TITLE 64
INTERPRETIVE RULES
BOARD OF HEALTH

SERIES 42
DESIGN STANDARDS FOR PUBLIC WATER SUPPLY SYSTEM

§64-42-1. General.

1.1. Scope -- These interpretive rules establish the design standards for the construction or modification of all public water supply systems requiring a State Health Department.

1.2. Authority -- W.Va. Code §16-1-7, §16-1-9

1.3. Filing Date -- October 30, 1969

1.4. Effective Date -- January 1, 1970

ED. NOTE: The design standards are omitted. They are available from the Secretary of State, State Health Department and most County Health Departments.

WEST VIRGINIA INTERPRETIVE RULES
BOARD OF HEALTH

Design Standards for Public Water Supply Systems

Chapter 16-1
Series 42
(1983)

INDEX

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Chapter 16-1
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Subject: Design Standards for Public Water Supply Systems

Section 1. General

1.1. Scope - These interpretive rules establish the design standards for the construction or modification of all public water supply systems requiring a state health department.

1.2. Authority - These interpretive rules are issued under the authority of Chapter 16, Article 1, Section 7 and are related to Chapter 16, Article 1, Section 9 of the West Virginia Code of 1931, as amended.

1.3. Filing Date - These interpretive rules were filed on the 30th day of October 1969 in the Secretary of State's office.

1.4. Effective Date - These interpretive rules became effective on the 1st day of January 1970.

1.5. Refiling Date - These interpretive rules were refiled pursuant to Chapter 29A, Article 2, Section 5 of the West Virginia Code of 1931, as amended on the 30th day of December 1982, in the Secretary of State's office.

Section 2. Submission of Plans

2.1. General - All reports, final plans and specifications shall be submitted at least 45 days prior to the date on which action by the division of sanitary engineering is desired. Preliminary plans and the engineer's report should be submitted for review prior to the preparation of final plans. No approval for construction can be issued until final, complete, detailed plans and specifications have been submitted to the division of

sanitary engineering and found to be satisfactory.

2.1.1. Documents submitted for formal approval shall include but not be limited to:

2.1.1.1. summary of complete design criteria;

2.1.1.2. general layout;

2.1.1.3. detailed plans;

2.1.1.4. specifications.

2.1.2. One set of approved plans and specifications will be retained by the division of sanitary engineering and one set will be returned to the applicant. Additional copies of plans and specifications will be approved upon request for the use of persons filing such plans and specifications.

2.1.3. Approval of plans and specifications by the division of sanitary engineering does not imply a guarantee against litigation that may result from construction or operation of the water supply system.

2.1.4. All installations and operations shall meet or exceed the relevant requirements of the national, state, local or trades good practices, codes, whichever has jurisdiction.

2.2. Engineer's Report - The engineer's report for water works improvements should, where pertinent, present the following information:

2.2.1. General information, including:

2.2.1.1. description of the existing water works and sewerage facilities;

2.2.1.2. identification of the municipality or area served;

2.2.1.3. name and mailing address of the owner or official custodian.

2.2.2. Extent of water works system, including:

2.2.2.1. description of the nature and extent of the area to be served;

2.2.2.2. provisions for extending the water works system to include additional areas;

2.2.2.3. appraisal of the future requirements for service, including existing and potential industrial, commercial, institutional and other water supply needs.

2.2.3. Alternate plans - Where two or more solutions exist for providing public water supply facilities, each of which is feasible and practicable, discuss the alternate plans and give reasons for selecting the one recommended, including financial considerations.

2.2.4. Soil, ground water conditions, and foundation problems, including:

2.2.4.1. description of the character of the soil through which water mains are to be laid;

2.2.4.2. description of foundation conditions prevailing at sites of proposed structures;

2.2.4.3. description of the approximate elevation of ground water in relation to subsurface structures.

2.2.5. Water consumption, including:

2.2.5.1. description of the population trends as indicated by available records, and the estimated population which will be served by the proposed water supply system or expanded system;

2.2.5.2. present and future water consumption values used as the basis of design;

2.2.5.3. present and estimated yield of the sources of supply.

2.2.6. Water distribution - Normal and maximum pressure and fire flow at the beginning of the system, ends of the system and intermediate points throughout the system. Include supporting data used as basis for design.

