TITLE 64
LEGISLATIVE RULE
BUREAU FOR PUBLIC HEALTH
DEPARTMENT OF HEALTH AND HUMAN RESOURCES

SERIES 77
PUBLIC WATER SYSTEMS DESIGN STANDARDS

§64-77-1. General.

1.1. Scope. -- The State of West Virginia provides for the regulation of public water supplies to promote and protect the public health by having the public served safe and potable water. The West Virginia Department of Health and Human Resources, Bureau for Public Health is empowered to adopt rules to implement the intent of the law.

1.1.a. This rule has been prepared to assist professional engineers responsible for the design and construction of public water supply systems. The design of these facilities shall not be limited by minimum requirements, but shall meet the needs of the particular situation. Nothing in this rule shall be construed as preventing the consulting engineer from recommending, or the West Virginia Department of Health and Human Resources (DHHR), Bureau for Public Health, from approving, more effective treatment where local conditions dictate such action.

1.1.b. The West Virginia DHHR, Bureau for Public Health (hereinafter BPH), requires that the applicant or the applicant's engineer submit reliable engineering data and a report if new or innovative technology is proposed. The BPH may permit an experimental installation. The BPH shall require the experimental installation to be replaced by a conventional installation, if the experimental installation fails to produce satisfactory results, as determined by the BPH.

The Recommended Standards for Water Works, 2007 Edition of the Great Lakes - Upper Mississippi River Boards of State Sanitary Engineers were used as a guide for this rule.

1.2. Authority. -- W. Va. Code §§16-1-4, 16-1-9, and 16-1-9a.

1.3. Filing Date. -- May 2, 2012.

1.4. Effective Date. -- May 2, 2012.

§64-77-2. Definitions.

2.1. AIA. -- American Insurance Association, 1130 Connecticut Ave. N.W., Ste. 1000, Washington, DC 20036, (202) 828-7100.

2.2. ANSI. -- American National Standard Institute, 11 W. 42nd St. 13th Floor, New York, NY 10036, (212) 642-4900.

2.3. API. -- American Petroleum Institute, 1220 L. St. N.W., Washington, D.C. 20005, (202) 682-8000.

2.4. ASTM. -- American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103-11878, (215) 299-5400.

2.5. AWWA. -- American Water Works Association, 6666 West Quincy Ave., Denver, CO 80235, (303) 794-7711.

2.6. BPH. -- Bureau for Public Health in the WV Department of Health and Human Resources.

2.7. Chlorine Institute, Inc. -- a trade association of companies that are involved in the safe production, distribution and use of chlorine products. Their address is 2001 L Street, N.W., Suite 506, Washington, D.C. 20036.

2.8. Community Water System. -- A public water system that pipes water for human consumption to at least 15 service connections used by year-round residents, or one that regularly serves at least 25 year-round residents (e.g., municipality, subdivision, manufactured home community).

2.9. CT. -- C, residual disinfectant (mg/l) x T, contact time (min).

2.10. ISO. -- Insurance Service Office, 7 World Trade Center New York, NY 10048, (212) 898-6000.

2.11. MF. -- Membrane filter.

2.12. MPN. -- Most probable number.

2.13. NEC. -- National Electric Code, Quincy, MA 02269.

2.14. NGWA. -- National Ground Water Association, 601 Dempsey Road, Westerville, OH 43081-9895, (800) 551-7379.

2.15. NIOSH. -- National Institute for Occupational Safety and Health, Appalachian Laboratory for Occupational Safety and Health, 944 Chestnut Ridge Road, Morgantown, WV 26505, (304) 291-4126.

2.16. Non-Community Non Transient Water System. -- A public water system that serves at least 25 of the same persons over six months per year (e.g., schools, factories, industrial parks, office buildings).

2.17. NSF. -- National Sanitary Foundation, 3475 Plymouth Rd., P.O. Box 130140, Ann Arbor, MI 48113-0140, (313) 922-6222.

2.18. NTU. -- Nephelometric turbidity units.

2.19. NWSC. -- National Water Systems Council, 600 S. Federal St., Ste. 400. Chicago, IL 60605, (312) 922-6222.

2.20. PVC. -- Polyvinyl chloride.

2.21. Standard Methods for the Examination of Water and Wastewater. -- A joint publication of the American Public Health Association, the AWWA and the Water Pollution Control Association.

2.22. Transient Water System. -- A public water system that serves at least 25 people (not the same people) at least 60 days a year (e.g., highway rest stops, motels, restaurants, parks).

2.23. WSC. -- Water Systems Council, 600 S. Federal St., Ste. 400, Chicago, IL 60605, (312) 922-6222.

2.24. WVDEP. -- West Virginia Department of Environmental Protection, 601 57th Street SE, Charleston, WV 25304, (304) 926-0499.

§64-77-3. Submission of Plans.

3.1. General. -- The applicant or the applicant's engineer shall submit all reports, final plans and specifications, in the time frame noted in the Bureau for Public Health rule, Public Water System, 64CFR3, prior to the date on which action by the BPH is desired. For public water system wells, if emergency conditions prohibit meeting the permit application requirements, the applicant, the applicant's engineer, or the West Virginia Certified Water Well Driller that drilled the well shall notify the BPH by facsimile, email or telephone within five (5) calendar days after the emergency well is drilled. Emergency conditions exist when public water systems experience source water outages, low source water quantity due to drought or source water failure to produce enough water for daily demands, or existing source water sudden contamination by a regulated contaminant in which the maximum contaminant level is exceeded. For emergency wells, the applicant or the applicant's engineer shall submit the permit application within thirty (30) calendar days after the well is drilled. Emergency wells shall meet all of the requirements of this rule and shall be drilled by a West Virginia Certified Water Well Driller. Permits for construction, for waste discharges, for stream crossings, etc., may be required from other federal, state or local agencies. Preliminary plans and the engineer's report shall be submitted for review prior to the preparation of final plans. The BPH shall issue a permit to construct only after review and approval of submitted final, complete detailed applications, plans and specifications.

3.1.a. The applicant shall submit four (4) complete sets of documents for a formal review by the BPH. The documents shall include but not be limited to: application forms; a summary of the basis of design; operation requirements, where applicable; general layout; detailed plans; and specifications.

3.1.b. All installation and operations shall meet or exceed the relevant requirements of the national, state, local or trades' good practices, regulations and codes, whichever has jurisdiction.

3.2. Engineer's Report. -- The engineer's report for public water systems improvements shall, where pertinent, present the following information:

3.2.a. General information, including a description of the existing public water systems and wastewater facilities; identification of the municipality or area served; and the name and mailing address of the owner or official custodian;

3.2.b. The extent of the public water system, including a description of the nature and extent of the area to be served; provisions for extending the public water system to include additional service areas; and an appraisal of the future requirements for service, including existing and potential industrial, commercial, institutional and other water supply needs;

3.2.c. List the alternate plans where two (2) or more solutions exist for providing public water supply facilities, each of which is feasible and practicable and give reasons for selecting the one (1) recommended, including financial considerations, operational considerations and a comparison of the minimum classifications of the public water system operators required for operation of each alternative facility;

3.2.d. Soil, groundwater conditions, and foundation problems, including a description of: the character of the soil through which water mains are to be laid; foundation conditions prevailing at sites of proposed structures and the approximate elevation of groundwater in relation to subsurface structures;

3.2.e. Water use data, including a description of the customer and population trends as indicated by available records, and the estimated population that will be served by the proposed water supply system or expanded system 20 years in the future in five year intervals or over the useful life of critical structures/equipment. Water use data shall also include present water consumption and the projected average and maximum daily demands, including fire flow demand; present and estimated yields of the sources of supply; unusual occurrences, and unaccounted for water;

3.2.f. Water distribution shall have average, minimum and maximum pressures with and without fire flow at the beginning of the system, at the ends of the system and intermediate points throughout the system. Include supporting data used as basis for design;

3.2.g. Flow requirements, including hydraulic analyses based on flow demands and pressure requirements; and fire flows, when fire protection is provided, which meet the recommendations of the ISO or other similar agency for the service area involved;

3.2.h. Describe the existing wastewater system with special reference to its relationship to existing or proposed public water system structures that may affect the location and operation of the public water system, or that may affect the quality of the supply;

3.2.i. Describe the proposed source or sources of water supply to be developed, the reasons for their selection, and provide the following information:

3.2.i.1. Surface water sources, including hydrological data, stream flow and weather records; safe yield, including all factors that may affect it; and maximum flood flow, together with approval for safety features of the spillway and dam from the appropriate reviewing authority. Include a description of the watershed, noting any existing or potential sources of contamination (such as highways, railroads, chemical facilities, etc.) that may affect water quality, and data on the quality of the raw water with special reference to fluctuations in quality, changing meteorological conditions, regulated contaminant levels, etc.;

3.2.i.2. Groundwater sources, including sites considered; advantages of the site selected; elevations with respect to surroundings; probable character of formations through which the source is to be developed, and geologic conditions affecting the site, such as anticipated interference between proposed and existing wells;

3.2.i.3. A summary of source exploration, test well depth and the method of construction; placement of liners or screen; test pumping rates and their duration; water levels and specific yield; and water quality;

3.2.i.4. Sources of possible contamination such as sewers and sewerage facilities, highways, railroads, landfills, outcroppings of consolidated water-bearing formations, chemical facilities, waste disposal wells, agriculture uses, etc.; and

3.2.i.5. A description and plat of the system's wellhead protection area and plan;

3.2.j. Summarize and establish the adequacy of proposed treatment processes and unit parameters for the treatment of the specific water under consideration. Alternative methods of water treatment and chemical use shall be considered as a means of reducing waste handling and disposal problems. Bench scale test, pilot studies, or demonstrations may be required to establish adequacy for some water quality standards;

3.2.k. Discuss the various aspects of waste disposal from the water treatment plant, including volume, proposed treatment and points of discharge. If discharging to a sanitary sewerage system, verify that the system, including any lift stations, is capable of handling the flow to the sewage treatment works and that the treatment works is capable and will accept the additional loading;

3.2.l. Provide supporting data justifying the use of automatic equipment, including the servicing and operator training to be provided. Manual override shall be provided for any automatic controls.

3.2.m. Give personnel information including the required number of plant operators and relief plant operators, distribution system maintenance personnel, meter readers, and clerical personnel needed to provide adequate coverage;

3.2.n. Project sites, including the discussion of the various sites considered and advantages of the recommended ones; the proximity of residences, industries, and other establishments, and any potential sources of pollution that may influence the quality of the supply or interfere with effective operation of the public water system, such as sewage absorption systems, septic tanks, privies, cesspools, sink holes, sanitary landfills, refuse and garbage dumps, etc.;

3.2.o. Financing, including estimated cost of integral parts of the system; detailed estimated annual cost of operation; and proposed methods to finance both capital charges and operating expenses; and

3.2.p. Summarize planning for future needs and services.

3.3. Plans. -- Plans for public water system improvements shall, where pertinent, provide the following:

3.3.a. A general layout which shall include: a suitable title; the name of the municipality, other entity or person responsible for the water system; the area or institution to be served; the scale; the north point; datums used; boundaries of the municipality or area to be served; date, name and address of the designing engineer; the imprint of the professional engineer's seal or the conformance with engineering registration requirements of West Virginia; 22" X 34" legible prints suitable for reproduction; the location and size of existing and proposed water mains; and the location and nature of existing public water system structures and appurtenances affecting the proposed improvements, noted on one sheet;

3.3.b. Detailed plans which shall include:

3.3.b.1. Stream crossings, providing profiles with elevations of the stream bed and the normal and extreme high and low water levels;

3.3.b.2. Profiles having a horizontal scale of not more than one hundred (100) feet to the inch and a vertical scale of not more than ten (10) feet to the inch, with both scales clearly indicated. Profiles are not required for water main construction; however, critical elevations (high points, low points, water tanks, booster stations, etc.) are required;

3.3.b.3. The location and size of the property to be used for the groundwater development with respect to known references such as roads, streams, section lines, or streets;

3.3.b.4. The topography and arrangement of present or planned wells or structures, with contour intervals not greater than two (2) feet;

3.3.b.5. Elevations of the one hundred (100) year flood level, the floor of the structure, upper terminal of protective casings and outside surrounding grade, using United States Coast and Geodetic Survey, United States Geological Survey or equivalent elevations where applicable as reference;

3.3.b.6. Plat and profile drawings of well construction, showing the estimated diameter and depth of drill holes, casing and liner diameters and depths, grouting depths, elevations and designation of geological formations, water levels and other details to describe the proposed well completely;

3.3.b.7. The location of all existing and potential sources of pollution that may affect the water source or underground treated water storage facilities;

3.3.b.8. The size, length and materials of proposed water mains. The location of existing or proposed streets, water sources, ponds, lakes, storm drains, sanitary sewers, house sewers, septic tanks, disposal fields and cesspools;

3.3.b.9. Schematic flow diagrams and hydraulic profiles showing the flow through various plant units;

3.3.b.10. Piping in sufficient detail to show flow through the plant, including waste lines;

3.3.b.11. The locations of all chemical storage areas, feeding equipment and points of chemical application;

3.3.b.l2. All appurtenances, specific structures, equipment, water treatment plant waste disposal units and points of discharge having any relationship to the plans for water mains and public water system structures;

3.3.b.13. The locations of sanitary or other facilities, such as lavatories, showers, toilets and lockers, when applicable or required by the BPH;

3.3.b.14. The locations, dimensions, and elevations of all proposed plant facilities;

3.3.b.15. The locations of all sampling taps; and

3.3.b.16. An adequate description of any features not otherwise covered by the specifications;

3.3.c. Plan sheet sizes are to be a minimum twenty-two inches by thirty-four inches (22” X 34”). The base mapping for water line construction shall accurately reflect the current surface features along the proposed water line routing; and

3.3.d. Aerial photo-enlargement plans which may be used for water line construction provided the enlargement is done utilizing electronic media (for archival purposes).

3.4. Specifications. -- The applicant or the applicant’s engineer shall supply complete, detailed technical specifications for the proposed project, including: pipe, valves and other building materials; a program for keeping existing public water system facilities in operation during construction of additional facilities so as to minimize interruption of service; laboratory facilities and equipment; the number and design of chemical feeding equipment; and materials or proprietary equipment for sanitary or other facilities including any necessary backflow or backsiphonage protection.

3.5. Design Criteria. -- The applicant or the applicant’s engineer shall submit a summary of the complete design criteria for the proposed project, containing but not limited to the following: the long-term dependable yield of the source of supply; the reservoir surface area, volume and a volume-versus-depth curve, if applicable. The summary shall include the area of watershed, if applicable; the estimated average and maximum day water demands for the design period; number of proposed services; fire-fighting requirements; flash mix, flocculation and settling basin capacities; retention times; unit loadings; the filter area, proposed filtration rate, and filter media; the backwash rate; feeder capacities and ranges, and disinfection facilities and CT calculations, where applicable. The summary shall include special facilities such as aerators, corrosion control, softeners, fluoridation, iron and manganese removal, taste and odor control. Summary shall include design calculations, including head loss, distribution system analysis and pressures at all high and low points under all flow conditions (normal flow, maximum design flow and normal flow with fire flow).

3.6. Revisions to Approved Plans. -- The applicant or the applicant's engineer shall obtain approval from the BPH before deviating from approved plans or specifications. Revised plans or specifications shall be submitted in time to permit the review and approval of the plans or specifications before any construction work, which will be affected by the changes, is begun.

3.7. Additional Information Required. -- The BPH may require additional information from the applicant that is not part of the construction drawings, such as proprietary technical data, copies of deeds, copies of contracts, etc.

§64-77-4. General Design Considerations.

4.1. General. -- The design of a public water system or treatment process encompasses a broad area and thus, is dependent upon the type of system or process involved.

4.2. Design Basis. -- The system including the water source, treatment facilities, operation and distribution system shall be designed for maximum day demand at the design year.

4.3. Plant Layout. -- The public water systems' engineer of the plant shall consider: functional aspects of the plant layout, including provisions for future plant expansion; provisions for expansion of the plant waste treatment and disposal facilities, including filter backwash effluent; access roads; site grading; site drainage; walks; driveways; and chemical delivery and storage.

4.4. Building Layout. -- The designer of the building shall provide for: adequate ventilation, lighting, heating and drainage; dehumidification equipment, if necessary; accessibility of equipment for operation, servicing, and removal; flexibility of operation; operator safety; and convenience of operation. The design of the building shall also provide for chemical storage and feed equipment in a separate room to reduce hazards and dust problems.

4.5. Location of Structures. -- The applicant or the applicant's engineer shall consult the West Virginia Department of Environmental Protection (WVDEP) regarding any structure that is located in such a way that normal or flood stream flows may be impeded. Where practical, all structures shall be located above the one hundred (100) year flood elevation or have adequate protection against one hundred year floods. The U.S. Army Corps of Engineers may require permits.

4.6. Electrical Controls. -- Main switch gear electrical controls shall be located above grade, in areas not subject to flooding.

4.7. Standby Power. -- Standby power may be required by the BPH so that water may be treated or pumped, or both, to the distribution system during power outages to meet the average day demand.

4.8. Shop Space and Storage. -- Adequate facilities shall be included for shop space and storage consistent with the designed facilities.

4.9. Laboratory Facilities. -- Each public water system shall have its own equipment and facilities for routine laboratory testing to ensure proper operation. Laboratory equipment selection shall be based on the characteristics of the raw water source and the complexity of the treatment process involved. Laboratory test kits that simplify procedures for making one or more tests may be acceptable. Necessary laboratory tests shall be performed by an operator or chemist qualified to perform the tests. Analyses conducted to determine compliance with drinking water regulations shall be performed in a laboratory certified by the United States Environmental Protection Agency or the West Virginia Office of Laboratory Services and shall be performed in accordance with Standard Methods for the Examination of Water and Wastewater or alternative methods approved by the BPH. Persons designing and equipping laboratory facilities shall confer with the BPH before beginning the preparation of plans or the purchase of equipment. Methods for verifying adequate quality assurances and for routine calibration of equipment shall be provided.

4.9.a. Laboratory testing equipment. -- At a minimum, the following laboratory equipment shall be provided:

4.9.a.1. Surface water supplies shall have a nephelometric turbidimeter meeting the requirements of "Standard Methods for the Examination of Water and Wastewater";

4.9.a.2. Each surface water treatment plant utilizing flocculation and sedimentation, including those which lime softens, shall have a pH meter, jar test equipment and titration equipment for both hardness and alkalinity;

4.9.a.3. Each community and non-community, non-transient public water system ion-exchange softening plant, and lime softening plant treating only groundwater shall have a pH meter and titration equipment for both hardness and alkalinity;

4.9.a.4. Each green sand filter using potassium permanganate iron removal plant shall have test equipment capable of accurately measuring iron to a minimum of 0.1 milligrams per liter. Each green sand filter using potassium permanganate manganese removal plant shall have test equipment capable of accurately measuring manganese to a minimum of 0.05 milligrams per liter;

4.9.a.5. Public water systems shall have test equipment for determining both free and total chlorine residual by the Standard Methods for the Examination of Water and Wastewater publication;

4.9.a.6. Public water systems that fluoridate shall have test equipment for determining fluoride by the "Standard Methods for the Examination of Water and Wastewater" publication; and

4.9.a.7. Public water systems that feed poly and/or orthophosphates shall have test equipment capable of accurately measuring phosphates from 0.1 to twenty (20) milligrams per liter.

4.9.b. Physical facilities. -- Sufficient bench space, adequate ventilation, adequate lighting, storage room, laboratory sink, and auxiliary facilities shall be provided. Air conditioning may be necessary.

4.10. Monitoring Equipment. -- Water treatment plants designed to serve three thousand three hundred (3,300) people or more shall be provided with continuous monitoring equipment (including recorders) to monitor water being discharged to the distribution system as follows:

4.10.a. Plants treating surface water and plants using lime for softening shall have the capability to monitor and record free chlorine residual and shall consider having the capacity to monitor and record turbidity; and

4.10.b. Plants treating ground water using iron removal or ion exchange softening shall have the capability to monitor and record free chlorine residual.

4.11. Sample Taps. -- Sample taps shall be provided so that water samples can be obtained from each raw water source and from appropriate locations in each process unit of the treatment system. 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 an interior or exterior aerator, or other type of appurtenance.

4.12. 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 or raw or partially treated water.

4.13. Wall Castings. -- Consideration shall be given to providing extra wall castings built into the structure to facilitate future uses whenever pipes pass through walls of concrete structures.

4.14. Meters. -- All community and non-community, non-transient public water systems water plants shall have a means of metering the raw, finished, washwater, any blended water of different quality and plant use water.

4.15. Piping Color Code. -- To facilitate identification of piping in plants and pumping stations it is recommended that the color scheme in Table 64-77A of this rule be used. In situations where two (2) colors do not have sufficient contrast to easily differentiate between them, a six inch (6") band of contrasting color shall be on one of the pipes at approximately thirty inch (30") intervals. The name of the liquid or gas shall also be on the pipe. In some cases it may be advantageous to provide arrows indicating the direction of flow.

4.16. Disinfection. -- All wells, pipes, tanks, and equipment that can convey or store potable water shall be disinfected in accordance with current AWWA procedures. Plans or specifications shall outline the procedure and include the disinfectant dosage, contact time, and method of testing the results of the procedure.

4.17. Operation and Maintenance Manual. -- An operation and maintenance manual including a parts list, parts order form, operator safety procedures and operational trouble-shooting section shall be supplied to the water works as part of any proprietary unit installed in the facility.

4.18. Operator Instruction. -- Provisions shall be made for operator instruction at the start-up of a plant or pumping station following the manufacturers' representatives trouble-shooting.

4.19. Paints, Coatings, Sealers and Liners. - Paints, coatings, sealers and liners that contact raw, partially treated or potable water and are used in pipes, tanks or equipment that can transport or store water shall have third party certification of compliance with ANSI\NSF Standard 61: Drinking Water System Components - Health Effects.

4.20. Safety. -- Consideration must be given to the safety of water plant personnel and visitors. The design must comply with all applicable safety codes and regulations that may include the Uniform Building Code, Uniform Fire Code, National Fire Protection Association Standards, International Building Code, International Plumbing Code, International Mechanical Code, International Fire Code and state and federal OSHA standards. Examples of some items to be considered include noise arresters, noise protection, confined space entry, protective equipment and clothing, gas masks, safety showers and eye washes, handrails and guards, warning signs, smoke detectors, toxic gas detectors and fire extinguishers.

4.21. Security. -- Appropriate measures to help ensure the security of water system facilities shall be incorporated. Such measures, at a minimum, shall include means to lock all exterior doorways, windows, gates and other entrances to source, treatment, booster stations, valve vaults, meter vaults and water storage facilities. Other measures may include fencing, signage, closed circuit monitoring, real-time water quality monitoring, and intrusion alarms. At a minimum, all finished water storage tanks are to be enclosed by a minimum six feet high chain link fence with a locking gate and the fence is to be located such that maintenance vehicles can maneuver between the tank and fencing.

4.22. Flood Protection. -- Other than surface water intakes, all public water system facilities and water treatment plant access roads shall be protected to at least the one hundred (100) year flood elevation.

4.23. Other Considerations. -- Consideration shall be given to the design requirements of other federal, state and local regulatory agencies for items such as safety requirements, special designs for the disabled, plumbing and electrical codes, construction in the flood plain, etc. Reviews of the design documents (plans and specifications) may be required by local building code officials, prior to construction.

§64-77-5. Source development.

5.1. General. -- In selecting the source of water to be developed, the public water system's engineer shall prove to the satisfaction of the BPH that an adequate quantity of water will be available, and that the water that is to be delivered to the consumers will meet the current requirements of the rule of the Bureau for Public Health, Public Water Systems, 64CSR3, with respect to microbiological, physical, chemical and radiological qualities. Each water system shall take its raw water from the best available source that is economically reasonable and technically possible.

5.2. Surface Water System. -- A surface water source includes all tributary streams and drainage basins, natural lakes, artificial reservoirs or impoundments above the point of water system intake and ground water under the direct influence of surface water. A source water protection plan shall be adopted by the public water system for the continued protection of the watershed from potential sources of contamination.

5.2.a. Quantity. -- The quantity of water at the source: shall be adequate to meet the maximum projected water demand of the service area as shown by calculations based on a one in fifty year drought or the extreme drought of record; shall provide a reasonable surplus for anticipated growth; shall be adequate to compensate for all losses such as silting, evaporation, seepage, etc.; shall be adequate to provide ample water for other legal users of the source; and shall provide minimum six (6) months storage based on average daily demand for all drainage basins, natural lakes and artificial reservoirs or impoundments.

5.2.b. Quality. -- A sanitary survey and study shall be made of the factors, both natural and man- made, that may affect the quality of the surface water. This survey and study shall include, but not be limited to: determining possible future uses of impoundments or reservoirs; determining the degree of control of watershed by the owner; assessing the degree of hazard to the supply by accidental spillage of materials that may be toxic, harmful or detrimental to treatment processes; obtaining samples over a sufficient period of time to assess the microbiological, physical, chemical and radiological characteristics of the water; assessing the capability of the proposed treatment process to reduce contaminants to applicable standards; and consideration of currents, wind and ice conditions, and the effect of confluent streams.

5.2.c. Minimum Treatment. -- The design of the water treatment plant shall consider the worst conditions that may exist during the life of the facility. The minimum treatment required shall be determined by the BPH. Filtration preceded by pretreatment approved by the BPH shall be provided for all surface waters.

5.2.d. Structures.

5.2.d.1. Design of intake structures shall provide for: withdrawal of water from more than one level if quality varies with depth; separate facilities for release of less desirable water held in storage; where frazil ice may be a problem, holding the velocity of flow into the intake structure to a minimum, generally not to exceed 0.5 feet per second; inspection manholes every one thousand (1000) feet for pipe sizes large enough to permit visual inspection; periodic cleaning of the inlet line; and adequate protection against rupture by dragging anchors, ice, etc. Ports shall be located above the bottom of the stream, lake or impoundment, but at sufficient depth to be kept submerged at low water levels. Where shore wells are not provided, a diversion device shall be capable of keeping large quantities of fish or debris from entering an intake structure and of controlling zebra mussels where applicable.

5.2.d.2. Raw Water pumping wells shall: have electrical controls located above grade and above the one hundred (100) year flood elevation; be accessible; be designed against flotation; be equipped with removable or traveling screens before the pump suction well; provide for introduction of a disinfectant or other chemicals in the raw water transmission main if necessary for quality control; have intake valves and provisions for backflushing or cleaning by a mechanical device and testing for leaks, where practical; have provisions for withstanding surges where necessary and include provisions for adequate ventilation for maintenance personnel.

5.2.d.3. An off-stream reservoir is a facility where water is pumped during periods of good quality and high stream flow for future release to treatment facilities. These off-stream reservoirs shall be constructed to assure that: water quality is protected by controlling runoff into the reservoir; dikes are structurally sound and protected against wave action and erosion; intake structures and devices meet requirements of this section; point of influent flow is separated from the point of withdrawal; and separate pipes are provided for influent to and effluent from the reservoir.

5.2.e. Impoundments and reservoirs.

5.2.e.1. Site preparation shall provide, where applicable: for the removal of brush and trees to high water elevation; for protection from floods during construction; for the abandonment of all water wells that will be inundated, in accordance with requirements of the BPH; and for the abandonment of all oil and gas wells in accordance with WVDEP oil and gas regulations.

5.2.e.2. Construction may require: approval from the WVDEP of the safety features for stability and spillway design; a permit from the WVDEP for controlling stream flow or installing a structure on the bed of a stream or interstate waterway; a withdrawal permit; and a U.S. Army Corps of Engineers permit.

5.3. Groundwater System. -- A groundwater source includes all water obtained from drilled, bored or driven wells, infiltration lines, springs and approved mines.

5.3.a. Quantity.

5.3.a.1. Source Capacity. -- The total developed groundwater source capacity shall equal or exceed the design maximum daily demand. For systems serving five hundred (500) people or more, source capacity shall equal or exceed the design average daily demand with the largest producing well out of service.

