1. Supernatant piping shall be 15 centimeters (6 inches) in diameter, or larger.

2. 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. If a supernatant selector is provided, provisions shall be made for at least one other draw-off level located in the supernatant zone of the tank in addition to a positive unvalved vented overflow pipe. High pressure backwash facilities shall be provided.

(6) AEROBIC SLUDGE DIGESTION. (a) General. 1. Aerobic digesters shall be designed to provide effective air mixing, reduction of organic matter, supernatant separation and sludge concentration.

2. The digester detention time may be calculated based upon the factors indicated in subd. 1. If such calculations are not done, the following minimum requirements shall be met:

a. A minimum of 15 days detention time shall be provided for waste activated sludge and 20 days for primary sludge or a combination of primary and waste activated sludge. Where sludge temperature is lower than 10°C (50°F), additional time shall be provided; and

b. The volatile suspended solids loading may not exceed 1.60 kilograms per cubic meter per day (100 pounds per 1,000 cubic feet per day) in the digestion unit. Lower loading rates may be necessary depending on temperature, type of sludge and other factors.

3. The aeration system for aerobic digesters shall be capable of meeting the oxygen requirements of par. (b), or the mixing requirements of par. (c), whichever is greater.

(b) Oxygen demand. 1. Aeration systems shall be capable of maintaining a minimum digester dissolved oxygen concentration of one milligram per liter.

2. In the absence of experimentally determined values, the design oxygen requirements for aerobic digesters shall be 2.0 kilograms oxygen per kilogram (2.0 pounds oxygen per pound) anticipated volatile suspended solids reduction. An additional 1.8 kilograms oxygen per kilogram (1.8 pounds oxygen per pound) of BOD_5 applied to the digester by primary sludge shall be supplied.

3. The design of the aeration system to meet the digester oxygen requirements shall comply with the provisions of s. NR 110.21(5)(c).

(c) Mixing requirements. 1. Digestion tanks shall be designed for effective mixing.

2. Diffused aeration systems shall be capable of delivering a minimum air flow rate of 30 cubic meters per minute per 1,000 cubic meters (30 cubic feet per minute per 1,000 cubic feet) of digester volume.

3. Mechanical aerators shall deliver 26.3 kilowatts per 1000 cubic meters (1.0 horsepower per 1,000 cubic feet) of digester volume.

(d) Aeration equipment. Aeration equipment needed to meet the requirements of pars. (b) and (c) shall comply with the provisions of s. NR 110.21(6).

(e) Supernatant withdrawal. Aerobic digesters shall be equipped for supernatant draw-off. It is recommended that multi-level draw-off be provided.

(7) OTHER SLUDGE STABILIZATION PROCESSES. (a) Lime stabilization. Sufficient lime shall be added to produce a pH of 12 after 2 hours of contact.

(b) Composting. Static aerated pile, within vessel, or windrow composting methods shall be maintained at a minimum operating temperature of 40°C (104°F) for at least 5 days. For 4 hours during this period the temperature must exceed 70°C (158°F). Composting design, siting and operation shall be done in accordance with ch. NR 180.

(c) Other methods. Other methods or operating conditions may be acceptable for sludge stabilization if pathogens and volatile solids are reduced to an extent equivalent to anaerobic digestion.

(8) SLUDGE DEWATERING. (a) Sludge drying beds. 1. The drying bed area shall be calculated based upon such factors as climatic conditions, character and volume of sludge to be dewatered, the method and character of sludge removal and other methods of sludge disposal. At least 0.19 square meters (2

square feet) of drying bed area per capita population equivalent shall be provided when the drying bed is the primary method of dewatering, and 0.09 square meters (1 square foot) per capita population equivalent if it is to be used as a back-up dewatering unit. The bed area shall be increased by 25% if the beds are paved.

2. At least 2 drying beds shall be provided.

3. Percolation type drying beds shall meet the following conditions:

a. The lower course of gravel around the underdrains shall be properly graded and shall be at least 30 centimeters (one foot) in depth, extending at least 15 centimeters (6 inches) above the top of the underdrains. It is desirable to place this in 2 or more layers. At least 8 centimeters (3 inches) of the top layer shall consist of gravel 3 to 6 millimeters (1/8 to 1/4 inches) in size.

b. The top course shall consist of at least 15 to 23 centimeters (6 to 9 inches) of clean, medium to coarse, sand with a grain size of 1 to 3 millimeters in diameter. The finished sand surface shall be level.

c. Underdrains shall be clay pipe or concrete drain tile at least 10 centimeters (4 inches) in diameter laid with open joints. Underdrains shall be spaced not more than 6 meters (20 feet) apart.

d. An impervious layer shall be provided immediately beneath the lower course to prevent the downward movement of filtrate into the groundwater.

4. Paved surface drying beds may be used if adequate center or side drains are provided. If partially paved drying beds are used, they shall be designed with consideration for space requirement to operate mechanical equipment for removing the dried sludge.

5. Sludge influent piping to the beds shall terminate at least 30 centimeters (one foot) above the surface and be so arranged that the beds will drain. Concrete splash plates for percolation type beds shall be provided at sludge discharge points.

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

7. Drying beds shall be arranged to facilitate sludge removal. Concrete truck tracks shall be provided for all sludge beds. Pairs of tracks shall be on 6 meter (20-foot) centers.