2.2.7. Fire flow requirements, including:

2.2.7.1. requirements of the american insurance association and related agencies as to fire flows required or recommended in the service area involved;

2.2.7.2. fire flow which will be made available by the proposed or enlarged system.

2.2.8. Sewerage system available - Describe the existing sewerage system and sewage treatment works, with special reference to their relationship to existing or proposed water works structures which may affect the operation of the water supply system, or which may affect the quality of the supply.

2.2.9. Sources of water supply - Describe the proposed source or sources of water supply to be developed, the reasons for their selection, and information as follows:

2.2.9.1. Surface water sources:

2.2.9.1.1. hydrological data, stream flow and weather records;

2.2.9.1.2. safe yield, including all factors that may affect it;

2.2.9.1.3. maximum flood flow, together with approval for safety features of spillway and dam from appropriate governmental authority;

2.2.9.1.4. summarized quality of raw water with special references to

fluctuations in quality, changing meteorological conditions, sources of contamination and similar pertinent conditions.

2.2.9.2. Ground water sources:

2.2.9.2.1. sites considered;

2.2.9.2.2. advantages of site selected;

2.2.9.2.3. elevations with respect to surroundings;

2.2.9.2.4. probable character of formations through which source is to be developed;

2.2.9.2.5. unusual geologic conditions affecting site;

2.2.9.2.6. summary of source exploration, test well depth, and method of construction; placement of liners or screen; pumping test, hours, capacity, water levels and specific yield; water quality;

2.2.9.2.7. possible sources of contamination.

2.2.10. Proposed treatment processes - Summarize and establish the adequacy of proposed processes for the treatment of the specific water under consideration. Pilot studies may be required.

2.2.11. Waste disposal - Discuss the various wastes from the water treatment plant, their volume, proposed treatment and points of discharge.

2.2.12. Automatic equipment - Provide supporting data justifying automatic equipment, including servicing.

2.2.13. Project sites, including:

2.2.13.1. discussion on various sites considered and advantages of the recommended ones;

2.2.13.2. proximity of residences, industries, and other establishments;

2.2.13.3. presence of any potential sources of pollution that may influence the quality of the supply or interfere with the effective operation of the water works system, such as sewage absorption systems, septic tanks, privies, cesspools, sink holes, refuse and garbage dumps and similar disciplines.

2.2.14. Financing, including:

2.2.14.1. estimated cost of integral parts of system;

2.2.14.2. detailed estimated annual cost of operation;

2.2.14.3. proposed methods to finance both capital charges and operating expenses.

2.2.15. Future extensions - Summarize planning for future needs and service.

2.3. Plans - Plans for water works shall, where applicable, provide the following:

2.3.1. General layout, including:

2.3.1.1. suitable title;

2.3.1.2. name and location of municipality, area or institution to be served;

2.3.1.3. scale, in feet;

2.3.1.4. north point;

2.3.1.5. datum used;

2.3.1.6. boundaries of the municipality or area to be served;

2.3.1.7. date, address and name of the designing engineer;

2.3.1.8. imprint of professional engineer's seal;

2.3.1.9. legible prints suitable for reproduction;

2.3.1.10. location and size of existing water mains;

2.3.1.11. location and nature of existing water works structures and appurtenances affecting the proposed improvements, noted on one sheet;

2.3.1.12. Plans shall be legible and shall be drawn to a scale which will permit all necessary information to be correctly shown. The size of the plan shall not be larger than 30 by 42 inches.

2.3.2. Detailed plans, including:

2.3.2.1. stream crossings, providing profiles with elevations of the stream bed and the normal and extreme high and low water levels;

2.3.2.2. profiles having a horizontal scale of not more than 100 feet to the inch and vertical scale of not more than 10 feet to the inch, with both scales clearly indicated;

2.3.2.3. location and size of the property to be used for the ground water development with respect to known references such as street intersections or section lines;

2.3.2.4. topography and arrangement of present or planned wells or structures, with contour interval not greater than 2 feet;

2.3.2.5. elevation of highest known flood level, floor of structure, upper terminal of protective casing, and outside surrounding grade, using United States geological survey or equivalent elevations where applicable as reference;

2.3.2.6. schematic drawing of well construction, showing diameter and depth of drillholes, 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;

