CHAPTER 12

Design and Construction Standards for Public Water Supplies

Section 1. **Authority**. These standards are promulgated pursuant to W.S. 35-11-101 through 35-11-1207. Specifically, W.S. 35-11-302 requires the administrator to establish standards for the issuance of permits for construction, installation, or modification of any public water supply.

Section 2. **Purpose**. The purpose of these standards is to:

(a) Ensure that the design and construction of public water supplies meet the purpose of the Environmental Quality Act.

(b) Prevent, reduce and eliminate pollution and enhance the waters of the State of Wyoming by ensuring that the design and construction of public water supplies are capable of the required treatment and distribution providing continued operation to protect the health, safety and welfare of the users and operators.

These standards pertain only to permits required pursuant to Chapter 3, Wyoming Water Quality Rules and Regulations.

Section 3. **Intent**. The design and construction standards included in these regulations are directed toward conventional public water systems. These standards impose limiting values of design for which a construction, installation, or modification permit application and plans and specifications can be evaluated by the division.

The terms "shall" and "must" are used when practice is sufficiently standardized to permit specific delineation of requirements or when safeguarding public health or protection of water quality justifies such definite action. Other terms, such as "should", "recommend", and "preferred" indicate desirable procedures or methods which allow deviations provided the purpose of these regulations can be accomplished.

The applicant shall use the date referenced copy of other standards referred to in these regulations. Where no date is listed for the referenced standards, the standards used shall be those in effect when these regulations become effective.

Section 4. **Definitions**. The following definitions supplement those contained in W.S. 35-11-103 of the Wyoming Environmental Quality Act.

(a) “Auxiliary source of supply” means any water supply on or available to the water user’s system other than an approved public water supply acceptable to the water supplier.

These auxiliary waters may include water from another supplier's public potable water supply or any natural source(s), such as a well, spring, river, stream, harbor, and so forth; used waters; or industrial fluids. These waters may be contaminated or polluted, they may be objectionable or they may be from a water source which the water supplier is uncertain of sanitary control.

(b) "Average daily demand" means the total annual water use divided by the number of days the system was in operation.

(b) "Backflow" means the undesirable reversal of flow of water or mixtures of water and other liquids, gases, or other substances into the distribution system of the public water supply from any other source or sources.

(c) "Backflow incident" means any identified backflow to a public water supply distribution system or to the potable water piping within the water user's system benefitting from a water service connection to the public water supply distribution system.

(d) "Back-pressure" means a form of backflow caused when the pressure of the water users' system is greater than that of the water supply system. This could be caused by a pump, elevated tank, elevated piping, boiler, pressurized process, pressurized irrigation system, air pressure or any other cause of pressure.

(e) "Back-siphonage" means a form of backflow caused by negative or reduced pressure in the water supply system. This situation can be caused by loss of pressure due to high water demands, a line break, excessive fire fighting flows, etc.

(f) "Containment" means the practice of installing approved backflow prevention devices at the water service connection of the water user in order to protect the public water supply from any backflow from the water users system.

(g) "Contamination" means an impairment of a public water supply by the introduction or admission of any foreign substance which degrades the quality of the potable water or creates a health hazard.

(h) "Cross connection" means any actual or potential connection between a potable water supply and any other source or system through which it is possible to introduce contamination into the system.

(i) "Degree of hazard" means either a high or low hazard situation where a substance may be introduced into a public water supply through a cross connection. The degree of hazard or threat to public health is determined by a hazard classification.

(j) "Domestic services" means services using potable water for ordinary living processes and not for commercial or industrial uses, fire protection systems with antifreeze or other chemicals, heating systems, etc. Examples may include residences, churches, office buildings, schools, etc.

(k) “Dual check” means a device conforming to ASSE Standard #1024 consisting of two independently acting check valves. Dual check valves are allowed only for residential water service connections that have a low hazard potential with back pressure or backsiphonage under continuous pressure.

(l) "Groundwater source" includes all water obtained from dug, drilled, bored, jetted or driven wells; springs which are developed so that the water does not flow on the ground and protected to preclude the entrance of surface contamination; and collection wells.

(m) “Hazard classification” means a determination by a hazard classification surveyor as to high hazard or low hazard and the potential cause of backflow as either back-pressure or back-siphonage.

(n) “Hazard classification survey” means inspection of a premises to identify the potable water systems, the location of any potential cross connections to the potable water systems, the hazard of the potential backflow, the physical identification of any backflow devices or methods present and the inspection status of any backflow devices or methods. The hazard classification survey results must be recorded and certified by a qualified hazard classification surveyor.

(o) “Hazard classification surveyor” means an individual certified by the USC-Foundation for Cross-Connection Control and Hydraulic Research as Cross Connection Control Specialist, the American Association of Sanitary Engineers (ASSE) as a Cross Connection Control Surveyor, or by another state certification program approved by the administrator, or by a water distribution system operator also certified as a backflow device tester employed by the public water supplier for the service where the survey is being conducted.

(p) “High hazard” means a situation created when any substance which is or may be introduced into a public water supply poses a threat to public health through poisoning, the spread of disease or pathogenic organisms, or any other public health concern.

(q) “Isolated” when referring to cross connections means the proper approved backflow prevention devices have been installed at each point of cross connection within the water user's system. This requires the installation of an approved backflow protection device at each source of possible contamination. This type of control has the advantage of protecting health within the water user's system as well as protecting the public water supply.

(r) “Low hazard” means a situation created when any substance which is or may be introduced into a public water supply does not pose a threat to public health but which does adversely affect the aesthetic quality of the potable water.

(s) "Maximum daily demand" means the demand for water exerted on the system over a period of 24 consecutive hours, for the period during which such demand is greatest.

(t) "Maximum hour demand" means the highest single hour demand exerted on the system. This may or may not occur on the maximum day.

(u) "Mineralized water" means any water containing more than 500 mg/L total dissolved solids.

(v) "Offstream reservoir" means a facility into which water is pumped during periods of good quality and high stream flow for future release to treatment facilities.

(w) "Surface water source" includes all tributary streams and drainage basins, natural lakes and artificial reservoirs or impoundments upstream from the point of the water supply intake.

(x) “Water service connection” means any water line or pipe connected to a distribution supply main or pipe for the purpose of conveying water to a water user’s system.

(y) “Water supplier” means any entity that owns or operates a public water supply, whether public or private.

(z) “Water user” means any entity, whether public or private, with a water service connection to a public water supply. The water user is also identified as a customer of a public water supply.

(aa) “Water user’s system” means that portion of the user’s water system between the water service connection and the point of use. This system includes all pipes, conduits, tanks, fixtures, and appurtenances used to convey, store or utilize water provided by the public water supply.

Section 5. **Facilities and Systems not Specifically Covered by these Standards**. This section is provided to encourage new technology and equipment and provide a process for evaluating and permitting designs which deviate from these regulations. The proposed construction of facilities and processes not in compliance with these regulations will be permitted provided that the facility, when constructed, can operate meeting the purpose of these regulations.

(a) Each application for a permit to construct a facility under this section shall be evaluated on a case-by-case basis using the best available technology. The following information should be included with the application:

(i) Data obtained from a full scale, comparable installation which demonstrates the acceptability of the design; and/or

(ii) Data obtained from a pilot plant operated under the design condition for a sufficient length of time to demonstrate the acceptability of the design; and/or

(iii) Data obtained from a theoretical evaluation of the design which demonstrates a reasonable probability of the facility meeting the design objectives; and

(iv) An evaluation of the flexibility of making corrective changes to the constructed facility in the event it does not function as planned.

(b) If an applicant wishes to construct a pilot plant to provide the data necessary to show the design will meet the purpose of the act, a permit to construct must be obtained.

Section 6. **Engineering Design Report.**

(a) Scope and purpose. An engineering design report shall be submitted with each application. The purpose of the report shall be to describe and provide technical justification for all aspects of the proposed construction, modifications and/or installations. The report should address existing conditions (if any), known or suspected problems, proposed actions, and the reasoning used to arrive at those proposed actions. There is no minimum or maximum size for the report, provided it meets the purpose of this section.

(b) Water distribution (water works) systems. The engineering design report for all new water distribution system extensions shall include:

(i) A description of the service area including scaled vicinity plan map(s) of the project with regard to adjacent and proposed development, elevations, and topographic features.

(ii) Current and projected system water demand for average day, maximum day, maximum hour, needed fire flows and per capita maximum daily flows.

(iii) Information on fire protection and fire flow capabilities of the proposed system.

(iv) Description of high service pumping systems and finished water storage facilities.

(c) Treatment facilities. The engineering design report shall include:

(i) A description of the facility site and location, including a scaled site plan, and:

(A) Present and projected facility property boundaries.

(B) Flood protection indicating predicted elevation of 25- and 100-year flood stages. The facility shall be protected from damage and be capable of being operated during the 100-year flood or maximum flood of record, whichever is greater. Flooding resulting from ice jams shall be considered.

(C) Present and proposed access.

(D) Distances from current habitation, the closest major treated water transmission line, the closest treated water storage facility, and the water source.

(E) Fencing and/or security.

(F) Topographic features and contours with indicated datum.

(G) Soil and subsurface geological characteristics. Provide a soils investigation report of the proposed site suitable for structural design of the proposed facilities.

(ii) A detailed description of the service area for the project including a scaled plan showing land use and boundaries.

(iii) A detailed description of the recycle flows and procedures for reclamation of recycle streams.

(iv) A detailed description of disposal techniques for settled solids, including a description of the ultimate disposal of sludge.

(v) Sources of water supply shall be described to include:

(A) Groundwater sources.

(I) Geology of aquifer and overlying strata.

(II) Summary of source exploration data, including test well depth and method of construction; test pumping rates and duration; and water levels and specific yield.

Water quality, including biological, radiological and chemical quality data sufficient to determine necessary treatment processes and compliance with all drinking water standards as determined by the administrator. The same water quality data for all secondary sources shall also be provided.

(III) Sources of possible contamination around well and in any known recharge areas, including location of any waste sites, industrial facilities and wastewater disposal areas.

(B) Surface water sources.

(I) Safe annual yield, the quantity of water available from the source during the average and driest years of record.

(II) Hydrological data, stream flows and diversion records.

(III) Representative water quality data, including bacteriological, radiological, chemical and physical data. These data shall be sufficient to determine the necessary process and the ability to meet water quality standards.

(IV) Description of the watershed noting sources of potential contamination.

(V) Description of any anticipated changes in water quality.

(VI) Description of any diversion dams, impoundments or reservoirs and appurtenances.

(vi) Plant design conditions, including:

(A) Historical and design population.

(B) Existing and projected maximum daily demand flows and demand variations.

(C) Complete description of existing facilities.

(D) Where applicable, a complete description of proposed treatment process including:

(I) Unit process design criteria addressing flash mixing, flocculation and settling basin size and equipment description; retention times; unit loadings and overflow rates; filter area and proposed filtration rate; backwash rate and volume requirements; chemical feeder capacities and ranges; and disinfection feeder capacities and ranges.

(II) Chemical requirements, including dosages and feed rates.

(III) Chemical delivery, handling, and storage systems.

(IV) Waste generation including types and volumes.

(V) Waste stream recycling, including holding basin capacities, pump sizes and recycle rates.

(VI) Methods of ultimate waste disposal.

(VII) Low service pumping facilities.

(E) Description of on-site restrooms and sanitary sewer facilities.

(vii) Summary of automatic operation and control systems, including basic operation, manual override operation, and maintenance requirements.

(viii) Description of the on-site laboratory facilities and a summary of those tests to be conducted on-site. If no on-site laboratory is provided, a description of plant control and water quality testing requirements, and where the testing will be conducted shall be included. Description of cross control measures to be provided at chemical feed tanks, filters, washdown taps, direct connection to sewer or other relevant protection.

(d) Hazard classification. The engineering design report shall include a hazard classification or specify the default classification identified in Section 14 (i) (i) (B) which shall be applicable to the project. A hazard classification shall include the following:

(i) A determination of the degree of hazard of all water service connections to be connected to the proposed project.

(ii) A determination of the potential cause of backflow for all water service connections.

Section 7. **Plans and Specifications Content**.

(a) All plans for water works and treatment facilities shall have a suitable title showing the following:

(i) Name of owner and location of project.

(ii) North arrow and drawing scale.

(iii) Name, Wyoming registration number, and seal or signature of the engineer.

(b) All plans shall contain a site plan of the proposed project with topography and boundaries of the project. Datum used shall be indicated.

(c) Water lines. Plans for transmission and distribution lines shall include:

(i) A detailed plan view at a legible scale of each reach of the water line showing all existing and proposed streets, adjacent structures, physical features, and existing locations of utilities. The location and size of all water lines, valves, access manholes, air-vacuum release stations, thrust blocking, and other appurtenances shall be indicated. Pertinent elevations shall be indicated on all appurtenances.

(ii) Profiles of all water lines shall be shown on the same sheet as the plan view at legible horizontal and vertical scales, with a profile of existing and finished surfaces, pipe size and material, valve size, material and type. The location of all special features such as access manholes, concrete encasements, casing pipes, blowoff valves, airvacuum relief valves, etc., shall be shown.

(iii) Special detail drawings, scaled and dimensioned to show the following:

(A) The bottom of the stream, the elevation of the high- and low-water levels, and other topographical features at all locations where the water line is near or crosses streams or lakes.

(B) Cross-section drawing of the pipe bedding.

(C) Additional features not otherwise covered by specifications.

(iv) Location of any sewer lines within 30 feet (9 m) horizontally. Sewers that cross water lines shall be shown on the profile drawings.

(d) Storage tanks, pumping stations and treatment facilities. Plans shall be submitted showing the relation of the proposed project to the remainder of the system. Layouts and detail plans shall show the following:

(i) Site location and layout including topographic and physical features, proposed arrangement of pumping or treatment units, existing facilities, existing and proposed piping and valving arrangements, access drive, power supply, fencing, embankments, clearwells, waste and sludge ponds, etc.

(ii) Schematic flow diagram(s) and hydraulic profile(s) for facility treated water, and flow diagram for sludge and wastewater flows.

(iii) Plan(s) and section view(s) of each treatment facility process unit with specific construction details, features and pertinent elevations. Details of each unit should include, but are not limited to: inlet and outlet devices, baffles, valves, arrangement of automatic control devices, mixers, motors, chemical feeders, sludge scrapers, sludge disposal, or other mechanical devices.

(e) Wells. Plan and profile drawings of well construction shall be submitted showing diameter and depth of drill holes, casing and liner diameters and depths, grouting depths, elevation and designation of geological formations, water levels, and other details to describe the proposed well completely.

(f) Specifications. Technical specifications shall accompany the plans for new water lines, pump stations, treatment facilities, wells, or additions/modifications to existing systems or facilities. Where plans are for extensions to water distribution systems, the specifications may be omitted, provided it is stated that the work is to be constructed under specifications authorized by the Water Quality Division. Specifications on file must conform to this standard. The specifications accompanying construction drawings shall include:

(i) Identification of construction materials.

(ii) The type, size, strength, operating characteristics, rating or requirements for all mechanical and electrical equipment, including machinery, valves, piping, electrical apparatus, wiring and meters; laboratory fixtures and equipment; operating tools; special appurtenances; and chemicals, when applicable.

(iii) Construction and installation procedure for materials and equipment.

(iv) Requirements and tests of materials and equipment to meet design standards.

(v) Performance tests for operation of completed works and component units.

(vi) Specialized requirements for tests, analyses, disinfection techniques, and other special needs.

(vii) Requirements for well construction and testing. The collection of the following must be recorded and reported to the Wyoming Department of Environmental Quality, Water Quality Division.

(A) Geological data.

(B) Well construction data. Well construction data shall include screen locations, size of screen openings, screen intervals, accurate records of drill hole diameters and depths, assembled order, size and length of casing and liners, casing wall thickness, grouting depths, formations penetrated, water levels, and location of any blast charges.

(C) Well test data. Well test data shall include test pump capacity-head characteristics; static water level; depth of test pump setting; time of starting and ending each test cycle; pumping rate; pumping water level; drawdown; and water recovery rate and levels.

(g) Technical specifications shall require that all water service connections will be provided with backflow prevention devices in accordance with the requirements of Section 14 (i) of these regulations.

Section 8. **General Design Considerations.**

(a) Design basis. The capacity of the water treatment or water production system shall be designed for the maximum daily demand at the design year. Where water use records are not available to establish water use, the equivalent per capita water use shall be at least 125 gpd (475 liters per day) and 340 gpd (1,285 liters per day) to size facilities for average and maximum daily water demand, respectively.

(b) Siting requirements.

(i) Location. Treatment facilities shall be located such that no sources of pollution may affect the quality of the water supply or treatment system. The facilities shall not be located within 500 feet of landfills, garbage dumps, or wastewater treatment systems.

(ii) Flood protection. All treatment process structures, mechanical equipment, and electrical equipment shall be protected from the maximum flood of record or the 100-year flood, whichever is greater. The treatment facilities shall remain fully operational and accessible during the 100-year flood.

(c) Level of treatment. Treatment shall be provided to produce a potable water that is bacteriologically, chemically, radiologically, and physically safe as determined by the administrator.

(i) Surface supplies. Treatment shall include:

(A) Chemical addition/coagulation, flocculation, sedimentation, filtration and disinfection; or

(B) Where the raw water maximum turbidity is less than 50 TU and is not attributable to clay and maximum color is less than 30 TU, treatment facilities may include slow sand filtration and disinfection; or

(C) Where the maximum monthly average raw water turbidity is less than 25 TU, the color is less than 30 TU and fecal coliform organisms are less than 100 mpn/100 ml, treatment facilities may be diatomaceous earth filters and disinfection.