5.3.a.2. Number of Sources. -- All community groundwater systems serving five hundred (500) or more people, shall provide a minimum of two (2) good sources of water with sufficient capacity so that with the largest producing source out of service the remaining source or sources can produce sufficient quantity to produce average daily demands.

5.3.a.3. All public water systems shall provide standby power if the system is treating greater than or equal to three (3) million gallons per day.

5.3.a.3.A. To ensure continuous service when the primary power has been interrupted, a power supply shall be provided through connection to at least two (2) independent public power sources, or portable or in-place auxiliary power.

5.3.a.3.B. When automatic pre-lubrication of pump bearings is necessary, and an auxiliary power supply is provided, the pre-lubrication line shall be provided with a valved bypass around the automatic control, or the automatic control shall be wired to the emergency power source.

5.3.b. Quality.

5.3.b.1. Microbiological Quality. -- Public water systems shall provide for disinfection of every new, modified or reconditioned groundwater source prior to use in accordance with AWWA Standard C655. Public water systems shall submit, after disinfection, in accordance with AWWA Standard C654, one (1) or more special purpose water samples to a State certified water quality laboratory for microbiological analysis with results reported to the BPH prior to placing the well into service. The BPH shall require the public water system to take samples to determine if a new groundwater source is under the direct influence of surface water, for all new groundwater sources (wells, springs, mines, etc.). The BPH shall establish the sampling parameters and make the determination. The sampling must be completed within one (1) year after the groundwater sources is in service.

5.3.b.2. Physical and Chemical Quality. -- Public water systems shall have every new groundwater source examined for all regulated primary and secondary contaminants by tests of a representative sample in a State certified water quality laboratory for drinking water, with the results reported to the BPH. Samples shall be collected at or near the conclusion of the test pumping procedure and examined as soon as practical. Field determinations of physical and chemical constituents or special sampling procedures may be required by the BPH.

5.3.c. Location.

5.3.c.1. Public water systems or their engineer shall consult with the BPH prior to design and construction regarding a proposed well location as it relates to required separation between existing and potential sources of contamination and groundwater development. The public water systems or their engineer shall provide a location map, a site map and an inventory of potential contamination activity sources within a two thousand (2000) foot radius of the proposed well location for community and non-community, non-transient public water systems and five hundred (500) foot radius of the proposed well location for transient public water systems. Under no circumstances shall the water well be located closer to sources of microbiological pollution or contamination than as provided in Table 64-77B of this rule.

5.3.c.2. Continued Protection. -- Public water systems shall provide continued protection of the well site from potential sources of contamination through the development of a wellhead protection program as approved by the BPH. Fencing of the site may be required by the BPH.

5.3.d. Testing and Records.

5.3.d.1. The public water system engineer or a West Virginia Certified Water Well Driller shall perform yield and drawdown tests on every production well after construction or subsequent treatment and prior to placement of the permanent pump; have the test methods clearly indicated in the project specifications; have a test pump capacity, at maximum anticipated drawdown, at least 1.5 times the quantity anticipated, and provide for continuous pumping for at least twenty-four (24) hours or until stabilized drawdown has continued for at least six (6) hours when test pumped at 1.5 times the design pumping rate for community and non-transient non-community public water supplies; and provide for continuous pumping for at least eight (8) hours for transient non-community public water supplies.

5.3.d.2. The public water system engineer or a West Virginia Certified Water Well Driller shall provide the following data to the BPH: test pump capacity-head characteristics; static water level; the depth of test pump setting; the time of starting, ending each test cycle and the zone of influence of the well or wells.

5.3.d.3. The public water system engineer or a West Virginia Certified Water Well Driller shall provide recordings and graphic evaluation of the following at one hour intervals or less as may be required by the BPH: pumping rate, pumping water level, drawdown, and water recovery rate and levels. The non-community transient water systems are not required to provide the graphic evaluation of pump test data.

5.3.d.4. The public water system engineer or a West Virginia Certified Water Well Driller shall provide an accurate geographical location such as latitude and longitude or GIS coordinates; determine the geological data from samples collected at five (5) foot intervals and at each pronounced change in formation; record the information and provide a report to the BPH; and be supplemented with information on accurate records of drill hole diameters and depths, assembled order of size and length of casing and liners, grouting depths, formations penetrated, water levels and location of any blast charges.

5.3.e. General Well Construction.

5.3.e.1. Wells shall be covered while unattended during construction. Drilling fluids and additives shall not impart any toxic substances to the water or promote bacterial contamination and shall have third party certification of conformance with ANSI/NSF Standard 60, Drinking Water Treatment Chemicals - Health Effects.

5.3.e.2. Minimum Protected Depths.

5.3.e.2.A. Minimum protected depths of drilled wells shall provide watertight construction to the depth required by the BPH to: exclude contamination; seal off formations that are, or may be, contaminated or yield undesirable water; and provide a minimum casing length as follows:

5.3.e.2.A.1. Ten (10) feet of casing in unconsolidated water bearing formations for wells that are thirty (30) feet deep or less if approved by the BPH;

5.3.e.2.A.2. Twenty (20) feet of casing in unconsolidated water bearing formations for wells that are deeper than thirty (30) feet; or

5.3.e.2.A.3. A minimum of twenty (20) feet of casing in bedrock wells with a minimum of five (5) feet of casing installed into unweathered bedrock. Unweathered bedrock is bedrock that is competent, hard, firmly-consolidated and unaltered by erosion or surficial weathering.

5.3.e.2.B. Other minimum protective depths of casing may be allowed upon the written approval of the BPH in special circumstances (i.e., the well supplies a surface water treatment plant).

5.3.e.3. Temporary Steel Casing. -- Temporary steel casing used for construction shall be capable of withstanding the structural load imposed during its installation and removal.

5.3.e.4. Permanent Steel Casing. -- Permanent steel casing pipe shall: be new steel casing pipe meeting AWWA Standard A-100, ASTM or API specifications for water well construction; have the minimum weights and thickness indicated in Table 64-77D of this rule; have additional thickness and weight if minimum thickness is not considered sufficient to assure the reasonable life expectancy of a well; be capable of withstanding forces to which it is subjected; be equipped with a commercial heat treated tempered drive shoe when driven; have full circumferential welds or threaded coupling joints for twelve (12) inch or less diameter wells. Wells with diameters larger than twelve (12) inch can use non-commercial materials for the drive shoes when driven and shall have full circumferential welds or threaded coupling joints;

5.3.e.5. Nonferrous Casing Materials. -- Nonferrous material proposed as a well casing: shall be resistant to the corrosiveness of the water and to the stresses to which it will be subjected during installation, grouting and operation; and shall comply with ANSI/NSF Standard 61, Water System Components - Health Effects.

5.3.e.6. Plastic Well Casing. -- Plastic well casings, liners, spline-lock mechanical joining systems, couplings and solvents shall be approved by the NSF Standard 14 and 61 and meet ASTM F 480. Temporary casing shall meet NSF Standard 61. Plastic well casing shall not be driven during the installation. Plastic well casing shall be installed in accordance with the manufacturer's specifications. Evidence of compliance is the display of the NSF seal on each section of casing and liner. All plastic casing and liners shall have a wall thickness that will be of adequate thickness to prevent collapse due to hydrostatic pressure or temperature effects. The minimum wall thickness for plastic well casing shall have a standard dimension ratio (SDR) of 21 or heavier as governed by the ASTM F 480 standards. Plastic well liners shall meet a minimum SDR of 26.

5.3.e.7. Packers. -- Packers shall be of material that will not impart taste, odor, toxic substance or bacterial contamination to the well water. Lead packers are prohibited.

5.3.e.8. Screens. -- 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 or gravel pack materials; and have sufficient length and diameter to provide adequate specific capacity and low aperture entrance velocity. Usually the entrance velocity shall not exceed 0.1 feet per second. Screens shall be installed so that the pumping water level remains above the screen under all operating conditions. Where applicable, screens shall be designed and installed to permit removal or replacement without adversely affecting watertight construction of the well and be provided with a bottom plate or washdown bottom fitting of the same material as the screen. Only commercially manufactured screens designed for the intended purpose are permitted. Plastic well screens shall comply with the ANSI/NSF Standard 61 - Water System Components - Health Effects.

5.3.e.9. Grouting requirements.

5.3.e.9.A. The full length of the well casing shall be fully grouted from the lower terminus up to the ground surface, except as noted in parts 5.3.e.9.A.1 through 5.3.e.9.A.3 of this subparagraph.

5.3.e.9.A.1. When drilling through caves, mines or other cavities, the lower portion of the casing shall be grouted in accordance with a method described in this section and a packer or similar bridging device may be used to permit grouting from the top of the cavity.

5.3.e.9.A.2. In unconsolidated aquifers (i.e., sand and gravel) above bedrock, the permanent casing shall be grouted.

5.3.e.9.A.3. In cases where a pitless adaptor is to be installed, upward grouting may terminate at the level of the pitless adapter.

5.3.e.9.B. Grout shall be neat cement, bentonite and cement mixtures, or bentonite. Other materials require the written approval of the BPH. The neat cement, bentonite and cement mixtures, and bentonite shall be mixed according to the manufacturer's specifications. Drilling muds shall not be used for grouting. Water used shall be fresh (not saline) and uncontaminated. A neat cement grout shall consist of cement and water with not more than six (6) gallons of water per ninety-four (94) pound sack of cement.

5.3.e.9.C. All public water system water wells shall be installed with an annular space seal between the casing and borehole, that hardens or forms a seal to prevent the entrance of water from sources other than the aquifers selected.

5.3.e.9.C.1. When grouting below the water level, grout shall be installed by a positive displacement method, placed from the bottom up. Grout material shall be placed by a positive displacement such as pumping or forced injection by air or hydraulic pressure. Grout shall be injected in the annular space between the inner casing and either the outer casing or the borehole. In wells where the outer casing is left in place, a dry bentonite shall be used while driving the casing.

5.3.e.9.C.2. When grouting above the water level, the annular space shall be a minimum of one and a half (1.5) inches for grout and a positive displacement method, placed from the bottom up, is the preferred method for grouting. The gravity placement method may be used for grouting not to exceed thirty (30) feet. Bentonite chips, pellets or granules with a diameter of three-eighths of an inch (3/8) or less, or neat cement shall either be poured freely down the borehole or added through a tremie pipe to seal the annular space. As the bentonite material is poured into the hole, bridging may occur. A tamper or a weighted line may be necessary to tamp the bentonite material into place.

5.3.e.9.C.3. When underreaming is used to set permanent casing in unconsolidated materials, either a dry or wet bentonite slurry shall be used at the ground surface while the casing is being installed. Upon termination of casing in unweathered bedrock and removal of the underreamer, bentonite or neat cement shall be placed in the bottom of the casing by a positive displacement or gravity placement method before casing is set in bedrock. All other methods require the written approval of the BPH.

5.3.e.9.C.4. If rapid loss of grout material occurs during emplacement, coarse fill material (e.g., sand, gravel, crushed stone or dry cement) may be used in the zones in which the loss is occurring. The remainder of the annular space shall be grouted as provided in this section.

5.3.e.9.C.5. If the annular space cannot be grouted in accordance with this section, alternative methods subject to prior written approval by the BPH may be considered.

5.3.e.10. Upper Terminal Well Construction. -- Permanent casing for all groundwater sources shall project at least twelve (12) inches above the pumphouse floor or at least twelve (12) inches above the final ground surface. Where a well house is constructed, the floor surface shall be at least six (6) inches above the final ground elevation. Sites subject to flooding shall be provided with an earth mound to raise the pumphouse floor to an elevation at least two (2) feet above the highest known flood elevation, or other suitable protection as determined by the BPH. The top of the well casing at sites subject to flooding shall terminate at least three (3) feet above the one hundred (100) year flood level or the highest known flood elevation, whichever is higher, or as the BPH directs. If the three (3) feet above the one hundred (100) year flood elevation or the highest known flood elevation requirement is not practical, the well shall be protected from flood waters entering the well and contaminating the aquifer.

5.3.e.11. Development. -- 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. Where chemical conditioning is required, the specifications shall include provisions for the method, equipment, chemicals, testing for residual chemicals, and disposal of waste and inhibitors. Where blasting procedures may be used, the specifications shall include the provisions for blasting and cleaning. Special attention shall be given to assure that the grouting and casing are not damaged by the blasting.

5.3.e.12. Capping Requirements. -- All caps shall be Water Systems Council approved. All caps in the 100 year flood plain shall be water tight. All caps above the 100 year flood plain shall, as a minimum, be vector (insects, rodents, snakes, etc.) proof. At all times during the progress of work, the

West Virginia Certified Water Well Driller shall provide protection to prevent tampering with the well or entrance of foreign materials.

5.3.e.13. Well Abandonment. -- When a public water system water well is to be abandoned, the work is to be performed by a West Virginia Certified Water Well Driller. The preferred method of abandonment involves casing removal. The borehole shall be completely sealed to reduce concern about channeling in the annular space or inadequate seals between casing and grout. When the casing is removed and the borehole is unstable, grout shall be simultaneously emplaced as the casing is "pulled" to prevent collapse of the borehole and an inadequate seal; however, if the casing is left in place, the casing shall be completely pressure grouted to reduce the possibility of annular channeling. All pumps, wiring, pipes, valves, accessories and hardware shall be removed prior to abandonment. The requirements herein pertain to wells and test holes in consolidated and unconsolidated formations. Each well abandonment shall be considered as an individual problem. Methods and materials are to be selected only after careful consideration of casing material, casing condition, the diameter of the casing, quality and quantity of the original grout seal, the depth of the well, well plumbness, hydrogeologic setting, level of contamination and the zones where contamination occurs. All abandonment procedures shall prohibit groundwater contamination.

5.3.e.13.A. All wells to be abandoned shall be completely filled. The public water system’s engineer or a West Virginia Certified Water Well Driller shall provide procedures and quantities of material used for water well abandonment to the BPH within thirty (30) days after abandonment.

5.3.e.13.B. Wells in Unconsolidated Formations. -- In water-bearing formations consisting of coarse gravel, and when producing wells are located nearby, care shall be taken to select sealing materials that will not affect the producing wells. Concrete may be used if the producing wells can be shut down for a sufficient time to allow the concrete to set. Clean, disinfected sand or gravel may also be used as fill material at the water-bearing formation elevations. The remainder of the well, especially the upper portion, shall be filled with clay, concrete, grout, or neat cement to exclude surface water. The latter method, using clay as the upper sealing material, is especially applicable to abandoned wells with a diameter greater than ten (10) inches. In gravel-packed gravel-envelope, or other wells in which coarse material has been added around the inner casing to within twenty (20) to thirty (30) feet of the surface, sealing outside the casing is very important. Sometimes this sealing may require removal of the gravel or perforation of the casing.

5.3.e.13.C. Wells in Creviced Formations. -- Abandoned wells that penetrate limestone or other creviced or channelized rock formations shall be filled with concrete, grout or neat cement to insure permanence of the seal. The use of clay or sand is not desirable because fine-grained fill material may be displaced by the flow of water through crevices of channels. Alternating layers of coarse stone and concrete may be used for fill material through the water producing horizon if limited vertical movement of water in the formation will not affect the quality or quantity in producing wells. Only concrete, neat cement or grout shall be used in this type of well. The portion of the well between a point ten (10) to twenty (20) feet below and a point ten (10) to twenty (20) feet above the creviced formation shall be sealed and a plug of sealing material formed above the creviced formation.

5.3.f. Source Types and Construction Methods. -- Special Conditions.

5.3.f.1. Radial Water Collector. -- Locations of all caisson construction joints and porthole assemblies shall be indicated. The caisson wall shall be reinforced to withstand the forces to which it will be subjected. Radial collectors shall be in areas and at depths approved by the BPH. Provisions shall be made to assure that radial collectors are horizontal. The top of the caisson shall be covered with a watertight floor or be above the 100 year flood elevation. All openings in the floor shall be curbed and protected from the entrance of foreign material. Commercially available watertight wall sleeves shall be used if the pump discharge piping is placed through the caisson walls.

5.3.f.2. Infiltration Lines. -- Infiltration lines may be considered only where geological conditions preclude the possibility of developing an acceptable drilled well. The area around infiltration lines shall be under the control of the water purveyor for a distance acceptable to or required by the BPH. Flow in the lines shall be by gravity to the collecting well.

5.3.f.3. Naturally Flowing Wells. -- Flow from naturally flowing wells shall be controlled. Permanent casing and grout shall be provided. If erosion of the confining bed appears likely, special protective construction may be required by the BPH.

5.3.f.4. Springs and Mine Openings. -- Springs and mine openings, when used as a source point, shall be protected from the entry of surface water and foreign objects and shall be housed in a permanent structure.

5.3.g. Well Pumps, Discharge Piping and Appurtenances.

5.3.g.1. Line shaft pumps. -- Wells equipped with line shaft pumps shall: have the pump structure firmly connected to the casing or have the casing inserted into a recess extending at least one-half (2) inch into the pump base; have the pump foundation and base designed to prevent water from coming into contact with the joint.

5.3.g.2. 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, and the electrical cable shall be firmly attached to the riser pipe at intervals of twenty (20) feet or less.

5.3.g.3. Discharge piping. -- The discharge piping shall: be designed so that the friction loss will be low; have control valves and appurtenances located above the pumphouse floor when an above-ground discharge is provided; 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 applicable, discharge piping shall be equipped with an air release-vacuum relief valve located upstream from the check valve, with exhaust/relief piping terminating in a down-turned position at least eighteen (18) inches above the floor and covered with a twenty-four (24) mesh corrosion resistant screen. Discharge piping: shall be valved to permit test pumping and control of each well; shall have all exposed piping, valves and appurtenances protected against physical damage and freezing; shall be properly anchored to prevent movement; and shall be protected against a surge or water hammer. The discharge piping shall be provided with a means of pumping the discharge directly to waste but shall not be directly connected to a sewer.

5.3.g.4. Pitless Well Units. -- The BPH shall be contacted by the public water system or its engineer for approval of specific applications of pitless units. Pitless units shall: be threaded or welded to the well casing; be of watertight construction throughout; be of materials and weight at least equivalent and compatible to the casing; have field connection to the lateral discharge from the pitless unit of threaded, flanged or mechanical joint connection; terminate at least twelve (12) inches above final ground elevation or three (3) feet above the one hundred (100) year flood level or as the BPH directs. If the three (3) feet above the one hundred (100) year flood elevation requirement is not practical, the well shall be protected from flood waters entering the well and contaminating the aquifer. The pitless unit installation shall consist of either a pitless well unit or pitless well adapter and well cap. The pitless unit shall be approved by the NWSC, NGWA or equivalent. If a field weld connection is made, the pitless well unit shall be specifically approved by the manufacturer for such welding. The only field welding permitted is that required to attach the pitless well unit and appurtenances to the casing.

5.3.g.4.A. The design of the pitless unit shall make provisions for: access to disinfect the well; a properly constructed casing vent meeting the requirements specified in this rule; facilities to measure water levels in the well; a cover at the upper terminus of the well that will prevent contamination; a contamination-proof entrance connection for electrical cable; and an inside diameter as great as that of the well casing, up to and including casing diameters of twelve (12) inches, to facilitate work and repair on the well, pump, or well screen. If the three (3) feet above the one hundred (100) year flood elevation requirement is not practical, the well shall be protected from flood waters entering the well and contaminating the aquifer.

5.3.g.5. Casing Vent. -- The public water system or a West Virginia Certified Water Well Driller shall make provisions for venting the well casing to the atmosphere. The pipe connecting the casing to the vent shall be of adequate size to provide rapid venting of the casing. For installations in the 100 year flood plain, refer to paragraph 5.3.e.12 of this rule.

5.3.g.6. Water level measurement. -- The public water system or a West Virginia Certified Water Well Driller shall make provisions for periodic measurement of water levels in the completed well for community and non-community, non-transient public water systems. Where pneumatic water level measuring equipment is used, the measurement 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.

5.3.g.7. 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; and be protected at the upper terminus to preclude entrance of foreign materials.

§64-77-6. Treatment (General and Clarification).

6.1. General. -- The design of treatment processes and devices shall depend on evaluation of the nature and quality of the particular water to be treated, seasonal variations, the desired quality of the finished water and the mode of operation planned. All treatment processes with only one (1) unit shall be capable of meeting the projected maximum daily demand in eight (8) hours of operation or less to provide "down time" for repairs and maintenance.

6.2. Clarification. -- Clarification is generally considered to consist of any process or combination of processes which reduce the concentration of suspended matter in drinking water prior to filtration. Plants designed for processing surface water shall: provide a minimum of two (2) units each for rapid mix, flocculation and sedimentation; permit operation of the units either in series or parallel where softening is performed and shall permit series or parallel operation where plain clarification is performed; be constructed to permit units to be taken out of service without disrupting operation; be constructed with drains or pumps sized to allow dewatering in a reasonable period of time; provide multiple-stage treatment facilities when required by the BPH; be started manually following a shutdown; and minimize hydraulic head losses between units to allow future changes in processes without the need for repumping. For ground water systems under the direct influence of surface water, the requirements in this subsection may be modified by the BPH, depending on the raw water quality characteristics.

6.2.a. Presedimintation. -- Surface waters containing high turbidity may require pretreatment, usually sedimentation either with or without addition of coagulation chemicals. Presedimentation basins shall have hopper bottoms or be equipped with continuous mechanical sludge removal apparatuses, have provisions for dewatering, provide for incoming water to be dispersed across the full width of the line of travel, prevent short-circuiting, provide for bypassing the presedimentation basins, and have a minimum two (2) hour detention.

6.2.b. Coagulation. -- Is a process using coagulant chemicals and mixing by which colloidal and suspended material are destabilized and agglomerated into settleable or filterable flocs, or both. The engineer shall submit the design basis for the velocity gradient (G value) selected, considering the chemicals to be added, water temperature, color and other related water quality parameters. For surface water plants using direct or conventional filtration, the use of a primary coagulant is required at all times.

6.2.b.1. Equipment. -- Basins shall be equipped with devices capable of providing adequate mixing for all treatment flow rates. Static mixing may be considered where the flow is relatively constant and will be high enough to maintain the necessary turbulence for complete chemical reactions. The coagulation and flocculation basins shall be as close together as possible.

6.2.b.2. Mixing. -- The detention period shall not be more than thirty seconds with mixing equipment capable of imparting a minimum velocity gradient (G) of at least 750 fps/ft. The design engineer shall determine the appropriate G value and detention time through jar testing.

6.2.c. Flocculation. -- Flocculation shall mean a process to enhance agglomeration or collection of smaller floc particles into larger, more easily settleable or filterable particles through gentle stirring by hydraulic or mechanical means.

6.2.c.1. Basin design. -- Inlet and outlet design shall minimize short-circuiting and destruction of floc. Series compartments are recommended to further minimize short-circuiting and to provide decreasing mixing energy with time. Basins shall be designed so that individual basins may be isolated without disrupting plant operation. A drain and/or pumps, or both, shall be provided to handle dewatering and sludge removal.

6.2.c.2. Detention. -- The detention time for floc formation should be at least 30 minutes with consideration to using tapered (i.e., diminishing velocity gradient) flocculation. The flow-though velocity shall be not less than 0.5 or greater than 1.5 feet per minute.

6.2.c.3. Equipment. -- Agitators shall be driven by variable speed drives with the peripheral speed of paddles ranging from 0.5 to three (3.0) feet per second. External, non-submerged motors are recommended.

6.2.c.4. Piping. -- Flocculation and sedimentation basins shall be as close together as possible. The velocity of flocculated water through pipes or conduits to settling basins shall be not less than 0.5 or greater than 1.5 feet per second. Allowances shall be made to minimize turbulence at bends, elevation drops and changes in direction.

6.2.c.5. Other Designs. -- The BPH may allow baffling to be used for flocculation in small plants if the design would permit the velocities and flows noted above to be maintained.

6.2.c.6. Superstructure. -- The BPH may require a superstructure over the flocculation basins.

6.2.d. Sedimentation. -- Sedimentation shall follow flocculation. The detention time for effective clarification is dependent upon a number of factors related to basin design and the nature of the raw water. The following criteria apply to conventional gravity sedimentation units:

6.2.d.1. Detention time. -- A minimum of four (4) hours of settling time shall be provided. This may be reduced to two (2) hours for lime-soda softening facilities treating only groundwater. Reduced sedimentation time may also be approved by the BPH when equivalent effective settling is demonstrated (i.e., tube settlers, lamella plates, etc.) but shall never be less than two (2) hours.

6.2.d.2. 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 shall be constructed across the basin close to the inlet end and shall project several feet below the water surface to dissipate inlet velocities and provide uniform flows across the basin;

6.2.d.3. Outlet devices. -- Outlet weirs or submerged orifices shall be designed to maintain velocities suitable for settling in the basin and to minimize short-circuiting. The use of submerged orifices is recommended in order to provide a volume above the orifices for storage when there are fluctuations in flow;

6.2.d.4. Overflow rate. -- The rate of flow over the outlet weir shall not exceed twenty thousand (20,000) gallons per day per foot of the outlet launder. Where submerged orifices are used as an alternate for overflow weirs, they shall be not lower than three (3) feet below the flow line. The entrance velocity through the submerged orifices shall not exceed 0.5 feet per second;

6.2.d.5. Velocity. -- The velocity through settling basins shall not exceed 0.5 feet per minute. The basins shall be designed to minimize short-circuiting. Fixed or adjustable baffles shall be provided as necessary to achieve the maximum potential for clarification;

6.2.d.6. Overflow. -- An overflow weir or pipe shall be installed that will establish the maximum water level desired on top of the filters. It shall discharge by gravity with a free fall at a location where the discharge will be noted;

6.2.d.7. Superstructure. -- The BPH may require a public water system to build a superstructure over the sedimentation basins. The BPH may allow a cover in lieu of a superstructure, if there is no mechanical equipment in the basins and if provisions are included for adequate monitoring under all expected weather conditions;

6.2.d.8. Sludge collection. -- Shall be designed to ensure the collection of sludge from throughout the basin;

6.2.d.9. Drainage. -- Basins shall be provided with a means for dewatering. Basin bottoms shall slope toward the drain not less than one (1) foot in twelve (12) feet where mechanical sludge collection equipment is not required;

6.2.d.10. Flushing lines. -- Flushing lines or hydrants shall be provided and shall be equipped with backflow prevention devices acceptable to the BPH;

6.2.d.11. Safety. -- Permanent ladders or handholds shall be provided on the inside walls of basins. Guard rails shall be included;

6.2.d.12. Sludge removal. -- Sludge removal design shall provide that sludge pipes shall be not less than three (3) inches in diameter and so arranged as to facilitate cleaning. The entrance to sludge withdrawal piping shall prevent clogging. Valves shall be located outside the tank for accessibility. The operator shall be able to observe and sample sludge being withdrawn from the unit; and

6.2.d.13. Sludge disposal. -- Facilities shall be provided for the proper disposal of sludge.

6.2.e. Solids contact unit. -- Combined softening and clarification units are generally acceptable in situations where water characteristics, especially temperature, do not fluctuate rapidly, flow rates are uniform and operation is continuous. The BPH shall give specific approval to the public water system engineer before these units are considered as clarifiers without softening. The public water system engineer shall design clarifiers for the maximum uniform rate and shall be adjustable to changes in flow that are less than the design rate and for changes in water characteristics. The BPH requires a minimum of two (2) units for surface water treatment.

6.2.e.1. Installation of equipment. -- A representative of the manufacturer shall supervise the installation of mechanical equipment, trouble-shooting, problem solving times and start-up and initial operation.

6.2.e.2. Operating equipment. -- The following shall be provided for plant operation: a complete outfit of tools and accessories; trouble shooting and problem solving manuals; necessary laboratory equipment; and adequate piping with suitable sampling taps located to permit the collection of samples of water from critical portions of the units.

6.2.e.3. Chemical feed. -- Chemicals shall be applied at such points and by such means as to insure satisfactory mixing of the chemicals with the water.