2.3.2.7. location of all sources of pollution within 250 feet of the source and 100 feet of treated water storage facilities;

2.3.2.8. size, length, identity and location of sewers, drains, water mains, and plant structures;

2.3.2.9. schematic flow diagrams and hydraulic profiles showing the flow through various plant units;

2.3.2.10. piping in sufficient detail to show flow through plant, including waste lines;

2.3.2.11. location of all chemical feeding equipment and points of chemical application (see 6.1.1);

2.3.2.12. 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/or water works structures;

2.3.2.13. location of sanitary or other facilities, such as lavatories, showers, toilets, and lockers, when applicable or required by the division of sanitary engineering;

2.3.2.14. location, dimensions and elevations of all proposed plant facilities;

2.3.2.15. adequate description of any features not otherwise covered by the specifications.

2.4. Specifications - Complete, detailed, technical specifications shall be supplied for the proposed project, including, but not limited to:

2.4.1. a program for keeping existing water works facilities in operation during construction of additional facilities so as to minimize interruption of service, and to provide a safe potable water supply at all times;

2.4.2. laboratory facilities and equipment, as well as sampling taps and their locations;

2.4.3. number and design of chemical feeding equipment (see 6.1.1);

2.4.4. materials or proprietary equipment for sanitary or other facilities including any necessary backflow or back-siphonage protection;

2.4.5. number, type, and capacity of all pumps and prime movers;

2.4.6. number, type, and capacity of water storage tanks.

2.5. Design Criteria - A summary of complete design criteria shall be submitted for the proposed project, containing but not limited to the following:

2.5.1. yield or source of supply;

2.5.2. reservoir surface area, if applicable;

2.5.3. area of watershed, if applicable;

2.5.4. estimated water consumption;

2.5.5. number of proposed services;

2.5.6. fire fighting requirements;

2.5.7. intake structures and low lift stations, if applicable;

2.5.8. basin capacities;

2.5.9. retention times;

2.5.10. unit loadings;

2.5.11. filter area and proposed filtration rate;

2.5.12. backwash rate;

2.5.13. feeder capacities and ranges;

2.5.14. laboratory facilities and personnel needed;

2.5.15. special facilities such as aerators, corrosion control, soft-

eners, fluoridation, iron and manganese removal, taste and odor control.

2.6. Revisions to Approved Plans - Any deviations from approved plans or specifications affecting capacity, hydraulic conditions, operating units, the functioning of water treatment processes, or the quality of water to be delivered, must be approved by the division of sanitary engineering before such changes are made. Revised plans or specifications shall be submitted in time to permit the review and approval of such plans or specifications before any construction work is begun.

Section 3. General Design Considerations

3.1. General - The design of a water supply system or treatment processes encompasses a broad area. Application of this part is dependent upon the type of system or process involved.

3.2. Plant Layout - System design shall consider:

3.2.1. functional aspects of plant layout;

3.2.2. provisions for future plant expansion;

3.2.3. access roads;

3.2.4. site grading;

3.2.5. site drainage;

3.2.6. walks;

3.2.7. driveways;

3.2.8. chemical delivery.

3.3. Building Layout - Design shall provide:

3.3.1. adequate ventilation;

3.3.2. adequate lighting;

3.3.3. adequate heating;

3.3.4. adequate drainage;

3.3.5. careful investigation of need for dehumidification equipment;

3.3.6. accessibility of equipment for operation, servicing, and removal;

3.3.7. flexibility of operation;

3.3.8. operator safety, including safety railings;

3.3.9. convenience of operation;

3.3.10. consideration of chemical storage and feed equipment in separate rooms to reduce dust problems.

3.4. The appropriate regulating authority must be consulted regarding any structure which is so located that normal or flood stream flows may be impeded.

3.5. Standby power generation may be required by the division of sanitary engineering so that water may be treated and/or pumped to the distribution system.

3.6. Facilities must be provided for the maintenance and servicing of automatic equipment when automatic equipment is provided.

3.7. Facilities should be included for shop space and storage consistent with the designed facilities.

3.8. Laboratory equipment and facilities shall be compatible with the raw water source, intended design of the treatment plant and the complexity of the treatment process involved.