(ii) Groundwater supplies. Groundwater supply facilities shall provide disinfection equipment and connections, as a minimum.

(d) Hydraulic and treatment reliability.

(i) Multiple units. Treatment facilities with 100,000 gallons per day (gpd) (378.5 m^3/day) capacity and over shall provide duplicate units, as a minimum, for chemical feed, flocculation, sedimentation, filtration and disinfection. Treatment facilities under 100,000 gpd (378.5 m^3/day) capacity shall provide duplicate units as described above or may provide finished water system storage equal to twice the maximum daily demand.

(ii) Multiple equipment. All treatment facility pumping shall provide the maximum daily flow with the largest single unit not in service. Finished water pumping in combination with finished water storage that floats on the distribution systems shall provide the maximum hour flow with the single largest unit not in service. When fire protection is provided, pumping and finished water storage that floats on the system shall provide the fire demand plus the maximum daily demand, or the maximum hour demand, whichever is greater.

(iii) Alternative power source. Where the finished water storage volume that floats on the distribution system is not capable of supplying the maximum daily demand, an alternative power shall be provided for the finished water pumps. The combined finished water storage volume and pumping capacity supplied by alternative power shall be at least adequate to provide the maximum daily demand. Acceptable alternative power sources include an engine generator, engine drive pumps, or a second independent electrical supply.

(e) Housing. Process equipment, including filters and appurtenances, disinfection, chemical feed and storage, electrical and controls, and pipe galleries shall be housed.

(f) Electrical.

(i) Equipment location. Service transformers and other critical electrical equipment shall be located above the 100-year flood and above-grade. Transformers shall be located so that they are remote or protected by substantial barriers from traffic. Motor controls shall be located in superstructures and in rooms that do not contain corrosive atmospheres.

(ii) Code requirements. Electrical design shall comply with the National Electrical Code as enacted and amended by the Wyoming Department of Fire Prevention and Electrical Safety. Areas in which the occurrence of explosive concentrations of hazardous gases, flammable fluids, or explosive dusts can occur shall be designed for hazardous locations in accordance with the National Electrical Code Class 1, Groups C and D, Division 1 locations.

(g) Structural.

(i) Construction materials. Construction materials shall be selected, apportioned, and/or protected to provide water tightness, corrosion protection, and resistance to weather variations.

(ii) Coatings. Coatings used to protect structures, equipment, and piping shall be suitable for atmospheres containing moisture and low concentrations of chlorine. Surfaces exposed in chemical areas shall be protected from chemical attack. Paints shall not contain lead, mercury, or other toxic metals or chemicals.

(iii) Geological conditions. Structural design shall consider the seismic zone, groundwater, and soil support. Soils investigations shall be made, or adequate previous soils investigations shall be available to develop structural design.

(h) Safety. The Wyoming Occupational Health and Safety (OHSA) Rules and Regulations shall be complied with. The following items shall also be provided:

(i) Instruction manuals. Instruction manuals shall be provided for all mechanical and electrical equipment describing operation, maintenance, and safety.

(ii) Handrails. In addition to all Wyoming OHSA requirements, barriers around treatment basins shall be provided.

(iii) Warning signs. Warning signs for pipes or hose bibs containing nontreated water, electrical hazards, mechanical hazards, chemical hazards, or other unsafe features shall be provided. Warning signs shall be permanently attached to the structure or appropriate equipment.

(iv) Equipment guards. Shields to protect operators from rotating or moving machinery shall be provided.

(v) Lighting. Provisions shall be made to light walkways, paths, and other accessways around basins, in buildings and on the site. All areas shall be lit in a manner that the failure of one lighting fixture will not cause an area to be dark, or the loss of power will not cause a room or enclosed area to be dark.

(vi) Climate conditions. Design of facilities such as exposed stairs, walkways, and sidewalks shall include nonskid surfaces.

(i) Instrumentation.

(i) Metering. The treatment facility shall have a flow measuring device provided for raw water influent and clear well effluent. The accuracy of the device shall be at least plus or minus two percent of span.

(ii) Type. All flow meters shall provide totalized flow. For plants with a maximum daily flow of 50,000 gpd (189 m^3/d) or more, the meter shall also include recording of instantaneous flow rate.

(iii) Controls. Automatic controls shall be designed to permit manual override.

(iv) Alarms. High effluent turbidity and chlorine leaks (when chlorine gas is used) shall be alarmed at an attended location.

(j) Sample taps. Sample taps shall be provided so that water samples can be obtained from each water source and from appropriate locations in each unit operation of treatment. Taps shall be consistent with sampling needs and shall not be of the petcock type. Taps used for obtaining samples for bacteriological analysis shall be of the smooth-nosed type without interior or exterior threads, shall not be of the mixing type, and shall not have a screen, aerator, or other such appurtenance.

(k) Ventilation. All enclosed spaces shall be provided with forced ventilation, except pumping station wetwells or clearwells. In areas where there are open treatment units exposed to the room, ventilation shall be provided to limit relative humidity to less than 85 percent but not less than 6 air changes per hour. In electrical and equipment rooms, ventilation shall be provided to limit the temperature rise in the room to less than 15° F (8° C) above ambient, but not less than 6 air changes per hour. Rooms housing chlorine storage and/or feeders shall have provisions for exhausting the room contents in 2 minutes and continuous ventilation to provide not less than 12 air changes per hour.

(l) Dewatering of treatment units. All treatment units, channels, basins, clearwells and wetwells shall be provided with drains or sumps that facilitate draining the unit for access and maintenance. Drainage shall be to the process waste system, filter washwater system or sanitary sewer. Basin slabs shall be designed to successfully resist the hydrostatic uplift pressure or an area dewatering system shall be provided. Considerations must be given in structural design to long span breakage in basins designed to resist uplift.

(m) Cold weather protection. All equipment not required to be in or on open basins (such as clarifier drives and flocculator) shall be housed in heated, lighted, and ventilated structures. Structure entrances shall be above grade. Piping shall be buried below frost level, placed in heated structures, or provided with heat and insulated.

(n) Chemical storage. All chemical storage shall be housed or buried. Areas designated for storage of specific chemicals shall be separated from areas designated for other reactive chemicals. Liquid storage containers shall be isolated from other portions of the structure by a curb that will contain ruptured tank contents. Concrete floors, walls, and curbs in chemical storage and feed areas shall be coated to protect the concrete from aggressive chemicals. Floors in polymer feed and storage areas shall be provided with nonslip surfaces. Rooms for chlorine storage and feed equipment shall be gastight and be provided with entry from outdoors. All toxic chemical storage areas shall be provided with lighting and ventilation switched from outside the room near the door. All toxic chemical storage areas shall be provided with windows either in the door or near the door to permit viewing the room from outside. Explosive chemicals shall be stored to protect operations personnel and equipment from injury or damage.

(o) Facility water supply. The facility water supply service line and the plant finished water sample tap shall be supplied from a source of finished water at a point where all chemicals have been thoroughly mixed, and the required disinfectant contact time has been achieved. There shall be no cross-connections between the facility water supply service line and any piping, troughs, tanks, or other treatment units containing wastewater, treatment chemicals, raw or partially treated water. The potable plant water supply line shall have provisions to prevent backflow.

(p) Design capacities. The plant capacity shall include maximum daily water demand, filter backwash quantities, and industrial water use. In the absence of data, filter backwash quantity shall be five percent of the maximum daily demand.

(q) Monitoring equipment. Water treatment plants having a capacity of 0.5 mgd (1892.6 m^3/d) or more shall be provided with continuous finished water turbidimeters (including recorders).

(r) Labels. All process piping shall be labeled to identify materials being conveyed.

Section 9. **Source Development**.

(a) Surface water.

(i) Structures.

(A) Design of reservoir or river intake structures.

(I) Facilities for withdrawal of water from more than one level shall be provided in impoundments if the maximum water depth at the intake is greater than 20 feet (6.1 m). All ports or intake gates shall be located above the bottom of the stream, lake, or impoundment. The lowest intake point shall be located at sufficient depth to be kept submerged at low water levels.

(II) Where water temperatures are 34° F (1° C) or less, the velocity of flow into the intake structure shall not exceed 0.5 feet per second (.152 m/s). Where intakes are located in shady reaches of a stream, facilities shall be available to diffuse air into the flow stream at a point in front of the intake pipe.

(III) Inspection manholes shall be located a maximum of every 1,000 feet (304.8 m) for pipe sizes 24 inches (0.61 m) and larger. Where pipelines operate by gravity and the hydraulic gradeline is below the ground surface, concrete manholes may be used. Where the pipeline is pressurized or the hydraulic gradeline is above ground, bolted and gasketed access ways shall be used.

(IV) Devices shall be provided to minimize entry of fish and debris from the intake structure.

(B) Offstream reservoir. Offstream reservoirs shall be constructed to assure that:

(I) Water quality is protected by controlling runoff into the reservoir.

(II) Dikes are structurally sound and protected against wave action and erosion.

(ii) Impoundments and reservoirs. The site of any impoundment or reservoir shall be cleared of all brush, trees, and other vegetation to the high water elevation.

(iii) Raw water supply piping. No customer service connection shall be provided from the raw water transmission line to the treatment plant, unless there are provisions to treat the water to meet these standards, or the sole purpose of the service is for irrigation or agricultural water use.

(b) Groundwater.

(i) Number and capacity. The total developed groundwater source, along with other water sources, shall provide a combined capacity that shall equal or exceed the design maximum daily demand. A minimum of 2 wells, or 1 well and finished water storage equal to twice the maximum daily demand shall be provided. Where 2 wells are provided, the sources shall be capable of equaling or exceeding the design average daily demand with the largest producing well out of service.

(A) General considerations.

(I) Every well shall be protected from and remain operational during the 100-year flood or the largest flood of record, whichever is greater.

(II) All wells shall be disinfected after construction, repair, or when work is done on the pump, before the well is placed in service. Disinfection procedures shall be those specified in AWWA A-100 for disinfection of wells.

(B) Relation to sources of pollution. Every well shall be located further from any of the sources of pollution listed below. The isolation distances listed below apply when domestic wastewater is the only wastewater present.

(I) If the domestic sewage flow is less than 2,000 gallons per day (7,560 L/day), the following minimum isolation distance shall be maintained:

Source of Domestic Wastewater	*Minimum Distance to Well*
Sewer	50 feet (15.2 m)
Septic tank	50 feet (15.2 m)
Disposal field	100 feet (30.5 m)
Seepage pit	100 feet (30.5 m)
Cesspool	100 feet (30.5 m)

(II) If the domestic sewage flow is greater than 2,000 gpd (7,560 L/day) but less than 10,000 gpd (37,800 L/day), the following minimum isolation distances shall be maintained:

Source of Domestic Wastewater	*Minimum Distance to Well*
Sewer	50 feet (15.2 m)
Septic tank	50 feet (15.2 m)
Disposal field	200 feet (61 m)
Seepage pit	200 feet (61 m)
Cesspool	200 feet (61 m)

(III) For systems larger than 10,000 gallons per day (37,800 L/day), the isolation distance shall be determined by a hydrogeological study, in accordance with the requirements of Section 15 of Chapter 3 Water Quality Rules and Regulations, but shall not be less than those listed above.

(IV) For wastewaters other than domestic wastewater, the isolation distance required shall be determined by a hydrogeological study, in accordance with the requirements of Section 15 of Chapter 3 Water Quality Rules and Regulations.

(C) Relation to buildings.

(I) When a well is adjacent to the building, the well shall be located so that the centerline, extended vertically, will clear any projection from the building by not less than 3 feet (0.91 m), and will clear any power line by not less than 10 feet (3.05 m).

(II) When a well is to be located inside a building, the top of the casing and any other well opening shall not terminate in the basement of the building, or in any pit or space that is below natural ground surface unless the well is completed with a properly protected submersible pump. Wells located in a structure must be accessible to pull the casing or the pump. The structure shall have overhead access.

(D) Relation to property lines. Every well shall be located at least 10 feet (3.05 m) from any property line.

(ii) Testing and records.

(A) Yield and drawdown tests. Yield and drawdown tests shall be performed on every production well after construction or subsequent treatment and prior to placement of the permanent pump. The test methods shall be clearly indicated in the specifications. The test pump capacity, at maximum anticipated drawdown, shall be at least 1.5 times the design rate anticipated. The test shall provide for continuous pumping for at least 24 hours or until stabilized drawdown has continued for at least 6 hours when test pumped at 1.5 times the design pumping rate.

(B) Plumbness and alignment requirements. Every well shall be tested for plumbness and alignment in accordance with AWWA A-100. The test method and allowable tolerance shall be stated in the specifications.

(iii) Well construction.

(A) Protection during construction. During any well construction or modification, the well and surrounding area must be adequately protected to prevent any groundwater contamination. Surface water must be diverted away from the construction area.

(B) Well types and construction methods.

(I) Dug wells. Dug wells shall be used only where geological conditions preclude the possibility of developing an acceptable drilled well.

(1.) Every dug well, other than the buried slab type, shall be constructed with a surface curbing of concrete, brick, tile or metal, extending from the aquifer to above the ground surface. Concrete grout, at least 6 inches (0.15 m) thick, shall be placed between the excavated hole and the curbing for a minimum depth of 10 feet (3.05 m) below original or final ground elevation, whichever is lower, or to the bottom of the hole, if it is less than 10 feet (3.05 m).

(2.) The well lining in the producing zone shall readily admit water, and shall be structurally sound to withstand external pressures.

(3.) The well cover or platform shall be reinforced concrete with a minimum thickness of 4 inches (10 cm). The top of the platform shall be sloped to drain to all sides. The platform shall rest on and overlap the well curbing by at least 2 inches (5 cm), or it may be cast with the curbing or the concrete grout. Adequately sized pipe sleeve(s) shall be cast in place in the platform to accommodate the type of pump, pump piping or wiring proposed for the well. Pump discharge piping shall not be placed through the well casing or wall.

(4.) A buried slab type of construction may be used if the dug well is greater than 10 feet (3.05 m) deep. The well lining shall be terminated a minimum of 10 feet (3.05 m) below the original or final ground elevation, whichever is lower. A steel-reinforced concrete slab or platform, at least 4 inches (10 cm) thick, shall rest on and overlap the lining. A standard unperforated well casing shall extend from the concrete slab to at least 12 inches (30 cm) above the original or final ground surface, whichever is higher. This casing shall be firmly imbedded in the slab or connected to a pipe cast in the slab to ensure that the connection is watertight. The excavation above the slab shall be backfilled with a bentonite slurry or clean earth thoroughly tamped to minimize settling.

(II) Drilled, driven, jetted, or bored wells.

(1.) A drilled well may be constructed through an existing dug well provided that an unperforated casing extends to at least 12 inches (30 cm) above the original ground or final surface, whichever is higher. A seal of concrete, at least 2 feet (0.61 m) thick, shall be placed in the bottom of the dug well to prevent the direct movement of water from the dug well into the drilled well. The original dug well shall be adequately protected from contamination as described above.

(2.) Every drilled, driven, jetted, or bored well shall have an unperforated casing that extends from a minimum of 12 inches (30 cm) above ground surface to at least 10 feet (3.05 m) below ground surface. In unconsolidated formations, this casing shall extend to the water table or below. In consolidated formations, the casing may be terminated in rock or watertight clay above the water table.

(III) Sand or gravel wells. If clay or hard pan is encountered above the waterbearing formation, the permanent casing and grout shall extend through such materials. If a sand or gravel aquifer is overlaid only by permeable soils, the permanent casing and grout shall extend to at least 20 feet (6.1 m) below original or final ground elevation, whichever is lower. If a temporary outer casing is used, it shall be completely withdrawn as grout is applied.

(IV) Gravel pack wells. The diameter of an oversized drill hole designed for the placement of an artificial gravel pack shall allow a thickness of gravel or sand outside the casing sufficient to block the movement of natural materials into the well. The size of the openings in the casing or screen shall be based on the size of the gravel or sand used in the gravel pack.

(1.) Gravel pack shall be well-rounded particles, 95 percent siliceous material, that are smooth and uniform, free of foreign material, properly sized, washed, and then disinfected immediately prior to or during placement. Gravel pack shall be placed in one uniformly continuous operation.

(2.) After completion, the well shall be overpumped, surged, or otherwise developed to ensure free entry of water without sediment. A gravel-packed well shall be sealed in one of two ways to prevent pollution to the groundwater supply:

If a permanent surface casing is not installed, the annular opening between the casing and the drill hole shall be sealed in the top 10 feet (3.05 m) with concrete or cement grout.

If a permanent surface casing is installed, it shall extend to a depth of at least 10 feet (3.05 m). The annular opening between this outer casing and the inner casing shall be covered with a metal or cement seal.

(3.) Gravel refill pipes, when used, shall be Schedule 40 steel pipe incorporated within the pump foundation and terminated with screwed or welded caps at least 12 inches (30 cm) above the pump house floor or concrete apron. Gravel refill pipes located in the grouted annular opening shall be surrounded by a minimum of 1-1/2 inches (3.8 cm) of grout. Protection from leakage of grout into the gravel pack or screen shall be provided.

(V) Radial water collector.