6.2.e.4. Mixing. -- The BPH may require a rapid mix device or chamber ahead of solids contact units to assure proper mixing of the chemicals applied. Mixing devices employed shall be constructed to provide mixing of the raw water with previously formed sludge particles, and prevent deposition of solids in the mixing zone.

6.2.e.5. Flocculation. -- Flocculation equipment shall: be adjustable (speed or pitch, or both); provide for coagulation in a separate chamber or baffled zone within the unit; and provide the flocculation and mixing period to be not less than thirty (30) minutes.

6.2.e.6. Sludge concentrators. -- The equipment shall provide either internal or external concentrators in order to obtain a concentrated sludge with a minimum of waste water. Large basins shall have at least two (2) sumps for collecting sludge with one (1) sump located in the central flocculation zone.

6.2.e.7. Sludge removal. -- Sludge removal design shall provide that sludge pipes shall be not less than three (3) inches in diameter and so arranged as to facilitate cleaning. Entrance to sludge withdrawal piping shall prevent clogging. Valves shall be located outside the tank for accessibility. The design shall permit the operator to observe and sample sludge being withdrawn from the unit.

6.2.e.8. Cross-connections. -- Blow-off outlets and drains shall terminate and discharge at places satisfactory to the BPH. Cross-connection control shall be included for the potable water lines used to backflush sludge lines.

6.2.e.9. Detention period. -- The detention time shall be based on the raw water characteristics and other local conditions that effect the operation of the unit. Based on design flow rates, the detention time shall be two (2) to four (4) hours for suspended solids contact clarifiers and softeners treating surface water and one (1) to two (2) hours for the suspended solids contact softeners treating only groundwater.

6.2.e.10. Suspended slurry concentrate. -- Softening units shall be designed so that continuous slurry concentrates of one per cent (1%) or more, by weight, can be satisfactorily maintained.

6.2.e.11. Water losses. -- Units shall be provided with suitable controls for sludge withdrawal. Total water losses shall not exceed five percent (5%) for clarifiers and three percent (3%) for softening units. The solids concentration of sludge bed to waste shall be three percent (3%) by weight for clarifiers and five percent (5%) by weight for softeners.

6.2.e.12. Weirs or orifices. -- The units shall be equipped with either overflow weirs or orifices constructed so that water at the surface of the unit does not travel more than ten (10) feet horizontally to the collection trough. Weirs shall be adjustable and at least equivalent in length to the perimeter of the tank. Weir loading shall not exceed ten (10) gallons per minute per foot of weir length for units used for clarifiers and twenty (20) gallons per minute per foot of weir length for units used for softeners. Where orifices are used, the loading rates per foot of launder rates shall be equivalent to weir loadings. Either weirs or orifices shall produce uniform rising rates over the entire area of the tank.

6.2.e.13. Upflow rates. -- The BPH shall receive supporting data from the public water system's engineer to justify rates exceeding the following: one (1) gallon per minute per square foot of area at the sludge separation line for units used for clarifiers; and 1.75 gallons per minute per square foot of area at the slurry separation line; for units used for softeners.

6.2.f. Tube or plate settlers. -- Commercial settler units consisting of variously shaped tubes or plates that are installed in multiple layers and at an angle to the flow may be used for sedimentation following flocculation.

6.2.f.1. General criteria.

6.2.f.1.A. Inlet and outlet considerations. -- The inlets and outlets shall be designed to maintain velocities suitable for settling in the basin and to minimize maldistribution acoss the units.

6.2.f.1.B. Drainage. -- Drain piping from the settler units shall be sized to facilitate a quick flush of the settler units and to prevent flooding other portions of the plant.

6.2.f.1.C. Protection from freezing. -- Although most units are located within a plant, outdoor installations shall provide sufficient freeboard above the top of settlers to prevent freezing in the units. A cover or enclosure is strongly recommended.

6.2.f.1.D. Application rate for tube settlers. -- A maximum rate of two (2) gallons per square foot per minute of cross-sectional area is required, unless higher rates are successfully shown through pilot plant or in-plant demonstration studies.

6.2.f.1.E. Application rate for plates. -- A maximum forward design flow through the inclined plate settler is 0.5 gallons per minute per square foot based on eighty percent (80%) of the projected horizontal plate area.

6.2.f.1.F. Flushing lines. -- Flushing lines shall be provided to facilitate maintenance and shall be properly protected against backflow or back siphonage.

6.2.f.1.G. Placement. -- Modules should be placed in zones of stable hydraulic conditions and in areas nearest effluent launders for basins not completely covered by modules.

6.2.f.1.H. Inlets and Outlets. -- Inlets and outlets shall conform to paragraphs 6.2.d.2 and 6.2.d.3.

6.2.f.1.I. Support. -- The support system must be able to carry the weight of the modules when the basin is drained plus any additional weight to support maintenance.

6.2.f.1.J. Cleaning. -- Provisions shall be made to allow the water level to be dropped, and a water or an air jet system for cleaning the modules.

6.2.g. High Rate Clarification Processes. -- The BPH may approve high rate clarification processes upon demonstration of full scale operation with similar raw water quality conditions. Reductions in detention times and/or increases in weir loading rates shall be justified. Examples of such processes may include dissolved air flotation, ballasted flocculation, contact flocculation/clarification, and helical upflow.

6.3. Filtration. -- Acceptable filters that may be considered are rapid rate gravity filters, rapid rate pressure filters, diatomaceous earth filtration, slow sand filtration, direct filtration, deep bed rapid rate gravity filters, membrane filtration, bag and cartridge filters. The application of any type of filter shall be supported by water quality data representing a reasonable period of time to characterize the variations in water quality. Pilot treatment studies may be required to demonstrate the applicability of the method of filtration proposed.

6.3.a. Rapid rate gravity filters.

6.3.a.1. Pretreatment. -- The use of rapid rate gravity filters shall require pretreatment.

6.3.a.2. Rate of filtration. -- The BPH shall determine the rate of filtration through consideration of such factors as raw water quality, the degree of pretreatment provided, filter media, water quality control parameters, the competency of operation personnel, and other pertinent factors. The maximum rate shall be two (2) gallons per minute per square foot of filter area for sand media, four (4) gallons per minute per square foot of filter area for dual media, and six (6) gallons per minute per square foot of filter for mixed media. In any case, the filter rate shall be proposed and justified by the designing engineer to the satisfaction of the BPH prior to the preparation of final plans and specifications.

6.3.a.3. Number. -- At least two (2) filter units are required. Where only two (2) units are provided, each shall be capable of meeting the plant design capacity (normally the projected maximum daily demand) at the approved filtration rate. Where more than two (2) filter units are provided, the filters shall be capable of meeting the plant design capacity at the approved filtration rate with one (1) filter removed from service. Where declining rate filtration is provided, the variable aspect of filtration rates and the number of filters shall be considered when determining the design capacity for the filters.

6.3.a.4. Structural details and hydraulics. -- The filter structure shall be designed to provide for: vertical walls within the filter; no protrusion of the filter walls into the filter media; covering by superstructure; head room to permit normal inspection and operation; minimum depth of filter box of eight and one half (8½) feet; minimum water depth over the surface of the filter media of three (3) feet; trapped effluent to prevent backflow of air to the bottom of the filters; prevention of floor drainage to the filter with a minimum four (4) inch curb around the filter; prevention of flooding by providing overflow; maximum velocity of treated water in pipe and conduits to filters of two (2) feet per second; cleanouts and straight alignment for influent pipes or conduits where solids loading is heavy, or following lime-soda softening; washwater drain capacity to carry maximum flow; walkways around filters, to be not less than twenty-four (24) inches wide; safety handrails or walls around filter areas adjacent to normal walkways; and construction to prevent cross connections and common walls between potable and non-potable water.

6.3.a.5. Washwater troughs. -- Washwater troughs shall be constructed to have: the bottom elevation above the maximum level of expanded media during washing, a two-inch freeboard at the maximum rate of wash; the top edge level and all at the same elevation; spacing so that each trough serves the same number of square feet of filter area; and maximum horizontal travel of suspended particles to reach the trough not to exceed three (3) feet.

6.3.a.6. Filter. -- The media shall be clean silica sand or other natural or synthetic media free from detrimental chemical or bacterial contaminants. The filter shall be constructed to provide the following characteristics: a total depth of not less than twenty-four (24) inches and generally not more than thirty (30) inches; and a minimum of twelve (12) inches of media with an effective size range no greater than 0.45 mm to 0.55 mm, and uniformity coefficient of the smallest material not greater than 1.65.

6.3.a.7. Types of filter media.

6.3.a.7.A. Anthracite. -- Filter anthracite shall consist of hard, durable anthracite coal particles of various sizes. Blending of non-anthracite material is not acceptable. Anthracite shall have: an effective size of 0.45 mm to 0.55 mm with uniformity coefficient not greater than 1.65 when used alone; an effective size of 0.8 mm to 1.2 mm with a uniformity coefficient not greater than 1.85 when used as a cap; specific gravity of 1.4, acid solubility less than five (5) percent, a Mho's scale of hardness greater than 2.7 and an effective maximum size of 0.8 mm for anthracite used as a single media on potable groundwater for iron and manganese removal only (effective sizes greater than 0.8 mm may be approved by the BPH based upon on-site pilot plant studies).

6.3.a.7.B. Sand. -- Sand shall be clean silica sand and have an effective size of 0.45 mm to 0.55 mm, a specific gravity greater than 2.5, an acid solubility less than 5 percent and a uniformity coefficient of not greater than 1.65.

6.3.a.7.C. Granular activated carbon (GAC). -- Granular activated carbon media may be considered. The design shall include the following: the media shall meet the basic specifications for filter media as given in this section except that larger size media may be allowed by the BPH where full scale tests have demonstrated that treatment goals can be met under all conditions; there shall be provisions for a free chlorine residual and adequate contact time in the water following the filters and prior to distribution; there shall be means for periodic treatment of filter material for control of bacterial and other growth; and provisions shall be made for frequent replacement or regeneration if GAC is used for filtration.

6.3.a.7.D. High Density Sand. -- High density sand shall consist of hard durable, and dense grain garnet, ilmente, hematite, magnetite, or associated minerals of those ores that resists degradation during handling and use. The high density sand shall contain at least ninety-five (95) percent of the associated material with a specific gravity of 3.8 or higher, have a uniformity coefficient of not greater than 1.65 and have an acid solubility less than five (5) percent.

6.3.a.7.E. Other Media. -- The BPH shall consider other media based on experimental data and operating experience.

6.3.a.7.F. Torpedo sand. -- A three (3) inch layer of torpedo sand shall be used as a supporting media for filter sand, and shall have an effective size of 0.8 mm to 2.0 mm and a uniformity coefficient not greater than 1.7.

6.3.a.7.G. Gravel. -- Gravel, when used as the supporting media, shall consist of a cleaned and washed hard, durable, rounded silica particles and shall not include flat or elongated particles. The coarsest gravel shall be approximately two (2) inches in size when the gravel rests directly on the strainer system and shall extend above the top of the perforated laterals. Not less than four (4) layers of gravel shall be provided in accordance with the size and depth distribution when used with perforated laterals, as illustrated in Table 64-77C of this rule. Reduction of gravel depths or other size gradations may be considered upon justification to the BPH when proprietary filter bottoms are specified or for slow sand filtration.

6.3.a.8. Filter bottoms and strainer systems. -- Departures from the standards under this rule may be acceptable for high rate filters and proprietary bottoms. Porous plate bottoms shall not be used where iron or manganese may clog them or with waters softened by lime. The design of manifold-type collection systems shall minimize loss of head in the manifold and laterals and assure even distribution of washwater and even rate of filtration over the entire area of the filter. The ratio of the area of the final openings of the strainer systems to the area of the filter shall be about 0.003. The total cross-sectional area of the laterals shall be about twice the total area of the final openings. The cross-sectional area of the manifold shall be one and one-half (1½) to two (2) times the total area of the laterals. Lateral perforations without strainers shall be directed downward.

6.3.a.9. Surface wash or subsurface wash. -- Surface or subsurface wash facilities are required except for filters used exclusively for iron, radionuclides, arsenic or manganese removal, and may be accomplished by a system of fixed nozzles or a revolving-type apparatus. All devices shall be designed with the provision for water pressures of at least forty-five (45) pounds per square inch and a properly installed vacuum breaker or other device approved by the BPH to prevent back siphonage if connected to the filtered or finished water system. The rate of flow shall be two (2) gallons per minute per square foot of filter area with fixed nozzles or 0.5 gallons per minute per square foot with revolving arms. Air wash can be considered based on experimental data and operating experiences.

6.3.a.10. Air scouring. -- Air scouring can be considered in place of surface wash. Air flow for air scouring the filter shall be three (3) to five (5) standard cubic feet per minute per square foot of filter area when the air is introduced in the underdrain; a lower air rate shall be used when the air scour distribution system is placed above the underdrains. A method for avoiding excessive loss of the filter media during backwashing shall be provided. Air scouring shall be followed by a fluidization wash sufficient to re-stratify the media. Air shall be free from contamination. Air scour distribution systems shall be placed below the media and supporting bed interface; if placed at the interface the air scour nozzles shall be designed to prevent media from clogging the nozzles or entering the air distribution system. Piping for the air distribution system shall not be flexible hose that will collapse when not under air pressure and shall not be a relatively soft material that may erode at the orifice opening with the passage of air at high velocity. Air delivery piping shall not pass down through the filter media nor shall there be any arrangement in the filter design that would allow short circuiting between the applied unfiltered water and the filtered water. Consideration shall be given to maintenance and replacement of air delivery piping. The backwash delivery system shall be capable of fifteen (15) gallons per minute per square foot of filter surface area; however, when air scouring is provided the backwash rate shall be variable and shall not exceed eight (8) gallons per minute per square foot unless operating experience shows that a higher rate is necessary to remove scoured particles from filter surfaces, and the filter underdrains shall be designed to accommodate air scour piping when the piping is installed in the underdrain.

6.3.a.11. Appurtenances. -- The following shall be provided for every filter: influent and effluent sampling taps; loss of head gauge; rate of flow controls; and an indicating rate-of-flow meter. A modified rate controller that limits the rate of filtration to a maximum rate may be used; Provided, that, equipment that simply maintains a constant water level on the filters is not acceptable unless the rate of flow onto the filter is properly controlled. A pump or a flow meter in each filter effluent line may be used as the limiting device for the rate of filtration only after consultation with the BPH. Provisions shall be made for filtering to waste (rewash) with appropriate measures for cross connection prevention. For surface water systems or groundwater under the direct influence of surface water systems with three (3) or more filters, on-line turbidimeters shall be installed on the effluent line from each filter. All turbidimeters shall report to a recorder that is designed and operated to allow the operator to accurately determine the turbidity at least once every 15 minutes. Turbidimeters on individual filters shall be designed to accurately measure low-range turbidities and have an alarm that sounds when the effluent level exceeds 0.3 NTU. It is recommended the following be provided for every filter: wall sleeves providing access to the filter interior at several locations for sampling or pressure sensing; a flow rate controller capable of providing gradual rate increases when placing the filters back into operation and a pressure hose and storage rack at the operating floor for washing filter walls.

6.3.a.12. Backwash. -- Provisions shall be made for washing filters with a minimum rate of fifteen (15) gallons per minute per square foot, consistent with water temperatures and specific gravity of the filter media. A rate of twenty (20) gallons per minute per square foot or a rate necessary to provide for a fifty percent (50%) expansion of the filter bed is recommended. A reduced rate of ten (10) gallons per minute per square foot may be acceptable for full depth anthracite or granular activated carbon filters. Filtered water shall be provided at the required rate by washwater tanks, a washwater pump, or from the high service main. Washwater pumps shall be in duplicate unless an alternate means of obtaining washwater is available. Washwater pumps shall run a minimum fifteen (15) minutes for the wash of one (1) filter at the design rate of wash. A washwater regulator or valve on the main washwater line shall be provided to obtain the desired rate of filter wash with the washwater valves on the individual filters open wide. A rate-of-flow indicator, preferably with a totalizer, on the main washwater line, shall be located so that it can be easily read by the operator during the washwater process. The design shall prevent rapid changes in backwash water flow. Backwash shall be operator initiated. Automated systems shall be operator adjustable.

6.3.a.13. Miscellaneous. -- Roof drains shall not discharge into the filters or basins and conduits preceding the filters.

6.3.b. Rapid rate pressure filters. -- The normal use of rapid rate pressure filters is for iron and manganese removal and may be used for surface supplies classified as groundwater under direct influence where turbidity is less than or equal to ten (10) NTU. Pressure filters shall not be used in the filtration of other surface supplies or following lime-soda softening.

6.3.b.1. General. -- Minimum criteria relative to rate of filtration, structural details, hydraulics, filter media, etc., provided for rapid rate gravity filters also apply to pressure filters where appropriate.

6.3.b.2. Rate of filtration. -- The rate shall not exceed three gallons per minute per square foot of filter area except where in-plant testing, as approved by the BPH, has demonstrated satisfactory results at higher rates.

6.3.b.3. Details of design. -- The filters shall be designed to provide for: loss of head gauges on the inlet and outlet pipes of each filter; an easily readable meter or flow indicator on each battery of filters (a flow indicator is recommended for each filtering unit); filtration and backwashing of each filter individually with an arrangement of piping as simple as possible to accomplish these purposes; minimum side wall shell height of five (5) feet (a corresponding reduction in side wall height is acceptable where proprietary bottoms permit reduction of the gravel depth); the top of the washwater collectors to be at least eighteen (18) inches above the surface of the media; the underdrain system to efficiently collect the filtered water and to uniformly distribute the backwash water at a rate not less than fifteen (15) gallons per minute per square foot of filter area; backwash flow indicators and controls that are easily readable while operating the control valves; an air release valve on the highest point of each filter; an accessible manhole of adequate size to facilitate inspection and repairs for filters thirty-six (36) inches in diameter; there are sufficient handholds for filters less than thirty-six (36) inches in diameter; manholes should be at least twenty-four (24) inches in diameter where feasible; and means to observe the wastewater during backwashing, and construction to prevent cross-connection.

6.3.c. Diatomaceous earth filtration. -- The use of diatomaceous earth filters may be considered for application to surface waters with low turbidity and low bacterial contamination.

6.3.c.1. Conditions of use. -- Diatomaceous earth filters are expressly excluded from considerations for the following conditions: bacteria removal; color removal; turbidity removal where either the quantity of turbidity is high or the turbidity exhibits poor filterability characteristics; and filtration of waters with high algae counts.

6.3.c.2. Pilot plant study. -- Installation of a diatomaceous earth filtration system shall be preceded by a pilot plant study on the water to be treated. Conditions of the study such as duration, filter rates, head loss accumulation, slurry feed rates, turbidity removal, bacteria removal, etc., shall be approved by the BPH prior to the study. Satisfactory pilot plant results shall be obtained prior to preparation of final construction plans and specifications. The pilot plant study shall demonstrate the ability of the system to meet applicable drinking water standards at all times.

6.3.c.3. Types of filters. -- Pressure or vacuum diatomaceous earth filtration units may be considered for approval; however, the BPH prefers the vacuum type for its ability to accommodate a design that permits observation of the filter surfaces to determine proper cleaning, damage to a filter element, and adequate coating over the entire filter area.

6.3.c.4. Treated water storage. -- Treated water storage capacity in excess of normal requirements shall be provided: to allow operation of the filters at a uniform rate during all conditions of system demand at or below the approved filtration rate; and to guarantee continuity of service during adverse raw water conditions without by-passing the system.

6.3.c.5. Number of units. -- See subdivision 6.3.b. "Rapid Rate Gravity Filters."

6.3.c.6. Pre-coat. -- When pre-coating is accomplished with a filter-to-waste system, 0.15 to 0.2 pounds per square foot of filter area is recommended.

6.3.c.6.A. Application. -- A uniform pre-coat shall be applied hydraulically to each septum by introducing a slurry to the tank influent line and employing a filter-to-waste or recirculation system.

6.3.c.6.B. Quantity. -- Diatomaceous earth in the amount of two tenths (0.2) pounds per square foot of filter area or an amount sufficient to apply a one-eighths (1/8) inch coating shall be used with recirculation.

6.3.c.7. Body feed. -- A body feed system to apply additional amounts of diatomaceous earth slurry during the filter run is required to avoid short filter runs or excessive head losses. Rate of body feed is dependent on raw water quality and characteristics and shall be determined in the pilot plant study. Operation and maintenance can be simplified by providing accessibility to the feed system and slurry lines. Continuous mixing of the body feed slurry is required.

6.3.c.8. Filtration.

6.3.c.8.A. Rate of filtration. -- The recommended nominal rate is one (1.0) gallon per minute per square foot of filter area with a recommended maximum of one and a half (1.5) gallons per minute per square foot. The filtration rate shall be controlled by a positive means.

6.3.c.8.B. Head loss. -- The head loss shall not exceed thirty (30) pounds per square inch for pressure diatomaceous earth filters, or a vacuum of fifteen (15) inches of mercury for a vacuum system.

6.3.c.8.C. Recirculation. -- A recirculation or holding pump shall be employed 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 one tenth (0.1) gallon per minute per square foot of filter area shall be provided.

6.3.c.8.D. Septum or filter element. -- the filter elements shall be structurally capable of withstanding maximum pressure and velocity variations during filtration and backwash cycles, and shall be spaced such that no less than one (1) inch is provided between elements or between any element and a wall.

6.3.c.8.E. Inlet design. -- The filter influent shall be designed to prevent scour of the diatomaceous earth from the filter element.

6.3.c.9. Backwash. -- A satisfactory method to thoroughly remove and dispose of spent filter cake shall be provided.

6.3.c.10. Appurtenances. -- The following shall be provided for every filter: sampling taps for raw and filtered water; a loss of head or differential pressure gauge; a rate-of-flow indicator, preferably with a totalizer; evaluation of the need for body feed, recirculation and any other pumps; provisions for filtering to waste with appropriate measures for backflow prevention; and a throttling valve used to reduce rates below normal during adverse raw water conditions. Recommend a pressure hose and storage rack at the operating floor for washing the filter; a throttling valve used to reduce rates below normal during adverse raw water conditions; a flow rate controller capable of providing gradual rate increases when placing the filters back into operation; and a continuous monitoring turbidimeter with recorder on each filter effluent for plants treating surface water.

6.3.d. Slow rate gravity filters. -- The use of slow rate gravity filters shall require prior engineering studies to demonstrate the adequacy and suitability of this method of filtration for the specific raw water supply.

6.3.d.1. Quality of raw water. -- Slow rate gravity filtration shall be limited to waters having maximum turbidities of ten (10) NTU and maximum color of fifteen (15) units; this turbidity shall not be attributable to colloidal clay. Raw water quality data shall include examinations for algae to determine the nature and extent of algae growths and their potential adverse affect on filter operation.

6.3.d.2. Number. -- At least two (2) units shall be provided. Where only two (2) units are provided, each shall be capable of meeting the plant design capacity (normally the projected maximum daily demand) at the approved filtration rate. Where more than two (2) filter units are provided, the filters shall be capable of meeting the plant design capacity at the approved filtration rate with one (1) filter removed from service.

6.3.d.3. Structural details and hydraulics. -- Slow rate gravity filters shall be designed to provide: a cover; headroom to permit normal movement by operation personnel for scraping and sand removal operations; adequate hatches and access ports for handling of sand and for ventilation; protection from freezing and an overflow at the maximum filter water level.

6.3.d.4. Rates of filtration. -- The permissible rates of filtration shall be determined by the quality of the raw water and shall be on the basis of experimental data derived from the water to be treated. The nominal rate may be forty-five (45) to one hundred fifty (150) gallons per day per square foot of sand area; higher rates are acceptable when demonstrated to the satisfaction of the BPH.

6.3.d.5. 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 spaced so that the maximum velocity of the water flow in the underdrain does not exceed 0.75 feet per second. The maximum spacing of laterals shall not exceed three (3) feet if pipe laterals are used.

6.3.d.6. Filtering material. -- Filter sand shall be placed on graded gravel layers for a minimum depth of thirty (30) inches. The effective size shall be between 0.15 mm and 0.30 mm. The BPH may require a pilot study if larger sand is proposed. The uniformity coefficient shall not exceed 2.5. The sand shall be clean and free from foreign matter. The sand shall be rebedded when scraping has reduced the bed depth to no less than nineteen (19) inches. Where sand is to be reused in order to provide biological seeding and shortening of the ripening process, rebedding shall utilize a “throw over” technique whereby new sand is placed on the support gravel and existing sand is replaced on top of the new sand.

6.3.d.7. Filter gravel. -- The supporting gravel shall conform to the size and depth distribution provided for rapid rate gravity filters.

6.3.d.8. Depth of water on filter beds. -- The design shall provide a depth of at least three (3) to six (6) feet of water over the sand. Influent water shall not scour the sand surface.

6.3.d.9. Control appurtenances. -- Each filter shall be equipped with: influent and effluent sampling taps; an indicating rate-of-flow meter (A modified rate controller that limits the rate of filtration to a maximum rate may be used, but equipment that simply maintains a constant water level on the filters is not acceptable unless the rate of flow onto the filter is properly controlled); a loss of head gauge or other means to measure head loss; an orifice, Venturi meter, or other suitable means of discharge measurement 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.

6.3.d.10. Ripening. -- Slow sand filters shall be operated to waste after scraping or rebedding during ripening period until the filter effluent turbidity falls to consistently below the regulated drinking water standard established for the system.

6.3.e. Direct filtration. -- Direct filtration, as used herein, refers to the filtration of a surface water or groundwater determined to be under the direct influence of surface water following chemical coagulation and possibly flocculation without prior settling. The nature of the treatment process shall depend upon the raw water quality. In-plant demonstration studies may be appropriate where conventional treatment plants are converted to direct filtration. Where direct filtration is proposed, an engineering report shall be submitted prior to conducting the pilot plant or in-plant demonstration studies.

6.3.e.1. Engineering report. -- The engineering report shall include a historical summary of operating conditions and of meteorological conditions and of raw water quality with special reference to fluctuations in quality and possible sources of contamination. The following raw water parameters shall be evaluated in the report: color; turbidity; bacterial concentration; microscopic biological organisms; temperature; total solids; general inorganic chemical characteristics; and additional parameters as required by the BPH. The report shall also include a description of methods and work to be done during a pilot plant study or, where appropriate, an in-plant demonstration study.

6.3.e.2. Pilot plant studies. -- The BPH may, after approval of the engineering report, require a pilot study or in-plant demonstration study by the public water system or their engineer. The study shall be conducted over a sufficient time to treat all expected raw water conditions throughout the year. The study shall emphasize, but not be limited to, the following items: chemical mixing conditions including shear gradients and detention periods; chemical feed rates; use of various coagulants and coagulant aids; flocculation conditions; filtration rates; filter gradation; types of media and depth of media; filter breakthrough conditions; and the adverse impact of recycling backwash water due to microorganisms, solids, algae, trihalomethane formation and other similar problems; length of filter runs; length of backwash cycles; quantities and make-up of the wastewater. The public water system or their engineer, prior to the initiation of design plans and specifications, shall submit a final report including the engineer's design recommendations to the BPH. The pilot plant filter shall be of a similar type and operated in the same manner as proposed for full scale operation. The pilot study shall demonstrate the minimum contact time necessary for optimum filtration for each coagulant proposed.

6.3.e.3. Pretreatment. -- The final coagulation and flocculation basin design should be based upon the pilot plant or in-plant demonstration studies augmented with applicable portions of subdivision 6.2.b. “Coagulation” and subdivision 6.2.c. “Flocculation.”

6.3.e.4. Filtration. -- Filters shall be rapid rate gravity filters with dual or mixed media. The final filter design shall be based on the pilot plant or in-plant demonstration studies and all portions of subdivision 6.3.a. “Rapid Rate Gravity Filters.” Pressure filters or single media sand filters shall not be used.