3.8.1. Testing equipment shall be provided for the purpose intended and recognized procedures must be utilized.

3.8.2. Sufficient bench space, ventilation, lighting, storage room,

lavatory sink, and auxiliary facilities shall be provided.

3.9. Sample taps shall be provided so that water samples can be obtained from each water source and from appropriate locations in each unit operation of treatment. Taps shall be consistent with sampling needs and preferably shall not be of the petcock type.

3.10. Consideration shall be given to providing extra wall castings built into the structure to facilitate expansion and unknown future uses whenever pipes pass through walls of concrete structures.

3.11. All water supplies shall have some means of metering the water.

3.12. The water supply service line for the facilities shall be taken from a point after there has been thorough mixing of all chemicals added to the water.

3.13. All pipes, tanks, and equipment which can convey or store potable water shall be disinfected in accordance with the West Virginia board of health regulations governing public water supplies, and/or the 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.

Section 4. Source Development

4.1. General - In selecting the source of water to be developed, the designing engineer must prove to the satisfaction of the division of sanitary engineering that the water which is to be delivered to the consumers will meet the current requirements of the division of sanitary engineering with respect to bacteriological, physical, chemical and radiological qualities.

4.2. Surface Water - A surface water source includes all tributary

streams and drainage basins, natural lakes and artificial reservoirs or impoundments above the point of water supply intake.

4.2.1. Quantity - The quantity of water at the source shall:

4.2.1.1. be adequate to supply the water demand of the service area;

4.2.1.2. provide a reasonable surplus for anticipated growth;

4.2.1.3. be adequate to compensate for all losses.

4.2.2. Quality - A sanitary survey and study shall be made of the factors, both natural and man-made, which will affect quality. Such survey and study shall include, but shall not be limited to:

4.2.2.1. obtaining samples over a sufficient period of time to assess the bacteriological, physical, chemical and radiological characteristics of the water;

4.2.2.2. determining future uses of impoundments or reservoirs;

4.2.2.3. determining degree of control of watershed by owner;

4.2.2.4. assessing degree of hazard to the supply by accidental spillage of materials that may be toxic, harmful or detrimental to treatment processes;

4.2.2.5. The Caliform group is not to exceed five thousand per one hundred milliliters as a monthly average value (MPN or MF count); nor exceed this number in more than twenty per cent of the samples examined during any month; nor exceed twenty thousand per one hundred milliliters in more than five per cent of the samples.

4.2.3. Structures

4.2.3.1. Intake structures design shall provide for:

4.2.3.1.1. withdrawal of water from more than one level if quality varies with depth;

4.2.3.1.2. separate facilities for release of less desirable water held in storage;

4.2.3.1.3. velocity of flow through inlet structure such that frazil ice will be held to minimum;

4.2.3.1.4. inspection manholes every 1000 feet for pipe sizes large enough to permit visual inspection;

4.2.3.1.5. adequate protection against rupture by floating logs, ice debris, and similar material;

4.2.3.1.6. ports located above bottom stream, lake or impoundment, but at sufficient depth to be kept submerged at low water levels;

4.2.3.1.7. A trash rack and/or screens shall be provided at the entrance to any inlet structure.

4.2.3.2. Shore wells shall:

4.2.3.2.1. have motors and electrical controls located above grade and flood level;

4.2.3.2.2. be readily accessible;

4.2.3.2.3. be designed against flotation;

4.2.3.2.4. be equipped with removable or traveling screens before pump suction well;

4.2.3.2.5. provide disinfection facilities for raw water transmission main if necessary for quality control;

4.2.3.2.6. have intake valved and provisions for backflushing and testing for leaks, where practical;

4.2.3.2.7. have provisions for surges where necessary.

4.2.3.3. Upground reservoir is a structure into which water is

pumped during periods of good quality and high stream flow for future release to treatment facilities; development shall assure that:

4.2.3.3.1. water quality is protected by controlling runoff into reservoir;

4.2.3.3.2. dikes are structurally sound and protected against wind action and erosion;

4.2.3.3.3. intake structures and devices meet requirements of Section 4.2.3.1;

4.2.3.3.4. point of influent flow is separated from the point withdrawal.

4.2.4. Impoundments and Reservoirs

4.2.4.1. Site preparation should provide:

4.2.4.1.1. removal of brush and trees to high water elevation;

4.2.4.1.2. protection from floods during construction.