(1.) Locations of all caisson construction joints and porthole assemblies shall be indicated on drawings. The caisson wall shall be reinforced to withstand the forces to which it will be subjected. The top of the caisson shall be covered with a watertight floor. The pump discharge piping shall not be placed through the caisson walls.

(2.) Provisions shall be made to assure that radial collectors are essentially horizontal.

(3.) All openings in the floor shall be curbed and protected from entrance of foreign material.

(VI) Infiltration lines. Where an infiltration line is used, the source shall be considered a surface source requiring treatment defined in Section 8(c) (i) unless, (1) the water system owner is in complete control of the surrounding property for a distance of 500 feet around the periphery of the infiltration system; (2) the area is fenced to exclude trespass; and (3) the infiltration collection lines are a minimum of 40 inches below the ground surface at all points within the infiltration collection system.

(VII) Limestone or sandstone wells. In consolidated formations, casing shall be driven a minimum of 5 feet into firm bedrock and cemented into place.

(VIII) Artesian wells.

(1.) When artesian water is encountered in a well, unperforated casing shall extend into the confining layer overlying the artesian zone. This casing shall be adequately sealed with cement grout into the confining zone to prevent both surface and subsurface leakage from the artesian zone. The method of construction shall be such that during the placing of the grout and the time required for it to set, no water shall flow through or around the annular space outside the casing, and no water pressure sufficient to disturb the grout prior to final set shall occur. After the grout has set completely, drilling operations may be continued into the artesian zone. If leakage occurs around the well casing or adjacent to the well, the well shall be recompleted with any seals, packers or casing necessary to eliminate the leakage completely.

(2.) If water flows at the surface, the well shall be equipped with valved pipe connections, watertight pump connections, or receiving reservoirs set at an altitude so that flow can be stopped completely. There shall be no direct connection between any discharge pipe and a sewer or other source of pollution.

(IX) Wells that penetrate more than one aquifer.

(1.) Where a well penetrates more than one aquifer or water-bearing strata, every aquifer and/or strata shall be sealed off to prevent migration of water from one aquifer or strata to another. Strata shall be sealed off by placing impervious material opposite the strata and opposite the confining formation(s). The seal shall extend above and below the strata no less than 10 feet. The sealing material shall fill the annular space in the interval to be sealed, and the surrounding void spaces which might absorb the sealing material. The sealing material shall be placed from the bottom to the top of the interval to be sealed.

(2.) Sealing material shall consist of neat cement, cement grout, or bentonite clay.

(X) Wells that encounter mineralized or polluted water.

(1.) Any time during the construction of a well that mineralized water or water known to be polluted is encountered, the aquifer or aquifers containing such inferior quality water shall be adequately cased or sealed off so that water shall not enter the well, nor will it move up or down the annular space outside the well casing. If necessary, special seals or packers shall be installed to prevent movement of inferior quality water. Mineralized water may be used if it can be properly treated to meet all drinking water quality standards as determined by the administrator. When mineralized water is encountered, it shall not be mixed with any other waters from different aquifers within the well. If a well is penetrating multiple aquifers, mineralized water shall be excluded from the well if water is taken from other non-mineralized aquifers.

(2.) In gravel packed wells, aquifers containing inferior quality water shall be sealed by pressure grouting, or with special packers or seals, to prevent such water from moving vertically in gravel packed portions of the well.

(XI) Conversion of existing oil or gas wells, or exploration test holes, into water wells.

(1.) Existing oil and gas wells, seismic test holes, or mineral exploration holes may be converted for use as water wells provided that the wells can be completed to conform to the minimum construction standards cited in this chapter. This does not relieve the applicant from obtaining appropriate permits.

(2.) Information on the geologic conditions encountered in the well at the time of the original drilling shall be used to determine what special construction standards shall be met in order to eliminate all movement of pollutants into the well or along the annular space surrounding the casing. If no original geologic information is available, an electric or other geophysical log is required to supplement known information.

(C) Construction materials.

(l) Casing. The casing shall provide structural stability to prevent casing collapse during installation as well as drill hole wall integrity when installed, be of required size to convey liquid at a specified injection/recovery rate and pressure, and be of required size to allow for sampling.

(1.) Temporary steel casing. Temporary steel casing used for construction shall be capable of withstanding the structural load imposed during its installation and removal.

(2.) Permanent steel casing. Permanent steel casing pipe shall be new pipe meeting AWWA Standard A-100 specifications for water well construction. The casing shall have full circumferential welds or threaded coupling joints to assure a watertight construction.

a. Standard and line pipe. This material shall meet one of the following specifications:

API Std. 5L, "Specifications for Line Pipe."

API Std. 5LX, "Specifications for High-Test Line Pipe."

ASTM A53 "Standard Specification for Pipe Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless."

ASTM A120 "Standard Specifications for Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses."

ASTM A134 "Standards Specifications for Electric-Fusion (arc) - Welded Steel Plate Pipe (sizes NPS 16 inches and over)."

ASTM A135 "Standard Specifications for Electric - Resistance - Welded Steel Pipe."

ASTM A139 "Standard Specification for Electric-Fusion (arc) - Welded Steel Pipe (Sizes 4" and over)."

ASTM A211 "Standard Specifications for Spiral - Welded Steel or Iron Pipe."

AWWA C200 "AWWA Standard for Steel Water Pipe 6 inches and Larger."

b. Structural steel. This material shall meet one of the following specifications:

ASTM A36 "Standard Specification for Structural Steel."

ASTM A242 "Standard Specifications for High Strength Low Alloy Structural Steel."

ASTM A283 "Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars of Structural Quality."

ASTM A441 "Tentative Specifications for High-Strength Low Alloy Structural Manganese Vanadium Steel."

ASTM A570 "Standard Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality."

c. High-strength carbon steel sheets or "well casing steel". Each sheet of material shall contain mill markings which will identify the manufacturer and specify that the material is well casing steel which complies with the chemical and physical properties published by the manufacturer.

d. Stainless steel casing shall meet the provisions of ASTM A409 "Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service".

(3.) Nonferrous casing materials. Nonferrous or plastic material may be used as a well casing. It must be resistant to the corrosiveness of the water and to the stresses to which it will be subjected during installation, grouting, and operation. The material shall be nontoxic. All joints shall be durable and watertight.

a. Thermoplastics. This material shall meet the requirements of ASTM F 480 "Standard Specification for Thermoplastic Water Well Casing Pipe and Couplings made in Standard Dimension Ratios (SDR)".

b. Thermosets. This material shall meet the requirements of the following specifications:

ASTM D2996 "Standard Specification for Filament Wound Reinforced Thermosetting Resin Pipe."

ASTM D2997 "Standard Specification for Centrifugally Cast Reinforced Thermosetting Resin Pipe."

ASTM D3517 "Standard Specification for Reinforced Plastic Mortar Pressure Pipe."

AWWA C950 "AWWA Standards for Glass - Fiber - Reinforced Thermosetting - Resin Pressure Pipe."

c. Concrete pipe used for casing should conform to one of the following specifications:

ASTM C14 "Standard Specifications for Concrete Sewer, Storm Drain, and Culvert Pipe."

ASTM C76 "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe."

AWWA C300 "AWWA Standards for Reinforced Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids."

AWWA C301 "AWWA Standards for Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids."

(4.) Casing diameter. The casing diameter (inside diameter) shall be a minimum of one size larger than the largest dimension/diameter of the pump or pumping structure. If a reduction in casing diameter is made, there shall be adequate overlap of the casing to prevent misalignment and to prevent the movement of unstable sediment into the well. To prevent the migration of mineralized, polluted, or otherwise inferior quality water, lead or neoprene packers shall be installed to seal the annular space between casings.

(II) Packers. Packers shall be material that will not impart taste, odor, toxic substance, or bacterial contamination to the well water.

(III) Screens.

(1.) Screens shall be constructed of materials resistant to damage by chemical action of groundwater or cleaning operations, and have size of openings based on sieve analysis of formation and/or gravel-pack materials. The screen shall have sufficient diameter to provide adequate specific capacity and low aperture entrance velocity. The entrance velocity shall not exceed 0.1 feet per second (3 cm/sec).

(2.) The screen shall be installed so that the pumping water level remains above the screen under all operating conditions, and shall be provided with a bottom plate or washdown bottom fitting of the same material as the screen.

(3.) For a nonhomogeneous aquifer having a uniformity coefficient less than 3.0 and an effective grain size less than 0.01 inches, an artificial filter or screen shall be used.

(IV) Grout and grouting requirements. All permanent well casing, except driven Schedule 40 steel casing, shall be surrounded by a minimum of 2 inches (5.1 cm) of grout. All temporary construction casings shall be removed. Where removal is not possible or practical, the casing shall be withdrawn at least 5 feet to ensure grout contact with the native formation.

(1.) Neat cement grout. Cement conforming to ASTM Standard C150 and water, with not more than 6 gallons (13.62 L) of water per sack of cement, must be used for 2 inch (5.1 cm) openings. Additives used to increase fluidity must meet ASTM C494.

(2.) Concrete grout. Equal parts of cement conforming to ASTM Standard C150 and sand, with not more than 6 gallons (13.62 L) of water per sack of cement, may be used for openings larger than 2 inches (5.1 cm). Where an annular opening larger than 4 inches (10 cm) is available, gravel not larger than 1/2 inch (1.27 cm) in size may be added.

(3.) Clay seal. Where an annular opening greater than 6 inches (15.2 cm) is available a clay seal of clean local clay mixed with at least 10 percent swelling bentonite may be used.

(4.) Application. Prior to grouting through creviced or fractured formations, bentonite or similar materials may be added to the annular opening in the manner indicated for grouting. After cement grouting is applied, work on the well shall be discontinued until the cement or concrete grout has properly set.

Sufficient annular opening shall be provided to permit a minimum of 2 inches (5.1 cm) of grout around permanent casings, including couplings.

When the annular opening is 4 or more inches (10 cm) and less than 100 feet (30.5 m) in depth and concrete grout is used, the grout may be placed by gravity through a grout pipe installed to the bottom of the annular opening in one continuous operation until the annular opening is filled.

When the annular opening exceeds 6 inches (15.2 cm), and less than 100 feet (30.5 m) in depth and a clay seal is used, it may be placed by gravity.

(5.) Guides. The casing must be provided with sufficient guides welded to the casing to permit unobstructed flow and uniform thickness of grout.

(V) Upper terminal well construction.

(1.) Permanent casing for all groundwater sources shall project at least 12 inches (30.5 cm) above the pumphouse floor or concrete apron surface and at least 18 inches (0.46 m) above final ground surface. The concrete floor or apron shall slope away from the casing at a slope of 1 inch per foot (8.33 cm/m).

(2.) Where a well house is constructed, the floor surface shall be at least 6 inches (15.2 cm) above the final ground elevation and shall slope away from the casing at a slope of 1/2 inch per foot (4.16 cm/m).

(3.) Sites subject to flooding shall be provided with an earthen berm surrounding the casing and terminating at an elevation at least 2 feet (0.61 m) above the highest known flood elevation, or other suitable protection shall be provided.

(4.) The top of the well casing at sites subject to flooding shall terminate at least 3 feet (0.91 m) above the 100-year flood level or the highest known flood elevation, whichever is higher.

(5.) The casing and/or well house shall be protected from entrance by animals.

(VI) Development.

(1.) Every well shall be developed to remove the native silts and clays, drilling mud or finer fraction of the gravel pack. Development shall continue until the maximum specific capacity is obtained from the completed well.

(2.) Where chemical conditioning is required, the specifications shall include provisions for blasting and cleaning. Special attention shall be given to assure that the grouting and casing are not damaged by the blasting.

(VII) Capping requirements. A welded metal plate or a threaded cap shall be used for capping a well. A properly fitted, firmly driven, solid wooden plug may be used for capping a well until pumping equipment is installed. At all times during the progress of work, the contractor shall provide protection to prevent tampering with the well or entrance of surface water or foreign materials.

(D) Well pumps, discharge piping and appurtenances.

(I) Line shaft pumps. Wells equipped with line shaft pumps shall have the casing firmly connected to the pump structure or have the casing inserted into a recess extending at least 1/2 inch into the pump base, have the pump foundation and base designed to prevent water from coming into contact with the joint, and avoid the use of oil lubrication at pump settings less than 400 feet (122 m).

(II) Submersible pumps. Where a submersible pump is used, the top of the casing shall be effectively sealed against the entrance of water under all conditions of vibration or movement of conductors or cables. The electrical cable shall be firmly attached to the rise pipe at 20 foot (6.1 m) intervals or less, and the pump shall be located at a point above the top of the well screen.

(III) Discharge piping.

(1.) The discharge piping shall have control valves and appurtenances located above the wellhouse floor. The piping shall be protected against the entrance of contamination and be equipped with a check valve, a shutoff valve, a pressure gauge, a means of measuring flow, and a smooth-nosed sampling tap located at a point where positive pressure is maintained. Where a submersible pump is used, a check valve shall be located in the casing in addition to the check valve located above ground to prevent negative pressures on the discharge piping.

(2.) For pipes equipped with an air release-vacuum relief valve, the valve shall be located upstream from the check valve, with exhaust/relief piping terminating in a downturned position at least 18 inches (0.46 m) above the floor and covered with a 24 mesh corrosion-resistant screen. The discharge piping shall be valved to permit test pumping and control of each well.

(3.) All exposed piping, valves and appurtenances shall be protected against physical damage and freezing.

(4.) The piping shall be properly anchored to prevent movement, and shall be protected against surge or water hammer.

(5.) The discharge piping shall be provided with a means of pumping to waste, but shall not be directly connected to a sewer.

(IV) Pitless well units. A pitless adaptor or well house shall be used where needed to protect the water system from freezing. A frost pit may be used only in conjunction with a properly protected pitless adaptor.

(1.) All pitless units shall be shop fabricated from the point of connection with the well casing to the unit cap or cover. They shall be threaded or welded to the well casing, and be of watertight construction throughout. The materials and weight shall be at least equivalent and compatible to the casing.

(2.) Pitless units shall have field connection to the lateral discharge from the pitless unit of threaded, flanged or mechanical joint connection, and the top of the pitless unit shall terminate at least 18 inches (0.46 m) above final ground elevation or 3 feet above the 100-year flood level or the highest known flood elevation, whichever is higher.

(3.) Provisions shall be made to disinfect the well. The unit shall have facilities to measure water levels in the well; a cover at the upper terminal of the well that will prevent the entrance of contamination; a contamination-proof entrance connection for electrical cable; an inside diameter as great as that of the well casing, up to and including casing diameters of 12 inches (30.5 cm), to facilitate work and repair on the well, pump, or well screen; and at least one check valve within the well casing.

(V) Casing vent. Provisions shall be made for venting the well casing to atmosphere. The vent shall terminate in a downturned position, at or above the top of the casing or pitless unit in a minimum 1-1/2 inch (3.8 cm) diameter opening covered with a 24 mesh corrosion-resistant screen. The pipe connecting the casing to the vent shall be of adequate size to provide rapid venting of the casing.

(VI) Water level management. Every well greater than 4 inches (10 cm) in diameter shall be equipped with an access port that will allow for the measurement of the depth to the water surface; or in the case of a flowing artesian well, with a pressure gauge that will indicate pressure. An air line used for level measurement shall be provided on all wells greater than 4 inches (10 cm) in diameter. Installation of water level measuring equipment shall be made using corrosion-resistant materials attached firmly to the drop pipe or pump column and in such a manner as to prevent entrance of foreign materials.

(VII) Discharge measuring device. Every well shall be piped so that a device capable of measuring the total well discharge can be placed in operation at the well for well testing. Every well field (or when only one well is present, every well) shall have a device capable of measuring the total discharge.

(VIII) Observation wells. Observation wells shall be constructed in accordance with the requirements for permanent wells if they are to remain in service after completion of a water supply well. They shall be protected at the upper terminal to preclude entrance of foreign materials.

(IX) Well abandonment. Test wells and groundwater sources which are not in use shall be sealed in accordance with requirements of Part G of Chapter 11, Water Quality Rules and Regulations.

Wells shall be sealed by filling with neat cement grout. The filling materials shall be applied to the well hole through a pipe, tremie, or bailer.

Section 10. **Treatment.**

(a) Design capacity. The capacity of the water treatment or water production system shall be designed for the maximum daily demand at the design year.

(b) Presedimentation. Raw waters which have episodes of turbidity in excess of 1,000 TU for a period of one week or longer shall be presettled.

(i) Detention time. Basins without mechanical sludge collection equipment shall have a minimum detention time of three days. Basins with mechanical sludge collection equipment shall have a minimum detention time of three hours.

(ii) Inlet. Inlet flow shall be evenly dispersed along the inlet of the basin.

(iii) Drains. Basins shall have a minimum of one 8-inch (20 cm) drain line to completely dewater the facility.

(iv) Bottom slope. Basins shall have a bottom slope to drain of 1/4 inch per foot (20 mm/m) without mechanical sludge collection equipment and 2 inches per foot (16 cm/m) with mechanical sludge collection equipment.

(v) Bypass. Basin bypass provisions shall be included in the process piping.

(c) Rapid mix. Rapid dispersal of chemicals throughout the water shall be accomplished by mechanical mixers, jet mixers, static mixers, or hydraulic jump.

(i) Mixing intensity. For mechanical mixers, the minimum Gt (velocity gradient (sec-1) x t (sec)) provided at maximum daily flow shall be 27,000.

(ii) Mixing time. The detention time in a flash mixing chamber shall not exceed 30 seconds at maximum daily flow conditions.

(iii) Drain. The basin shall have a drain.