6.3.e.5. Appurtenances. -- Every filter shall have an influent and effluent sampling taps, an indicating loss of head gauge and an indicating rate-of-flow meter. A modified rate controller which limits the rate of filtration to a maximum rate may be used but the equipment that simply maintains a constant water level on the filters is not acceptable unless the rate of flow onto the filter is properly controlled; and provisions for filtering to waste with appropriate measures for cross connection control. For systems with three or more filters, on-line turbidimeters shall be installed on the effluent line from each filter. All turbidimeters shall consistently determine and indicate turbidity in NTUs. Each turbidimeter shall report to a recorder that is designed and operated to allow the operator to accurately determine the turbidity at least once every fifteen (15) minutes. Turbidimeters on individual filters should be designed to accurately measure low-range turbidities and have an alarm that sounds when the effluent level exceeds 0.3 NTUs. It is recommended that every filter have wall sleeves providing access to the filter interior at several locations for sampling or pressure sensing; a pressure hose and storage rack at the operating floor for washing filter walls; and a flow rate controller capable of providing gradual rate increases when placing the filters back into operation.

6.3.e.6. Site requirements. -- The plant and its design and land ownership surrounding the plant shall allow for modifications of the plant.

6.3.f. Deep bed rapid rate gravity filters. -- Deep bed rapid rate gravity filters, as used herein, generally refers to rapid rate gravity filters with filter material depths equal to or greater than forty-eight (48) inches. Filter media sizes are typically larger than those required in conventional rapid rate gravity sand filters. Deep bed rapid rate filters may be considered based upon pilot studies approved by the BPH and shall comply with all applicable portions of subdivision 6.3.a. of this section.

6.3.g. Biologically active filters. -- Biologically active filtration, as used herein, refers to the filtration of a surface water (or a ground water with iron, manganese or significant natural organic material) which includes the establishment and maintenance of biological activity within the filtration media. Objectives of biologically active filtration may include control of disinfection byproduct precursors, increased disinfection stability, reduction of substrates for microbial regrowth, breakdown of small quantities of synthetic organic chemicals, reduction of ammonia-nitrogen, and oxidation of iron and manganese. Biological activity can have an adverse impact on turbidity, particle and microbial pathogen removal, disinfection practices; head loss development; filter run times and distribution system corrosion. Design and operation should ensure that aerobic conditions are maintained at all times. Biologically active filtration often includes the use of ozone as a pre-oxidant/disinfectant which breaks down natural organic materials into biodegradable organic matter and granular activated carbon filter media which may promote denser biofilms.

6.3.g.1. Pilot study. -- Biologically active filters may be considered based on pilot studies approved by the BPH. The study objectives must be clearly defined and must ensure the microbial quality of the filtered water under all anticipated conditions of operation. The pilot study shall be greater than three (3) months. The pilot study shall establish empty bed contact time, biomass loading, and/or other parameters necessary for successful operation as required by the BPH. The final filter design shall be based on the pilot study studies and shall comply with all applicable portions of subdivision 6.3.a. of this section.

6.3.h. Membrane Filtration Systems. -- Membrane filtration systems, as used herein, generally refer to a complete and fully functional treatment system employing the use of a selective, physical barrier, consisting of thin sheets or hollow fibers of polymeric and/or inorganic materials, for the removal of suspended and/or dissolved solids from the source water. Such systems are often comprised of several sub-systems, or components, including: Membrane modules or cassettes; the membrane filtration skids, basins, or arrays; backwash sub-systems for frequent removal of suspended solids; chemical clean-in-place sub-systems to maintain the membrane performance and treatment capacity; air compressors and air blowers for control, maintenance, and integrity testing of the membrane system components; pumps; valves; piping; and related motor and supervisory controls necessary to operate and monitor membrane filtration performance. Membrane filtration systems require consideration for prescreening, pre-treatment, post-treatment, and residuals handling to properly maintain long-term performance.

6.3.h.1. Applicability. -- Membrane filtration systems can be identified within four (4) categories, including microfiltration (MF), ultrafiltration (UF), nanofiltration (NF), and reverse osmosis (RO). These categories of membranes shall be used in the following three (3) types of membrane filtration systems; Provided, that the membranes may be used in other systems with the approval of BPH.

6.3.h.1.A. Low Pressure Membrane Filtration Systems. -- Microfiltration and ultrafiltration are specifically used for the removal of suspended solids, including pathogens [e.g., protozoa, bacteria, and viruses, particulate matter, and natural organic matter (NOM)] depending on the membrane material's effective pore size. These types of systems are recognized as a treatment technique for the removal of Giardia, Cryptosporidium, and other pathogens from surface water sources and groundwater sources under the influence of surface water.

6.3.h.1.B. High Pressure Membrane Filtration Systems. -- Reverse osmosis and nanofiltration are specifically used for the removal of dissolved solids, including monovalent (e.g., sodium and chloride) and divalent (e.g., calcium and manganese) ions, depending on the membrane material's diffusive properties. These types of systems are recognized as a Best Available Technology (BAT) for the removal of inorganic constituents, e.g. radium and nitrates, from groundwater sources.

6.3.h.1.C. Alternative Membrane Filtration Systems. -- Membrane filtration systems can be configured in various ways to target specific treatment objectives. For example, integrated membrane filtration systems can use a combination of both low and high pressure membrane filtration systems. Electrodialysis reversal (EDR) systems employ electrical charges placed on either side of the membrane filter material to promote ion specific removal through high pressure membrane filtration systems.

6.3.h.2. Design Considerations. -- When considering the use of membrane filtration technologies, the BPH shall be contacted prior to the development of an Engineer's Report (subsection 3.2) to establish additional requirements necessary for approval, as identified in subdivision 3.2.j of this rule. Design criteria for the proposed membrane filtration system should consist, at a minimum, of data related to gross and net flux (gallons per day per square foot of active membrane area), range of backwash frequencies, backwash duration and rates, range of membrane system recovery as a percentage of production vs. feed water, membrane system area, membrane system configuration, clean-in-place frequencies and solutions, transmembrane pressure operating range, number of skids/basins/arrays, residuals quantity and quality, and related design parameters. To demonstrate treatment efficacy, approval of the Engineer's Report may be based on the following items:

6.3.h.2.A. Effective Removal Credit. -- The BPH shall make a determination based on the effective log removal value (LRV) credit given for pathogens based on treatment objectives and type of membrane system. Data demonstrating membrane system LRV credit shall be provided to the BPH, including, but not limited to, standard calculations, integrity testing procedures, and actual test data demonstrating performance based on applicable ASTM, AWWA, and other standards.

6.3.h.2.B. Water Quality. -- Water quality can have a measureable and potentially deleterious impact on membrane system performance, impacting the membrane system feasibility and life cycle cost. Therefore, a review of source water quality data, including range of turbidity, pH, alkalinity, hardness, total and dissolved inorganics, total and dissolved organic carbon, water temperature, color, seasonal variations, microbial and algal activity, in addition to other physical parameters should be conducted. Anticipated feed water quality goals, based on the amount and type of pretreatment, shall be evaluated to compare the amount of membrane area and transmembrane pressure required to operate at design flows with seasonal fluctuations in water quality. In anticipation of extreme conditions (e.g., failure of pretreatment, high turbidity, cold temperature, high algal counts, and high organic carbon concentrations), data should be evaluated and summarized, demonstrating how water quality and membrane filtration system capacity can be maintained during and after these extreme conditions. If source water quality is unknown or insufficiently demonstrated, the BPH may require additional water quality sampling for specific constituents, specified frequency, and duration of time to understand potential variations in water quality.

6.3.h.2.C. Redundancy. -- The amount of membrane surface area in operation at any given time shall be sufficient to maintain the rated design capacity, with a portion of the total membrane surface out of service, to maintain redundant systems. A redundant membrane filtration system design should be based on a minimum N-1 installation, where N is the total number of membrane system skids, basins or arrays that are supplied for the specific project, and N-1 is the total of membrane system skids, basins or arrays supplied minus one skid, basin or array out-of-service. Under N-1 operation, consideration shall be given to N being sufficient, such that clean-in-place, integrity, and backwash procedures can be performed with a reasonable impact on design capacity and operations. Additional redundancy shall be provided for critical membrane filtration system components including, but not limited to, valves, sensors, computers and related control systems, compressed air systems, certain pumps and other identified system components.

6.3.h.2.D. Long Term Fouling Allowance. -- Membrane materials are susceptible to declining permeability, or decrease in the amount of water produced for the same transmembrane pressure, because of long term fouling. While water conditions vary, the design should consider space within each skid, basin or array to increase the total membrane surface area to at least one hundred ten percent (110%) of the installed design membrane filtration surface area, without the need to construct additional infrastructure. The reserved unused space shall be provided with false modules or cassettes to maintain uniform conditions within membrane skid, basin or array.

6.3.h.3.E. Membrane Integrity. -- Based on the LRV credit established by the BPH, low pressure membrane systems shall be equipped with an automated membrane integrity test procedure that measures and calculates the effective LRV value of the membrane material on a daily basis. Integrity testing shall be based on the pressure decay test procedure established in ASTM D6908 – Integrity Testing of Water Filtration Membrane Systems or other approved method. When theta (θ) is less than 1, as indicated within the ASTM D908 standard, procedures and data shall be provided on how the membrane material surface wetting angle should be verified to calculate the effective LRV. Concentration of suspended solids within each skid, basin, or array during normal operation may also contribute to the LRV calculation. The membrane filtration system shall be provided with a method for detecting broken or comprised membrane modules, cassettes, and related appurtenances, including equipment and materials necessary to restore membrane system integrity.

6.3.h.3.F. Pretreatment. -- Membrane filtration system designs rely on an understanding of acceptable feedwater characteristics. The performance of the pretreatment process must be coordinated with the membrane system design. Without suitable pretreatment or acceptable feed water quality, membrane life is often shortened due to irreversible fouling or by more frequent, oxidant based clean-in-place procedures to maintain system capacity. At a minimum, the following pretreatment considerations shall be included:

6.3.h.3.F.1. Surface water systems. -- The following pretreatment systems shall be provided for low pressure membrane filtration systems including chemical coagulant and related storage and feed systems, disinfection, clarification consisting of: rapid mix; a combination of flocculation and a four (4) hour retention time based sedimentation basins (the BPH may allow a two (2) hour retention time if the raw water source is a reservoir with a minimum of six (6) months storage and a plate/tube settler is used in the sedimentation basins); or a four (4) hour retention time based solid contact units (the BPH may allow a 2 hour retention time if the raw water source is a reservoir with a minimum of six (6) months storage); and prescreening to protect the membrane filtration from exposure to environmental debris, e.g. leaves, dust, and biota. Four (4) hour retention time shall be based on design flows higher than the production capacity of the membrane filtration system to account for total of production water, backwash water, and clean-in-place make up water, sediment or sludge removal, and other water demand requirements of the planned facility.

6.3.h.3.F.2. Groundwater and groundwater under the influence of surface water based systems. -- The following pretreatment systems shall be provided for high pressure membrane filtration systems for the removal of suspended solids, e.g. cartridge filters or low pressure membrane filtration systems, stabilization of the feed water to prevent scale formation, microbial control, and pH adjustment. Additional consideration shall be given for disinfection, aeration, and ion specific pretreatment depending on treatment objectives. For low pressure membrane filtration systems, pretreatment should minimally consist of at least disinfection to prevent microbial growth and oxidation techniques specific for iron and manganese removal. For both types of systems, additional pretreatment or other treatment techniques may be required based on conditions after well development and operation have been verified because of varying well borehole conditions, e.g. sand production and drawdown characteristics, geological strata, and water quality.

6.3.h.3.G. Pilot studies. -- The BPH requires the development of a pilot system test protocol for evaluation of the proposed treatment process using membrane filtration. The pilot system test protocol shall adequately describe the proposed pilot system setup, sampling frequencies and location, system monitoring and controls, integrity testing procedures, treatment goals and objectives, quality control, and operating conditions, consistent with the planned operation of the full scale membrane filtration system and overall treatment process. Following approval of the pilot system test protocol by the BPH, the pilot study or in-plant demonstration shall be conducted by the public water system and/or their engineer. The pilot study should be conducted over a sufficient time (recommended 6 months to 12 months) to treat anticipated water quality conditions throughout the year for surface water systems, but shall not be less than six (6) weeks. Groundwater systems shall provide a pilot study of at least six (6) weeks, based on anticipated use, e.g., if the well is planned to operate eight (8) hours every day with sixteen (16) hours of recovery, the pilot should be run for a similar twenty-four (24) hour operating condition for up to a total of forty five (45) operational days. The pilot system study should target a range of operating and feed water quality and quantity conditions that could be expected during operation of the planned full scale system. For disposal or treatment of the membrane filtration system reject, concentrate, backwash, and/or spent clean-in-place solutions, additional bench or pilot scale studies may be required to demonstrate the quantity and quality of discharge for the assessment of disposal costs, waste treatment controls, and ability to meet permit requirements established by the BPH and other agencies.

6.3.h.3.H. Total Life Cycle Cost. -- Full scale membrane filtration systems are associated with quantifiable costs for purchase, operation, and maintenance. Where possible, the evaluation and comparison of multiple membrane filtration systems shall be based on similar design parameters and treatment objectives. Capital costs should consider the equipment, appurtenances, infrastructure, and special services required for design, installation, startup, training, and post-startup assistance. Operational costs related to power consumption, chemical use, membrane replacement, maintenance replacement, residuals handling and disposal, and facility operations should also be identified and evaluated. The Engineering Report should be used to establish how operational costs are calculated based on planned production, transmembrane pressure, clean-in-place types and frequencies, membrane life, maintenance reserve, and facility operations. Conservative membrane replacement costs require specific attention to useful life and distribution of payments, and may be supported by operational data from other similar facilities. Pilot study data may be used to verify total life cycle costs prior to construction of full scale facilities.

6.3.h.3.I. Cross-connection Control. -- Membrane skids, basins, or arrays shall be equipped with positive controls to prevent cross-connection of chemical clean-in-place and waste solutions with the treated water supplying the public water system. Methods incorporating block-and-bleed systems and air gaps are preferred for chemical clean-in-place solution piping. Following chemical clean-in-place procedures, rinsing procedures should be considered to reduce the impact of residual chemical clean-in-place solutions on finished water quality.

6.3.h.3.J. NSF Applicability. -- Oils, greases, lubricants and in-situ clean-in-place chemicals in contact with the process water should be NSF/ANSI Standard 60 certified or of suitable food grade quality (FDA). Where applicable, membrane system components and materials in contact with the process water shall be NSF/ANSI Standard 61 certified.

6.4. Disinfection. -- Chlorine is the preferred disinfecting agent. Disinfection may be accomplished with gas and liquid chlorine, calcium or sodium hypochlorites, chlorine dioxide, ozone or ultraviolet light. Other disinfecting agents may be considered, providing reliable application equipment is available and testing procedures for a residual are recognized in "Standard Methods for the Examination of Water and Wastewater," latest edition. Continuous disinfection is required for all public water systems. Since disinfection agents other than chlorine usually demonstrate shortcomings when applied to a public water system, proposals for use of disinfecting agents in combination with chlorine or other than chlorine require approval by the BPH prior to preparation of final plans and specifications.

6.4.a. Chlorination equipment.

6.4.a.1. Type. -- Solution-feed, gas chlorinators or hypochlorite feeders of the positive displacement type shall be provided.

6.4.a.2. Capacity. -- The chlorinator capacity shall be such that a free chlorine residual of at least two (2) milligrams per liter can be maintained in the water to meet the CT for surface water and ground water when maximum flow rate coincides with anticipated maximum chlorine demand, maximum pH and minimum temperatures. The equipment shall be of such design that it operates accurately over the desired feeding range.

6.4.a.3. Standby equipment. -- Standby equipment of sufficient capacity shall be available to replace the largest unit. Spare parts shall be made available to replace parts subject to wear and breakage. If there is a large difference in feed rates between routine and emergency dosages, a gas metering tube shall be provided for each dose range to ensure accurate control of the chlorine feed.

` 6.4.a.4. Automatic switchover. -- Automatic switchover of chlorine cylinders shall be provided, where necessary, to assure continuous disinfection.

6.4.a.5. Automatic proportioning. -- Automatic proportioning chlorinators are required where the rate of flow or chlorine demand is not reasonably constant.

6.4.a.6. Eductor. -- Each eductor shall be selected for the point of application with particular attention given to the quantity of chlorine to be added, the maximum injector water flow, the total discharge back pressure, the injector operating pressure, and the size of the chlorine solution line. Gauges for measuring water pressure and vacuum at the inlet and outlet of each eductor shall be provided.

6.4.a.7. Injector/diffuser. -- The chlorine solution injector/diffuser shall be compatible with the point of application to provide a rapid and thorough mix with all the water being treated. The center of a pipeline is the preferred application point.

6.4.b. Contact time and point of application.

6.4.b.1. Due consideration shall be given to the contact time of the chlorine in water with relation to pH, ammonia, taste-producing substances, temperature, bacterial quality, disinfection byproduct formation potential and other pertinent factors. The disinfectant shall be applied at a point that provides adequate contact time. All basins used for disinfection shall be designed to minimize short circuiting. Additional baffling can be added to new or existing basins to minimize short circuiting and increase contact time.

6.4.b.2. At plants treating surface water, provisions shall be made for applying disinfectant to the raw water, settled water, filtered water, and water entering the distribution system. The contact time as required shall be provided after filtration.

6.4.b.3. As a minimum, at plants treating groundwater, provisions shall be made for applying the disinfectant to the detention basin inlet and water entering the distribution system.

6.4.b.4. The minimum contact time for surface water sources and ground water sources shall be determined by "CT Calculations." Details for calculating "CT" values are contained in the West Virginia Bureau for Public Health's rule, Public Water Systems, 64CSR3. If primary disinfection is accomplished using ozone or some other chemical that does not provide a residual disinfectant, then chlorine shall be added to provide a residual disinfectant as provided in subdivision 6.4.c.

6.4.c. Residual chlorine. -- Minimum total chlorine residual at all points in a water distribution system shall be two tenths (0.2) milligrams per liter. Higher residuals may be required depending on pH, temperature and other characteristics of the water. Booster chlorination may be required to maintain proper residuals.

6.4.d. Testing equipment. -- Chlorine residual test equipment recognized in the latest edition of the Standard Methods for the Examination of Water and Wastewater publication, shall be provided and shall be capable of measuring residuals as contained in the West Virginia Bureau for Public Health's legislative rule, Public Water Systems, 64CSR3. Automatic chlorine residual recorders shall be provided where the chlorine demand varies appreciably over a short period of time. All surface water treatment plants designed to serve three thousand three hundred (3,300) people or more shall be equipped with recording chlorine analyzers and continuous recorders monitoring water entering the distribution system.

6.4.e. Chlorinator piping.

6.4.e.1. Cross-connection protection. -- The chlorinator water supply piping shall be designed to prevent contamination of the treated water supply by sources of questionable quality. At all facilities treating surface water, pre- and post-chlorination systems shall be independent to prevent possible siphoning of partially treated water into the clear well. The water supply to each eductor shall have a separate shut-off valve. No master shut-off valve is allowed.

6.4.e.2. Pipe material. -- The pipes carrying elemental liquid or dry gaseous chlorine under pressure shall be Schedule Eighty (80) seamless steel tubing or other materials recommended by the Chlorine Institute, Inc. (never use poly vinyl chloride, PVC). Rubber, PVC, polyethylene, or other materials recommended by the Chlorine Institute, Inc. shall be used for chlorine solution piping and fittings. Nylon products are not acceptable for any part of the chlorine solution piping system.

6.4.f. Housing. -- Adequate housing must be provided for the chlorination equipment and for storing the chlorine.

6.4.g. Ozone.

6.4.g.1. Design considerations. -- Ozone systems are generally used for the purpose of disinfection, oxidation and microflocculation. When applied, all of these reactions may occur but typically only one is the primary purpose for its use. The other reactions would become secondary benefits of the installation. Effective disinfection occurs as demonstrated by the fact that the "CT" values for ozone, for inactivation of viruses and Giardia cysts, are considerably lower than the "CT" values for other disinfectants. In addition, recent research indicates that ozone can be an effective disinfectant for the inactivation of cryptosporidium. Microflocculation and enhanced filterability has been demonstrated for many water supplies but has not occurred in all waters. Oxidation of organic compounds such as color, taste and odor, and detergents and inorganic compounds such as iron, manganese, heavy metals and hydrogen sulfide has been documented. The effectiveness of oxidation has been varied, depending on pH, alkalinity of the water. These parameters affect the formation of highly reactive hydroxyl radicals, or, conversely the scavenging of this oxidant. High levels of hydroxyl radicals cause lower levels of residual ozone. Depending on the desired oxidation reaction, it may be necessary to maximize ozone residuals or maximize hydroxyl radical formation. For disinfection, residual ozone is necessary for development of "CT". As a minimum, bench scale studies shall be conducted to determine minimum and maximum ozone dosages for disinfection "CT" compliance and oxidation reactions. More involved pilot studies shall be conducted when necessary to document benefits and disinfectant by-product (DBP) precursor removal effectiveness. Consideration shall be given to multiple points of ozone addition. Pilot studies shall be conducted for all surface waters. Extreme care must be taken during bench and pilot scale studies to ensure acute results: particularly sensitive measurements for gas flow rate, water flow rate, and ozone concentration. Following the use of ozone, the application of a disinfectant which maintains a measurable residual is required throughout the distribution system. Because of the sophisticated nature of the ozone process, the public water system managers must make a commitment to obtaining qualified operators that are trained in the ozone process prior to the startup of an ozone process. The production of ozone is an energy intensive process: substantial economics in electrical usage, reduction in equipment size, and waste heat removal requirements can be obtained using oxygen enriched air or 100% oxygen as feed, and by operating at increased electrical frequency. The use of ozone may result in increases in biologically available organics content of the treated water. Consideration of biologically active filtration may be required to stabilize some treated waters. Ozone use may also lead to increased chlorinated byproduct levels if the water is not stabilized and free chlorine is used for distribution protection.

6.4.g.2. Feed gas preparation.

6.4.g.2.A. General. -- Feed gas can be air, oxygen enriched air or high purity oxygen. Sources of high purity oxygen include purchased liquid oxygen; on-site generation using cryogenic air separation; or temperature, pressure or vacuum swing (absorptive separation) technology. For high purity oxygen-fed systems, dryers typically are not required. Air handling equipment on conventional low pressure feed systems shall consist of an air compressor, water/air separator, refrigerant dryer, heat reactivated desiccant dryer, and particulate filters, Provided, that some "package" ozonation systems for small plants may work effectively operating at high pressure without the refriderant dryer and with a "heat-less" desiccant dryer and may not be required to have those elements. In all cases the design engineer shall ensure that the maximum dew point of -76ºF (-60°C) is not exceeded at any time.

6.4.g.2.B. Air compressor. -- Air compressors shall be of the liquid-ring or rotary lobe, oil-less positive displacement type for smaller systems or dry rotary screw compressors for larger systems. The air compressors shall have the capacity to simultaneously provide for maximum ozone demand, provide the air flow required for purging the desiccant dryers (where required) and allow for standby capacity. Air feed for the compressor shall be drawn from a point protected from rain, condensation, mist, fog and contaminated air sources to minimize moisture and hydrocarbon content of the air supply. A compressed air after-cooler and/or entrainment separator with automatic drain shall be provided to the dryers to reduce the water vapor. A back-up air compressor shall be provided so that the ozone generation is not interrupted in the event of a break-down.

6.4.g.2.C. Air drying. -- Dry, dust-free and oil-free feed gas shall be provided to the ozone generator. Dry gas is essential to prevent formation of nitric acid, to increase the efficiency of ozone generation and to prevent damage to the generator dielectrics. Sufficient drying to a maximum dew point of -76ºF (-60ºC) shall be provided at the end of the drying cycle. Drying for high pressure systems may be accomplished using heatless desiccant dryers only. For low pressure systems, a refrigeration air dryer I series with heat-reactivated desiccant dryers shall be used. A refrigeration dryer capable of reducing inlet air temperature to 40ºF (4ºC) shall be provided for low pressure air preparation systems. The dryer may be of the compressed refrigerant type or chiller water type. For heat-reactivated desiccant dryers, the unit shall contain two desiccant filled towers complete with pressure relief valves, two four-way valves and a heater. In addition, external type dryers shall have a cooler unit and blowers. The size of the unit shall be such that the specified dew point is achieved during a minimum absorption cycle time of sixteen (16) hours while operating at the maximum expected moisture loading conditions. Multiple air dryers shall be provided so that the ozone generation is not interrupted in the event of a breakdown. Each dryer shall be capable of venting “dry” gas to the atmosphere, prior to the ozone generator, to allow start-up when other dryers are “on-line”.

6.4.g.2.D. Air filters. -- Air filters shall be provided on the suction side of the air compressors, between the air compressors and the dryers and between the dryers and the ozone generators. The filter before the desiccant dryers shall be of the coalescing type and be capable of removing aerosol and particulates larger than three tenths (0.3) microns in diameter. The filter after the desiccant dryer shall be of the particulate type and be capable of removing all particulates greater than one tenths (0.1) microns in diameter, or smaller if specified by the generator manufacturer.

6.4.g.2.E. Preparation piping. -- Piping in the air preparation system may be common grade steel, seamless copper, stainless steel or galvanized steel. The piping shall be designed to withstand the maximum pressures in the air preparation system.

6.4.g.3. Ozone Generator.

6.4.g.3.A. Capacity. -- The production rating of the ozone generators shall be stated in pounds per day and kilowatt hours per pound at a maximum cooling water temperature and maximum ozone concentration. The design shall ensure that the minimum concentration of ozone in the generator exit gas is not less than one (1%) percent by weight. Generators shall be sized to have sufficient reserve capacity so that the system does not operate at peak capacity for extended periods of time, which can result in premature breakdown of the dielectrics. The production rate of ozone generators may decrease as the temperature of the coolant increases. If there is to be a variation in the supply temperature of the coolant throughout the year, then the pertinent data shall be used to determine production changes due to the temperature change of the supplied coolant. The design shall ensure that the generators can produce the required ozone at maximum coolant temperature. Ozone backup equipment must be provided.

6.4.g.3.B. Cooling. -- Adequate cooling shall be provided. The required water flow to an ozone generator varies with the ozone production. Normally unit design provides a maximum cooling water temperature rise of 5ºF (2.8ºC). The cooling water shall be properly treated to minimize corrosion, scaling and microbiological fouling of the water side of the tubes. A closed loop cooling water system is often used to insure proper water conditions are maintained. Where cooling water is treated cross connection control shall be provided to prevent contamination of the potable water supply.

6.4.g.3.C. Materials. -- To prevent corrosion, the ozone generator shell and tubes shall be constructed of Type 316L stainless steel.

6.4.g.4. Ozone Contactors. -- The selection of design of the contactor and method of ozone application depends on the purpose for which the ozone is being used.

6.4.g.4.A. Bubble diffusers. -- Where disinfection is the primary application a minimum of two contact chambers each equipped with baffles to prevent short circuiting and induce countercurrent flow shall be provided. Ozone shall be applied using porous-tube or dome diffusers. The minimum contact time shall be ten (10) minutes. A shorter contact time may be approved by the BPH if justified by appropriate design and “CT” considerations. For ozone applications in which precipitates are formed, such as with iron and manganese removal, porous diffusers should be used with caution. Where taste and odor control is of concern, multiple application points and contactors shall be considered. Contactors should be separate closed vessels that have no common walls with adjacent rooms. The contactor must be kept under negative pressure and sufficient monitors shall be provided to protect worker safety. The contactor shall be placed where the entire roof is exposed to the open atmosphere. Large contact vessels shall be constructed of reinforced concrete. All reinforcement bars shall be covered with a minimum of one and one half (1.5) inches of concrete. Smaller contact vessels can be made of stainless steel, fiberglass or other material which is stable in the presence of residual ozone and ozone in the gas phase above the water level. When necessary a system shall be provided between the contactor and the off-gas destruct unit to remove froth from the air and return the other tot the contactor or other location acceptable to the BPH. If foaming is expected to be excessive, then a potable water spray system shall be placed in the contactor head space. All openings into the contactor for pipe connections, hatchways, etc. shall be properly sealed using welds or ozone resistant gaskets such as Teflon or Hypalon. Multiple sampling ports shall be provided to enable sampling of each compartment's effluent water and to confirm "CT" calculations. A pressure/vacuum relief valve shall be provided in the contactor and piped to a location where there will be no damage to the destruction unit. The diffusion system should work on a countercurrent basis such that ozone is fed at the bottom of the vessel and water is fed at the top of the vessel. The depth of water in bubble diffuser contactors should be a minimum of eighteen (18) feet. The contactor should also have a minimum of three (3) feet of freeboard to allow for foaming. All contactors shall have provisions for cleaning, maintenance and drainage of the contactor. Each contactor compartment shall be equipped with an access hatchway. Aeration diffusers shall be fully serviceable by either cleaning or replacement.