4.2.4.2. Construction may require:

4.2.4.2.1. approval of safety features for stability and spillway design of any structures to be obtained from appropriate governmental authority;

4.2.4.2.2. permit for controlling stream flow or structure on bed of navigable stream or interstate water, to be obtained from appropriate governmental authority.

4.2.4.3. Shall be of sufficient capacity to store a six months supply of water based on estimated peak usage.

4.3. Ground Water - A ground water source includes all water obtained from dug, drilled, bored or driven wells, infiltration lines and springs.

4.3.1. Minimum protective depths of drilled wells shall provide:

4.3.1.1. watertight construction to such depth as may be required by the division of sanitary engineering to exclude pollution, but in no event shall this distance be less than ten feet;

4.3.1.2. design to seal off formations that are, or may be, contaminated or yield undesirable water;

4.3.1.3. annular opening of at least 1.5 inches outside the protective casing filled with:

4.3.1.3.1. concrete grout, or

4.3.1.3.2. neat cement grout, or

4.3.1.3.3. other material approved by the division of sanitary engineering.

4.3.2. Required special protection for various sources:

4.3.2.1. Gravel Wall Wells

4.3.2.1.1. gravel shall be free of foreign material, properly sized, washed and then disinfected prior to or during placement;

4.3.2.1.2. gravel refill pipes, when used, shall be incorporated within pump foundation and terminated with screwed or welded caps at least 12 inches above pumphouse floor or concrete apron;

4.3.2.1.3. gravel refill pipes in grouted annular opening shall be surrounded by a minimum of 1½ inches of grout;

4.3.2.1.4. prevention of leakage of grout into gravel pack or screen shall be provided;

4.3.2.1.5. water used in construction shall be from source approved by the division of sanitary engineering;

4.3.2.1.6. minimum protective casing and grouted depth shall be acceptable to the division of sanitary engineering.

4.3.2.2. Radial Water Collector

4.3.2.2.1. location of all caisson construction joints and porthole assemblies shall be indicated;

4.3.2.2.2. caisson wall shall be substantially reinforced;

4.3.2.2.3. radial collectors shall be in areas and at depths approved by the division of sanitary engineering;

4.3.2.2.4. provisions shall be made to assure minimum vertical rise;

4.3.2.2.5. top of caisson shall be covered with watertight floor;

4.3.2.2.6. all openings in floor shall be curbed and protected from entrance of foreign material;

4.3.2.2.7. pump discharge piping shall not be placed through caisson walls.

4.3.2.3. Dug or Bored Wells

4.3.2.3.1. considered only where geological conditions preclude possibility of developing an acceptable drilled well;

4.3.2.3.2. watertight cover shall be provided;

4.3.2.3.3. minimum protective lining and grouted depth shall be acceptable to reviewing authority;

4.3.2.3.4. openings shall be curbed and protected from entrance of foreign material.

4.3.2.4. Infiltration Lines

4.3.2.4.1. considered only where geological conditions preclude possibility of developing an acceptable drilled well;

4.3.2.4.2. area around lines shall be under control of water purveyor for distance acceptable to or required by the division of sanitary engineering;

4.3.2.4.3. flow in lines shall be by gravity to collecting well;

4.3.2.5. Sand or Gravel Wells

4.3.2.5.1. if clay or hardpan encountered, inner casing and grout shall extend through such materials;

4.3.2.5.2. outer casing can be removed or withdrawn as grouting proceeds;

4.3.2.5.3. outer casing left in place should be withdrawn to at least 5 feet above clay, hardpan or similar material.

4.3.2.6. Limestone Wells

4.3.2.6.1. where depth of mantle over considerable area is more than 50 feet, casing shall be firmly seated in uncreviced rock;

4.3.2.6.2. where depth of mantle is less than 50 feet, the division of sanitary engineering shall be consulted for required casing depths;

4.3.2.6.3. minimum depth of grout shall be 50 feet;

4.3.2.7. Sandstone Wells

4.3.2.7.1. minimum depth of protective casing shall be 50 feet;

4.3.2.7.2. where depth of mantle is more than 50 feet protective casing shall be firmly seated in firm sandstone where sandstone is first rock formation;

4.3.2.7.3. where depth of mantle is less than 50 feet, the division of sanitary engineering shall be consulted as to required depth of protective casing.