(d) Flocculation. The low velocity agitation of chemically treated water shall be accomplished by mechanical flocculators.

(i) Detention time. A minimum of 10 minutes detention time shall be provided.

(ii) Mixing intensity. The velocity gradient (G value) imposed shall be adjustable by providing variable speed drives or shall be designed to be 30 sec-1 if a single basin is provided, 20 sec-1 in the final basin of a two stage system, and 10 sec-1 in the final basin of a three stage system. For a single speed drive system, the tip speed of the mixer shall not exceed 3 feet per second (0.91 m/sec). Variable speed drives shall provide tip speeds of 0.5 to 3.0 feet per second (0.15-0.91 m/sec).

(iii) Drains. Flocculation basins shall have a minimum of one drain line to dewater the facility.

(iv) Piping. The velocity of flocculated water through pipes or conduits to settling basins shall not be less than 0.5 or greater than 1.5 feet per second (0.15-0.46 m/sec).

(e) Sedimentation basins.

(i) Diameter. The maximum diameter in circular basins shall be 80 feet.

(ii) Overflow rate. The basin overflow rate shall not exceed 1,000 gpd/ft^2 (41 m^3/m^2·d) at design conditions.

(iii) Weir loading rate. Weir loading rates shall not exceed 20,000 gpd/ft (2480 m^3m·d) of length. The weir length shall be computed as the length of the centerline of the launder. Where the weir is located at 3/4 the radius, the weir may be loaded at 36,000 gpd/ft (4464 m^3/m·d).

(iv) Side water depth. The minimum basin side water depth shall be 8 feet (2.43 m) if mechanical sludge collection equipment is provided or basins or basin sludge hopper segments are less than 100 square feet (9.3 m) in surface area and 15 feet (4.6 m) if basins are manually cleaned. Mechanical sludge collection equipment includes mechanically driven drives that use scrapers or differential water level to collect the sludge.

(v) Freeboard. The outer walls of settling basins shall extend at least 12 inches (30.5 cm) above the surrounding ground and provide at least 12 inches (30.5 cm) of freeboard to the water surface. Where basin walls are less than 4 feet (1.22 m) above the surrounding ground, a fence or other debris barrier shall be provided on the wall.

(vi) Inlet devices. Inlets shall be designed to distribute the water equally and at uniform velocities. Open ports, submerged ports, and similar entrance arrangements are required. A baffle should be constructed across the basin close to the inlet end and should project several feet below the water surface to dissipate inlet velocities and provide uniform flows across the basin.

(vii) Velocity. The velocity through settling basins shall not exceed 0.5 feet per minute (0.15 m/min). The basins must be designed to minimize short-circuiting.

(viii) Sludge collection. If settleable organics are present in the water or if there is a history of organically related taste and odor problems, mechanical sludge collection shall be provided.

(ix) Sludge removal. Sludge removal design shall provide that sludge pipes shall be not less than 6 inches (15.2 cm) in diameter and arranged to facilitate cleaning. Valves on the sludge line shall be located outside the tank.

(x) Flushing lines. Flushing lines or hydrants shall be provided near the basins.

(xi) Drainage. Basin bottoms shall slope toward the drain at not less than 1 inch per foot (8 cm/m) where mechanical sludge collection equipment is provided and 1/4 inch per foot (2 cm/m) where no mechanical sludge collection equipment is provided.

(f) Softening sedimentation - clarification. Conventional sedimentation - clarification as described above shall be provided in softening operations, except for softening a groundwater supply of constant quality. Where a groundwater supply is softened, the requirements may be modified as follows:

(i) Overflowrate. The basin overflow rate at the design flow shall not exceed 2,100 gpd/ft^2 (86 m^3/m^2·d).

(ii) Sludge. Mechanical sludge removal shall be provided and shall be designed to handle a load of 40 lbs/foot (60 kg/m) of collector scraper arm length.

(iii) Other design considerations shall be the same as conventional sedimentation - clarification.

(g) Solids contact units. These treatment units are acceptable for combined softening and clarification of well water where water quality characteristics are not variable and flow rates are uniform. The units shall be designed to meet the criteria detailed previously.

(i) Such units may be considered for use as clarifiers without softening when they are designed to meet the criteria detailed in the conventional sedimentation - clarification.

(ii) These units may also be used for other treatment purposes, such as rapid mixing, flocculation, etc., when the individual components of the solids contact units are designed in accordance with the design criteria for that individual treatment process as described above.

(h) Settling tube clarifiers. Shallow depth sedimentation devices or tube clarifier systems of the essentially horizontal or steeply inclined types may be used when designed as follows:

(i) Sludge removal. Sludge shall be removed using 45 or steeper hoppered bottoms, or mechanical devices that move the sludge to hoppers, or devices that remove settled sludge from the basin floor using differential hydraulic level.

(ii) Tube cleaning. A method of tube cleaning shall be provided. This may include a provision for obtaining a rapid reduction in clarifier water surface elevation, a water jet spray system, or an air scour system. Where cleaning is automatic, controls shall be provided to cease clarifier operation during tube cleaning and a 20 minute rest period.

(iii) Tube placement. Tops of tubes shall be more than 12 inches (0.3 m) from the underside of the launder and more than 18 inches (0.46 m) from the water surface.

(iv) Loading rates. The maximum overflow rate shall be less than 2.0 gpm/sq ft (62.7 m^3/m^2·d) based on the surface area of the basin covered by the tubes.

(v) Effluent launderers. The spacing between effluent launderers shall not exceed three times the distance from the water surface to the top of the tube modules.

(i) Filtration.

(i) Pressure granular media filters. Vertical or horizontal pressure filters shall not be used for filtration of surface waters. Pressure filters may be used for groundwater filtration, including iron and manganese removal.

(ii) Gravity filters.

(A) Slow rate sand filters. These types of filters may be used when maximum raw water turbidity is less than 50 TUs and the turbidity present is not attributable to colloidal clay. Maximum color shall not exceed 30 units.

(I) Loading rates. The allowable loading rates at maximum daily demands shall not exceed 0.1 gpm/ft^2 (5.9 m^3/m^2.d) unless satisfactory pilot testing is completed prior to design which shows a higher rate is appropriate.

(II) Number of filters. At least two units shall be provided. Where only two units are provided, each shall be capable of meeting the plant design capacity at the maximum filtration rate. Where more than two filter units are provided, the filters shall be capable of meeting the plant design at the maximum filtration rate with one filter removed from service.

(III) Underdrains. Each filter unit shall be equipped with a main drain and an adequate number of lateral underdrains to collect the filtered water. The underdrains shall be so spaced that the maximum velocity of the water flow in the lateral underdrain will not exceed 0.75 feet per second (0.22 m/sec). The maximum spacing of the laterals shall not exceed 12 feet (3.7 m).

(IV) Filter material. Filter sand shall be placed on graded gravel layers for a minimum sand depth of 30 inches (0.76 m). The effective size shall be between 0.15 mm and 0.35 mm. The uniformity coefficient shall not exceed 2.0. The sand shall be clean and free from foreign matter. The supporting gravel shall conform to the size and depth distribution provided for rapid rate gravity filters.

(V) Depth of water on filter beds. Design shall provide a depth of at least 3 feet (0.91 m) of water over the sand. Influent water shall enter the water surface at a velocity of less than 2 feet per second (0.61 m/sec). An overflow shall be provided at the maximum water surface elevation.

(VI) Appurtenances. Each filter shall be equipped with loss of head gauge; an orifice, Venturi meter, or other suitable metering device installed on each filter to control the rate of filtration; and an effluent pipe designed to maintain the water level above the top of the filter sand.

(VII) Covers. When covers are provided for temperature or sunlight control, they shall be designed to allow adequate headroom above the top of the sand and adequate access ports or manholes.

(B) Rapid rate filters.

(I) Loading rates. The maximum allowable loading rates at maximum daily demands shall not exceed 3 gpm/ft^2 (177 m^3/m^2·d) for single media filters or 5 gpm/ft^2 (295 m^3/m^2·d) for dual or mixed media filters. Each filter shall have a rate limiting device to prevent the filter from exceeding the maximum rate.

(II) Filter compartment design. The filter media compartment shall be constructed of durable material not subject to corrosion or decay and structurally capable of supporting the loads to which it will be subjected.

(1.) There shall be an atmospheric break between filtered and non-filtered water, accomplished by double wall construction.

(2.) The compartment walls shall be vertical and shall not protrude into the filter media.

(3.) There shall be a minimum of 2½ feet (0.76 m) of headroom above the top of the filter compartment walls.

(4.) Neither floor nor roof drainage shall enter the filter. If the top of the filter compartment is at floor level, a minimum 4 inch curb shall be constructed around the box.

(5.) Walkways or observation platforms shall be provided for each filter compartment. Walk-ways around the filter shall be a minimum of 24 inches wide.

(6.) Effluent line shall be trapped or submerged below the low water level in the clearwell to prevent air from entering the filter bottom. The velocity in the filter influent line shall not exceed 4 feet per second (1.2 m/sec). An overflow from the influent of the filter compartment shall be provided.

(7.) The distance between the operating water level in the filter and the high water level in the clearwell or effluent trap shall be 10 feet (3.05 m) minimum. The minimum operating water level over the media shall be 3 feet (0.91 m), and the minimum depth of the filter box shall be 8-1/2 feet (2.6 m).

(III) Washwater troughs. Washwater troughs shall be constructed to provide for not more than 6 feet (1.8 m) clear distance between troughs. The troughs shall not cover more than 25 percent of filter area.

(1.) Minimum clearance between the bottom of trough and top of unexpanded media shall be 12 inches (30.5 cm).

(2.) Minimum distance between the weir of the trough and the unexpanded media shall be 30 inches (0.76 m).

(3.) The trough and washwater waste line shall be sized to carry a filter backwash rate of 20 gpm/ft^2 (1181 m^3/m^2·d) plus a surface wash rate of 2.0 gpm/ft^2 (118 m^3/m^2·d).

(IV) Backwash system.

(1.) The backwash system shall be sized to provide a minimum backwash flow rate of 20 gpm/ft^2 (1181 m^3/m^2·d). Washwater storage shall be designed to provide two 20 minute washes in rapid succession. Where multiple units are not required and only one filter compartment is present, backwash storage capabilities may be reduced to provide one 20 minute backwash. Where pumps are used to provide backwash to the filter or to supply water to a washwater tank, the washwater pumps shall be in duplicate.

(2.) The backwash and surface wash washwater supply shall be filtered and disinfected.

(3.) Washwater rate shall be controlled by a separate valve, manual or automatic, on the main washwater line. Washwater flow rates shall be metered and indicated.

(4.) Air-assisted backwash systems may be used when the design precludes disturbing the gravel support.

(5.) A surface wash system shall be provided. The system shall be capable of supplying 0.5 gpm/ft^2 (29.5 m^3/m^2·d) for system with rotating arms and 2.0 gpm/ft^2 (118 m^3/m^2·d) with fixed nozzles, at a minimum pressure of 50 psi (344 kPa). The surface wash shall use filtered and disinfected water or air and filtered disinfected water. The supply system shall be provided with adequate backflow prevention.

(V) Filter materials. For rapid rate filters, coarse-to-fine beds of mixed or dual media or fine-to-coarse single media beds may be used.

(1.) Types of filter media:

a. Anthracite. Clean crushed anthracite, or a combination of anthracite and other media shall have an effective size of 0.45 mm - 0.55 mm with uniformity coefficient not greater than 1.65 when used alone, or an effective size of 0.8 mm - 1.2 mm with a uniformity coefficient not greater than 1.65 when used as a cap. The anthracite shall meet the requirements of AWWA B100.

b. Sand. Sand shall have an effective size of 0.45 mm to 0.55 mm, a uniformity coefficient of not greater than 1.65, and shall meet the requirements of AWWA B100.

c. Granular activated carbon (GAC). Granular activated carbon media may be used in place of anthracite. There must be means for periodic treatment of granular activated carbon filter material for control of bacterial and other growths. Provisions must be made for replacement or regeneration if GAC is used for filtration.

d. Torpedo sand or garnet. A layer of torpedo sand or garnet shall be used as a supporting media for filter sand.

(2.) Sand for single media beds. The media shall be clean silica sand having a depth of not less than 24 inches (0.61 m), an effective size of from 0.45 mm to 0.55 mm, and a uniformity coefficient not greater than 1.65. A 3 inch (7.6 cm) layer of torpedo sand or other high density material shall be used as a supporting media for the filter sand. The material shall have an effective size of 0.8 mm to 2.0 mm, and a uniformity coefficient not greater than 1.7.

(3.) Anthracite for single media beds. Clean crushed anthracite or a combination of sand and anthracite may be used. Such media shall have an effective size from 0.45 mm to 0.55 mm, and a uniformity coefficient not greater than 1.65.

(4.) Gravel. When used as a supporting media, gravel shall consist of coarse aggregate in which a high proportion of the particles are rounded and tend toward a generally spherical or equidimensional shape. It shall possess sufficient strength and hardness to resist degradation during handling and use, be substantially free of harmful materials, and exceed the minimum density requirement. The gravel shall meet the requirements of AWWA B100.

(5.) Multi-media. Filter beds of this type shall contain a depth of fine media made up of anthracite coal, specific gravity 1.5; silica sand, specific gravity 2.6; and garnet sand or ilemite, specific gravity 4.2 - 4.5.

a. Bed depths and distribution of the media shall be determined by the water quality, but shall not be less than 10 inches (0.25 m) of fine sand and 24 inches (0.61 m) of coal. The relative size of the particles shall be such that hydraulic grading of the material during backwash will result in a filter bed with pore space graded progressively from coarse to fine in the direction of filtration (down).

b. The multi-media shall be supported on two layers of special high density gravel placed above the conventional silica gravel supporting bed. The special gravel shall have a specific gravity not less than 4.2. The bottom layer shall consist of particles passing No. 5 and retained on No. 12 U.S. mesh sieves and shall be 1-1/2 inches (3.8 cm) thick. The top layer shall consist of particles passing No. 12 and retained on No. 20 U.S. mesh sieves, and shall be 1-1/2 inches (3.8 cm) thick.

(6.) Dual media. Coal sand filters shall consist of a coarse coal layer above a layer of fine sand. The media shall consist of not less than 8 inches (20 cm) of sand and 15 inches (0.38 m) of coal on a torpedo sand or garnet layer support of not less than 3 inches (7.8 cm) on the gravel support.

(VI) Filter bottoms. Acceptable filter bottoms and strainer systems shall be limited to pipe, perforated pipe laterals, tile block and perforated tile block. Perforated plate bottoms or plastic nozzles shall not be used.

(VII) Appurtenances. Every filter shall have influent and effluent sampling taps; indicating loss of head gauge; indicating effluent turbidimeter; a waste drain for draining the filter compartment to waste; and a filter rate flow meter. Every filter shall provide polymer feed facilities including polymer mixing and storage tank and at least one feed pump for each filter compartment. On plants having a capacity in excess of 0.5 MGD, recorders shall be provided on the turbidimeters.

(VIII) Filter rate control. Filter rate control shall be such that the filter is not surged. Filter rate of flow shall not change at a rate greater than 0.3 gpm/ft^2 (17.7 $m^3/m^2 \cdot d$) per minute. Filters that stop and restart during a cycle shall have a filter to waste system installed. Declining flow rate filters shall not be used unless the flow rate for each filter is controlled to rates less than allowed in 10 (i)(ii)(B) and there are four or more individual filters.

(IX) A filter to waste cycle shall be provided after the filter backwash operation. The filter to waste cycle shall be at least 10 minutes.

(j) Diatomaceous earth filtration. These types of filters may be used as the filtration process to remove turbidity from surface waters where turbidities entering the filters do not exceed 25 TU and where total raw water coliforms do not exceed 100 organisms/100 ml. These filters may be used where the raw water quality exceeds the above limits when flocculation and sedimentation are used preceding the filters. Diatomaceous earth filters may also be used for removal of iron from groundwaters.

(i) Types of filters. Pressure or vacuum diatomaceous earth filtration units will be considered for approval.

(ii) Precoat. A precoating system shall be provided.

(A) Application. A uniform precoat shall be applied hydraulically to each septum by introducing a precoat slurry to the filter influent line and employing a filter to waste or recirculation system.

(B) Feed capabilities. Diatomaceous earth in the amount of 0.20 lb/ft^2 (1 Kg/m^2) minimum of filter area shall be used with recirculation. When precoating is accomplished with a filter to waste system, 0.3 lbs/ft^2 (1.5 Kg/m^2) minimum shall be provided.

(iii) Body feed. A body feed system to apply diatomaceous earth slurry continuously during the filter run shall be provided. Continuous mixing of the body feed slurry tank during the filter cycle shall be provided.

(iv) Filtration.

(A) Rate of filtration. The maximum rate of filtration shall not exceed 1.5 gpm/ft^2 (88.6 $m^3/m^2 \cdot d$) of septum area. The filtration rate shall be controlled by a positive means.

(B) Head loss. The head loss shall not exceed 30 psi (206 kPa) for pressure diatomaceous earth filters, or a vacuum of 15 inches of mercury (50.8 kPa) for vacuum system.

(C) Recirculation. A recirculation or holding pump shall be provided to maintain differential pressure across the filter when the unit is not in operation in order to prevent the filter cake from dropping off the filter elements. A minimum recirculation rate of 0.1 gallons per minute per square foot (5.9 $m^3/m^2 \cdot d$) of filter area shall be provided. The filter control system shall prevent automatic restart after power failure.