6.4.g.4.B. Other contactors. -- Other contactors, such as venture or aspirating turbine mixer contactor, may be approved by the BPH provided adequate ozone transfer is achieved and the required contact times and residuals can be met and verified.

6.4.g.5. Ozone Destruction Unit. -- A system for treating the final off-gas from each contactor shall be provided in order to meet safety and air quality standards. Acceptable systems include thermal destruction and thermal/catalytic destruction units. To reduce the risk of fires, the use of units that operate at lower temperatures is encouraged, especially where high purity oxygen is the feed gas. The maximum allowable ozone concentration in the discharge is 0.1 ppm by volume. At least two (2) units shall be provided that are each capable of handling the entire gas flow. Exhaust blowers shall be provided in order to draw off-gas from the contactor into the destruct unit. Catalysts shall be protected from froth, moisture and other impurities which may harm the catalysts. The catalysts and heating elements shall be located where they can easily be reached for maintenance.

6.4.g.6. Piping Materials. -- Only low carbon 304L or 316L stainless steel shall be used for ozone service with 316L the preferred.

6.4.g.7. Joints and Connections. -- Connections on piping used for ozone service shall be welded where possible. Connections with meters, valves, or other equipment are to be made with flanged joints with ozone resistant gaskets, such as Teflon or Hypalon. Screwed fittings shall not be used because of their tendency to leak. A positive closing plug or butterfly valve plus a leak-proof check valve shall be provided in the piping between the generator and the contactor to prevent moisture reaching the generator.

6.4.g.8. Instrumentation. -- Pressure gauges shall be provided at the discharge from the air compressor, at the inlet to the refrigeration dryers, at the inlet and outlet of the desiccant dryers, at the inlet to the ozone generators and contactors and at the inlet to the ozone destruction unit. Electric power meters shall be provided for measuring the electric power supplied to the ozone generators. Each generator shall have a trip that shuts down the generator when the wattage exceeds a certain preset level. Dew point monitors shall be provided for measuring the moisture of the feed gas from the desiccant dryers. Because it is critical to maintain the specified dew point, it is recommended that continuous recording charts be used for dew point monitoring which allows for proper adjustment of the dryer cycle. Where there is potential for moisture entering the ozone generator during shutdown, post generator dew point monitors shall be used. Air flow meters shall be provided for measuring air flow from the desiccant dryers to each of other ozone generators, air flow to each contactor and purge air flow to the desiccant dryers. Temperature gauges shall be provided for the inlet and outlet of the ozone cooling water and the inlet and outlet of the ozone generator feed gas, and if necessary, for the inlet and outlet of the ozone power supply cooling water. Water flow meters shall be installed to monitor the flow of cooling water to the ozone generators and, if necessary, to the ozone power supply. Ozone monitors shall be installed to measure ozone concentration in both the feed-gas and off gas from the contactor and in the off-gas from the destruct unit. For disinfection systems, monitors shall also be provided for monitoring ozone residuals in the water. The number and location of ozone residual monitors shall be such that the amount of time that the water is in contact with the ozone residual can be determined. A minimum of one (1) ambient ozone monitor shall be installed in the vicinity of the contactor and a minimum of one (1) shall be installed in the vicinity of the generator. Ozone monitors shall also be installed in any areas where ozone may accumulate.

6.4.g.9. Alarms. -- The following alarm/shutdown systems shall be considered at each installation: Dew point shutdown/alarm - this system should shut down the generator in the event the system dew point exceeds -76°F(-60ºC). Ozone generator cooling water flow shutdown/alarm - this system shall shutdown the generator in the event that cooling water flows decrease to the point that generator damage could occur. Ozone power supply cooling water flow shutdown/alarm - this system shall shutdown the power supply in the event that cooling water flow decreases to the point that damage could occur to the power supply. Ozone generator cooling water temperature shutdown/alarm - this system shall shutdown the generator if either the inlet or outlet cooling water exceeds a certain preset temperature. Ozone power supply water temperature shutdown/alarm - this system shall shutdown the power supply if either the inlet or outlet cooling water exceeds a certain preset temperature. Ozone generator inlet feed-gas temperature shutdown/alarm - this system shall shutdown the generator if the feed-gas temperature is above a preset value. Ambient ozone concentration shutdown/alarm - the alarm shall sound when ozone level in the ambient air exceeds 0.1 ppm or a lower value chosen by the water supplier and ozone generator shutdown shall occur when ambient ozone levels exceed 0.3 ppm (or a lower level) in either the vicinity of the ozone generator or the contactor. Ozone destruct temperature alarm - this alarm shall sound when temperature exceeds a preset value.

6.4.g.10. Safety. -- The maximum allowable ozone concentration in the air to which workers may be exposed shall not exceed 0.1 ppm (by volume). Noise levels resulting from the operating equipment of the ozonation system shall be controlled to within acceptable limits by special room construction and equipment isolation. High voltage and high frequency electrical equipment shall meet current electrical and fire codes. Emergency exhaust fans shall be provided in rooms containing the ozone generators to remove ozone gas if leakage occurs. A portable purge air blower shall be provided that removes residual ozone in the contactor prior to entry for repair or maintenance. A sign shall be posted indicating “No smoking, oxygen in use” at all entrances to the treatment plant. In addition, no flammable or combustible materials shall be stored within the oxygen generator areas.

6.4.g.11. Construction considerations. -- Prior to connecting the piping from the desiccant dryers to the ozone generators the air compressors shall be used to blow the dust out of the desiccant. The contactor shall be tested for leakage after sealing the exterior and this can be done by pressurizing the contactor and checking for pressure losses. Connections on the ozone service line shall be tested for leakage using the soap-test method.

6.4.h. Chlorine Dioxide. -- May be considered as a primary and residual disinfectant, a pre-oxidant to control taste and odors, to oxidize iron and manganese, and to control hydrogen sulfide and phenolic compounds. It has been shown to be a strong disinfectant which does not form THMs or HAAs. When choosing chlorine dioxide, consideration must be given to formation of the regulated byproducts, chlorite and chlorate.

6.4.h.1. Chlorine dioxide generators. -- Chlorine dioxide generation equipment shall be factory assembled pre-engineered units with a minimum efficiency of 95 percent (95%). The excess free chlorine shall not exceed three percent (3%) of the theoretical stoichiometric concentration required.

6.4.h.2. Feed and storage facilities. -- Chlorine gas and sodium chlorite feed and storage facilities shall comply with subsection 7.0.

6.4.h.3. Other design requirements. -- The design shall comply with all applicable portions of subdivisions 6.4.a, 6.4.b, 6.4.d and 6.4.e of this section. The minimum residual disinfectant shall be established by the BPH.

6.4.h.4. Public notification. -- Notification of a change in disinfection practices and the schedule for the changes shall be made known to the public; particularly to hospitals, kidney dialysis facilities and fish breeders, as chlorine dioxide and its byproducts may have similar effects as chloramines.

6.4.i. Ultraviolet light. -- The United States Environmental Protection Agency (EPA) has promulgated the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) to further reduce microbial contamination of drinking water. The rule requires additional treatment for some public water supplies based on their source water Cryptosporidium concentrations and current treatment practices. Ultraviolet light (UV) disinfection is one option public water supplies have to comply with the additional treatment requirements. The EPA has released a document entitled Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule. This guidance manual may be used as the basis for the validation, design and operation of all UV systems used for public water systems and for the development of the recommended standards for those systems. Supplemental disinfection for additional virus inactivation and to provide a residual in the water distribution system is required by the BPH.

6.4.i.1. Criteria for UV Water Treatment Devices. -- UV water treatment devices must be validated by a third-party entity in accordance with the USEPA Ultraviolet Light Disinfection Guidance Manual (USEPA UVDGM), the German Association of Gas and Water (UVGW), the Austrian Standards Institute (ONORM), the National Water Research Institute/American Water Works Association Research Foundation (NWR/AwwaRF), the Class A criteria under ANSI/NSF Standard 55- Ultraviolet Microbiological Water Treatment Systems; or other standards approved by the BPH. The validation must demonstrate that the unit is capable of providing a UV light dose of 40 millijoules per square centimeter (mJ/cm^2) throughout the reactor based on water quality, specifically transmittance of the dose through the treated water. Higher dosages may be required depending on application, e.g., type of pathogen inactivation and water quality conditions. In addition to the requirements cited in the USEPA UVDGM each UV water treatment device shall meet the following: 1) The UV assemblies shall be accessible for visual observation, cleaning and replacement of the lamp, lamp jackets and sensor window/lens. A wiper assembly or chemical-in-place system should be installed to allow in-situ cleaning of lamp jackets. Adequate controls shall be in place to prevent contamination of potable water with cleaning chemicals. 2) An automatic shutdown valve shall be installed in the water supply line ahead of the UV treatment system that is activated whenever the water treatment system losses power or is tripped by a monitoring devise when the dosage is below the validated operating design dose. When power is not being supplied to the UV unit the valve shall be in a closed (fail-safe) position. 3) The UV housing shall be stainless steel 304 or 316L. 4) A flow or time delay mechanism shall be provided to permit sufficient time for UV lamp warm-up before water flows from the unit upon startup. 5) A sufficient number (required number plus one) of parallel UV treatment systems shall be provided to assure a continuous water supply when one unit is out of service unless other disinfection can be provided when the unit is out of service.

6.4.i.2. Record keeping and access. -- A record shall be kept of the dates of lamp replacement and cleaning, a record of when the device was shut down and the reason for the shutdown. The BPH shall have access to the UV water treatment system and records.

6.4.j. Other disinfecting agents. -- Proposals for use of disinfecting agents other than those listed must be pre-approved by the BPH, prior to preparation of the final plans and specifications.

6.5. Softening. -- The softening process selected shall be based upon the mineral qualities of the raw water and the desired finished water quality in conjunction with requirements for disposal of sludge or brine waste, cost of plant, cost of chemicals and plant location. Applicability of the process chosen shall be demonstrated.

6.5.a. Lime or lime-soda process. -- Design standards for rapid mix, flocculation and sedimentation are in "Clarification," subsection 6.2. of this rule. Additional consideration shall be given to the following process elements.

6.5.a.1. Hydraulics. -- When split treatment is used, the bypass line shall be sized to carry total plant flow, and an accurate means of measuring and splitting the flow shall be provided.

6.5.a.2. Aeration. -- Determinations shall be made for the carbon dioxide content of the raw water. When concentrations exceed ten (10) milligrams per liter, the economics of removal by aeration as opposed to removal with lime shall be considered if it has been determined that dissolved oxygen in the finished water will not cause corrosion problems in the distribution system.

6.5.a.3. Chemical feed point. -- Lime shall be fed directly into the rapid mix basin.

6.5.a.4. Rapid mix. -- Rapid mix basins shall provide not more than thirty (30) seconds detention time with adequate velocity gradients to keep the lime particles dispersed.

6.5.a.5. Stabilization. -- Equipment for stabilization of water softened by the lime or lime-soda process is required.

6.5.a.6. Sludge collection. -- Mechanical sludge removal equipment shall be provided in the sedimentation basin. Sludge recycling to the rapid mix shall be provided not to exceed a rate of ten percent (10%) of the incoming flow.

6.5.a.7. Sludge disposal. - Provisions shall be included in the water treatment plant design for proper disposal of softening sludge.

6.5.a.8. Disinfection. -- The use of excess lime is not an acceptable substitute for disinfection.

6.5.a.9. Plant start-up. -- The plant processes shall be manually started following shut-down.

6.5.b. Cation exchange process. -- Alternative methods of hardness reduction shall be investigated when the sodium content and dissolved solids concentration is of concern.

6.5.b.1. Pre-treatment requirements. -- Iron, manganese, or a combination of the two, shall not exceed 0.3 milligrams per liter in the water as applied to the ion exchange resin. Pre-treatment is required when the content of iron, manganese, or a combination of the two (2), is one (1) milligram per liter or more. Waters having five (5) units or more turbidity shall not be applied directly to the cation exchange softener.

6.5.b.2. 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 unless manual regeneration is justified and is approved by the BPH. A manual override shall be provided on all automatic controls.

6.5.b.3. Exchange capacity. -- The design capacity for hardness removal shall not exceed twenty thousand (20,000) grains per cubic foot when resin is regenerated with 0.3 pounds of salt per kilogram of hardness removed.

6.5.b.4. Depth of resin. -- The depth of the exchange resin shall not be less than three (3) feet.

6.5.b.5. Flow rates. -- The rate of softening shall not exceed seven (7) gallons per minute per square foot of bed area, and the backwash rate shall be six (6) to eight (8) gallons per minute per square foot of bed area. Rate-of-flow controllers or the equivalent shall be installed for the rate of softening.

6.5.b.6. Freeboard. -- The freeboard will depend upon the specific gravity of the resin and the direction of water flow. Generally, the washwater collector shall be twenty-four (24) inches above the top of the resin on downflow units.

6.5.b.7. Underdrains and supporting gravel. -- The bottoms, strainer systems and support for the exchange resin shall conform to criteria provided for rapid rate gravity filters.

6.5.b.8. Brine distribution. -- Facilities shall be included for even distribution of the brine over the entire surface of both upflow and downflow units.

6.5.b.9. 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.

6.5.b.10. Bypass piping and equipment. -- A bypass shall be provided around softening units to produce a blended water of desirable hardness. Totalizing meters shall be installed on the bypass line and on each softener unit. The bypass line shall have a shutoff valve and should have an automatic proportioning or regulating device. In some installations, it may be necessary to treat the bypassed water to obtain acceptable levels of iron and/or manganese in the finished water.

6.5.b.11. Additional limitations. -- Silica gel resins shall not be used for waters having a pH above 8.4 or containing less than six (6) milligrams per liter silica and shall not be used when iron is present. When the applied water contains a chlorine residual, the cation exchange resin shall be a type that is not damaged by residual chlorine. Phenolic resin shall not be used.

6.5.b.12. Sampling taps. -- Smooth-nose sampling taps shall be provided for the collection of representative samples. The taps shall be located to provide for sampling of the softener influent, effluent and blended water. The sampling taps for the blended water shall be at least twenty (20) feet downstream from the point of blending. Petcocks are not acceptable as sampling taps. Sampling taps shall be provided on the brine tank discharge piping.

6.5.b.13. Brine and salt storage tanks.

6.5.b.13.A. Salt dissolving or brine tanks and wet salt storage tanks shall be covered and shall be corrosion-resistant.

6.5.b.13.B. The make-up 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 make-up water line.

6.5.b.13.C. Wet salt storage basins shall be equipped with manholes or hatchways for access and for direct dumping of salt from truck or rail car. Openings shall be provided with raised curbs and watertight covers having overlapping edges similar to those required for finished water reservoirs. Each cover shall be hinged on one side, and shall have locking device.

6.5.b.13.D. Overflows, where provided, shall be protected with corrosion resistant screens and shall terminate with either a turned down bend having a proper free fall discharge or a self-closing flap valve.

6.5.b.13.E. Two (2) wet salt storage tanks or compartments designed to operate independently shall be provided.

6.5.b.13.F. The salt shall be supported on graduated layers of gravel placed over a brine collection system.

6.5.b.13.G. The public water system engineer may consider alternative designs that are conducive to frequent cleaning of the wet salt storage tank.

6.5.b.14. Salt and brine storage capacity. -- Reserve salt and brine storage capacity for at least thirty (30) days of operation shall be available.

6.5.b.15. 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.

6.5.b.16. Stabilization. -- Stabilization for corrosion control shall be provided. An alkali feeder shall be provided except when exempted by the BPH.

6.5.b.17. Waste disposal. -- Suitable disposal shall be provided for brine waste. Where the volume of spent brine is reduced, consideration may be given to using a part of the spent brine for a subsequent regeneration.

6.5.b.18. 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 that is compatible with salt and brine.

6.5.b.19. Housing. -- Bagged salt and dry bulk salt storage shall be enclosed and separated from other operating areas in order to prevent damage to equipment.

6.6. Aeration. -- Aeration may be used to help remove offensive tastes and odors due to dissolved gases from decomposing organic matter, to reduce or remove objectionable amounts of carbon dioxide, hydrogen sulfide, etc., and to introduce oxygen to assist in iron or manganese removal, or both. The packed tower aeration process is an aeration process applicable to removal of volatile organic contaminants.

6.6.a. Natural draft aeration. -- The design shall provide: perforations in the distribution pan three-sixteenths (3/16) to one-half (½) inches in diameter, spaced one (1) to three (3) inches on centers to maintain a six (6) inch water depth, and eight (8) to ten (10) inches of inert media, such as coke or limestone that will not disintegrate due to freezing cycles; distribution of water uniformly over the top tray and discharge through a series of three (3) or more trays with separation of trays not less than twelve (12) inches; loading at a rate of one (1) to five (5) gallons per minute for each square foot of total tray area; trays with slotted, heavy wire [one half (½) inch openings] mesh or perforated bottoms and construction of durable material resistant to aggressiveness of the water and dissolved gases; protection from loss of spray water by wind carriage by enclosure with louvers sloped to the inside at an angle of approximately forty-five (45) degrees; protection from insects by twenty-four (24) mesh screen; and provisions for continuous disinfection feed shall be provided after aeration.

6.6.b. Forced or induced draft aeration. -- Forced or induced draft aeration devices shall be designed to: include a blower with a weatherproof motor in a tight housing and screened enclosure and ensure adequate counter current of air through the enclosed aerator column; exhaust air directly to the outside atmosphere; include a down-turned and twenty-four (24)-mesh screened air outlet and inlet; ensure that air introduced in the column is as free from obnoxious fumes, dust, and dirt as possible; be such that sections of the aerator can be easily reached or removed for maintenance of the interior or installed in a separate aerator room; provide loading at a rate of one (1) to five (5) gallons per minute for each square foot of total tray area; ensure that the water outlet is adequately sealed to prevent unwarranted loss of air; discharge though a series of five or more trays with separation of trays not less than six (6) inches; provide distribution of water uniformly over the top tray; be of durable material resistant to the aggressiveness of the water and dissolved gases; provide for continuous disinfection feed after aeration.

6.6.c. Spray aeration. -- The design shall provide a hydraulic head of between five (5) and twenty five (25) feet; nozzles, with the size, number, and spacing of the nozzles being dependent on the flow rate, space and amount of head available; nozzle diameter in the range of one (1) to one and a half (1.5) inches to minimize clogging; an enclosed basin to contain the spray with any openings for ventilation, etc. being protected by a twenty-four (24)-mesh screen; and for continuous disinfection feed after aeration.

6.6.d. Pressure aeration. -- Pressure aeration may be used for oxidation purposes only if the pilot plant study indicates the method is applicable; it is not acceptable for removal of dissolved gases. Filters following pressure aeration shall have adequate exhaust devices for the release of air. Pressure aeration devices shall be designed to give a thorough mixing of compressed air with the water being treated and provide screened and filtered air, free of obnoxious fumes, dust, dirt and other contaminants.

6.6.e. Packed Tower Aeration. -- Packed tower aeration (PTA) that is also known as air stripping involves passing water down through a column of packing material while pumping air counter-currently up through the packing. PTA is used for the removal of volatile organic chemicals, trihalomethanes, carbon dioxide, and radon. Generally, PTA is feasible for compounds with a Henry's Constant greater than one hundred (100) (expressed in atm mol/mol - at twelve (12) degrees C), but not normally feasible for removing compounds with a Henry's Constant less than ten (10). For values between ten (10) and one hundred (100), PTA may be feasible but shall be extensively evaluated using pilot studies. The Public Water Systems' engineer shall discuss values for Henry's Constant with the BPH prior to final design.

6.6.e.1. Process Design.

6.6.e.1.A. Process design methods for PTA involve the determination of Henry's Constant for the contaminant, the mass transfer coefficient, air pressure drop and stripping factor. The Public Water Systems' engineer shall provide justification to the BPH for the design parameters selected (i.e., height and diameter of the unit, air to water ratio, packing depth, surface loading rate, etc.). Pilot plant testing shall be provided. The pilot test shall evaluate a variety of loading rates and air to water ratios at the peak contaminant concentration. The public water systems' engineer shall give special consideration to removal efficiencies when multiple contaminations occur. Where there is considerable past performance data on the contaminant to be treated and there is a concentration level similar to previous projects, the BPH may approve the process design based on use of appropriate calculations without pilot testing. The Public Water Systems' engineer shall discuss proposals of this type with the BPH prior to submission of any permit applications.

6.6.e.1.B. The tower shall be designed to reduce contaminants to below the maximum contaminant level (MCL) and to the lowest practical level.

6.6.e.1.C. The ratio of the column diameter to packing shall be at least seven (7) to one (1) for the pilot unit and at least ten (10) to one (1) for the full scale tower. The type and size of the packing used in the full scale unit shall be the same as that used in the pilot work.

6.6.e.1.D. The minimum volumetric air to water ratio at peak water flow shall be twenty-five (25) to one (1). The maximum air to water ratio for which credit will be given is eighty (80) to one (1).

6.6.e.1.E. The design shall consider potential fouling problems from calcium carbonate, manganese and iron precipitation and from bacterial growth. It may be necessary to provide pretreatment. Disinfection capability shall be provided prior to and after PTA.

6.6.e.1.F. The effects of temperature shall be considered since a drop in water temperature can result in a drop in contaminant removal efficiency.

6.6.e.2. Materials of Construction. -- The tower may be constructed of stainless steel, concrete, aluminum, fiberglass or plastic. Uncoated carbon steel is not recommended because of corrosion. Towers constructed of light-weight materials shall be provided with adequate support to prevent damage from wind. Packing materials shall be resistant to the aggressiveness of the water, dissolved gases and cleaning materials and shall be suitable for contact with potable water.

6.6.e.3. Water Flow System. -- Water shall be distributed uniformly at the top of the tower using spray nozzles or orifice-type distributor trays that prevent short circuiting. A mist eliminator shall be provided above the water distributor system. A side wiper redistribution ring shall be provided at least every ten (10) feet to prevent water channeling along the tower wall and short circuiting. Smooth nosed sample taps shall be provided in the influent and effluent piping. The effluent sump, if provided, shall have easy access for cleaning purposes and be equipped with a drain valve. The drain shall not be connected directly to any storm or sanitary sewer. A blow-off line shall be provided in the effluent piping to allow for discharge of water and chemicals used to clean the tower. The design shall prevent freezing of the influent riser and effluent piping when the unit is not operating. If piping is buried, it shall be maintained under positive pressure. The water flow to each tower shall be metered. An overflow line shall be provided that discharges twelve (12) to fourteen (14) inches above a splash pad or drainage inlet. Proper drainage shall be provided to prevent flooding of the area.

6.6.e.4. Air Flow System. -- The air inlet to the blower and tower discharge vent shall be protected with a non-corrodible twenty-four (24) mesh downturned screen to prevent contamination from extraneous matter. The air inlet shall be in a protected location. An air flow meter shall be provided on the influent air line or an alternative method to determine the air flow shall be provided. A backup motor for the air blower shall be readily available.

6.6.e.5. Other Features that Shall Be Provided. -- The following shall be provided: a sufficient number of access ports with a minimum diameter of twenty-four (24) inches to facilitate inspection, media replacement, media cleaning and maintenance of the interior; a method of cleaning the packing material when iron, manganese, or calcium carbonate fouling may occur; tower effluent collection and pumping wells constructed to clearwell standards; provisions for extending the tower height; a BPH approved alternative supply during periods of maintenance and operation interruptions; no bypass unless specifically approved by the BPH; disinfection application points both ahead of and after the tower to control biological growth; disinfection and adequate contact time after the water has passed through the tower and prior to the distribution system; adequate packing support to allow free flow of water and to prevent deformation with deep packing heights; adequate foundation to support the tower and lateral support to prevent overturning due to wind loading; fencing and locking gate to prevent vandalism; an access ladder with safety cage for inspection of the aerator including the exhaust port and de-mister; and electrical interconnection to allow simultaneous operation and disconnect of the blower, disinfectant feeder and well pump.

6.6.e.6. Environmental Factors. -- The applicant shall contact the appropriate air quality office to determine if permits are required under the Clean Air Act. Noise control facilities shall be provided on PTA systems located in residential areas.

6.6.f. Other methods of aeration. -- Other methods of aeration may be used if applicable to the treatment needs. These methods include but are not restricted to spraying, diffused air, cascades and mechanical aeration. The treatment process shall be designed to meet the particular needs of the water to be treated and is subject to the approval of the BPH.

6.6.g. Protection of aerators. -- All aerators except those discharging to lime softening or clarification plants shall be protected from contamination by birds, insects, wind borne debris, rainfall and water draining off the exterior of the aerator.

6.6.h. Bypass. -- A bypass shall be provided for all aeration units except those installed to comply with maximum contaminant levels.

6.6.i. Corrosion control. -- The aggressiveness of the water after aeration shall be determined and corrected by additional treatment, if necessary.

6.6.j. Quality control. -- Equipment shall be provided to test for dissolved oxygen, pH and temperature to determine proper functioning of the aeration device. Equipment to test for iron, manganese and carbon dioxide should also be considered.

6.6.k. Redundancy. -- Redundant equipment shall be provided for units to comply with the Safe Drinking Water Act primary contaminants, unless otherwise approved by the BPH.

6.7. Iron and Manganese Control. -- Iron and manganese control, as used in this subsection, refers solely to treatment processes designed specifically for this purpose. The treatment process used depends upon the character of the raw water. The selection of one (1) or more treatment processes shall meet specific local conditions as determined by engineering investigations, including chemical analyses of representative samples of water to be treated, and receive the approval of the BPH. It may be necessary to operate a pilot plant in order to gather all information pertinent to the design. Consideration shall be given to adjusting the pH of the raw water to optimize the chemical reaction. Testing equipment and sampling taps shall be provided.

6.7.a. Removal by oxidation, detention and filtration.

6.7.a.1. Oxidation. -- Oxidation may be by aeration or by chemical oxidation with chlorine, potassium permanganate, sodium permanganate, ozone or chlorine dioxide.

6.7.a.2. Detention.

6.7.a.2.A. Reaction. -- A minimum detention time of thirty (30) minutes shall be provided following aeration to insure that the oxidation reactions are as complete as possible. This minimum detention may be omitted only where a pilot plant study indicates no need for detention. The detention basin shall be designed as a holding tank with no provisions for sludge collection but with sufficient baffling to prevent short circuiting.

6.7.a.2.B. Sedimentation. -- Sedimentation basins shall be provided when treating water with high iron or manganese content, or where chemical coagulation is used to reduce the load on the filters. Provisions for sludge removal shall be made.

6.7.b. Removal by the lime-soda softening process, as in subdivision 6.5.a. of this rule.