(b) Sludge drying lagoons. The bottom of the lagoons must be at least 1.25 meters (4 feet) above the maximum seasonal high groundwater level and at least 3 meters (10 feet) above bedrock. The bottom of the lagoons shall be constructed in accordance with s. NR 110.28.

2. Lagoons may not be more than one meter (39 inches) in depth.

3. The area required will depend on design conditions. At least 2 lagoons shall be provided.

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

(c) Mechanical dewatering facilities. 1. General. Provision shall be made to maintain sufficient continuity of service so that sludge may be dewatered without accumulation beyond storage capacity. Design calculations or pilot plant data shall be submitted to justify the basis of design and equipment.

2. The capacity of vacuum filters, centrifuges, filter presses, belt filters or other mechanical dewatering facilities shall be sufficient to dewater the sludge produced with the largest unit out of service.

3. There shall be provided at least one back-up vacuum pump and one back-up filtrate pump for each vacuum filter installation. The vacuum filter shall be designed to allow for the easy removal and replacement of the vacuum pump and filtrate pump.

4. The dewatering area shall be ventilated.

(d) Drainage and filtrate disposal. The drainage from drying beds or shallow lagoons and the filtrate from dewatering units shall be returned to the sewage treatment process at approriate points.

(e) Other dewatering facilities. If other methods of reducing the quantity of sludge are proposed, a detailed description of the process and design data shall accompany the plans.

(9) SLUDGE REDUCTION. (a) Incineration. Adequate provisions for residue disposal and air pollution control shall be provided. The appropriate requirements of chs. NR 154 and 180, shall be met.

(b) Other reduction facilities. If other methods of reducing the quantity of sludge are proposed, a detailed description of the process and design data shall accompany the plans.

(10) SLUDGE STORAGE FACILITIES. (a) General. A detailed description of the wastewater treatment process and design data shall accompany the plans for the proposed storage facility.

(b) Liquid sludge storage facilities. Liquid sludge storage facilities shall be designed and constructed in accordance with s. NR 110.24(4).

1. The liquid sludge storage facility shall be designed to facilitate easy addition and removal of sludge from the lagoon without causing damage to the pond seal and embankments.

2. The maximum lagoon depth shall be 6 meters (20 feet). The depth may be increased on a case-by-case basis.

3. In the event a storage lagoon is a temporary facility, the lagoon shall be abandoned in such a manner so as to prevent safety, environmental, and aesthetic problems from occurring. The department shall be notified in writing if the storage facility is to be abandoned and how abandonment will be accomplished.

(c) Cake storage facilities. 1. Permanent and temporary cake storage facilities shall be designed to minimize odors and to protect surface waters, groundwaters, and soil.

2. Surface runoff shall be diverted away from the storage location.

3. Cake storage facilities designed as pits shall provide a method of draining-off and collecting precipitation.

(d) Monitoring wells. Monitoring wells may be required on a case-by-case basis. Construction of monitoring wells shall comply with the requirements of s. NR 110.25(5).

(11) TRANSPORTATION OF SLUDGES. (a) Liquid. 1. Liquid sludge shall be transported in an enclosed watertight unit from treatment plant to disposal site.

2. The department recommends that all sludge field spreading equipment be provided with a control so that the discharge valve can be opened and closed by the driver while the vehicle is in motion.

(b) 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 the spilling of sludge from the vehicle while in transit and to prevent an odor nuisance while in transit.

(12) ULTIMATE DISPOSAL. (a) Sludge management. 1. The owner of a municipal wastewater treatment plant shall be responsible for compliance with WPDES permit sludge management reporting requirements.

2. The owner of the municipal wastewater treatment plant shall be responsible for the implementation of the sludge management plan in accordance with WPDES permit requirements.

3. The department shall evaluate sludge management plans and reports on the basis of recommendations in Wisconsin department of natural resources technical bulletin no. 88 and any other pertinent information deemed appropriate to the review of sludge management plans and reports. Copies of technical bulletin no. 88 are available for inspection at the offices of the department of natural resources, secretary of state, and the revisor of statutes. Copies of technical bulletin no. 88 may be obtained for personal use from the Department of Natural Resources, 101 S. Webster St., P.O. Box 7921, Madison, Wisconsin 53707.

4. Sludge management program requirements shall include the submission of following reports if required by the WPDES permit plus any additional information which the department may require:

a. General sludge management information;

b. Sludge characteristics;

c. Landfilling and public use;

d. Agricultural site characteristics and operations; and,

e. Sludge disposal records.

(b) Landspreading. Landspreading and storage of sludge from municipal wastewater treatment facilities shall be done in accordance with WPDES permit requirements and subs. (10) and (11).

(c) Landfilling. Landfilling of sludge from municipal wastewater treatment facilities shall comply with the requirements of ch. NR 180.

Section 15 - NR 110.27 through 110.30 are repealed.

The foregoing rules were approved and adopted by the State of Wisconsin Natural Resources Board on September 22, 1982.

The rules contained herein shall take effect as provided in s. 227.026(1) (intro.), Stats.

Dated at Madison, Wisconsin November 19, 1982

STATE OF WISCONSIN DEPARTMENT OF NATURAL RESOURCES

By Carroll D. Besadny
Carroll D. Besadny, Secretary

(SEAL)