(D) Septum or filter element. The filter elements shall be structurally capable of withstanding maximum pressure and velocity variations during filtration and cleaning cycles, and shall be spaced so that not less than 2 inches (5.1 cm) are provided between elements or between any element and a wall.

(E) Inlet design. The filter influent shall be designed to prevent scour of the diatomaceous earth from the filter element.

(v) Appurtenances. Every filter shall provide sampling taps for raw and filtered water; loss of head or differential pressure gauge; rate of flow indicator, with totalizer; and a throttling valve used to reduce rates during adverse raw water conditions.

(vi) Monitoring. A continuous monitoring turbidimeter is required on the filter effluent from each filter unit for plants treating surface water.

(k) Disinfection. Chlorine, chlorine dioxide, ozone or other disinfectant as approved by the administrator may be used for disinfection. Where the primary disinfectant is ozone, chlorination equipment shall be provided to enable maintaining a residual disinfectant throughout the distribution system. Automatic proportioning of disinfectant feed to flow rate is required where the plant flow control is automatic.

(i) Chlorination equipment.

(A) Type. Solution feed gas chlorinators or hypochlorite feeders of the positive displacement type shall be provided.

(B) Capacity. The chlorinator capacity shall be such that a minimum 5 mg/L disinfection dose can be added on the maximum day. The equipment shall be of such design that it will operate accurately over the desired feeding range.

(C) Standby equipment. Standby equipment of sufficient capacity shall be available to replace the largest chlorinator unit, except for a well water system providing no treatment other than disinfection.

(D) Automatic switchover. Automatic switch-over of chlorine cylinders shall be provided.

(E) Diffuser. The chlorine solution injection/diffuser shall provide a rapid and thorough mix with all the water being treated. If the application point is to a pipeline discharging to a clearwell, the chlorine shall be added to the center of the pipe at least 10 pipe diameters upstream of the discharge into the clearwell.

(F) Injector/Eductor. For gas feed chlorinators, the injector/eductor shall be selected based on solution water pressure, injector waterflow rate, feed point backpressure, and chlorine solution line length and size. The maximum feed point backpressure shall not exceed 110 psi (759 kPa). Where backpressure exceeds 110 psi (750 kPa), a chlorine solution pump shall be used. Gauges shall be provided for chlorine solution pressure, feed water pressure and chlorine gas pressure, or vacuum.

(ii) Points of application and contact time.

(A) At plants treating surface water, provisions shall be made for applying disinfectant to the raw water, filter influent, and filtered water.

(B) For plants treating groundwater, provisions shall be made for applying disinfectant to a point in the finished water supply line prior to any commercial, industrial, or municipal user. Agricultural users may remove water from the supply line prior to disinfectant application point.

(C) Where free chlorine residual is provided, 1/2 hour contact time shall be provided for groundwaters and 2 hours for surface waters. Where combined residual chlorination is provided, 2 hours contact time for groundwater and 3 hours contact for surface water shall be provided.

(D) When chlorine is applied to a groundwater source for the purpose of maintaining a residual, no contact time is required.

(iii) Testing equipment. Chlorine residual test equipment recognized in the 15th Edition of *Standard Methods for the Examination of Water and Wastewater* shall be provided and shall be capable of measuring residuals to the nearest 0.1 mg/L in the range below 0.5 mg/L, to the nearest 0.3 mg/L between 0.5 mg/L and 1.0 mg/L and to the nearest 0.5 mg/L between 1.0 mg/L and 2.0 mg/L.

(iv) Chlorinator piping.

(A) Cross-connection protection. The chlorinator water supply piping shall be designed to prevent contamination of the treated water supply. At all facilities treating surface water, pre- and post- chlorination systems shall be independent to prevent possible siphoning of partially treated water into the clearwell. The water supply to each eductor shall have a separate shutoff valve. No master shutoff will be allowed. Chlorine solution feed water shall be finished water.

(B) Pipe material. The pipes carrying liquid or gaseous chlorine shall be Schedule 80 black steel pipe with forged steel fittings. Bushings shall not be used. Vacuum piping for gaseous chlorine may be polyethylene tubing. Gas piping between the chlorine pressure reducing valve of the chlorinator and the ejector shall be PVC or polyethylene. Piping for aqueous solutions of chlorine beyond the ejector shall be PVC, fiberglass or steel pipe lined with PVC or saran.

(v) Maximum withdrawal. The maximum withdrawal rate of gaseous chlorine shall be limited to 40 lbs/day (18.1 kg/day) for 100 or 150 lb (45.4 or 68.0 kg) cylinders and 400 lbs/day (181 kg/day) for 2,000 lb (907 kg) cylinders, unless chlorine evaporators are employed.

(vi) Ozonation equipment.

(A) Capacity. The ozonator capacity shall be such that an applied dose of at least 10 mg/L can be attained at the maximum daily flows. The equipment shall be of such design that it will operate ± 5 percent over the desired feeding range.

(B) Piping. Injection equipment and piping in contact with ozonated air and air water emulsions shall be of stainless steel, teflon or other material resistant to ozone. Valves carrying ozonized air shall be made of metal coated with ozone resistant materials.

(C) Application. Ozone may be applied to the water directly as a gas or by an injector system similar to a chlorine injector system. In gas applications, depth of submergence of the diffusers shall be a minimum of 10 feet (3.05 m). Diffusion shall be fine bubble or mixed.

(D) Contact time and point of application. Ozone shall be applied at a point which will provide contact time not less than 30 minutes. At plants treating surface water, provisions should be made for applying a disinfectant to the raw water, filter influent, filtered water and final contact basin. At plants treating groundwater, provisions should be made for applying ozone to the clear-well inlet.

(E) Testing equipment. Testing equipment shall enable measurement of residuals to the nearest 0.1 mg/L in the range below 0.5 mg/L and to the nearest 0.2 mg/L above 0.5 mg/L.

(F) Ozone destruct. An ozone destruct device shall be provided to destruct all ozone contractor off gases.

(G) The use of ozone for disinfection will be allowed only if a chlorine or combined chlorine residual is provided in the distribution system.

(l) Softening.

(i) Lime or lime soda process. Design standards for rapid mix, flocculation and sedimentation are the same as for conventional treatment previously outlined. Lime or lime soda softened effluent shall be filtered.

(A) Hydraulics. When split treatment is used, the bypass line shall be sized to carry total plant flow, and a means of measuring and splitting the flow shall be provided.

(B) Chemical feed point. Lime and recycled sludge shall be fed directly into the rapid mix basin.

(C) Stabilization. Provisions shall be made to chemically stabilize waters softened by the lime or lime soda process.

(D) Sludge collection. Mechanical sludge removal equipment shall be provided in the sedimentation basin. Sludge recycling to the rapid mix shall be provided.

(E) Disinfection. The use of excess lime shall not be considered a substitute for disinfection. Disinfection, as previously outlined, shall be provided.

(ii) Cation exchange process.

(A) Pretreatment requirements. Pretreatment is required when the content of iron, manganese, or a combination of the two, is 1 mg/L or more. Water with 5 units or more turbidity shall not be applied directly to the cation exchange softener.

(B) Design. The units may be of pressure or gravity type, of either an upflow or downflow design. Automatic regeneration based on volume of water softened shall be used. A manual override shall be provided on all automatic controls.

(C) Exchange capacity. The design capacity for hardness removal shall not exceed 20,000 grains per cubic foot (45,880 g/L) when resin is regenerated with 0.3 pounds (.14 kg) of salt per kilograin (2.29 g/L) of hardness removed.

(D) Depth of resin. The depth of the exchange resin shall not be less than 2 feet (0.6 m).

(E) Flowrates. The flow applied to the softening unit shall not exceed 7 gpm/ft^2 (413 m^3/m$^2\cdot$d) of bed area. The minimum backwash rate shall be 6 gpm/ft^2 (354 m^3/m$^2\cdot$d) of bed area or shall provide a minimum of 150 percent bed expansion at winter water temperatures. A positive means of controlling flow must be present.

(F) Underdrains and supporting gravel. The bottoms, strainer systems and support for the exchange resin shall conform to criteria provided for rapid rate gravity filters.

(G) Brine distribution. Facilities shall be included for even distribution of the brine over the entire surface of both upflow and downflow units.

(H) Cross-connection control. Backwash, rinse and air relief discharge pipes shall be installed in such a manner as to prevent any possibility of back siphonage.

(I) Bypass piping and equipment. A by-pass shall be provided around softening units to produce a blended water of desirable hardness. Totalizing meters must be installed on the bypass line and on each softener unit. An automatic proportioning or regulating device and shutoff valve shall be provided on the bypass line.

(J) Additional limitations.

(I) Silica gel resins shall not be used for waters having a pH above 8.4 or containing less than 6 mg/L silica and shall not be used when iron is present.

(II) When the applied water contains a chlorine residual, the cation exchange resin shall be a type that is not damaged by residual chlorine.

(III) Phenolic resin shall not be used.

(K) Brine and salt storage tanks.

(I) Salt dissolving or brine tanks and wet salt storage tanks shall be covered and constructed of corrosion-resistant materials.

(II) The makeup water inlet shall be protected from back siphonage. Water for filling the tank shall be distributed over the entire surface by pipes above the maximum brine level in the tank. The tanks shall be provided with an automatic declining level control system on the makeup water line.

(III) Wet salt storage basins shall be equipped with manholes or hatchways for access and for direct dumping of salt from truck or railcar. Openings shall be provided with raised curbs and watertight covers having overlapping edges similar to those required for finished water reservoirs.

(IV) Overflows, if provided, must be turned down, have a proper free fall discharge and be protected with corrosion-resistant screens or self-closing flap valves.

(V) Two wet salt storage tanks or compartments designed to operate independently shall be provided.

(VI) The salt shall be supported on graduated layers of gravel under which is a suitable means of collecting the brine.

(L) Salt and brine storage capacity. Total salt storage capacity shall provide for at least 30 days of operation.

(M) Brine pump or eductor. An eductor may be used to transfer brine from the brine tank to the softeners. If a pump is used, a brine measuring tank or means of metering shall be provided to obtain proper dilution.

(N) Stabilization. Facilities for stabilizing corrosion control shall be provided.

(O) Construction materials. Pipes and contact materials shall be resistant to the aggressiveness of salt. Plastic and red brass are acceptable piping materials. Steel and concrete shall be coated with a non-leaching protective coating which is compatible with salt and brine.

(P) Housing. Bagged salt and dry bulk salt storage shall be enclosed and separated from other operating areas in order to prevent damage to equipment.

(m) Aeration. Aeration may be used to help remove tastes and odors due to dissolved gases from decomposing organic matter; to reduce or remove objectionable amounts of carbon dioxide, hydrogen sulfide, etc.; to introduce oxygen to assist in iron and/or manganese removal; and to strip volatile organic compounds for controlling the formation of trihalomethanes by removing the trihalomethane precursors.

(i) Natural draft aeration - tray type. The design shall provide perforations in the distribution pan to provide uniform distribution of water over the top tray. The discharge shall be through a series of three or more trays. Tray material shall be resistant to aggressiveness of the water and dissolved gases. The loading rate shall not exceed five gpm/ft^2 (203 L/m^2) of total tray area.

(ii) Forced or induced draft aeration. Devices shall:

(A) Be constructed and located so that air introduced into the column shall be free from obnoxious fumes, dust, and dirt. All sections of the aerator shall be easily reached or removed for maintenance.

(B) Provide distribution of water uniformly over the top tray and discharge through a series of five or more trays.

(C) Be constructed so that the water outlet is adequately sealed to prevent unwarranted loss of air. Material shall be resistant to the aggressiveness of the water and dissolved gases. Loading shall be provided at a rate not to exceed five gpm/ft^2 (203 L/m^2) of total tray area.

(iii) Pressure aeration. Pressure aeration may be used for oxidation purposes only; it is not acceptable for removing dissolved gases.

(iv) Protection of aerators. All aerators except those discharging to lime softening or clarification plants shall be protected from contamination by birds and insects by using louvers and 24 mesh screen.

(v) Disinfection. Disinfection must be provided as a final treatment to all waters receiving aeration treatment.

(vi) Bypass. A bypass shall be provided around all aeration units.

(vii) Volatile organics removal. Volatile organic compounds may be stripped by packed tower or diffused aeration methods.

(n) Iron and manganese control. Iron and manganese control, as used here, refers solely to treatment processes designed specifically for this purpose.

(i) Removal by oxidation, detention, and filtration.

(A) Oxidation. Oxidation may be accomplished by aeration or by chemical oxidation using chlorine, potassium permanganate, ozone, hydrogen peroxide, or chlorine dioxide.

(B) Detention following aeration. A minimum detention time of 20 minutes shall be provided following aeration. The detention basin shall be designed as a holding tank with sufficient baffling to prevent short-circuiting. Sedimentation basins shall be provided when treating water with iron and/or manganese above 2 mg/L, or where chemical coagulation is used to reduce the load on the filters. Provisions for sludge removal shall be made.

(C) Filtration. Gravity or pressure filters shall be provided. Where pressure filters are used, the following criteria supplements that found in Section 10(i).

(I) Rate of filtration. The rate shall not exceed 3 gpm/ft^2 (176 $m^3/m^2 \cdot d$) of filter area.

(II) Design criteria. The filters shall have a minimum side wall shell height of 5 feet, and an air release valve on the highest point of each filter. Each filter shall have a means to observe the wastewater during backwashing and also a manhole to facilitate inspection and repairs.

(ii) Removal by the lime soda softening process. These processes shall conform to the lime soda process in Section 10(i).

(iii) Removal by manganese greensand filtration. Provide feed capability of potassium permanganate to the influent of a manganese greensand filter.

(A) An anthracite media cap of at least 6 inches (0.15 m) shall be provided over manganese green-sand.

(B) The filtration rate shall not exceed 4 gpm/ft^2 (236 $m^3/m^2 \cdot d$).

(C) Provide a minimum backwash capability of 12 gpm/ft^2 (708 $m^3/m^2 \cdot d$), with a rate control device.

(D) Air washing or surface washing is required.

(iv) Removal by ion exchange. This process of iron and manganese removal shall not be used for water containing more than 0.3 mg/L of iron, manganese or combination of the two. This process is not acceptable where either the raw water or washwater contains dissolved oxygen.

(v) Sequestration by polyphosphates. This process shall not be used when iron, manganese or a combination of the two as exceeds 1.0 mg/L. The total phosphate applied shall not exceed 10 mg/L as PO_4. Where phosphate treatment is used, facilities shall be provided for maintaining a 0.5 mg/L free or combined chlorine residual at remote points in the distribution system.

(A) The stock phosphate solution tank shall be covered. Facilities shall be provided for disinfecting the solution tank. The facilities shall be capable of providing a minimum of 10 mg/L free chlorine residual.

(B) Polyphosphates shall not be applied ahead of iron and manganese removal treatment. The point of application shall be prior to any aeration, oxidation or disinfection if no iron or manganese removal treatment is provided.

(vi) Sequestration by sodium silicates. Sodium silicate sequestration of iron and manganese shall be used for groundwater supplies prior to air contact. Rapid oxidation of the metal ions by chlorine, chlorine dioxide, ozone, hydrogen peroxide, or other strong oxidant must accompany or closely precede the sodium silicate addition. Injection of sodium silicate shall not occur at a point more than 15 seconds after oxidation feed point. Feed and dilution equipment shall be sized on the basis of feed solutions stronger than 5 percent silica as $Si0_2$. Sodium silicate addition may be used only on water containing up to 2 mg/L of iron, manganese or a combination of the two. Sodium silicate addition shall not be used on waters where 20 mg/L or more $Si0_2$ is required or where the amount of added and naturally occurring silicate will exceed 60 mg/L as $Si0_2$.

(A) Facilities shall be provided for maintaining a chlorine residual of 0.5 mg/L throughout the distribution system.

(B) Sodium silicate shall not be applied ahead of iron or manganese removal treatment.

(vii) Testing equipment. Testing equipment shall be provided for all iron and manganese control plants.

(A) The equipment should have the capacity to measure the iron content to a minimum of 0.1 mg/L and the manganese content to a minimum of 0.05 mg/L.

(B) Where polyphoshate sequestration is practiced, phosphate testing equipment shall be provided.

(o) Fluoridation and defluoridation.

(i) Fluoride compound storage. Storage tanks shall be covered; all storage shall be inside a building. Storage tanks for hydrofluosilic acid shall be vented to the atmosphere at a point outside the building.

(ii) Chemical feed equipment. Fluoride feed equipment shall meet the following requirements.

(A) Scales or loss of weight recorders shall be provided for dry chemical feeds. Feeders shall be accurate to within five percent of any desired feed rate.

(B) The point of application of hydrofluosilic acid, if into a horizontal pipe, shall be in the lower half of the pipe. Fluoride compound shall not be added before lime soda softening or ion exchange softening.

(C) A fluoride solution shall be applied by a positive displacement pump having a stroke rate not less than 20 nor more than 95 strokes per minute. Fluoride solutions shall not be injected to a point of negative pressure.

(D) All fluoride feed lines and dilution water lines shall be isolated from potable water supplies by either an air gap above the solution tank or a reduced pressure principal backflow preventor.

(E) Water used for sodium flouride dissolution shall have a hardness not exceeding 50 mg/L. Softening shall be provided for the solution water where hardness exceeds 45 mg/L.

(F) Flow meters for treated flow rate and fluoride solution water shall be provided.