6.7.c. Removal by manganese greensand filtration. -- This process consists of a continuous or batch feed of potassium permanganate to the influent of a manganese coated media filter. Provisions shall be made to apply the permanganate as far ahead of the filter as practical and to a point immediately before the filter. Other oxidizing agents or processes such as chlorination or aeration may be used prior to the permanganate feed to reduce the cost of the chemical. An anthracite media cap of at least six inches shall be provided over manganese greensand. The normal filtration rate is three (3) gallons per minute per square foot or not to exceed the rate specified by manufacturer. The normal wash rate is eight (8) to ten (10) gallons per minute per square foot for manganese greensand and fifteen (15) to twenty (20) gallons per minute with manganese coated media. Air washing shall be provided. Smooth nosed sample taps shall be provided for the raw water, immediately ahead of filtration, at the filter effluent and at points between the anthracite media and the manganese coated media. Recommend potassium permanganate feed system have a means of automatic shut-off if overfeed occurs.

6.7.d. Removal by ion exchange. -- The ion exchange process of iron and manganese removal shall not be used for water containing more than three tenths (0.3) milligrams per liter of iron, manganese or a combination thereof. This process is not acceptable where either the raw water or wash water contains dissolved oxygen.

6.7.e. Sequestration by polyphosphates. -- The sequestration by polyphosphates process shall not be used when iron, manganese or a combination thereof exceeds one (1) milligram per liter (mg/l). The total phosphate applied shall not exceed ten (10) mg/l as PO_4. Where phosphate treatment is used, satisfactory chlorine residuals shall be maintained in the distribution system. Stock phosphate solution must be kept covered and disinfected by carrying approximately ten (10) mg/l free chlorine residual unless the phosphate is not able to support bacterial growth and the phosphate is being fed from the covered shipping container. Phosphate solutions having a pH of two (2.0) or less may be exempt from this requirement by the BPH. Feeding equipment shall conform to the requirements of "Chemical Application," in subdivision 7.1.b. of this rule. 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. The phosphate feed point shall be located as far ahead of the oxidant feed point as possible. Phosphate chemicals shall meet AWWA Standards and conform to ANSI/NSF Standard 60: Drinking Water Treatment Chemicals - Health Effects.

6.7.f. Sequestration by sodium silicates. -- Sodium silicate sequestration of iron and manganese is appropriate only for groundwater supplies prior to air contact. On-site pilot tests are required to determine the suitability of sodium silicate for the particular water and the minimum feed needed. Rapid oxidation of the metal ions such as by chlorine or chlorine dioxide shall accompany or closely precede the sodium silicate addition. Injection of sodium silicate more than fifteen (15) seconds after oxidation may cause a detectable loss of chemical efficiency. Dilution of feed solutions much below five per cent (5%) silica as silica dioxide shall also be avoided for the same reason. Sodium silicate addition is applicable to waters containing up to two (2) mg/l of iron, manganese or a combination thereof. Chlorine residuals shall be maintained throughout the distribution system to prevent biological breakdown of the sequestered iron. The amount of silicate added shall be limited to twenty (20) mg/l as silica dioxide, but the amount added and naturally occurring silicate shall not exceed sixty (60) mg/l as silica dioxide. Feeding equipment shall conform to the requirements of "Chemical Application," in section 7 of this rule. Sodium silicate shall not be applied ahead of iron or manganese removal treatment. Liquid sodium silicate shall meet AWWA Standard B404 and shall conform to ANSI/NSF Standard 60: Drinking Water Treatment Chemicals - Health Effects.

6.7.g. Sampling taps. -- Smooth-nosed sampling taps shall be provided for control purposes. Taps shall be located on each raw water source, each treatment unit influent and each treatment unit effluent.

6.7.h. Testing equipment shall be provided for all plants. The equipment shall have the capacity to accurately measure the iron content to a minimum of 0.1 milligrams per liter and the manganese content to a minimum of 0.05 milligrams per liter. Where polyphosphate sequestration is practiced, appropriate phosphate testing equipment shall be provided.

6.8. Fluoridation. -- Sodium fluoride, sodium silicofluoride and hydrofluosilicic acid shall conform to the applicable AWWA standards and shall conform to ANSI/NSF Standard 60: Drinking Water Treatment Chemicals - Health Effects. Other fluoride compounds that may be available shall be approved by the BPH. The proposed method of fluoride feed shall be approved by the BPH prior to preparation of final plans and specifications.

6.8.a. Fluoride compound storage. -- Fluoride chemicals shall be isolated from other chemicals to prevent contamination. Compounds shall be stored in covered or unopened shipping containers and shall be stored inside a building. Storage of hydrofluosilicic acid shall be in sealed carboys unless the treatment plant is designed with bulk storage tanks. While being used, the unsealed storage units for hydrofluosilicic acid shall be vented to the atmosphere at a point outside any building. Bags, fiber drums and deldrums shall be stored on pallets.

6.8.b. Chemical feed equipment and methods. -- In addition to the requirements in "Chemical Application," in section 7 of this rule, fluoride feed equipment shall meet the following requirements: scales, loss-of-weight recorders or liquid level indicators, as appropriate, accurate to within five percent (5%) of the average daily change in reading shall be provided for chemical feeds; feeders shall be accurate to within five percent (5%) of any desired feed rate; the fluoride compound shall be fed by a fluoride saturator, volumetric, gravimetric, or hydrofluosilicic acid fifteen (15) gallon carboy or fifty-five (55) gallon drum only (solution tanks are not permitted, exclusive of saturators); fluoride compound shall be added last, either directly into the clearwell or into the plant discharge line; the point of application for hydrofluosilicic acid or sodium fluoride, if into a horizontal pipe, shall be forty-five (45) degrees from the bottom of the pipe with the injector protruding into the pipe one-third (1/3) of the pipe diameter; a fluoride solution shall be applied by a positive displacement pump having a stroke rate not less than twenty (20) strokes per minute; anti-siphon devices shall be provided for all fluoride lines and dilution water lines; a device to measure the flow of water to be treated is required; water used for sodium fluoride saturated solution shall be softened if hardness exceeds seventy-five (75) mg/l as calcium carbonate; fluoride solutions shall not be injected to a point of negative pressure; the electrical outlet used for the fluoride feed pump shall have a nonstandard receptacle, unless it would void the pump warranty, and shall be interconnected with the well or high service pump; and saturators shall be of the upflow type and be provided with a meter and backflow protection on the makeup water line. Consideration shall be given to providing a separate room for florosilicic acid storage and feed.

6.8.c. Secondary controls. -- Secondary control systems for fluoride chemical feed devices may be required by the BPH as a means of reducing the possibility for overfeed; these may include flow or pressure switches, break boxes or other devices.

6.8.d. Protective equipment. -- Protective equipment as recommended by the compound manufacturer shall be provided for operators handling fluoride compounds. Deluge showers and eye wash devices shall be provided at all fluorosilicic acid installations.

6.8.e. Dust control. -- Provision shall be made for 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 that may enter the room in which the equipment is installed. The enclosure shall be provided with an exhaust fan and dust filter that place the hopper under a negative pressure. Air exhausted from fluoride handling equipment shall discharge through a dust filter to the atmosphere outside of the building. Provision shall be made for disposing of empty bags, drums or barrels in a manner that minimizes exposure to fluoride dusts. A floor drain shall be provided to facilitate the hosing of floors.

6.8.f. Testing equipment. -- Equipment shall be provided for measuring the quantity of fluoride in the water. The equipment is subject to the approval of the BPH.

6.9. Stabilization. -- Water that is unstable due either to natural causes or to subsequent treatment shall be stabilized.

6.9.a. Carbon dioxide addition. -- Recarbonation basin design shall provide a total detention time of twenty (20) minutes. Two compartments, with a depth that provides a diffuser submergence of not less than 7.5 feet nor greater submergence than recommended by the manufacturer are required. One compartment shall be a mixing compartment having a detention time of at least three minutes and the second compartment shall be a reaction compartment. The practice of on-site generation of carbon dioxide is discouraged. Where liquid carbon dioxide is used, adequate precautions shall be taken to prevent carbon dioxide from entering the plant from the recarbonation process. Consideration should be given to the installation of a carbon dioxide alarm system with light and audio warning, especially in low areas. Recarbonation tanks shall be located outside or be sealed and vented to the outside with adequate seals and adequate urge flow of air to ensure worker safety. Provisions shall be made for draining the carbonation basin and removing sludge.

6.9.b. Acid addition. -- Feed equipment shall conform to "Chemical Application" subdivision 7.1.b. Adequate precautions shall be taken for operator safety, such as not adding water to the concentrated acid.

6.9.c. Phosphates. -- The feeding of phosphates may be applicable for sequestering calcium, corrosion control, and in conjunction with alkali feed following ion exchange softening. Feed equipment shall conform to "Chemical Application," subdivision 7.1.b of this rule. Phosphate shall meet AWWA standards and shall conform to ANSI/NSF Standard 60: Drinking Water Treatment Chemicals - Health Effects. Stock phosphate solution shall be kept covered and disinfected by carrying approximately ten (10) milligrams per liter free chlorine residual unless the phosphate is not able to support bacterial growth and the phosphate is being fed from the covered shipping container. Phosphate solutions having a pH of two (2) or less may be exempted from this requirement by the BPH. Satisfactory chlorine residuals shall be maintained in the distribution system when phosphates are used.

6.9.d. "Split treatment". -- Under some conditions, a lime-softening water treatment plant may be designed using "split treatment" in which raw water is blended with lime-softened water to partially stabilize the water prior to secondary clarification and filtration. Treatment plants designed to utilize "split treatment" shall also contain facilities for further stabilization by other methods.

6.9.e. Alkali feed. -- Water with low alkalinity or pH should be treated with an alkali chemical.

6.9.f. Carbon dioxide reduction by aeration. -- The carbon dioxide content of an aggressive water may be reduced by aeration.

6.9.g. Other treatment. -- Other treatment for controlling corrosive waters by the use of calcium hydroxide, sodium silicate and sodium bicarbonate may be used where necessary. Any proprietary compound shall receive the specific approval of the BPH before use.

6.9.h. Water unstable due to biochemical action in distribution system. -- Unstable water resulting from the bacterial decomposition of organic matter in water (especially in dead end mains), the biochemical action within tubercles, and the reduction of sulfates to sulfides shall be prevented by the maintenance of a free and/or combined chlorine residual throughout the distribution system.

6.9.i. Control. -- Laboratory equipment shall be provided for determining the effectiveness of stabilization treatment.

6.10. Taste and Odor Control. -- Provision shall be made for the control of taste and odor at all surface water treatment plants. Chemicals shall be added sufficiently ahead of other treatment processes to assure adequate contact time for effective and economical use of the chemicals. Where severe taste and odor problems are encountered, in-plant or pilot plant, or both, studies are required.

6.10.a. Flexibility. -- Plants treating water that is known to have taste and odor problems shall be provided with equipment that makes several of the control processes available so that the operator has flexibility in operation.

6.10.b. Chlorination. -- Chlorination can be used for the removal of some objectionable odors. Adequate contact time shall be provided to complete the chemical reactions involved. Excessive potential disinfection byproduct production shall be investigated by adequate bench-scale testing prior to the design.

6.10.c. Chlorine dioxide. -- Chlorine dioxide has been generally recognized as a treatment for tastes caused by industrial wastes, such as phenols. Chlorine dioxide may 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, so as to eliminate any danger of explosion.

6.10.d. Powdered activated carbon. -- Powdered activated carbon shall be added as early as possible in the treatment process to provide maximum contact time. Flexibility to allow the addition of carbon at several points is preferred. Activated carbon shall not be applied near the point of chlorine application or any other oxidant. The carbon can be added as a pre-mixed slurry or by means of a dry-feed machine as long as the carbon is properly wetted. Continuous agitation or re-suspension equipment is necessary to keep the carbon from depositing in the slurry storage tank. Provision shall be made for adequate dust control. The required rate of feed of carbon in a water treatment plant depends upon the tastes and odors involved, but provision shall be made for adding from 0.1 milligrams per liter to at least forty (40) milligrams per liter. Powdered activated carbon shall be handled as a potentially combustible material. It shall be stored in a building or compartment as nearly fireproof as possible. Other chemicals shall not be stored in the same compartment. A separate room shall be provided for carbon feed installations. Carbon feeder rooms shall be equipped with explosion-proof electrical outlets, lights and motors.

6.10.e. Granular activated carbon. -- Replacement of anthracite with GAC may be considered as a control measure for geosmin and methyl isoborneol (MIB) taste and odors from algae blooms. Demonstration studies may be required by the BPH.

6.10.f. Copper sulfate and other copper compounds. -- Continuous or periodic treatment of water with copper compounds to kill algae or other growths shall be controlled to prevent copper in excess of one (1) milligram per liter as copper in the plant effluent or distribution system. Care shall be taken to assure an even distribution within the treatment area.

6.10.g. Aeration. -- See "Aeration," subsection 6.6 of this rule.

6.10.h. Potassium permanganate. -- Application of potassium permanganate may be considered, providing the treatment shall be designed so that the products of the reaction are not visible in the finished water.

6.10.i. Ozone. -- Ozonation may be used as a means of taste and odor control. Adequate contact time shall be provided to complete the chemical reactions involved. Ozone is generally more desirable for treating water with high threshold odors.

6.10.j. Other methods. -- The decision to use any other methods of taste and odor control shall be made only after careful laboratory or pilot plant, or both, tests and in consultation with the BPH.

6.11. Microscreening. -- A microscreen is a mechanical supplement of treatment 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, when filtration is necessary to provide satisfactory water nor used in place of coagulation in the preparation of water for filtration.

6.11.a. Design. -- Design shall give due consideration to: the nature of the suspended matter to be removed corrosiveness of the water, the effect of chlorination, when required as pre-treatment; the duplication of units for continuous operation during equipment maintenance: and automated backflushing operation when used in conjunction with microfiltration treatment. Design shall provide a durable, corrosion-resistant screen, by-pass arrangements, protection against back-siphonage when potable water is used for washing, and proper disposal of wash waters.

6.12. Waste Handling and Disposal. -- Provisions shall be made for proper disposal of water treatment plant waste such as sanitary waste, laboratory waste, clarification sludge, softening sludge, iron sludge, filter backwash water, and brines. All waste discharges are governed by West Virginia Department of Environmental Protection (WVDEP) requirements. The requirements under this rule shall be considered minimum requirements as WVDEP may have more stringent requirements. In locating waste disposal facilities, due consideration shall be given to preventing potential contamination of the water supply. Alternative methods of water treatment and chemical use shall be considered as a means of reducing waste volumes and the associated handling and disposal problems.

6.12.a. Sanitary waste. -- The sanitary waste from water treatment plants, pumping stations, and other waterworks installations shall receive treatment. Waste from these facilities shall be discharged directly to a sanitary sewer system, when available and feasible, to an adequate on-site waste treatment facility approved by the County Health Department or to a treatment system approved by the BPH.

6.12.b. Brine waste. -- Waste from ion exchange plants, demineralization plants, or other plants that produce a brine, may be disposed of by controlled discharge to a stream if adequate dilution is available. Surface water quality requirements of the WVDEP control the rate of discharge. Except when discharging to large waterways, a holding tank of sufficient size shall be provided to allow the brine to be discharged over a twenty-four (24) hour period. Where discharging to a sanitary sewer, a holding tank may be required to prevent the overloading of the sewer or interfering with the waste treatment processes. The effect of brine discharge to sewage lagoons may depend on the rate of evaporation from lagoons.

6.12.c. Precipitative softening sludge. -- Sludge from plants using precipitative softening water varies in quantity and in chemical characteristics depending on the softening process and the chemical characteristics of the water being softened. Recent studies show that the quantity of sludge produced is much larger than indicated by stoichiometric calculations. Methods of treatment and disposal are as follows:

6.12.c.1. Lagoons. -- Temporary lagoons that are cleaned periodically shall be designed on the basis of 0.7 acres per million gallons per day per one hundred (100) milligrams per liter of hardness removed based on usable lagoon depth of five feet. This shall provide about 2 years storage. At least two (2) but preferably more lagoons shall be provided in order to give flexibility in operation. An acceptable means of final sludge disposal shall be provided. Provisions shall be made for convenient cleaning. Permanent lagoons shall have a volume of at least four (4) times that for temporary lagoons. The design of both temporary lagoons and permanent lagoons shall provide for: locations free from flooding; when necessary, dikes, deflecting gutters or other means of diverting surface water so that it does not flow into the lagoons; a minimum usable depth of five (5) feet; adequate freeboard of at least two (2) feet; an adjustable decanting device; an effluent sampling point; safety provisions; and parallel operation.

6.12.c.2. Land Application. -- The application of liquid lime sludge or dewatered sludge to farm land shall be considered as a method of ultimate disposal. Approval from the WVDEP shall be obtained.

6.12.c.3. Sanitary Sewers. -- Discharge of lime sludge to sanitary sewers is only permitted when the sewerage system has the capability to adequately handle the lime sludge.

6.12.c.4. Mixing. -- Mixing of lime sludge with activated sludge waste may be considered as a means of co-disposal.

6.12.c.5. Landfills. -- Disposal at a landfill may be done as either a solid or liquid if the landfill can accept such waste, depending on WVDEP requirements.

6.12.c.6. Mechanical Dewatering. -- Mechanical dewatering of sludge may be considered. Pilot studies on a particular plant waste are recommended. The BPH may require operational data from similar water treatment facilities treating similar raw water and require performance guaranteed specifications for the mechanical equipment.

6.12.c.7. Calcination. -- Calcination of sludge may be considered. Pilot studies on a particular plant waste are recommended. The BPH may require operational data from similar water treatment facilities treating similar raw water and require performance guaranteed specifications for the mechanical equipment.

6.12.c.8. Drying Beds. -- Lime sludge drying beds are not recommended.

6.12.d. Alum sludge. -- Lagooning may be used as a method of handling alum sludge. Lagoon size may be calculated using total chemicals used plus a factor for turbidity. Mechanical concentration may be considered. A pilot plant study is required before the design of a mechanical dewatering installation. Freezing changes the nature of alum sludge so that it can be used for fill. Acid treatment of sludge for alum recovery may be a possible alternative. Alum sludge may be discharged to a sanitary sewer; however, initiation of this practice depends on obtaining approval from the owner of the sewerage system as well as from the BPH before final designs are made. Lagoons shall be designed to produce an effluent satisfactory to the WVDEP and shall provide for: locations free from flooding; where necessary, dikes, deflecting gutters or other means of diverting surface water so that it does not flow into the lagoon; a minimum usable depth of five feet; freeboard of at least two (2) feet; an adjustable decanting device; an effluent sampling point; safety provisions; and a minimum two (2) cells, each with appropriate inlet/outlet structures to facilitate independent filling/dewatering operations. Mechanical dewatering shall be preceded by sludge concentration and chemical pre-treatment. Alum sludge may be disposed of by land application with approval from the WVDEP.

6.12.e. "Red water" waste. -- Waste filter wash water from iron and manganese removal plants can be disposed of as follows:

6.12.e.1. Sand filters. -- Sand filters shall have the following features:

6.12.e.1.A. Total filter area, regardless of the volume of water to be handled, shall be no less than one hundred (100) square feet. Unless the filter is small enough to be cleaned and returned to service in one (1) day, two (2) or more cells are required;

6.12.e.1.B. The "red water" filter shall have sufficient capacity to contain, above the level of the sand, the entire volume of wash water produced by washing all of the production filters in the plant, unless the production filters are washed on a rotating schedule and the flow through the production filters is regulated by true rate of flow controllers. Then sufficient volume shall be provided to properly dispose of the wash water involved;

6.12.e.1.C. Sufficient filter surface area shall be provided so that, during any one (1) filtration cycle, no more than two (2) feet of backwash water may accumulate over the sand surface;

6.12.e.1.D. The filter shall not be subject to flooding by surface runoff or flood waters. Finished grade elevation shall be established to facilitate maintenance, cleaning and removal of surface sand as required. Flash boards or other non-watertight devices shall not be used in the construction of filter side walls;

6.12.e.1.E. The filter media shall consist of a minimum of twelve (12) inches of sand, three (3) to four (4) inches of supporting small gravel or torpedo sand and nine (9) inches of gravel in graded layers. All sand and gravel shall be washed to remove fines;

6.12.e.1.F. Filter sand shall have an effective size of 0.3 to 0.5 mm and a uniformity coefficient not to exceed 3.5. The use of larger sized sands shall be justified by the designing engineer to the satisfaction of the BPH;

6.12.e.1.G. The filter shall be provided with an adequate under-drainage collection system to permit satisfactory discharge of filtrate;

6.12.e.1.H. Provision shall be made for the sampling of the filter effluent;

6.12.e.1.I. Overflow devices from "red water" filters shall not be permitted;

6.12.e.1.J. Where freezing is a problem, provisions shall be made for covering the filters during the winter months; and

6.12.e.1.K. "Red water" filters shall comply with the common wall provisions that pertain to the possibility of contamination of finished water with unsafe water. The BPH shall be contacted for approval of any arrangement where a separate structure is not provided.

6.12.e.2. Lagoons. -- Lagoons shall have the following features: be designed with volume ten (10) times the total quantity of wash water discharged during any twenty-four (24) hour period; a minimum usable depth of three (3) feet, length four (4) times width, and the width at least three (3) times the depth, as measured at the operating water level; an outlet at the end opposite the inlet; a weir overflow device at the outlet end with weir length equal to or greater than depth; and velocity dissipated at the inlet end.

6.12.e.3. Discharge to community sanitary sewer. -- "Red water" may be discharged to a community sewer; however, approval of this method depends on obtaining approval from the owner of the sewerage system as well as from the BPH before final designs are made. A holding tank is recommended to prevent overloading the sewers. Design shall prevent cross connections and there shall be no common walls between potable and non-potable water.

6.12.e.4. Recycling "Red Water" waste. -- Recycling of supernatant or filtrate from "red water" waste treatment facilities to the head end of an iron removal plant is not allowed except as approved by the BPH.

6.12.e.5. Discharge to surface water. -- Plants shall have a permit from the WVDEP for disposal of backwash water into surface water.

6.12.f. Waste filter wash water. -- Waste filter wash water from surface water treatment or lime softening plants shall have suspended solids reduced to a level acceptable to the WVDEP before being discharged. Many plants have constructed holding facilities and return this water to the inlet end of the plant. The holding facility shall be of such a size that it contains the anticipated volume of waste wash water produced by the plant when operating at design capacity. A plant that has two (2) filters shall have a holding facility that contains the total waste wash from both filters calculated by using a fifteen (15) minute wash at twenty (20) gallons per minute per square foot. In plants with more filters, the size of the holding facilities depends on the anticipated hours of operation. It is required that waste filter wash water be returned at a rate of less than ten percent (10%) of the raw water influent rate. Filter backwash water shall not be recycled when the raw water contains excessive algae, when finished water taste and odor problems are encountered, or when disinfection byproduct levels in the distribution system may exceed allowable levels. Particular attention must be given to the presence of protozoans such as Giardia and Cryptosporidium concentrating in the waste water stream. Water utilities may need to treat filter waste water prior to recycling to reduce pathogen population and improve coagulation or avoid reclaiming filter wash water given the increased risk to treated water quality.

6.12.g. Radioactive materials. -- Radioactive materials include, but are not limited to, granulated activated carbon (GAC); ion-exchange regeneration waste from radium removal; and manganese greensand backwash solids from manganese removal systems, precipitative softening sludge, and reverse osmosis concentrates where radiological constituents are present. The buildup of radioactive decay products of radon shall be considered, and adequate shielding and safeguards shall be provided for operators and visitors. These materials may require disposal as radioactive waste in accordance with Nuclear Regulatory Commission regulations. Approval shall be obtained from the WVDEP prior to disposal of radioactive materials.

6.12.h. Arsenic waste residuals. -- Arsenic-bearing wastes from an arsenic treatment facility may be considered hazardous. Under the Resource Conservation and Recovery Act (RCRA), a residual from an arsenic water treatment facility is defined as being hazardous waste if it exhibits a Toxicity Characteristic Leaching Procedure (TCLP) result of 5.0 mg/l. Approval shall be obtained from the WVDEP prior to disposal of arsenic waste residuals.

§64-77-7. Chemical Application.

7.1. General. -- No chemicals shall be applied to treat drinking waters unless specifically approved by the BPH.

7.1.a. Plans and specifications. -- Plans and specifications shall be submitted to the BPH for review and approval and shall include: descriptions of feed equipment, including maximum and minimum feed ranges; the location of feeders, piping layout and points of application; storage and handling facilities; specifications for chemicals to be used; operating and control procedures including proposed application rates; the descriptions of testing equipment and procedures; system including all tanks with capacities, (with drains, overflows, and vents), feeders, transfer pumps, connecting piping, valves, points of application, backflow prevention devices, air gaps, secondary containment and safety eye washes and showers.

7.1.b. Chemical application. -- Chemicals shall be applied to the water at such points and by such means as to assure maximum efficiency of treatment, assure maximum safety to consumers, provide maximum safety to operators, assure satisfactory mixing of the chemicals with the water, provide maximum flexibility of operation through various points of application, when appropriate, and prevent backflow or back-siphonage between multiple points of feed through common manifolds.

7.1.c. General equipment design. -- General equipment design shall be such that: feeders are able to supply, at all times, the necessary amounts of chemicals at an accurate rate, throughout the range of feed; chemical-contact materials and surfaces are resistant to the aggressiveness of the chemical solution; corrosive chemicals are introduced in such a manner as to minimize potential for corrosion; chemicals that are incompatible are not stored or handled together; all chemicals are conducted from the feeder to the point of application in separate conduits; chemical feeders are as near as practical to the feed point; chemical feeders and pumps operate at no lower than twenty per cent (20%) of the feed range unless two (2) fully independent adjustment mechanisms such as pump pulse rate and stroke length are fitted when the pump shall operate at no lower than ten (10) percent of the rated maximum; and chemicals are fed by gravity where practical.

7.1.d. Chemical information. -- For each chemical the information shall include: specifications for the chemical to be used; purpose of the chemical; proposed minimum non-zero, average and maximum dosages, solution strength or purity (as applicable), and specific gravity or bulk density; and method for independent calculation of amount fed daily.

7.2. Feed Equipment.

7.2.a. Number of feeders. -- Where chemical feed is necessary for the protection of the supply, such as chlorination, coagulation or other essential processes, the standby unit or a combination of units of sufficient capacity shall be available to replace the largest unit when it is out of service. The standby unit or a combination of units of sufficient capacity shall be available to replace the largest unit during shut-downs. A separate feeder shall be used for each chemical applied. Spare parts shall be available for all equipment to replace parts that are subject to wear and damage.

7.2.b. Control. -- Feeders may be manually or automatically controlled, with automatic controls designed to allow override by manual controls. Process shall be manually started following shutdown, unless otherwise approved by the BPH. At automatically operated facilities, chemical feeders shall be electrically interconnected with the well or service pump. Chemical feed rates shall be proportional to the flow stream being dosed. A means to measure the flow stream shall be provided in order to determine chemical feed rates. Provisions shall be made for measuring the quantities of chemicals used. Automatic chemical dose or residual analyzers may be approved by the BPH for use and shall provide alarms for critical values and recording charts.

7.2.b.1. Weighing scales. -- Weighing scales shall be provided for weighing cylinders at all plants utilizing chlorine gas; shall be required for fluoride solution fed from supply drums or carboys; should provide for volumetric dry chemical feeders; shall be capable of providing reasonable precision in relation to average daily dose. Where conditions warrant, for example with rapidly fluctuating intake turbidity, coagulant and coagulant aid addition may be made according to turbidity, streaming current or other sensed parameter.

7.2.c. Dry chemical feeders. -- Dry chemical feeders shall measure chemicals volumetrically or gravimetrically, provide adequate solution/slurry water and agitation of the chemical at the point of placing solution/slurry, completely enclose chemicals to prevent emission of dust to the operating room.

7.2.d. Positive displacement solution pumps. -- Positive displacement type solution feed pumps shall: be used to feed liquid chemicals but shall not be used to feed chemical slurries; be capable of operating at the required maximum rate against the maximum head conditions found at the point of injection; be provided with calibration tubes or mass flow monitors which allow for direct physical measurement of actual feed rates; and have a pressure relief valve on the pump discharge line.