(iii) Protective equipment. Protective equipment, including air purifying respirators approved by the National Institute of Occupational Safety and Health and emergency showers, shall be provided for operators handling fluoride compounds.

(iv) Dust control.

(A) Provisions shall be made to allow the transfer of dry fluoride compounds from shipping containers to storage bins or hoppers in such a way as to minimize the quantity of fluoride dust which may enter the room in which the equipment is installed. The enclosure shall be provided with an exhaust fan and dust filter which places the hopper under a negative pressure. Air exhausted from fluoride handling equipment shall discharge through a dust filter to the outside atmosphere of the building. The discharge shall not be located near a building fresh air intake.

(B) A floor drain shall be provided.

(v) Testing equipment. Equipment shall be provided for measuring the quantity of fluoride in the water.

(vi) Defluoridation. Where fluoride removal is required the following methods are acceptable:

(A) Activated alumina may be employed in open gravity filter tanks or pressure filter tanks. The minimum media depth shall be 5 feet. The units shall not be loaded at a rate exceeding 4 gallons per minute per square foot (236 $m^3/m^2 \cdot d$). The activated alumina media shall be in mesh sizes ranging from 28 to 48. Regeneration facilities shall be provided to regenerate the media. These shall include both weak caustic and weak acid systems.

(B) Bone char filtration or lime softening with magnesium addition.

(p) Stabilization. Stabilized water is a water that does not tend to corrode the pipe nor deposit large quantities of scale.

(i) Carbon dioxide addition.

(A) Recarbonation basin design shall provide a minimum total detention time of 20 minutes. Two compartments consisting of a mixing compartment having a detention time of at least three minutes and a reaction compartment are required. Each compartment shall have a minimum depth of 8 feet (2.4 m).

(B) Plants generating carbon dioxide from combustion shall have top recarbonation tanks in order to dissipate carbon monoxide gas. Care shall be taken to prevent the basin off-gases from entering any treatment plant structure.

(C) The recarbonation basin shall be sloped to a drain.

(ii) Acid addition. Facilities shall be provided for feeding both acid and alkalinity, such as sodium carbonate, lime or sodium bicarbonate.

(iii) Polyphosphates. The feeding of polyphosphates is applicable for sequestering calcium in lime softened water, corrosion control, and in conjunction with alkali feed following ion exchange softening. Chlorination equipment and feed points shall be available to chlorinate the phosphate solution tank to maintain a 10 mg/L free chlorine residual and to maintain a 0.5 mg/L residual in the distribution system.

(iv) Alkali feed. Unstable water created by ion exchange softening shall be stabilized by an alkali feed. An alkali feeder shall be provided for all ion exchange water softening plants.

(v) Control. Laboratory equipment shall be provided for determining the effectiveness of stabilization treatment. This shall include testing equipment for hardness, calcium, alkalinity, pH and magnesium, as a minimum.

(q) Taste and odor control. Provision shall be made for the control of taste and odor at all surface water treatment plants.

(i) Flexibility. Plants treating water that is known to have taste and odor problems shall be provided with equipment that makes at least two of the control processes available.

(ii) Chlorination. When chlorination is used for the removal of some objectionable odors, two hours of contact time must be provided to complete the chemical reactions involved.

(iii) Chlorine dioxide. Chlorine dioxide can be used in the treatment of any taste and odor that is treatable by an oxidizing compound. Provisions shall be made for proper storing and handling of the sodium chlorite to eliminate any danger of explosion.

(iv) Powdered activated carbon. Provisions shall allow the addition of carbon to the presedimentation basin influent, rapid mix basin, and clarifier effluent. Carbon feed equipment shall be capable of feeding from 0 to 40 mg/L at plant design flows.

A provision shall be made for adequate dust control. Powdered activated carbon shall be handled as a potentially combustible material. It shall be stored and used in a building or compartment as nearly fireproof as possible. Carbon feeder rooms shall be designed for hazardous locations, National Electric Code, Class 1, Groups C and D, Division 1.

(v) Granular activated carbon adsorption units. Open or closed carbon contacting may be used for taste and odor control by adsorption of organics. The loading rate shall not exceed 10 gpm/ft^2 (236 $m^3/m^2 \cdot d$). The minimum empty bed contact time shall be 20 minutes. Provisions shall be made for moving carbon to and from the contactors.

(vi) Potassium permanganate. The application point shall be in the raw water or ahead of the clarifier influent. Facilities shall be capable of feeding not less than 10 mg/L of permanganate.

(vii) Ozone. Thirty minutes of contact time must be provided to complete the chemical reactions involved. The facilities shall be capable of an applied ozone feed rate of 15 mg/L minimum.

(r) Microscreening. A microscreen will be allowed as a mechanical supplement to treatment. The microscreening shall be capable of removing suspended matter from the water by straining. It may be used to reduce nuisance organisms and organic loadings. It shall not be used in place of filtration or coagulation.

(i) Screens shall be of a corrosion-resistant material, plastic or stainless steel.

(ii) Bypass piping shall be provided around the unit.

(iii) Protection against back siphonage shall be provided when potable water is used for washing the screen.

(iv) Washwaters shall be wasted and not recycled to the microscreen.

(s) Organics removal by granular carbon adsorption.

(i) Adsorption of organics on granular activated carbon. Water to be treated may be contacted with granular activated carbon. The pH of the water shall be less than 9.0. The turbidity of the applied water shall be less than 2 TU when packed beds are used.

(ii) Contact time. The carbon beds or columns shall provide a minimum of 20 minutes of empty bed contact time at design flow. Surface loading rates shall not exceed 10 gpm/ft^2 (590 $m^3/m^2 \cdot d$).

(iii) Carbon bed or column design.

(A) If an upflow countercurrent contactors is used, it may be either packed or expanded. A single unit is acceptable. If a downflow contactor is used, two or more beds in parallel are required.

(B) Contactors may be designed as open gravity units, or pressure beds. They may be constructed of concrete, steel, or fiberglass reinforced plastic. Steel vessels shall be protected against corrosion by coaltar epoxy coating, rubber or glass lining, or other means.

(C) All carbon beds or columns shall be equipped with provisions for flow reversal and bed expansion. Combination downflow filter contactors shall have backwashing facilities to provide up to 50 percent bed expansion and shall meet the same backwash criteria as rapid filters.

(D) Inlet and outlet screens shall be 304 or 316 stainless steel or other suitable materials.

(E) Carbon beds and columns shall have a means for removing spent carbon and introducing makeup or regenerated carbon.

(F) Pressure contactors shall be equipped with air-vacuum release valves fitted with a stainless steel screen, slot size 0.036 mm (0.14 inches), to prevent plugging with carbon.

(t) Radionuclides. Where radionuclide removal is practiced, the waste shall be evaluated for its classification as a hazardous or low level radioactive waste and disposed of as required by the Nuclear Regulatory Commission or other appropriate authority.

(u) Waste handling and disposal. Disposal of any waste sludge or liquid shall meet all the requirements of Chapter 11 of the Water Quality Rules and Regulations where applicable.

(i) Sanitary and laboratory wastes. The sanitary and laboratory wastes from water treatment plants, pumping stations, etc., shall not be recycled to any part of the water plant. Waste from these facilities must be discharged directly to a sanitary sewer system when feasible, or to an on-site waste treatment facility permitted by the Wyoming Department of Environmental Quality.

(ii) Brine waste. The waste from ion exchange plants, demineralization plants, etc., may not be recycled to the plant. Where discharging to a sanitary sewer, a holding tank shall be provided to prevent the overloading of the sewer and/or interference with the waste treatment processes. The effect of brine discharge to sewage lagoons may depend on the rate of evaporation from the lagoons. Where disposal to an off-site waste treatment system is proposed, it must be demonstrated that the sewer and the facility have the required capacity and dilution capability. The impact on any treatment system discharge shall be evaluated.

(iii) Lime softening sludge. Acceptable methods of treatment and disposal are as follows:

(A) Sludge lagoons. Lagoons shall be designed on the basis of providing a surface area of 0.7 acres (.28 ha) per million gallons per day (3785 m^3/day) (average day) per 100 mg/L of hardness removed, based on a usable lagoon depth of 5 feet (1.5 m). At least 2 lagoons shall be provided. An acceptable means of final sludge disposal must be provided. Provisions must be made for convenient cleaning of the lagoons.

The design of lagoons shall provide for location above the 100-year flood or adequately protected from the 100-year flood. There shall be means of diverting surface water runoff so that it does not flow into the lagoons. Minimum free-board of 3 feet (0.66 m) shall be present. An adjustable decanting device for recycling the overflow shall be present. There shall be an accessible effluent sampling point.

(B) Land application of liquid lime sludge shall comply with Part E of Chapter 11 of the Water Quality Rules and Regulations.

(C) Disposal at a suitable landfill shall be authorized by the Solid Waste Management Program of the Department of Environmental Quality.

(D) Mechanical dewatering of sludge may be employed.

(E) Recalcination of sludge may be employed.

(F) Lime sludge drying beds shall not be used.

(iv) Alum sludge.

(A) Lagooning may be used as a storage and interim disposal method for alum sludge. The volume of alum sludge storage lagoons shall be at least 100,000 gallons (378.5 m^3) per 1,000,000 gpd (3,785 m^3/d) of treatment plant capacity.

(B) Discharge of alum sludge to sanitary sewers may be used only when the sewage system has the capability to adequately handle the flow and sludge.

(C) Mechanical dewatering of sludge may be employed.

(D) Alum sludge drying beds may be used.

(E) Alum sludge may be acid treated and recovered.

(F) Disposal at a suitable landfill shall be authorized by the Solid Waste Management Program of the Department of Environmental Quality.

(v) Iron and manganese waste. Waste filter washwater from iron and manganese removal plants may be disposed by filtration, by lagooning, or by discharge to the sewer system.

(A) Sand filters. Sand filters should have a total filter area of not less than 100 square feet (9.29 m^2) in a minimum of 2 compartments. The filter shall have sufficient surface area and capacity to contain, in a volume of 2 feet (0.61 m) above the level of the sand, the entire volume of washwater produced by washing the production filters.

(I) The filter shall not be subject to flooding by surface runoff or flood waters. Finished grade elevation shall be such as to facilitate maintenance, cleaning and removal of surface sand as required.

(II) The filter media shall consist of a minimum of 12 inches (30.4 cm) of sand, 3 inches (7.6 cm) of supporting small gravel or torpedo sand, and 9 inches (0.22 m) of gravel in graded layers. All sand and gravel shall be washed to remove fines. Filter sand shall have an effective size of 0.3 to 0.5 mm and a uniformity coefficient not to exceed 3.5.

(III) The filter shall be provided with an underdrain collection system, and provision shall be made for an accessible sample point.

(IV) Overflow devices from these filters shall not be permitted.

(V) Where freezing may occur, provisions shall be made for covering the filters during the winter months.

(VI) Iron and manganese waste filters shall provide an atmosphere air break between adjacent compartments that contain finished water and unfiltered water.

(B) Washwater recovery lagoons. Filter backwash wastewater may be recovered by washwater recovery lagoons. Decanted filter backwash wastewater from the lagoons shall be recycled to the head of the plant. Lagoons shall provide 250,000 gallons of storage (946 m^3) for each 1,000,000 gallons per day (3,785 m^3/day) of treatment capacity. Lagoons shall have a minimum usable depth of 3 feet (0.91 m), a length 4 times the width, and a width of at least 3 times the water depth.

Section 11. **Chemical Application**.

(a) General.

(i) Chemical application. Chemicals shall be applied by such means as to prevent backflow or back siphonage between multiple points of feed through common manifolds.

(ii) General equipment design. General equipment design shall be such that:

(A) Feeders will be able to supply the necessary amounts of chemical throughout the feed range at all times.

(B) Chemical contact materials and surfaces are resistant to the aggressiveness of the chemical solution.

(C) Corrosive chemicals are introduced in such a manner as to minimize potential for corrosion.

(D) Chemicals that are incompatible are not stored or handled together.

(E) All chemicals are conducted from the feeder to the point of application in separate conduits.

(F) Chemical feeders and pumps operate at no lower than 20 percent of the feed range.

(G) Slurry type chemicals, especially lime, are fed by gravity where practical.

(b) Facility design.

(i) Number of feeders. A separate feeder shall be provided for each chemical applied.

(ii) Control. Feeders may be manually or automatically controlled. Automatic controls shall be designed to allow override by manual controls. Where plant flow rates are not manually controlled, chemical feed rates shall be automatically proportioned to flow.

Calibration cylinders shall be provided for each chemical system, enabling exact measurement of chemical feed dose.

(iii) Dry chemical feeders. Dry chemical feeders shall measure chemicals volumetrically or gravimetrically; they shall be provided with a solution water system and mixer in the solution tank and; shall completely enclose chemicals to prevent emission of dust to the operating room.

(iv) Positive displacement pumps. Positive displacement pumps shall be sized for the maximum pressure at the point of injection. A backpressure valve shall be provided in instances where chemicals can flow by gravity through the pump and pump check valves.

(v) Liquid chemical feeders - siphon control. Liquid chemical feeders shall be such that chemical solutions cannot be siphoned into the water supply.

(vi) Cross-connection control. Cross-connection control must be provided to assure that the service water lines discharging to solution tanks shall be protected from backflow and that liquid chemical solutions cannot be siphoned through solution feeders into the water supply. No direct connection shall exist between any sewer and a drain or overflow from the feeder, solution chamber or tank. All drains shall terminate at least 6 inches (0.15 m) or 2 pipe diameters, whichever is greater, above the overflow rim of a receiving sump, conduit or waste receptacle.

(vii) In-plant water supply. The in-plant water supply shall be of sufficient quantity and pressure to meet the chemical system needs. A minimum capability of 15 gpm at 50 psi is required.

There shall be a new means of controlling and measuring the water when used for preparing specific solution concentrations by dilution, i.e., rotometer and control valve. The water shall be properly treated for hardness when hardness affects the chemical solution.

(viii) Storage of chemicals.

(A) Storage space or tank volume shall be provided for at least 30 days of chemical supply. The storage shall provide protection from intermixing of 2 different chemicals.

(B) Storage tanks and pipelines for liquid chemicals shall be specific to the chemical and not for alternates.

(C) Liquid chemical storage tanks must have a liquid level indicator, an overflow and a receiving basin or drain capable of receiving accidental spills or over-flows, and be located in a contained area sized to store the total contents of a ruptured tank.

(D) All chemical storage tanks shall be constructed of materials which are resistant to the chemical which they store. The tank shall not lose its structural integrity through chemical action or be subject to corrosion.

(ix) Solution and slurry tanks.

(A) Feed and dilution systems shall be designed to maintain uniform strength of solution in solution tanks. A mixer shall be provided to mix the tank contents when batching solutions. Continuous agitation shall be provided to maintain slurries in suspension. A means shall be provided to measure the solution level in the tank. Chemical solution tanks shall have a cover. Large tanks with access openings shall have such openings curbed and fitted with overhanging covers.

(B) Subsurface locations for solution tanks shall be free from sources of possible contamination, and assure positive drainage for groundwaters, accumulated water, chemical spills and overflows.

(C) Overflow pipes, when provided, shall be turned downward, with the end screened. They shall have a free fall discharge and be located where noticeable.

(D) Acid storage tanks must be vented to the outside atmosphere, but not through vents shared with any other material.

(E) Each tank shall be provided with a valved drain, protected against backflow by an air gap of 6 inches (0.15 m) or 2 pipe diameters, whichever is greater.

(x) Day tanks.

(A) Day tanks shall be provided where bulk storage of liquid chemical is provided and a dilute solution is to be fed, or where chemicals are manually batched. Day tanks shall meet the requirements of solution tanks. Tanks shall be properly labeled to designate the chemical contained.

(B) Hand pumps may be used to transfer chemicals from a carboy or drum. A tip rack may be used to permit withdrawal into a bucket from a spigot. Where motor-driven transfer pumps are provided, a liquid level limit switch and an overflow from the day tank shall be provided.

(C) Continuous agitation shall be provided to maintain chemical slurries in suspension. A mixer shall be provided to mix the initial dilution.

(xi) Feed lines:

(A) Shall be of durable material, resistant to the chemical handled.

(B) Shall be readily accessible for maintenance when located within structures.

(C) Shall be protected against freezing.

(D) Shall be readily cleanable by using plugged crosses for 90° bends.

(E) Shall slope upward from the chemical source to the feeder when conveying gases.

(F) Shall be designed consistent with scale-forming or solids-depositing properties of the water, chemical, solution, or mixtures conveyed.

(G) Shall be color coded.

(H) Shall have a connection for a flushing line.

(xii) Handling.

(A) Carts, elevators and other appropriate means shall be provided for lifting chemical containers.

(B) Provisions shall be made for the transfer of dry chemicals from shipping containers to storage bins or hoppers to minimize the quantity of dust which may enter the room in which the equipment is installed. Provisions shall also be made for disposing of empty bags, drums or barrels which will minimize exposure to dusts. Control may be provided by using:

(I) Vacuum/pneumatic equipment or closed conveyor systems.

(II) Facilities for emptying shipping containers in special enclosures.

(III) Exhaust fans and dust filters which put the hoppers or bins under negative pressure.

(C) Provision shall be made for measuring quantities of chemicals used to prepare feed solutions.

(xiii) Housing. Floor surfaces shall be smooth and impervious, slip-resistant and well drained with 2.5 percent minimum slope. Vents from feeders, storage facilities and equipment exhaust shall discharge to the outside atmosphere above grade and remote from air intakes.

(c) Specific chemicals.

(i) Chlorine gas.

(A) Respiratory protection equipment. Respiratory protection equipment, meeting the requirements of the National Institute of Occupational Safety and Health (NIOSH), shall be available where chlorine gas is handled, and shall be stored at a convenient location, but not inside any room where chlorine is used or stored. The units shall use compressed air, have at least a 30 minute capacity, and be compatible with or exactly the same as units used by the fire department responsible for the plant.

(B) Chlorine leak detection. Where ton containers are used, or where plants store more than 1000 lbs (454 kg) of chlorine, continuous electronic chlorine leak detection equipment shall be provided.

(C) Repair kits. Repair kits approved by the Chlorine Institute shall be provided for plants employing chlorine gas chlorination. The chlorine repair kits shall be available for each size container stored at the facility.

(D) Feed and storage areas. Chlorine gas feed and storage shall be enclosed and separated from other operating areas. The chlorine room shall be provided with a shatter resistant window installed in an interior wall. The room shall be constructed in such a manner that all openings between the chlorine room and the remainder of the plant are sealed. The doors shall be equipped with panic hardware, assuring ready means of exit and opening outward only to the building exterior.

(E) Ventilation. Where chlorine gas is used, the room shall have an exhaust ventilating system with a capacity which provides one complete air change every two minutes. The ventilating system shall take suction within 18 inches (0.46 m) of the floor, as far as practical from the door and air inlet, with the point of discharge so located as not to contaminate air intakes to any rooms or structures.

Air intakes shall be through louvers near the ceiling. Louvers for chlorine room air intake and exhaust shall facilitate airtight closure.

Separate switches for the fan and lights shall be located outside of the chlorine room and at the inspection window. Outside switches shall be protected from vandalism. A signal light indicating fan operation shall be provided at each entrance when the fan can be controlled from more than one point.

Vents from feeders and storage shall discharge to the outside atmosphere, above grade. The room location shall be on the prevailing downwind side of the building away from entrances, windows, louvers, walkways, etc.

Floor drains shall discharge to the outside of the building and shall not be connected to other internal or external drainage systems.

(F) Cylinders. Full and empty cylinders of chlorine gas shall be isolated from operating areas, restrained in position to prevent upset, stored in rooms separate from ammonia storage, and stored in areas not in direct sunlight or exposed to excessive heat.

(G) Heating. Chlorinator rooms shall be heated to 60° F (15.6° C) and be protected from excessive heat. Cylinders and gas lines shall be protected from temperatures above that of the feed equipment.

(H) Feed lines. Pressurized chlorine feed lines shall not carry chlorine gas beyond the chlorinator room.

(ii) Acids and caustics.

(A) Acids and caustics shall be kept in closed corrosion-resistant shipping containers or in covered bulk storage units.

(B) Acids and caustics shall be pumped in undiluted form from original containers or bulk storage units through suitable pipe or hose to the point of treatment or to a covered day tank.

(C) An emergency deluge shower and eye wash shall be provided where corrosive chemicals are stored or used.

(iii) Sodium chlorite. Provisions shall be made for proper storage and handling of sodium chlorite to eliminate any danger of explosion. No hydrocarbons or organics shall be stored with sodium chlorite.

Section 12. **Pumping Facilities**.

(a) Total dynamic head. The total dynamic head rating of pumping units shall be based on pipe friction, pressure losses from piping entrances, exits, appurtenances (bends, valves, etc.), and static head at the design flow.

(b) Location.

(i) The pumping station shall be elevated or protected to a minimum of 3 feet above the 100-year flood elevation, or 3 feet above the highest recorded flood elevation, whichever is higher.

(ii) The station shall be accessible to operating personnel at all times, and during all weather.

(iii) The site around the station shall be graded to lead surface drainage away from the station.

(iv) The station shall have security installed to prevent vandalism and entrance by unauthorized persons or animals.

(c) Pumping stations - raw and finished water.

(i) They shall have outward opening doors.

(ii) They shall have a floor elevation or a main level entry of at least 6 inches above finished grade. All floors shall slope at least 2-1/2 inches in every 10 feet to a suitable drain. Pumps shall have an outlet for drainage from pump glands without discharging onto the floor.

(iii) They shall have any underground structures waterproofed.

(d) Wetwells. Finished water wetwells shall be covered. All vents shall be turned down and screened. Finished water wetwells shall be located above the groundwater table and the top of the walls from the wetwell shall be at least 18 inches above finished grade.

(e) Equipment servicing. Pump stations shall be provided with craneways, hoist beams, eyebolts, or other facilities for servicing or removing pumps, motors or other heavy equipment. They shall be rated for not less than 50 percent more than the weight of the heaviest single item to be lifted. Openings in floors and roofs shall be provided as needed for removal of heavy or bulky equipment.

(f) Stairways and ladders. Stairways or ladders shall be provided between all floors, and in pits or compartments which must be entered. They shall have handrails on both sides, and treads of non-slip material. The Wyoming Occupational Health and Safety Rules and Regulations shall be complied with.

(g) Heating. Provisions shall be made for heating to maintain a minimum temperature of 40° F (4° C) if not typically occupied and 50° F (10° C) if occupied.

(h) Ventilation. All accessible pumping station areas shall be ventilated. Ventilation may be continuous or intermittent. If intermittent, ventilation in areas normally visited by operating personnel shall be started automatically at not greater than 30 minute intervals. Permanently installed drywell ventilation shall provide at least 6 air changes per hour if continuous, and 12 air changes per hour if intermittent. Intermittent ventilating equipment shall ensure starting upon entry of operating personnel. Wetwells shall be designed to permit the use of portable blowers that will exhaust the space and continue to supply fresh air during access periods.

(i) Dehumidification. In below ground pumping stations, a means for dehumidification shall be provided. The facilities shall be sized to maintain the dewpoint at least 2 below the coldest anticipated temperature of water to be conveyed in the pipes.

(j) Lighting. Lighting levels shall be sufficient to permit safe operation and maintenance of all equipment within the pumping stations, but not less than 30 foot candles. All areas shall be lit in such a manner that the failure of 1 lighting fixture or lamp will not cause the area to be completely dark.

(k) Sanitary and other conveniences. All pumping stations that are manned for four or more hours per day shall be provided with potable water, lavatory and toilet facilities. Wastes shall be discharged to the sanitary sewer or to an on-site waste treatment system.

(l) Pumps. At least two pumping units shall be provided. With the largest pump out of service, the remaining pump or pumps shall be capable of providing the maximum pumping rate of the system.

(m) Suction lift. Pumps shall be selected so that the net positive suction head required at maximum flow (NPSHR) is less than the net positive suction head available (NPSHA) minus 4 feet (1.2 m) based on the hydraulic conditions and altitude of the pumping station. If this condition is not met, then priming shall be provided.

Priming water must not be of lesser sanitary quality than that of the water being pumped. Vacuum priming may be used.

When an air operated ejector is used, the screened intake shall draw clean air from a point at least 10 feet above the ground or other source of possible contamination.

(n) Surge control. Piping systems shall be designed to withstand the maximum possible surge (water hammer) from the pumping station, or adequate surge control provided to protect the piping. Pressure relief valves are not acceptable surge control.

(o) Booster pumps.

(i) Booster pumps shall not produce a pressure less than 5 psi in suction lines. Where the suction line has service connections, booster pump intake pressure shall be at least 35 psi (138 kPa) when the pump is in normal operation and shall be provided with a low pressure cutoff switch if the suction line pressure is a minimum of 20 psi (69 kPa).

(ii) Automatic or remote control devices shall have a range between the start and cutoff pressure which will prevent cycling of more than 1 start every 15 minutes.

(iii) In-line booster pumps shall be accessible for servicing and repairs. The access opening and vault shall be large enough to remove the pump.

(iv) Individual home booster pumps shall not be allowed for any individual service from the public water supply main.

(p) Automatic and remote controlled stations. Conditions that may affect continuous delivery of water shall be alarmed at an attended location.

(q) Appurtenances.

(i) Valves.

(A) All pumps except submersibles shall have a suction and discharge valve to permit satisfactory operation, maintenance and repair of the equipment. Submersible pumps shall have a check valve and discharge valve to permit satisfactory operation, maintenance and repair of the equipment.

(B) If foot valves are necessary, they shall have a net valve area of at least 2-1/2 times the area of the suction pipe and they shall be screened.

(C) Each pump shall have an individual suction line or the lines shall be so manifolded that they will ensure similar hydraulic and operating conditions.

(D) Check. All pumps shall be provided with a check valve located between the pump and the discharge shutoff valve, except where arranged so that backflow is not possible under normal operating conditions.

(E) Air release. Air release valves shall be provided where the pipe crown is dropped in elevation.

(ii) Gauges. Each pump shall have a standard pressure gauge on its discharge line. Each pump shall have a compound gauge on its suction line, except wet pit type pumps.

(iii) Water seals. Water seals shall not be supplied with water of a lesser sanitary quality than that of the water being pumped. Where pumps are sealed with potable water and are pumping water of lesser sanitary quality, the seal shall be supplied from a break tank open to atmospheric pressure. The tank shall have an air gap of at least 6 inches (0.15 m) or 2 pipe diameters, whichever is greater, between the feeder line and the spill line of the tank.

(iv) Controls. Pumps, their prime movers and accessories, shall be controlled in such a manner that they will operate at rated capacity without overload. Provision shall be made to prevent energizing the motor in the event of a backspin cycle. Electrical controls shall be located above grade.

Section 13. **Finished Water Storage.**

(a) General. Steel finished water storage structures shall be provided using the requirements of the AWWA D100 or AWWA D103. All tank design and foundation design shall be performed by a registered professional engineer and the plans or contractor-furnished information shall so designate the registered engineer providing the design. Materials other than steel may be used for water storage tanks.

(i) Sizing. Storage facilities shall have the capacity to meet domestic demands, and where required, fire protection storage.

(A) Water systems serving less than 50,000 gallons (189 m^3) on the design average daily demand shall provide clearwell and system storage capacity equal to the average daily demand.

(B) Water systems serving from 50,000 to 500,000 gallons (189-1,892 m^3) on the design average daily demand shall provide clearwell and system storage capacity equal to the average daily demand plus fire storage, based on recommendations established by the State Fire Marshall or local fire agency.

(C) Water systems serving in excess of 500,000 gallons (1.892 m^3) on the design average daily demand shall provide clearwell and system storage capacity equal to 25 percent of the design maximum daily demand, plus added fire storage based on recommendations established by the State Fire Marshall or local fire agency.

(D) Storage need not be provided in a well supply system where a minimum of two wells are provided and the maximum hour demand or fire demand, whichever is greater, can be supplied with the largest well out of service.

(ii) Location of ground level reservoirs.

(A) The bottom of reservoirs and standpipes shall be above or protected from the 100year flood or highest flood of record, whichever is greater.

(B) When the bottom is below normal ground surface, it shall be placed above the groundwater table. Sewers, drains, standing water, and similar sources of possible contamination must be kept at least 50 feet (15.2 m) from the reservoir. Watermain pipe, pressure tested in place to 50 psi (345 kPa) without leakage, may be used for gravity sewers at distances greater than 20 feet (6.1 m) and less than 50 feet (15.2 m).

(C) The top of the reservoir walls shall not be less than 18 inches (0.46 m) above normal ground surface. Clearwells constructed under filters are exempted from this requirement when the total design gives the same protection.

(iii) Protection. All finished water storage structures shall have suitable watertight roofs which exclude birds, animals, insects, and excessive dust.

(iv) Protection from trespassers. Security-type fencing, locks on access manholes, and other precautions shall be provided to prevent trespassing, vandalism, and sabotage at above ground storage facilities. Below ground level storage facilities may be exempt from the fencing requirements.

(v) Drains. No drain on a water storage structure may have a direct connection to a sewer or storm drain. Water storage structures drained to sewer or storm drains shall be drained through piping which allows an air gap such that the drain pipe is at least three pipe diameters above the ground level at the drain point to the sanitary or storm drain.

(vi) Overflow. All water storage structures shall be provided with an overflow which is brought down to an elevation between 12 and 24 inches (0.3-0.61 m) above the ground surface, and discharges over a drainage inlet structure or a splash plate. No overflow may be connected directly to a sewer or a storm drain. All overflow pipes shall be located so that any discharge is visible.

(A) When an internal overflow pipe is used on elevated tanks, it shall be located in the access tube. For vertical drops on other types of storage facilities, the overflow pipe shall be located on the outside of the structure.

(B) The overflow of a ground level structure shall open downward and be screened with noncorrodible screen installed within the pipe at a location least susceptible to damage by vandalism.

(C) The overflow pipe shall be of sufficient diameter to permit wasting of water in excess of the filling rate.

(vii) Access. Finished water storage structures shall be designed with access to the interior for cleaning and maintenance. Manholes above the waterline shall be framed at least 4 inches (0.1 m) above the surface of the roof at the opening; on ground level structures, manholes should be elevated a minimum of 24 inches (0.61 m) above the top. The manholes shall be fitted with a solid watertight cover which overlaps the framed opening and extends down around the frame at least 2 inches (5 cm). The cover shall be hinged at 1 side and shall have a locking device. The man-hold shall have a minimum inside opening diameter of 24 inches.

(viii) Vents. Finished water storage structures shall be vented. Overflows shall not be considered as vents. Open construction between the sidewall and roof is not permissible. Vents shall prevent the entrance of surface water and rainwater, and shall exclude birds and animals.

(A) For elevated tanks and standpipes, 24 mesh noncorrodible screen may be used.

(B) For ground level structures, the vents shall terminate in an inverted U construction with the opening a minimum of 24 inches (0.61 m) above the roof and covered with 24 mesh noncorrodible screen installed within the pipe at a location least susceptible to vandalism.

(ix) Roof and sidewall. The roof and sidewalls of all structures shall be watertight with no openings except properly constructed vents, manholes, overflows, risers, drains, pump mountings, control ports, or piping for inflow and outflow.

(x) Painting and/or cathodic protection. Protection shall be given to metal surfaces by paints or other protective coatings, by cathodic protective devices, or by both. Materials and procedures shall conform to AWWA Standard D102. Paint systems, after proper curing, shall not transfer any substance to the water which will be toxic or cause tastes or odors. Paints containing lead or mercury shall not be used. All paints and other protective coatings shall be compatible.

(xi) Disinfection. Finished water storage structures shall be specified to be disinfected in accordance with AWWA Standard D105. Sampling shall be specified.

(b) Plant storage.

(i) Washwater tanks. Washwater tanks shall be sized, in conjunction with available pump units and finished water storage, to provide the backwash water required by Section 10 (i). The storage and pumping shall be sized so that a minimum of two filters may be backwashed in rapid succession.

(ii) Clearwell. Clearwell storage shall be sized, in conjunction with distribution system storage, to relieve the filters from having to follow fluctuations in water use. Where water is pumped from clearwater storage to the system, an overflow shall be provided.

(iii) Adjacent compartments. Finished water must be separated from unfinished water in adjacent compartments by double walls.

(iv) Basins and wetwells. Receiving basins and pump wetwells for finished water shall be designed as finished water storage structures.

(c) Hydropneumatic tanks. Hydropneumatic (pressure) tanks may be used as the only storage facility when the system serves less than 50 homes. When servicing more than 50 homes, ground or elevated storage designed in accordance with Section 13(a) should be provided. Pressure tank storage is not to be considered for fire protection purposes. Pressure tanks shall meet ASME code requirements or local laws and regulations for the construction and installation of unfired pressure vessels.

(i) Location. The tank shall be located above normal ground surface and be completely housed.

(ii) Sizing. The capacity of the wells and pumps in a hydropneumatic system shall be at least 10 times the average daily consumption rate. The gross volume of the hydropneumatic tank, in gallons, shall be at least 10 times the capacity of the largest pump, rated in gallons per minute. For example, a 250 gpm (1,364 m^3/d) pump should have a 2,500 gallon (9.46 m^3) pressure tank.

(iii) Piping. The tank shall be plumbed with bypass piping.

(iv) Appurtenances. Each tank shall have an access manhole, a drain, and control equipment consisting of pressure gauge, water tight glass, automatic or manual air blowoff, means for adding air, and pressure operated startstop controls for the pumps.

Section 14. **Distribution Systems.**

(a) Materials.

(i) Types of commercial pipe approved for water systems include:

(A) PVC water pipe: ASTM D2241, less than 4" diameter (10 cm); AWWA C900: 4" (10 cm) and larger diameter.

(B) Asbestos cement pressure pipe: AWWA C400.

(C) Ductile iron pipe: AWWA C151.

(D) Glass fiber - reinforced thermosetting - resin pressure pipe: AWWA C950.

(E) Polyethelyene: AWWA C901.

(F) Polybutelyene: AWWA C902.

(ii) Used materials. Watermains and valves which have been used previously for conveying potable water may be reused provided they are in good working order and can meet these standards. No other used materials may be employed.

(iii) Joints. Packing and jointing materials used in the joints of pipe shall be flexible and durable. Flanged piping shall not be used for buried service except for connections to valves; push-on or mechanical joints shall be used.

(iv) Service connections. Service connections shall mean and include any water line or pipe connected to a distribution supply main or pipe for the purpose of conveying water to a building or dwelling. All service connections shall be constructed in conformance with the Uniform Plumbing Code.

(b) Watermain design.