7.2.e. Liquid chemical feeders. -- Siphon control -- Liquid chemical feeders shall be such that chemical solutions cannot be siphoned into the water supply by assuring discharge at a point of positive pressure or by providing vacuum relief, a suitable air gap, or anti-sipon device, or other suitable means or combinations as necessary.

7.2.f. Cross-connection control. -- Cross-connection control shall be provided to assure that the service water lines discharging to liquid storage tanks are properly protected from backflow as required by the BPH. Design shall prevent chemical solutions or slurries from being siphoned through solution feeders into the water supply, and no direct connection shall exist between any sewer and a drain or overflow from the feeder, solution chamber or tank by providing that all drains terminate at least six (6) inches or two (2) pipe diameters, whichever is greater, above the overflow rim of a receiving sump, conduit or waste receptacle.

7.2.g. Chemical feed equipment location. -- Chemical feed equipment shall: be located in a separate room to reduce hazards and dust problems; be conveniently located near points of application to minimize length of feed lines; be readily accessible for servicing, repair, and observation of operation including cleanouts; be located such that the flow to the rapid mix is by gravity, except in case of in-line static mixers; be located with protective curbing so that chemicals from equipment failure, spillage or accidental drainage shall not enter the water in conduits, treatment or storage basins; and have floor drains to facilitate area cleaning.

7.2.h. In-Plant water supply. -- The in-plant water supply shall be: only from a safe, source approved by the BPH, ample in quantity and adequate in pressure; provided with means for measurement when preparing specific solution concentrations by dilution; properly treated for hardness, when necessary; and properly protected against backflow as approved by the BPH.

7.2.i. Storage of chemicals. -- Space shall be provided for at least thirty (30) days of chemical supply, the convenient and efficient handling of chemicals, dry storage conditions, and a minimum storage volume of 1½ truckloads where purchase is by truckload lots. Storage tanks and pipelines for liquid chemicals shall be specific to the chemicals and not for alternates. Where possible, connectors for each liquid chemical shall be different and distinctly marked. Chemicals shall be stored in covered or unopened shipping containers, unless the chemical is transferred into a storage unit approved by the BPH. Liquid chemical storage tanks shall have a liquid level indicator, have an overflow and a receiving basin or drain capable of containing accidental spills or overflows, provide for sufficient containment volume to prevent accidental discharge in the event of failure of the largest tank.

7.2.j. Bulk liquid storage tanks. -- A means shall be provided in a solution tank to maintain a uniform strength of solution. Continuous agitation shall be provided to maintain slurries in suspension. A means to assure continuity of chemical supply while servicing a liquid storage tank shall be provided. Means shall be provided to measure the liquid level in the tank. Liquid storage tanks shall be kept covered. Large liquid storage tanks with access openings shall have the openings curbed and fitted with overhanging covers. Subsurface locations for solution tanks shall be free from sources of possible contamination and assure positive drainage for groundwater, accumulated water, chemical spills and overflows. Overflow pipes, when provided, shall be turned downward, with the end screened, have a free fall discharge, and be located where noticeable. Liquid storage tanks shall be vented, but not through vents in common with day tanks. Acid storage tanks shall be vented to the outside atmosphere. Each tank shall be provided with a valved drain and be protected against cross-connections. Liquid storage tanks shall be located with protective curbing so that chemicals from equipment failure, spillage or accidental drainage shall not enter the water in conduits, treatment or storage basins. Secondary containment volumes shall be able to hold the volume of the largest storage tank. Piping shall be designed to minimize or contain chemical spills in the event of pipe ruptures.

7.2.k. Day tanks. -- Day tanks shall be provided where bulk storage of liquid chemical is provided, however, the BPH may allow chemicals to be fed directly from shipping containers no larger than fifty-five (55) gallons. Day tanks shall meet all the requirements of bulk liquid storage tanks, except that shipping containers do not require overflow pipes and drains. Day tanks shall hold no more than a thirty (30) hour supply, but no less than a one (1) day of operation supply at design flow. Day tanks shall be scale-mounted or have a calibrated gauge painted or mounted on the side if liquid level can be observed in a gauge tube, manometer or through translucent sidewalls of the tank. In opaque tanks, a gauge rod extending above a reference point at the top of the tank, attached to a float, may be used. Except for fluosilicic acid, hand pumps may be provided for transfer from a shipping container. 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 shall be provided. A means which is consistent with the nature of the chemical solution shall be provided to maintain uniform chemical strength in a day tank. Continuous agitation shall be provided to maintain chemical slurries in suspension. Tanks and tank refilling line entry points shall be clearly labeled with the name of the chemical contained. Filling of day tanks shall not be automated, unless authorized by the BPH.

7.2.l. Feed lines. -- Feed lines: shall be as short as possible, and of durable, corrosion-resistant material, easily accessible throughout the entire length, protected against freezing, and readily cleaned; shall slope upward from the chemical source to the feeder when conveying gases; shall be designed consistent with scale-forming or solids depositing properties of the water, chemical, solution or mixtures conveyed; and shall be color coded and labeled.

7.2.m. Handling. -- Carts, elevators and other appropriate means shall be provided for lifting chemical containers to minimize excessive lifting by operators. Provisions shall be made for disposing of empty bags, drums or barrels by an approved procedure that minimizes exposure to dusts. Provision shall be made for the proper transfer of dry chemicals from shipping containers to storage bins or hoppers in such a way as to minimize the quantity of dust that may enter the room in which the equipment is installed. Control shall be provided by use of vacuum pneumatic equipment or closed conveyor systems; facilities for emptying shipping containers in special enclosures; or for exhaust fans and dust filters that put the hoppers or bins under negative pressure. Provision shall be made for measuring quantities of chemicals used to prepare feed solutions.

7.2.n. Housing. -- Floor surfaces shall be smooth and impervious, slip-proof and well drained. Vents from feeders, storage facilities and equipment exhaust shall discharge to the outside atmosphere above grade and remote from air intakes and doors.

7.3. Chemicals.

7.3.a. Shipping containers. -- Chemical shipping containers shall be fully labeled to include the chemical's name, purity and concentration and supplier name and address.

7.3.b. Specifications. -- Chemicals shall meet AWWA specifications and shall conform to ANSI/NSF Standard 60: Drinking Water Treatment Chemicals - Health Effects where applicable.

7.3.c. Assay. -- Provisions may be required for the assay of chemicals delivered.

7.4. Operator Safety.

7.4.a. Ventilation. -- Special provisions shall be made for ventilation of chlorine feed and storage rooms.

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

7.4.c. Chlorine leak detection. -- A bottle of ammonium hydroxide, fifty-six percent (56%) ammonia solution, shall be available for chlorine leak detection. Where ton containers are used, a leak repair kit approved by the Chlorine Institute shall be provided. Where pressurized chlorine gas is present, continuous chlorine leak detection equipment is required and shall be equipped with both an audible alarm and a warning light.

7.4.d. Protective equipment. -- The public water system shall provide each operator at least one (1) pair of rubber gloves, a dust respirator of a type meeting NIOSH requirements for toxic dusts, an apron or other protective clothing and goggles or face mask. A deluge shower and eye-washing device shall be installed where strong acids and alkalis are used or stored. A water holding tank that allows water to come to room temperature shall be installed in the water line feeding the deluge shower and eye-washing device. Other methods of water tempering may be considered on an individual basis. Other protective equipment shall be provided as necessary.

7.5. Specific Chemicals.

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

7.5.a.1. 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.

7.5.a.2. Where chlorine gas is used, adequate housing shall be provided for the chlorination equipment and for storing chlorine. The room shall be constructed to provide the following: a ventilating fan designed specifically to handle chlorine gas with a capacity that provides one complete air change per minute when the room is occupied; the ventilating fan shall take suction near the floor as far as practical from the door and air inlet, with the point of discharge located so as not to contaminate air inlets or entrance doors to any rooms or structures; air inlets shall be through corrosion resistant louvers near the ceiling; and 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 are discouraged. Where provided, the floor drains shall discharge to the outside of the building and shall not be connected to other internal or external drainage systems. Where located near residential or developed areas and deemed necessary by the BPH, provision shall be made to chemically neutralize chlorine gas before discharge from the water treatment plant building into the environment. Such equipment shall be designed as part of the chlorine gas storage and feed areas to automatically engage in the event of any measured chlorine release. The equipment shall be sized to treat the entire contents of the largest storage container on site.

7.5.a.3. Chlorinator rooms shall be heated to sixty (60) degrees F and be protected from excessive heat. Cylinders and gas lines shall be protected from temperatures above that of the feed equipment.

7.5.a.4. Pressurized chlorine feed lines shall not carry chlorine gas beyond the chlorinator room.

7.5.b. Acids and caustics. -- Acids and caustics shall be kept in closed corrosion-resistant shipping containers or bulk liquid storage tanks with the contents identified by signs or placards. Acids and caustics shall not be handled in open vessels but shall be pumped in undiluted form from original containers through suitable hose to the point of treatment or to a covered day tank.

7.5.c. Sodium chlorite for chlorine dioxide generation. -- Proposals for the storage and use of sodium chlorite shall be approved by the BPH prior to the preparation of final plans and specifications. Provisions shall be made for proper storage and handling of sodium chlorite to eliminate any danger of fire or explosion associated with its powerful oxidizing nature.

7.5.c.1. Storage. -- Sodium chlorite shall be stored by itself in a separate room and preferably shall be stored in an outside building detached from the water treatment facility. It shall be stored away from organic materials that would react violently with sodium chlorite. The storage structures shall be constructed of noncombustible materials. If the storage structure is located in an area where a fire may occur, water shall be available to keep the sodium chlorite area cool enough to prevent decomposition from heat and the resultant explosive conditions.

7.5.c.2. Handling. -- Care shall be taken to prevent spillage. An emergency plan of operation shall be available for the clean-up of any spillage. Storage drums shall be thoroughly flushed prior to being recycled or disposed.

7.5.c.3. Feeders. -- Positive displacement feeders shall be provided. Tubing for conveying sodium chlorite or chlorine dioxide solutions shall be Type 1 PVC, polyethylene or materials recommended by the manufacturer. Chemical feeders may be installed in gas chlorine rooms if sufficient space is provided for facilities meeting the chlorine room requirements. Feed lines shall be installed in a manner to prevent formation of gas pockets and shall terminate at a point of positive pressure. Check valves shall be provided to prevent the backflow of chlorine into the sodium chlorite line.

7.5.d. Sodium Hypochlorite. -- Storage and handling procedures shall be arranged to minimize the slow natural decomposition process of sodium hypochlorite either by contamination or by exposure to more extreme storage conditions. In addition, feed rates shall be regularly adjusted to compensate for this progressive loss in chlorine content.

7.5.d.1. Storage. -- Sodium hypochlorite shall be stored in the original container or in sodium hypochlorite compatible bulk liquid storage tanks. Storage containers or tanks shall be located out of sunlight in a cool area and shall be vented to the outside of the building. Whenever feasible, stored sodium hypochlorite shall be pumped undiluted to the point of addition. Where dilution is unavoidable, deionized or softened water should be used. Storage areas, tanks, and pipe work shall be designed to avoid the possibility of uncontrolled discharges and a sufficient amount of appropriately selected spill absorbent shall be stored on-site.

7.5.d.2. Feeders. -- Positive displacement pumps with sodium hypochlorite compatible materials for wetted surfaces shall be used. To avoid air locking in smaller installations, small diameter suction lines shall be used with foot valves and degassing pump heads. In larger installations flooded suction shall be used with pipe work arranged to ease escape of gas bubbles. Calibration tubes or mass flow monitors which allow for direct physical checking of actual feed rates shall be provided. Injectors shall be made removable for regular cleaning where hard water is to be treated.

7.5.e. Ammonia. -- Ammonia for chloramines formation may be added to water either as a water solution of ammonium sulfate, or as aqua ammonia, or as anhydrous ammonia (purified 100% ammonia in liquid or gaseous form).

7.5.e.1. Ammonium sulfate. -- A water solution is made by the addition of ammonium sulfate solid to water with agitation. The tank and dosing equipment contact surfaces shall be made of corrosion resistant non-metallic materials. Provisions shall be made for removal of the agitator after dissolving the solid. The tank shall be fitted with an air-tight lid and vented outdoors. The application point shall be at the center of treated water flow at a location where there is high velocity movement.

7.5.e.2. Aqua ammonia (ammonium hydroxide). -- Aqua ammonia feed pumps and storage shall be enclosed and separated from other operating areas. The aqua ammonia room shall be equipped as per a chlorine gas room with the following changes: Corrosion resistant, closed, unpressurized tank shall be used for bulk liquid storage and day tanks, vented through inert liquid traps to a high point outside; an incompatible connector or lockout provisions shall be provided to prevent accidental addition of other chemicals to the bulk liquid storage tank(s); the bulk liquid storage tank(s) shall be designed to avoid conditions where temperature increases cause the ammonia vapor pressure over the aqua ammonia to exceed atmospheric pressure by refrigeration or other means of external cooling, or by dilution and mixing of the contents with water without opening the bulk liquid storage tank; an exhaust fan shall be installed to withdraw air from high points in the room and makeup air shall be allowed to enter at a low point; the aqua ammonia shall be conveyed directly from a day tank to the treated water stream injector without the use of a carrier water stream unless the carrier stream is softened; the application point shall be placed in a region of rapid, preferably turbulent, water flow; provisions shall be made for easy access for removal of calcium scale deposits from the injector; and provisions of a modestly-sized scrubber capable of handling occasional minor emissions should be considered.

7.5.e.3. Anhydrous ammonia. -- Anhydrous ammonia is readily available as a pure liquefied gas under moderate pressure in cylinders or as a cryogenic liquid boiling at -15 Celsius at atmospheric pressure. The liquid causes severe burns on skin contact. Anhydrous ammonia and storage feed systems (including heaters where required) shall be enclosed and separated from other work areas and constructed of corrosion resistant materials. Pressurized ammonia feed lines shall be restricted to the ammonia room. An emergency air exhaust system with an elevated intake shall be provided in the ammonia storage room. Leak detection systems shall be provided in all areas through which ammonia is piped. Special vacuum breaker/regulator provisions must be made to avoid potentially violent results of backflow of water into cylinders or storage tanks. Carrier water systems of soft or pre-softened water may be used to transport ammonia to the application point and to assist in mixing. The ammonia injector should use a vacuum eductor or consist of a perforated tube fitted with a closely fitting flexible rubber tubing seal punctured with a number of small slits to delay fouling by lime or other scale deposits. Provisions shall be made for periodic removal of lime or other scale deposits from injectors and carrier piping. Consideration shall be given to the provision of an emergency gas scrubber capable of absorbing the entire contents of the largest anhydrous ammonia storage unit whenever there is a risk to the public as a result of potential ammonia leaks.

7.5.f. Potassium permanganate. -- A source of heated water should be available for dissolving potassium permanganate and mechanical mixers shall be provided.

7.5.g. Fluoride – At least two (2) diaphragm operated anti-siphon devices shall be provided on all fluoride saturator or fluosilicic acid feed systems with one (1) diaphragm operated anti-siphon device to be located on the discharge side of the feed pump and one (1) to be located at the point of application. A physical break box is required in high hazard situations where the application point is substantially lower than the metering pump. In this situation, either a dual head feed pump or two (2) separate pumps are required and the anti-siphon device at the discharge side of the pump may be omitted. The point of application shall enter into the lower half of the pipe, preferably at a forty-five (45) degree angle from the bottom of the pipe and shall protrude into the pipe one third of the pipe diameter.

7.6. Other chemical feed system or treatment methodologies may be installed in accordance with manufacturers and industry recommendations if approved by the BPH.

§64-77-8. Pumping Facilities.

8.1. General. -- Pumping facilities shall be designed to maintain the sanitary quality of pumped water. Subsurface pits or pump rooms and inaccessible installations shall be avoided. No pumping station shall be subject to flooding.

8.2. Location. -- The pumping station shall be located so that the proposed site meets the requirements for sanitary protection of water quality, hydraulics of the system and protection against interruption of service by fire, flood or any other hazard.

8.2.a. Site protection. -- The pumping station shall be: elevated to a minimum of three (3) feet above the one hundred (100) year flood elevation, or three (3) feet above the highest recorded flood elevation, whichever is higher, or protected to such elevations; readily accessible at all times unless permitted to be out of service for the period of inaccessibility; graded around the station so as to drain surface water away from the station; protected to prevent vandalism and entrance by animals or unauthorized persons. The pump station shall be located within a secure area such as a locked building or fenced area; and labeled such that the pumps and valves in the station are tagged to correspond to the maintenance record and for proper identification.

8.3. Pumping Stations.

8.3.a. Both raw and finished water pumping stations: shall have adequate space for the installation of additional units, if needed, and for the safe servicing of all equipment; be of durable construction, fire and weather resistant and with outward-opening doors; have a floor elevation of at least six (6) inches above finished grade; have underground structure waterproofed; have all floors drained in such a manner that the quality of the potable water is not endangered; have floors slope to a suitable drain; provide a suitable outlet for drainage from pump glands without discharging onto the floor; provide sampling taps, suction and discharge pressure gauges with stop cocks; and provide metering facilities.

8.3.b. Suction well. -- Suction wells shall be watertight, have floors sloped to permit removal of water and entrained solids, be covered or otherwise protected against contamination and have two pumping compartments or other means to allow the suction well to be taken out of service for inspection, maintenance or repair.

8.3.c. Equipment servicing. -- Pump stations shall be provided with: crane-ways, hoist beams, eye bolts, or other adequate facilities for servicing or removal of pumps, motors or other heavy equipment; openings in floors, roofs or wherever else needed for removal of heavy or bulky equipment; and a convenient tool board, or other facilities as needed, for proper maintenance of the equipment.

8.3.d. Stairways and ladders shall: be provided between all floors and in pits or compartments that are entered; and have handrails on both sides, and treads of non-slip material. Stairs are preferred in areas where there is frequent traffic or where supplies are transported by hand. They shall have risers not exceeding nine (9) inches and treads wide enough for safety.

8.3.e. Heating. -- Provisions shall be made for adequate heating for the comfort of the operator and the safe and efficient operation of the equipment. In pump houses not occupied by personnel, only enough heat need be provided to prevent freezing of equipment or treatment process.

8.3.f. Ventilation. -- Ventilation shall conform to existing local and state codes. Adequate ventilation shall be provided for all pumping stations. Forced ventilation of at least six (6) changes of air per hour shall be provided for all rooms, compartments, pits and other enclosures below the ground floor and any area where an unsafe atmosphere may develop or where excessive heat may be built up.

8.3.g. Dehumidification. -- In areas where excess moisture could cause hazards to safety or damage to equipment, means for dehumidification shall be provided.

8.3.h. Lighting. -- Pump stations shall be adequately lighted throughout. All electrical work shall conform to the requirements of the NEC and the relevant state and local codes.

8.3.i. Sanitary and other conveniences. -- All pumping stations that are manned for extended periods shall be provided with potable water, lavatory and toilet facilities. Plumbing shall be installed so as to prevent contamination of a public water supply.

8.4. Ground Water Pump Stations. -- Where pumping facilities are used, wells and springs shall be vented by properly hooded and screened pipe extending at least twelve (12) inches above the pump station floor or ground surface. Where necessary, provision shall be made for lubricating the pump from a point at least six (6) inches above the top of the well cover, by means that prevents contamination of the water supply.

8.4.a. Driven or Drilled Wells. -- Pumping stations located over driven or drilled wells shall: have riser pipe or casing extending at least six (6) inches, and preferably twelve (12) inches, above the floor, and equipped with a flange or suitable stuffing box; have riser pipe or casing firmly connected to the pump structure or have casing inserted into a recess extending at least one (1) inch into the base of the pump, if a watertight connection is not provided; have the base of the pump not less than six (6) inches above the pump room floor; and have the pump foundation and base designed to prevent water from coming into contact with the joint.

8.4.b. Submersible Pumps. -- Where a submersible pump is used, the top of the casing shall be equipped with pitless adaptors or vents, or both, approved by the NSF or WSC with an approved cap to effectively seal against entrance of water under all conditions of vibration or movements of conductors or cables.

8.4.c. Discharge Piping. -- Discharge piping shall be provided with means to pump to waste but shall not be directly connected to a sewer. The discharge line shall have control valves located above the pump floor, be protected against freezing, be valved to permit testing and control of each well, have watertight joints, and have all exposed valves protected.

8.5. Pumps.

8.5.a. At least two pumping units shall be provided. With any pump out of service, the remaining pump or pumps shall be capable of providing the maximum daily pumping demand of the system. The pumping units shall: have ample capacity to supply the peak demand against the required distribution system pressure without dangerous overloading; be driven by prime movers able to meet the maximum horsepower condition of the pumps; be provided with readily available spare parts and tools; be served by control equipment that has proper heater and overload protection for air temperature encountered; and be able to pump the maximum pumping demand of the system.

8.5.b. Suction lift. -- Suction lift shall be avoided, if possible, and be within manufacturers specifications, preferably less than fifteen (15) feet. If suction lift is necessary, provision shall be made for priming the pumps.

8.5.c. Priming. -- Priming water shall not be of lesser sanitary quality than that of the water being pumped. Means shall be provided to prevent backpressure or backsiphonage backflow. When an air-operated ejector is used, the screened intake shall draw clean air from a point at least ten (10) feet above the ground or other source of possible contamination unless the air is filtered by an apparatus approved by the BPH. Vacuum priming may be used.

8.6. Booster Pumps.

8.6.a. Booster pump stations shall be constructed in accordance with "Pumping Stations," in subsection 8.3 of this section, and shall contain sampling taps and sufficient room for booster chlorination facilities.

8.6.b. Booster pumps shall be located or controlled so that they do not produce negative pressure in their suction lines. Pumps installed in the distribution system shall maintain inlet pressure as required in Subdivision 10.2.b under all operating conditions. Pumps taking suction from storage tanks shall be provided adequate net positive suction head. Automatic shutoff or low pressure controller shall maintain at least 20 psi in the suction line under all operating conditions, unless otherwise approved by the BPH. Pumps taking suction from ground storage tanks shall be equipped with automatic shutoffs or low pressure controllers as required by the pump manufacturer. Automatic or remote control devices shall have a range between the start and cutoff pressure that prevents excessive cycling. A bypass shall be available.

8.6.c. Duplicate pumps. -- Each booster pumping station shall contain not less than two (2) pumps with capacities such that peak demand can be satisfied with the largest pump out of service.

8.6.d. Metering. -- All booster pumping stations shall be fitted with a flow rate indicating and totalizer meter.

8.6.e. In-line booster pumps. -- In-line booster pumps shall be accessible for servicing and repairs.

8.6.f. Individual home booster pumps. -- Individual home booster pumps shall not be allowed for any individual service from the public water supply main where residual pressures are less than five (5) pounds per square inch under any flow conditions. Where used, backflow prevention, approved by the BPH, consisting of at least a double check valve assembly shall be provided by the customer to protect the public water supply.

8.7. Automatic and Remote Controlled Stations. -- All automatic stations shall be provided with automatic signaling apparatus that reports when the station is out of service. All remote controlled stations shall be electrically operated and controlled and shall have signaling apparatus of proven performance. Installation of electrical equipment shall conform with the applicable state and local electrical codes and the National Electrical Code.

8.8. Appurtenances.

8.8.a. Valves. -- Each pump shall have an isolation valve on the intake and discharge side of the pump to permit satisfactory operation, maintenance and repair of the equipment. If foot valves are necessary, they shall have a net valve area of at least two and a half (2½) times the area of the suction pipe, and they shall be screened. Each pump shall have a positive-acting check valve on the discharge side between the pump and the shut-off valve. Surge relief valves or slow acting check valves shall be designed to minimize hydraulic transients.

8.8.b. Piping. -- In general, piping shall: be designed so that the friction losses are minimized and not be subject to contamination; have watertight joints; be protected against a surge or water hammer; be such that each pump has an individual suction line or lines are so manifolded that they insure similar hydraulic and operating conditions,

8.8.c. Gauges and meters. -- Each pump shall have a pressure gauge on its discharge line, shall have a compound gauge on its suction line, shall have recording meters and gauges in the larger stations (250 gallons per minute or larger) and shall have a means for measuring the discharge. The station shall have indicating, totalizing and recording metering of the total water pumped.

8.8.d. 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 less sanitary quality the seal shall be provided with either an approved reduced pressure backflow assembly or a break tank open to atmospheric pressure and have an air gap of at least six (6) inches or two (2) pipe diameters, whichever is greater, between the feeder line and the spill line of the tank.

8.8.e. Controls. -- Pumps, their motors and accessories, shall be controlled in such a manner that they operate at rated capacity without dangerous overload. Where two (2) or more pumps are installed for redundancy, provision shall be made for alternation. Provision shall be made to prevent energizing the motor in the event of a backspin cycle. Electrical controls shall be installed in accordance with NEC requirements. Equipment shall be provided, or other arrangements shall be made, to prevent surge pressures from activating controls that switch on pumps or activate other equipment outside the normal design cycle of operation.

8.8.f. Standby power. -- To ensure continuous service when the primary power had been interrupted, a power supply shall be provided from at least two (2) independent sources or a standby or an auxiliary source shall be provided. If standby power is provided by on-site generators or engines, the fuel storage and fuel line shall be designed to protect the water supply from contamination.

8.8.g. Water pre-lubrication. -- When automatic pre-lubrication of pump bearings is necessary and an auxiliary direct drive power supply is provided, the pre-lubrication line shall be provided with a valved bypass around the automatic control so that the bearings can, if necessary, be lubricated manually before the pump is started or the pre-lubrication controls shall be wired to the auxiliary power supply.

8.8.h. Oil or grease lubrication. -- All lubricants which come into contact with the potable water shall be certified for conformance to ANSI/NSF Standard 60.

§64-77-9. Finished Water Storage.

9.1. General. -- The materials and designs used for finished water storage structures shall provide stability and durability as well as protect the quality of the stored water. Steel structures shall follow the current AWWA standards concerning steel tanks, standpipes, reservoirs, and elevated tanks wherever they are applicable. Other materials of construction are acceptable when properly designed to meet the requirements of this section.

9.1.a. Sizing. -- Storage facilities shall have sufficient capacity, as determined from engineering studies, to meet domestic, commercial and industrial demands, and where fire protection is provided, fire flow demands.

9.1.a.1. Fire flow requirements established by the ISO shall be satisfied where fire protection is provided.

9.1.a.2. The minimum storage capacity (or equivalent capacity) for systems providing fire protection shall be equal to twice the average daily demand of one hundred fifty (150) gallons per customer per day plus fire flow unless it can be demonstrated that the supply capacity of the system is sufficient to warrant less. This requirement may be reduced when the source and treatment facilities have sufficient capacity with standby power to supplement peak demands of the system.

9.1.a.3. A recommended storage capacity for community and non-community, non-transient public water systems not providing fire protection shall be equal to twice the average daily demand of one hundred fifty (150) gallons per customer per day.

9.1.b. Location of ground-level reservoirs. -- The bottom of reservoirs and standpipes shall be placed at the normal ground surface and shall be above the one hundred (100) year flood level. When the bottom is below normal ground surface, it shall be placed above the groundwater table. At least fifty per cent (50%) of the water depth of the reservoir may be above grade. Sewers, drains, standing water, and similar sources of possible contamination shall be kept at least fifty (50) feet from the reservoir. A water main pipe, pressure tested in place to fifty (50) pounds per square inch without leakage, may be located from twenty (20) to fifty (50) feet from a sewer, but under no circumstances shall it be located within twenty (20) feet of a sewer.

The top of a partially buried storage structure shall be at least two (2) feet above normal ground surface. Clearwells constructed under filters may be excepted from this requirement when the design provides adequate protection from contamination.

9.1.c. Protection. -- All finished water storage structures shall have suitable watertight roofs and screened vents that exclude birds, animals, insects, and excessive dust. The installation of appurtenances, such as antenna, shall be done in a manner that ensures no damage to the tank, coatings or water quality.