(i) Pressure. All watermains, including those not designed to provide fire protection, shall be sized after a hydraulic analysis based on flow demands and pressure requirements. The system shall be designed to maintain a minimum pressure of 20 psi (138 kPa) at ground level at all points in the distribution system under all conditions of flow. The normal working pressure in the distribution system shall be not less than 35 psi (276 kPa).

(ii) Diameter. The minimum size of a watermain for providing fire protection and serving fire hydrants shall be 6 inches (0.15 m) diameter when service is provided from 2 directions, or where the maximum length of 6 inches pipe serving the hydrant from 1 direction does not exceed 250 feet, or 8 inches (0.2 m) where service is provided from 1 direction only. Larger size mains shall be provided as necessary to allow the withdrawal of the required fire flow while maintaining the minimum residual pressure of 20 psi (138 kPa).

(iii) Fire protection. When fire protection is to be provided, system design shall be such that fire flows can be served.

(iv) Small mains. Any main smaller than 6 inches (0.15 m) shall be justified by hydraulic analysis and future water use.

(v) Hydrants. Only watermains designed to carry fire flows shall have fire hydrants connected to them.

(vi) Deadends. Deadends shall be minimized by looping.

(vii) Flushing. Where deadend mains occur they shall be provided with a flushing hydrant or blowoff for flushing purposes. Flushing devices shall be sized to provide flows which will give a velocity of 2.5 feet per second minimum in the watermain being flushed. No flushing device shall be directly connected to any sewer.

(c) Valves. Valves shall be provided on watermains so that inconvenience and sanitary hazards will be minimized during repairs. Valves shall be located at not more than 500 foot (152 m) intervals in commercial districts and at not more than 1 block or 800 foot (244 m) intervals in other districts.

(d) Hydrants.

(i) Hydrant leads. The hydrant lead shall be a minimum of 6 inches (0.15 m) in diameter. Valves shall be installed in all hydrant leads.

(ii) Protection from freezing. Provisions shall be made to protect fire hydrant leads and barrels from freezing. The use of hydrant weep holes is not allowed when groundwater levels are above the gravel drain area. In these cases it will be necessary to pump the hydrant dry or use other means of dewatering.

(iii) Drainage. Hydrant drains shall not be connected to or located within 10 feet (3.05 m) of sanitary sewers or storm drains.

(e) Air relief valves; Valve, meter and blowoff chambers.

(i) Air relief valves. In all transmission lines and in distribution lines 16 inches and larger at high points (where the water pipe crown elevation falls below the pipe invert elevation), provisions shall be made for air relief. Fire hydrants or active service taps may be substituted for air relief valves on 6- and 8-inch lines. Manholes or chambers for automatic air relief valves shall be designed to prevent submerging the valve with groundwater or surface water.

(ii) Chamber drainage. Chambers, pits or man-holes containing valves, blowoffs, meters, or other such appurtenances to a distribution system, shall not be connected directly to any storm drain or sanitary sewer, nor shall blowoffs or air relief valves be connected directly to any sewer. Such chambers or pits shall be drained to the surface of the ground where they are not subject to flooding by surface water or to absorption pits underground. Where drainage cannot be provided, a sump for a permanent or portable pump shall be provided.

(f) Excavation, bedding, installation, backfill.

(i) Excavation. The trench bottom shall be excavated for the pipe bell. All rock shall be removed within 6 inches (15.2 cm) of the pipe. The trench shall be dewatered for all work.

(ii) Bedding. Bedding shall be designed in accordance with ASTM C12 - types A, B, C - for rigid pipe and ASTM D2321 - types I, II, III - for flexible pipe.

(iii) Installation. The pipe shall be joined to assure a watertight fitting. Ductile iron pipe shall be installed in accordance with AWWA 600 and PVC piping shall be installed in accordance with AWWA manual M23.

(iv) Backfill. Backfill shall be performed without disturbing pipe alignment. Backfill shall not contain debris, frozen material, unstable material, or large clods. Stones greater than 3 inches (7.6 cm) in diameter shall not be placed within 2 feet (0.6 m) of pipe. Compaction shall be to a density equal to or greater than the surrounding soil.

(v) Cover. All watermains shall be located to protect them from freezing and frost heave.

(vi) Blocking. All tees, bends, plugs, and hydrants shall be provided with reaction blocking, tie rods, or joints designed to prevent movement.

(vii) Pressure and leakage testing. All types of installed pipe shall be specified to be pressure tested and leakage tested in accordance with AWWA Standard C600.

(viii) Disinfection. All new, cleaned, repaired, or reused watermains shall be specified to be disinfected in accordance with AWWA Standard C601. Specifications shall include detailed procedures for the adequate flushing, disinfection, and microbiological testing of all watermains.

(g) Separation of watermains, sanitary sewers and storm sewers.

(i) Horizontal and vertical separation from sewer lines. Minimum horizontal separation shall be 10 feet (3 m) where the invert of the watermain is less than 1.5 feet (0.46 m) above the crown of the sewer line. Minimum vertical separation shall be 1.5 feet (0.46 m) at crossings. Joints in sewers at crossings shall be located at least 10 feet (3 m) from water mains. The upper line of a crossing shall be specially supported. Where vertical and/or horizontal clearances cannot be maintained, the sewer or water line shall be placed in a separate conduit pipe.

(ii) Sewer manholes. No water pipe shall pass through or come in contact with any part of a sewer manhole.

(h) Surface water crossings.

(i) Above water crossings. The pipe shall be adequately supported and anchored, protected from damage and freezing, and accessible for repair or replacement.

(ii) Underwater crossings. A minimum cover of 2 feet (0.61 m) shall be provided over the pipe. When crossing water courses which are greater than 15 feet (4.6 m) in width, the following shall be provided:

(A) The pipe shall be of special construction, having flexible watertight joints.

(B) Valves shall be provided at both ends of water crossings so that the section can be isolated for testing or repair; the valves shall be easily accessible and not subject to flooding; and the valve closest to the supply source shall be located in a manhole.

(i) Cross-connections.

(i) Cross-connections. There shall be no water service connection installed or maintained between a public water supply and any water user whereby unsafe water or contamination may backflow into the public water supply.

(A) Applicability. In order to protect all public water supplies from the possibility of the introduction of contamination due to cross connections, the water supplier shall require backflow prevention devices for each water service connection in accordance with Table 1 which appears at the end of this section, with the exception of (B)(I) residential water service connections and (B)(II) domestic non-residential water service connections. The water supplier shall take appropriate actions which may include immediate disconnection for any water user that fails to maintain a properly installed backflow prevention device or comply with other measures as identified in Section 14 (i) of these regulations.

(I) Any high hazard non-residential connection to any public water supply shall be protected by the appropriate backflow prevention device.

(II) Any service connection made to facilities constructed under a permit to construct issued after adoption of this regulation, Section 14 (i), shall be in full compliance with this section. This requirement applies to all service connections made or initially activated after the adoption of this regulation.

(III) Water suppliers shall establish record keeping and management procedures to ensure that requirements of this regulation for installation and maintenance of backflow prevention devices are being met.

(B) The method of backflow control, selected from Table 1, shall be determined based upon the degree of hazard of the cross connection and the cause of the potential backflow. Hazards shall be classified as high hazard or low hazard. The potential cause of the backflow shall be identified as being back-siphonage or back-pressure.

(I) Residential water service connections shall be considered to be low hazard back-siphonage connections, unless determined otherwise by a hazard classification.

(II) Domestic non-residential water service connections shall be considered to be low hazard back-pressure connections, unless determined otherwise by a hazard classification conducted by the water supplier. Examples include schools without laboratories, churches, office buildings, warehouses, motels, etc.

(III) Any water user's system with an auxiliary source of supply shall be considered to be a high hazard, back pressure cross connection. A reduced pressure principle backflow device shall be installed at the water service connection to any water user's system with an auxiliary source of supply.

(IV) All water loading stations shall be considered high hazard connections. A device, assembly, or method consistent with Table 1 shall be provided.

(V) Non-domestic commercial or industrial water service connections shall be considered to be high hazard back pressure connections, unless determined otherwise by a hazard classification. Examples include restaurants, refineries, chemical mixing facilities, sewage treatment plants, mortuaries, laboratories, laundries, dry cleaners, irrigation systems, facilities producing or utilizing hazardous substances, etc. For some of these service connections, a hazard classification may result in a determination of a back-siphonage or low hazard classification. The backflow prevention device required shall be appropriate to the hazard classification. Where potential high hazards exist within the non-residential water user's system, even though such high hazards may be isolated at the point of use, an approved backflow prevention device shall be installed and maintained at the water service connection.

(C) Determination of the hazard classification of a water service connection is the responsibility of the water supplier. The water supplier may require the water user to furnish a hazard classification survey to be used to determine the hazard classification.

(D) Hazard classifications shall be conducted by hazard classification surveyors that are certified by the USC-Foundation for Cross-Connection Control and Hydraulic Research, the American Association of Sanitary Engineers (ASSE), or by another state certification program approved by the administrator, or by a water distribution system operator also certified as a backflow device tester employed by the public water supplier for the service where the survey is being conducted.

(E) All backflow prevention devices must be in-line serviceable (repairable), in-line testable except for devices meeting ASSE Standard #1024, and installed in accordance with manufacturer instructions and applicable plumbing codes.

(F) All backflow prevention devices must have a certification by an approved third party certification agency. Approved certification agencies are:

(I) American Society of Sanitary Engineers (ASSE),

(II) International Association of Plumbing/Mechanical officials (IAPMO), and

(III) Foundation for Cross-Connection Control and Hydraulic Research, University Of Southern California (USC_FCCCHR).

(G) Backflow prevention devices at water service connections shall be inspected and certified by a certified backflow assembly tester at the time of installation. Certification of the assembly tester shall be by one of the following:

(I) The American Society Sanitary Engineers (ASSE),

(II) American Backflow Prevention Association (ABPA),

(III) A state certification program approved by the administrator.

(H) Backflow prevention devices installed at high hazard non-residential cross connections shall be inspected and tested on an annual basis by a certified backflow assembly tester.

(I) The administrator may conduct inspections of backflow prevention devices. If any device is found to be defective or functioning improperly, it must be immediately repaired or replaced. Failure to make necessary repairs to a backflow prevention device will be cause for the water service connection to be terminated.

(J) All public water suppliers shall report any high hazard backflow incident within seven (7) days to the Wyoming Department of Environmental Quality, Water Quality Division. The backflow incident shall be reported on a form provided by the administrator.

(ii) Recycling water. Neither steam condensate nor cooling water from engine jackets or other heat exchange devices shall be returned to the public water supply after it has passed through the water service connection.

TABLE 1
Backflow Prevention Devices, Assemblies and Methods

	Degree of Hazard				
Device, Assembly or Method	Low Hazard		High Hazard		Notes
	Back-Siphonage	Back-Pressure	Back-Siphonage	Back-Pressure	
Airgap	X		X		See Note 1
Atmospheric Vacuum Breaker	X		X		Not allowed under continuous pressure situations

Spill-proof Pressure-type Vacuum Breaker	X		X		
Double Check Valve Backflow Preventer	X	X			
Pressure Vacuum Breaker	X		X		
Reduced Pressure Principle Backflow Preventer	X	X	X	X	See Note 2
Dual Check	X				Restricted to residential services

Note 1 Minimum Airgap for Water Distribution. For spouts with an effective opening diameter of one-half inch or less, the minimum airgap when the discharge is not affected by side walls shall be one inch. The minimum airgap when the discharge is affected by sidewalls shall be one and one-half inches. For effective openings greater than one-half inch, the minimum airgap shall be two times the effective opening diameter when the discharge is not affected by side walls. The minimum airgap when the discharge is affected by sidewalls shall be three times the effective opening diameter.

Note 2 Extreme Hazards. In the case of any water user's system where, in the opinion of the water supplier or the administrator, an undue health threat is posed because of the presence of extremely toxic substances or potential back pressures in excess of the design working pressure of the device, the water supplier may require an air gap at the water service connection to protect the public water system.

Section 15. **Laboratory Requirements**.

(a) Test procedures. Test procedures for analysis of monitoring samples shall conform to the 15th Edition of *Standard Methods for the Examination of Water and Wastewater*.

(b) Testing requirements. All treatment plants shall have the capability to perform or contract for the self-monitoring analytical work required by the Safe Drinking Water Act and/or state regulation. All plants shall, in addition, be capable of performing or contracting the analytical work required to assure good management and control of plant operation and performance.

(c) Minimum requirements.

(i) Location and space. The laboratory shall be located away from vibrating machinery or equipment which might have adverse effects on the performance of laboratory instruments or the analyst and shall be designed to prevent adverse effects from vibration.

Where a full-time chemist is proposed to work in the laboratory, a minimum of 400 square feet (37.2 m^2) of floor space shall be provided in the laboratory. If more than two persons will be working in the laboratory, 100 square feet (9.3 m^2) of additional space shall be provided for each additional person.

(ii) Materials. Walls shall have an easily cleaned, durable and impervious surface. Two exit doors or openings shall be located to permit a straight exit from the laboratory; one exit shall be directly to the outside of the building. Panic hardware shall be used. Interior doors shall have glass windows.

(iii) Cabinets and benchtops. Cabinet and storage space shall be provided for dust-free storage of instruments and glassware.

Bench top height shall be 30 inches (0.91 m). Tops should be field joined into a continuous surface with acid, alkali, and solvent resistant cements.

(iv) Hoods. Fume hoods shall be provided where reflux or heating of toxic or hazardous materials is required. A hood shall not be situated near a doorway, unless a secondary means of exit is provided. All switches, electrical outlets, and utility and baffle adjustment handles shall be located outside the hood. Light fixtures shall be explosion-proof. Twenty-four hour continuous exhaust capability shall be provided. Exhaust fans shall be explosion-proof.

(v) Sinks. The laboratory shall have a minimum of 2 sinks per 400 ft^2 (37.2 m^2) (not including cup sinks). Sinks shall be double well with drainboards and shall be made of epoxy resin or plastic. All water fixtures shall be provided with reduced pressure zone backflow preventers. Traps constructed of glass, plastic, or lead and accessible for cleaning shall be provided.

(vi) Ventilation and lighting. Laboratories shall be separately heated and cooled, with external air supply for 100 percent makeup volume. Separate exhaust ventilation shall be provided. Ventilation outlet locations shall be remote from ventilation inlets.

Lighting shall provide 100 foot candles at the bench top.

(vii) Gas. If gas is required in the laboratory, natural gas shall be supplied.

(viii) Water still. Distilled water shall conform to the quality specified by *Standard Methods for the Examination of Water and Wastewater*, 15th Edition.

(ix) Emergency shower and eye wash. All laboratories shall be equipped with an emergency eye wash and shower that is located within the laboratory.

(d) Portable testing equipment. Portable testing equipment shall be provided where necessary for operational control testing.

Section 16. **Operation and Maintenance Manuals.**

(a) Where required. Plant operation and maintenance manuals are required for each new or modified treatment or pumping facility. The manuals shall provide the following information as a minimum:

(i) Introduction.

(ii) Description of facilities and unit processes within the plant from influent structures through effluent structures.

(iii) Plant control system.

(iv) Utilities and systems.

(v) Emergency operation and response.

(vi) Permit requirements and other regulatory requirements.

(vii) Staffing needs.

(viii) Index to manufacturer's manuals.

(b) When required. Acceptance of the final operation and maintenance manuals is required prior to plant startup.

(c) Description of facilities. The description of facilities and unit processes shall include the size, capacity, model number (where applicable) and intended loading rate.

(i) Each unit. The manual shall describe each unit, including the function, the controls, the lubrication and maintenance schedule. The manual shall also include start-up operations; routine operations; abnormal operations; emergency or power outage operations; bypass procedures; and safety.

(ii) Flow diagrams. The manual shall provide flow diagrams of the entire process, as well as individual unit processes. The flow diagrams shall show the flow options under the various operational conditions listed above.

(d) Operating parameters. The O & M manual shall provide the design criteria for each unit process. The data shall include the number, type, capacity, sizes, etc., and other information, as applicable.

(e) Troubleshooting guide. Each equipment maintenance manual shall include a section on troubleshooting. These manuals are to be indexed in the plant O & M manual. The troubleshooting guide shall include typical operation problems and solutions. The guide shall include a telephone number for factory troubleshooting assistance.

(f) Emergency procedures. The plant O & M manual shall detail emergency operations procedures for possible foreseeable emergencies, including power outage, equipment failure, development of unsafe conditions, and other emergency conditions. The details shall include valve positions, flow control settings, and other information to ensure continued operation of the facility at maximum possible efficiency.

The manual shall also detail emergency notification procedures to be followed to protect health and safety under various emergency conditions.

(g) Safety. The manual shall provide general information on safety in and around the plant and its components. Each unit process discussion shall include applicable safety procedures and precautions. For unit processes or operations having extreme hazards (such as chlorine, closed tanks, etc.), the discussion shall detail appropriate protection, rescue procedures, and necessary safety equipment.

(h) Maintenance manuals. Maintenance manuals shall be required for each piece of equipment. These manuals must meet the requirements of the engineer and contractor for installation and startup of equipment. The information included in the manufacturer's manuals shall not be included in the O & M manual.

The manual shall have a neatly typewritten table of contents for each volume arranged in a systematic order. The general contents shall include product data; drawings; written text as required to supplement product data for the particular installation; and a copy of each warranty, bond and service contract issued.

The manuals for equipment and systems shall include a description of unit and component parts; operating procedures; maintenance procedures and schedules; service and lubrication schedule; sequence of control operation; a parts list; and a recommended spare parts list.