9.1.d. Protection from trespassers. -- Fencing, locks on access manholes, and other necessary precautions shall be provided to prevent trespassing, vandalism and sabotage, including the installation of high strength locks or lock covers to prevent direct cutting of a lock, if possible.

9.1.e. Drains. -- No drain on a water storage structure may have a direct connection to a sewer or storm drain. The design shall allow draining the storage facility for cleaning or maintenance without causing loss of pressure in the distribution system.

9.1.f. Overflow. -- All water storage structures shall be provided with an overflow that is brought down to an elevation between twelve (12) and twenty-four (24) inches above the ground surface and that 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.

9.1.f.1. 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.

9.1.f.2. The overflow of a ground-level structure shall open downward and be screened with twenty-four (24) mesh non-corrodible screen installed within the pipe at a location least susceptible to damage by vandalism.

9.1.f.3. The overflow pipe shall be of sufficient diameter to permit waste of water in excess of the filling rate.

9.1.g. Access. -- Finished water storage structures shall be designed with reasonably convenient access to the interior for cleaning and maintenance. Manholes above the water line: shall be framed at least four (4) inches, and preferably (6) six inches, above the surface of the roof at the opening; on ground-level structures, shall be elevated twenty-four (24) to thirty-six (36) inches above the top or covering sod; shall be fitted with a solid watertight cover that overlaps the framed opening and extends down around the frame at least two (2) inches; shall be hinged at one (1) side; and shall have a locking device.

9.1.h. 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, animals and insects, as much as this function can be made compatible with effective venting. For elevated tanks and standpipes, four (4) mesh non-corrodible screen may be used. On ground-level structures, standpipes shall terminate in an inverted U construction with the opening twenty-four (24) to thirty-six (36) inches above the roof or sod and be covered with twenty-four (24) mesh non-corrodible screen installed within the pipe at a location least susceptible to vandalism.

9.1.i. 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 and piping for inflow and outflow.

9.1.i.1. Any pipes running through the roof or sidewall of a finished water storage structure shall be welded, or properly gasketed in metal tanks. In concrete tanks, these pipes shall be connected to standard wall castings that were poured in place during the forming of the concrete. These wall castings shall have seepage rings imbedded in the concrete.

9.1.i.2. Openings in a storage structure roof or top, designed to accommodate control apparatus or pump columns, shall be curbed and sleeved with proper additional shielding to prevent the access of surface or floor drainage water into the structure.

9.1.i.3. Valves and controls shall be located outside the storage structure so that the valve stems and similar projections do not pass through the roof or top of the reservoir.

9.1.i.4. The roof of concrete reservoirs with an earthen cover shall be sloped to facilitate drainage. Consideration shall be given to installation of an impermeable membrane roof covering.

9.1.i.5. Locks shall be provided on valve vaults where applicable.

9.1.j. Drainage of roof. -- The roof of the storage structure shall be well drained. Downspout pipes shall not enter or pass through the reservoir. Parapets, or similar construction that would tend to hold water and snow on the roof, shall not be approved by the BPH unless adequate waterproofing and drainage are provided.

9.1.k. Safety. -- The safety of employees shall be considered in the design of the storage structure. As a minimum, employee safety matters shall conform to pertinent laws and rules.

9.1.k.1. Ladders, ladder guards, balcony railings, and safely located entrance hatches shall be provided where applicable. Elevated tanks with riser pipes more than eight inches in diameter shall have protective bars over the riser openings inside the tank. Railings or handholds shall be provided on elevated tanks where persons transfer from the access tube to the water compartment. Confined space entry requirements shall be considered.

9.1.l. Freezing. -- All finished water storage structures and their appurtenances, especially the riser pipes, overflows, and vents, shall be designed to prevent freezing that interferes with proper functioning. Equipment used for freeze protection that comes into contact with the potable water shall meet ANSI/NSF Standard 61 or be approved by the BPH. If a water circulation system is used, it is recommended that the circulation pipe be located separately from the riser pipe.

9.1.m. Internal catwalk. -- Every catwalk over finished water in a storage structure shall have a solid floor with raised edges designed so that shoe scrapings and dirt do not fall into the water.

9.1.n. Silt stop. -- The discharge pipes from all reservoirs shall be located in a manner that prevents the flow of sediment into the distribution system. Removable silt stops shall be provided.

9.1.o. Grading. -- The area surrounding a ground-level structure shall be graded in a manner that prevents surface water from standing within fifty (50) feet.

9.1.p. Painting and cathodic protection. -- Proper protection shall be given to metal surfaces by paints or other protective coatings, by cathodic protective devices, or by both. Paint systems shall be certified to conform to ANSI/NSF Standard 61: Drinking Water System Components - Health Effects. Interior paint shall be properly applied and cured. After curing, the coating shall not transfer any substance to the water that is toxic or cause tastes or odors. Prior to placing in service, an analysis for volatile organic compounds is advisable to establish that the coating is properly cured. Consideration shall be given to 100% solids coatings. Wax coatings for the tank interior shall not be used on new tanks. Recoating with a wax system is not allowed. Old wax coating shall be completely removed before using another coating. Cathodic protection shall be installed on below grade steel reservoirs and shall be designed and installed by competent technical personnel; a maintenance contract shall be provided.

9.1.q. Disinfection. -- Finished water storage structures shall be disinfected in accordance with current AWWA Standard C652. Two (2) or more successive sets of samples, taken at twenty-four (24) hour intervals, shall be microbiologically satisfactory before the facility is placed into operation. Disposal of heavily chlorinated water from the tank disinfection process shall be in accordance with the requirements of the WVDEP. The disinfection procedure (AWWA C652 chlorination method 3, subsection 4.3.) that allows use of the chlorinated water held in the storage tank for disinfection purposes is not recommended. When that procedure is used, it is recommended that the initial heavily chlorinated water be properly disposed in order to prevent the release of water that may contain various chlorinated organic compounds into the distribution system.

9.1.r. Provisions of Sampling. -- Smooth-nosed sampling taps shall be provided to facilitate collection of water samples for both bacteriologic and chemical analysis. The sampling tap(s) shall be easily accessible.

9.2. Plant Storage. -- The applicable design standards for finished water storage shall be followed for plant storage.

9.2.a. Filter Washwater tanks. -- Filter washwater tanks shall be sized, in conjunction with available pump units and finished water storage, to provide the backwash water required. Consideration shall be given to the backwashing of several filters in rapid succession.

9.2.b. Clearwell. -- Clearwell storage shall be sized, in conjunction with distribution system storage, to relieve the filters from having to follow fluctuations in water use and meet peak demands, including filter backwash water. When finished water storage is used to provide contact time for chlorine, special attention shall be given to size and baffling. To ensure adequate chlorine contact time in accordance with the West Virginia Bureau for Public Health rule, Public Water Systems, 64CSR3, sizing of the clearwell shall include extra volume to accommodate depletion of storage during the nighttime for intermittently operated filtration plants with automatic high service pumping from the clearwell during non-treatment hours. An overflow and vent shall be provided. A minimum of two (2) clearwell compartments shall be provided.

9.2.c. Adjacent compartments. -- Finished water shall not be stored or conveyed in a compartment adjacent to untreated or partially treated water when the two compartments are separated by a single wall.

9.2.d. Other treatment plant storage tanks. -- Receiving basins, detention basins, backwash reclaim tanks and pump wet wells for finished water shall be designed as finished water storage structures.

9.3. Hydropneumatic Tanks. -- Hydropneumatic (pressure) tanks serving community and non-community, non-transient public water systems, when provided as the only storage facility, are acceptable only in very small service areas. Systems serving more than 150 living units shall have ground or elevated storage. Hydropneumatic tank storage is not permitted for fire protection purposes. Pressure tanks shall meet ASME code requirements or an equivalent requirement of state or local laws and rules of construction and installation of unfired pressure vessels. Non-ASME, factory-built hydropneumatic tanks may be allowed if approved by the BPH.

9.3.a. Location. -- The tank shall be located above normal ground surface and be completely housed.

9.3.b. Sizing. -- The capacity of the pumps in a hydropneumatic system shall be at least ten (10) times the average daily consumption rate. The gross volume of the hydropneumatic tank, in gallons, shall be at least ten (10) times the capacity of the largest pump, rated in gallons per minute. For example, a two hundred fifty (250) gallon per minute pump shall have a two thousand five hundred (2,500) gallon pressure tank, unless other measures, such as variable speed drives in conjunction with the pump motors are provided to meet the maximum demand. Sizing of hydropneumatic storage tanks shall consider the need for chlorine detention time, as applicable, independent of the storage requirements. If hydropneumatic tanks are considered for chlorine contact, separate inlet and outlet connectors at top and bottom of the tank are required.

9.3.c. Piping. -- The hydropneumatic tank shall have bypass piping to permit operation of the system while it is being repaired or painted.

9.3.d. Appurtenances. -- Each hydropneumatic tank shall have an access manhole, a drain and control equipment consisting of pressure gauge, water sight glass, automatic or manual air blow-off, a means for adding air, and pressure operated start-stop controls for the pumps. A pressure relief valve shall be installed and be capable of handling the full pumpage rate of flow at the pressure vessel design limit. Where practical the access manhole shall be twenty-four (24) inches in diameter.

9.3.e. Coatings. -- The interior coating of all tanks shall meet ANSI/NSF Standard 61: Drinking Water System Components - Health Effects.

9.4. Distribution Storage. -- The applicable design standards of subsection 9.1. of this rule shall be followed for distribution system storage. The minimum storage capacity (or equivalent capacity) for systems providing fire protection shall be equal to twice the average daily demand of one hundred fifty (150) gallons per customer per day plus fire flow unless it can be demonstrated that the supply capacity of the system is sufficient to warrant less. All tanks shall be controlled to provide an adequate turn-over of at least twenty percent (20%) of the total volume each twenty-four (24) hour period. The BPH may allow a variance to the minimum twenty percent (20%) turn-over requirement, if adequate justification is provided such as no distribution water quality violations, booster chlorination, etc. This may require a main line altitude valve or externally controlled valves.

9.4.a. Pressures. -- The maximum variation between high and low levels in standpipes or elevated storage structures providing pressure to a distribution system shall not exceed thirty (30) feet (thirteen (13) pounds per square inch). The minimum pressure in the distribution system shall be thirty (30) pounds per square inch under static conditions and twenty (20) pounds per square inch under all flow conditions. The normal working pressures of the distribution mains shall be designed based upon the pipe manufacturer's recommendations and the applicable AWWA standards for the type of pipe. Pressure regulating/pressure reducing valves shall be used to protect the distribution mains from excessive pressures. When static pressures in the distribution mains exceed one hundred thirty five (135) pounds per square inch, the utility shall have the option of installing pressure reducing valves on service lines or requiring (or recommending) the customer install and maintain a pressure reducing valve on the customer's service line.

9.4.b. Drainage. -- Storage structures that provide pressure directly to the distribution system shall be designed so they can be isolated from the distribution system and drained for cleaning or maintenance without necessitating loss of pressure in the distribution system. The drain shall discharge to the ground surface with no direct connection to a sewer or storm drain.

9.4.c. Level controls. -- Commercially available control systems shall be provided to maintain levels in distribution system storage structures for community and non-community, non-transient public water systems. Level indicating devices shall be provided at a central location. Pumps shall be controlled from tank levels with the signal transmitted by telemetering equipment when any appreciable head loss occurs in the distribution system between the source and the storage structure. Altitude valves or equivalent controls may be required for additional structures on the system. Overflow and low-level warnings or alarms shall be located at places in the community where they are under responsible surveillance twenty-four (24) hours a day.

§64-77-10. Distribution Systems.

10.1. Materials.

10.1.a. Standards and materials selection. -- Pipe, fittings, valves and fire hydrants shall conform to ASTM, AWWA standards, meet ANSI/NSF Standard 61: Drinking Water System Components - Health Effects and shall be acceptable to the BPH. In the absence of these standards, materials meeting applicable product standards and acceptable to the BPH may be selected. Special attention shall be given to selecting pipe materials that protect against both internal and external pipe corrosion. Pipes and pipe fittings containing more than eight percent (8%) lead shall not be used. All products shall comply with ANSI/NSF Standard 61: Drinking Water System Components - Health Effects.

10.1.b. Permeation of system by organic compounds. -- Where distribution systems are installed in areas of groundwater contaminated by organic compounds: pipe and joint materials that are not subject to permeation of the organic compounds shall be used; and non-permeable materials shall be used for all portions of the system including water main, service connections and hydrant leads.

10.1.c. Used materials. -- Water mains that have been used previously for conveying potable water may be reused provided they meet the standards contained in this rule.

10.1.d. Joints. -- Packing and jointing materials used in the joints of pipe shall meet the standards of the AWWA, ANSI/NSF Standard 61 and the BPH. Pipe having mechanical joints or slip-on joints with rubber gaskets is preferred. Lead-tip gaskets shall not be used. Repairs to lead-joint pipe shall be made using alternative methods. Manufacturer approved transition joints shall be used between dissimilar piping materials.

10.2. Water Main Design.

10.2.a. All distribution systems shall be designed to provide a residential peak demand flow (not including fire flows) in accordance with Table 64-77E of this rule.

10.2.b. Pressure. -- All water mains, including those not designed to provide fire protection, shall be sized after a hydraulic analysis based on peak flow demands and pressure requirements. The system shall be designed to maintain a minimum pressure of twenty (20) pounds per square inch at ground level at all points in the distribution system under all conditions of flow and thirty (30) pounds per square inch under static conditions. The normal working pressure in the distribution system shall be designed based upon the pipe manufacturer's recommendations and the applicable AWWA standards for the type of pipe.

10.2.c. Surge Pressures. -- All water mains shall be designed to provide adequate strength to withstand water surge pressure. Table 64-77F of this rule lists the minimum acceptable pressure surge for PVC for each foot per second velocity of water. Design shall allow for at least five (5) feet per second instantaneous flow velocity change or higher if conditions warrant.

10.2.d. Diameter. -- The minimum size of a water main for providing fire protection and serving fire hydrants shall be of six (6) inch diameter. Larger size mains are required if necessary to allow the withdrawal of the required fire flow while maintaining the minimum residual pressures.

10.2.e. Fire protection. -- When fire protection is to be provided, the recommended system design shall be such that fire flows and facilities are in accordance with the requirements of the ISO. Under no circumstances shall fire flows be less than two hundred fifty (250) gallons per minute.

10.2.f. Small mains. -- Any departure from minimum six (6) inch diameter requirements shall be justified by hydraulic analysis and future water use, and can be considered only in special circumstances; however, no mains less than two (2) inches are permitted.

10.2.g. Hydrants. -- Water mains not designed to carry fire-flows shall not have fire hydrants connected to them.

10.2.h. Dead ends. -- In order to provide increased reliability of service and reduce head loss, dead ends shall be minimized by making appropriate tie-ins whenever practical. Where dead-end mains occur, they shall be provided with a fire hydrant if flow and pressure are sufficient, or with a flushing hydrant or blow-off, approved by the BPH, for flushing purposes. Flushing devices shall be sized to provide flows that give a velocity of at least two and a half (2.5) feet per second in the water main being flushed. No flushing devices shall be directly connected to any sewer.

10.3. Valves. -- A sufficient number of valves shall be provided on water mains so that inconvenience and sanitary hazards are minimized during repairs. Valves shall be located at not more than five hundred (500) foot intervals in commercial districts and at not more than one block or eight hundred (800) foot intervals in other districts. Where systems serve widely scattered customers and where future development is not expected, the valve spacing shall not exceed two thousand five hundred (2,500) feet.

10.4. Hydrants.

10.4.a. Location and spacing. -- Hydrants shall be provided at each street intersection and at intermediate points between intersections as recommended by the ISO. Generally, hydrant spacing may range from three hundred fifty (350) to one thousand (1000) feet depending on the area being served.

10.4.b. Valves and nozzles. -- Fire hydrants shall have a bottom valve size of at least five (5”) inches, one four and one half (4½”) inch pumper nozzle and two (2) two and a half (2½”) inch nozzles.

10.4.c. Hydrant leads. -- The hydrant lead shall be a minimum of six (6) inches in diameter. Auxiliary valves shall be installed in all hydrant leads.

10.4.d. Drainage. -- Hydrant drains shall be provided with a gravel pocket, or a dry well shall be provided unless the natural soils provide adequate drainage. Hydrant drains shall not be connected to or located within ten (10) feet of sanitary sewers or storm drains.

10.4.e. Draining type frost proof yard hydrants are not permitted.

10.5. Air Relief Valves, Valve, Meter and Blow-off Chambers.

10.5.a. Air relief valves. -- At high points in water mains where air can accumulate, provisions shall be made to remove the air by means of hydrants or air relief valves. Automatic air relief valves shall not be used in situations where flooding of the manhole or chamber may occur.

10.5.b. Air relief valve piping. -- The open end of an air relief pipe from automatic valves shall be provided with a screened, downward-facing elbow. The pipe from a manually operated valve shall be extended to the top of the pit. Use of manual air relief valves is recommended wherever possible.

10.5.c. Chamber drainage. -- Chambers, pits or manholes containing valves, blow-offs, meters or other such appurtenances to a distribution system shall not be connected directly to any storm drain or sanitary sewer nor shall blow-offs or air relief valves be connected directly to any sewer. These 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.

10.6. Installation of Mains.

10.6.a. Standards. -- Specifications shall incorporate the provisions of the AWWA standards and manufacturer's recommended installation procedures.

10.6.b. Bedding. -- A continuous and uniform bedding shall be provided in the trench for all buried pipe. Backfill material shall be tamped in layers around the pipe and to a sufficient height above the pipe to adequately support and protect the pipe. Stones found in the trench shall be removed for a depth of at least six (6) inches below the bottom of the pipe.

10.6.c. Cover. -- All water mains shall be covered with sufficient earth or other insulation to prevent freezing. All distribution mains shall be provided with a minimum of thirty-six (36) inches of earth covering; forty-two (42) inches are recommended. All mains of less than eight (8) inches in diameter within five (5) feet of a heavily traveled highway shall be provided with at least forty-two (42) inches of cover.

10.6.d. Blocking. -- All tees, bends, plugs and hydrants shall be provided with reaction blocking, tie rods or joints designed to prevent movement.

10.6.e. Pressure and leakage testing. -- All types of installed pipe shall be pressure tested and leakage tested in accordance with AWWA Standard C600.

10.6.f. Disinfection. -- All new, cleaned or repaired water mains shall be disinfected in accordance with AWWA Standard C651. The specifications shall include microbiological testing of all water mains. Microbiological sampling shall be collected by a BPH certified public water system operator or other individual authorized by the BPH.

10.6.g. All non-metallic mains shall be provided with tracer wire or metallic tape.

10.6.h. Anchoring of fusible pipe. -- Additional restraint may be necessary on fusible pipe at the connection to appurtenances or transitions to different pipe materials to prevent separation of joints. The restraint may be provided in the form of an anchor ring encased in concrete or other methods as approved by the BPH.

10.6.i. External corrosion. -- If soils are found to be aggressive, necessary action to protect the water main shall be taken, such as by encasement of the water main in polyethylene, provision of cathodic protection (in very severe instances), or using corrosion resistant water main materials.

10.7. Separation of Water Mains, Sanitary Sewers and Storm Sewers.

10.7.a. General. -- The following factors shall be considered in providing adequate separation: materials and type of joints for water and sewer pipes; soil conditions; service and branch connections into the water main and sewer line compensating variations in the horizontal and vertical separations; space for repair and alterations of water and sewer pipes and off-setting of pipes around manholes.

10.7.b. Parallel installation. -- Water mains shall be laid at least ten (10) feet horizontally from any existing or proposed sewer. The distance shall be measured edge to edge.

10.7.c. Crossings. -- Water mains shall cross above sewers and shall be laid to provide a minimum vertical distance of eighteen (18) inches between the bottom of the water main and the top of the sewer. At crossings, one full length (20 feet) of water pipe shall be located so both joints will be as far from the sewer as possible. Special structural support for the water and sewer pipes may be required.

10.7.d. Force mains. -- There shall be at least a ten (10) foot horizontal separation between water mains and sanitary sewer force mains. There shall be an eighteen (18) inch vertical separation at crossings as required.

10.7.e. Exception. -- The BPH may approve a variance from the above requirements when it determines that compliance with the specified separation distances cannot be practically achieved.

10.7.f. Sewer manholes. -- No water pipe shall pass through or come in contact with any part of a sewer manhole.

10.7.g. Separation of water mains from other sources of contamination. -- Design engineers shall exercise caution when locating water mains at or near certain sites such as sewage treatment plants or industrial complexes. Individual septic tanks shall be located and avoided. The engineer shall contact the BPH to establish specific design requirements for locating water mains near any source of contamination.

10.8. Surface Water Crossings. -- The BPH shall be consulted before final plans are prepared.

10.8.a. Above-water crossings. -- An above-water crossing pipe shall be adequately supported and anchored, be protected from vandalism, damage and freezing and be accessible for repair or replacement.

10.8.b. Underwater crossings. -- A minimum cover of three (3) feet shall be provided over the pipe unless otherwise approved by the BPH. When crossing water courses that are greater than fifteen (15) feet in width, the following shall be provided: the pipe shall be of special construction, having flexible watertight joints; 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 permanent taps shall be made on each side of the valve to allow insertion of a small meter to determine leakage and for sampling purposes.

10.9. Cross-connections and Interconnections.

10.9.a. Cross-connections. -- There shall be no connection between the distribution system and any pipes, pumps, hydrants, or tanks whereby unsafe water or other contaminating materials may be discharged or drawn into the system. Each water utility shall have a program conforming to the BPH requirements to detect and eliminate cross connections.

10.9.b. Cooling water. -- Neither steam condensate nor cooling water from engine jackets or other heat exchange devices shall be returned to the potable water supply.

10.9.c. Interconnections. -- The approval of the BPH shall be obtained for interconnections between approved public water systems.

10.10. Water Services and Plumbing.

10.10.a. Plumbing. -- Water services and plumbing shall conform to relevant local and state plumbing codes or to the applicable National Plumbing Code. Solders and flux containing more than two tenths percent (0.2%) lead and pipe and pipe fittings containing more than eight percent (8%) lead shall not be used. The public water system is not responsible for an individual customer's private plumbing.

10.10.b. Booster pumps. -- Individual booster pumps are not allowed for any individual service from the public water supply mains where residual pressures are less than five (5) pounds per square inch under all flow conditions. Where used, backflow prevention, approved by the BPH, consisting of at least a double check valve assembly shall be provided by the customer to protect the public water supply.

10.11. Service Meters. -- Each service connection shall be individually metered.

10.12. Water Loading Stations. -- Water loading stations present special problems since the fill line may be used for filling both potable water vessels and other tanks or contaminated vessels. To prevent contamination of both the public supply and potable water vessels being filled, the following principles shall be met in the design of water loading stations: there shall be a double check valve assembly approved by the BPH and installed to prevent backflow to the public water supply; the piping arrangement shall prevent contaminant being transferred from a hauling vessel to another. Hoses shall not be contaminated by contact with the ground and shall be capped when not in use. Water meters shall be provided.

§64-77-11. Enforcement Penalties.

Violators of this rule are subject to the civil and administrative penalties of W. Va. Code §§16-1-9a(d)(2) and (3) and the criminal penalties of W. Va. Code §§16-1-9, 16-1-9a(d)(1) and 16-1-18.

§64-77-12. Administrative Due Process.

Those persons aggrieved by the administrative enforcement of this rule may request a contested case hearing in accordance with the Bureau for Public Health procedural rule, "Rules and Procedures for Contested Case Hearings and Declaratory Rulings," 64CSR1.

TABLE 64-77A

Water Treatment Plant Pipe Color Code Requirements

	Water Lines
Raw	Olive Green
Settled or Clarified	Aqua
Finished or Potable	Dark Blue
	Chemical Lines
Alum or Primary Coagulant	Orange
Ammonia	White
Carbon Slurry	Black
Caustic	Yellow with Green Band
Chlorine (Gas or Solution)	Yellow
Fluoride	Light Blue with Red Band
Lime Slurry	Light Green
Ozone	Yellow with Orange Band
Phosphate Compounds	Light Green with Red Band
Polymers or Coagulant Aids	Orange with Green Band
Potassium Permanganate	Violet
Soda Ash	Light Green with Orange Band
Sulfuric Acid	Yellow with Red Band
Sulfur Dioxide	Light Green with Yellow Band
	Waste Lines
Backwash Waste	Light Brown
Sludge	Dark Brown
Sewer (Sanitary or Other)	Dark Gray
	Other
Compressed Air	Dark Green
Gas	Red
Other Lines	Light Gray

TABLE 64-77B

Minimum Horizontal Distance Between a New Public Water System Groundwater Well and a Potential Contamination Source

Source	Minimum Distance
Septic Tanks	50 feet (100 feet)
Sewage Treatment Facilities	200 feet
Sewers and Drains (Watertight)	10 feet
Sewers and Drains (Non watertight)	50 feet (100 feet)
Sewage Holding Tanks and Privies (Vault)	50 feet (100 feet)
Barnyard/Feeding and Watering Areas	100 feet
Streams, Rivers and Impoundments	25 feet
Sewage Absorption Fields	100 feet

Note that the distance noted in parenthesis shall be required when a water well is lower in elevation than the source of pollution or contamination referenced.

Note that the sewer and drain materials shall be of potable water main standards and installed and hydrostatically tested as approved by the commissioner.

TABLE 64-77 C

Rapid Rate Gravity Filters Size and Depth of Gravel Supporting Media

	Size
2 1/2 to 1/2 inches	5 to 8 inches
1 1/2 to 3/4 inches	3 to 5 inches
3/4 to 1/2 inches	3 to 5 inches
1/2 to 3/16 inches	2 to 3 inches
3/16 to 3/32 inches	2 to 3 inches

TABLE 64-77D

Groundwater Well Steel Pipe Casing Requirements *					
SIZE	DIAMETER (inches)		THICKNESS (inches)	WEIGHT PER FOOT (pounds)	
	EXTERNAL	INTERNAL		PLAIN ENDS (calculated)	WITH THREADS AND COUPLINGS (nominal)
6 ID.	6.625	6.065	0.280	18.97	19.18
8	8.625	7.981	0.322	28.55	29.35
10	10.750	10.020	0.365	40.48	41.85
12	12.750	12.000	0.375	49.56	51.15
14 OD.	14.000	13.250	0.375	54.57	57.00
16	16.000	15.250	0.375	62.58	
18	18.000	17.250	0.375	70.59	
20	20.000	19.250	0.375	78.60	
22	22.000	21.000	0.500	114.81	
24	24.000	23.000	0.500	125.49	
26	26.000	25.000	0.500	136.17	
28	28.000	27.000	0.500	146.85	
30	30.000	29.000	0.500	157.53	
32	32.000	31.000	0.500	168.21	
34	34.000	33.000	0.500	178.89	
36	36.000	35.000	0.500	189.57	

*****Abstracted from AWWA Standard for Deep Wells, AWWA A100.

TABLE 64-77E

Estimated Peak Design Flows Per Home For Water Distribution Systems

No. of Homes	Peak Design Flow gpm	No. of Homes	Peak Design Flow gpm
1	14	50	70
2	18	60	76
3	20	70	82
4	22	80	88
6	25	90	94
8	28	100	100
10	30	125	110
15	37	150	120
20	43	175	132
25	48	200	140
30	53	300	175
40	62	400	200

More than 400 homes, use 0.5 gallons per minute per home.

Note: Commercial, industrial, or other high-user customers are not covered in this table and shall be included in the design of the distribution system.

TABLE 64-77F

DESIGN TABLE FOR PVC PIPE
PRESSURE SURGE vs. DIMENSION RATIO

[In response to 1 foot per second instantaneous flow velocity change]

Dimension Ratio	Pressure Surge, psi (kPa)
13.5	20.2 (139)
14	19.8 (139)
17	17.9 (123)
18	17.4 (120)
21	16.0 (110)
25	14.7 (101)
26	14.4 (99)
32.5	12.8 (88)
41	11.4 (79)