4.3.2.8. Flowing Artesian Wells

4.3.2.8.1. flow shall be controlled;

4.3.2.8.2. protective casing and grout shall be provided;

4.3.2.8.3. if erosion of the confining bed appears likely, an inner casing, joined watertight to the protective casing shall be provided.

4.3.2.9. Springs

4.3.2.9.1. considered only when it is not possible to develop an acceptable well;

4.3.2.9.2. shall be protected from entry of surface water and foreign objects;

4.3.2.9.3. shall be housed in permanent structure.

4.3.3. General Well Construction Requirements:

4.3.3.1. Location - The division of sanitary engineering must be consulted as to required separation between sources of pollution and the ground water development.

4.3.3.2. Casing and liner pipe of wrought iron or steel

4.3.3.2.1. shall be prime pipe meeting ASTM or API specifications;

4.3.3.2.2. for driven casings, shall have minimum weights and thicknesses given in Tables 1 and 2;

4.3.3.2.3. for non-driven casings,

4.3.3.2.3.1. shall be surrounded by a minimum of 4 inches of grout;

4.3.3.2.3.2. should have minimum thickness of 0.322 inch;

4.3.3.2.4. shall have additional thickness and weight if standard thickness is not considered sufficient by the division of sanitary engineering to assure reasonable life expectancy of well;

4.3.3.2.5. shall be capable of withstanding forces to which they are subjected;

4.3.3.2.6. shall be equipped with drive shoe when driven;

4.3.3.2.7. shall have welded or threaded pipe joints.

Table 1

WROUGHT IRON PIPE*

SIZE (inches)	DIAMETER (inches)		THICKNESS (inches)	WEIGHT PER FOOT (pounds)	
	EXTERNAL	INTERNAL		PLAIN ENDS (calculated)	WITH THREADS AND COUPLINGS (nominal)
6 id.	6.625	6.053	0.286	18.97	19.45
8	8.625	7.967	0.329	28.55	29.35
10	10.750	10.005	0.372	40.48	41.85
12	12.750	11.985	0.383	49.56	51.15
14 od.	14.000	13.234	0.383	54.56	57.00
16	16.000	15.234	0.383	62.58	65.30
18	18.000	17.165	0.417	76.84	81.20
20	20.000	19.000	0.500	102.10	106.62
22	22.000	21.000	0.500	112.57	
24	24.000	23.000	0.500	123.04	
26	26.000	25.000	0.500	133.51	
28	28.000	27.000	0.500	143.99	
30	30.000	29.000	0.500	154.46	

*Abstracted from AWWA Standard for Deep Wells, AWWA A100-66, p. 34 & 35.

Table 2

STEEL PIPE*

SIZE (inches)	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	65.30
18	18.000	17.250	0.375	70.59	73.00
20	20.000	19.250	0.375	78.60	81.00
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 A100-66, p. 34 & 35.

4.3.3.3. Pipe other than wrought iron or steel must be adaptable to the stresses to which they will be subjected during installation and to the corrosiveness of the water. Plastic pipe shall meet national sanitation foundation (NSF) or equivalent standards.

4.3.3.4. Concrete wall casing must:

4.3.3.4.1. be at least four inches thick (six inches recommended);

4.3.3.4.2. be poured in one operation, if possible;

4.3.3.4.3. have construction joint within ten feet of original ground surface.

4.3.3.5. Pre-cast casing, such as concrete well pipe, vitrified pipe and similar forms, must:

4.3.3.5.1. extend to a depth at least ten feet below existing ground surface;

4.3.3.5.2. be surrounded with at least four inches of neat cement or concrete grout pumped, vibrated or puddled and placed in one operation.

4.3.3.6. Packers shall be of a material that will not impart taste, odors, toxic substances or bacterial contamination to the water in the well.

4.3.3.7. Screens shall:

4.3.3.7.1. be constructed of material which will not be damaged by chemical action of ground water or future cleaning operations;

4.3.3.7.2. have size of openings to be based on sieve analysis;

4.3.3.7.3. be installed so that exposure above pumping level will not occur;

4.3.3.7.4. be designed and installed to permit removal or replacement without adversely affecting watertight construction of well.

4.3.3.8. Yield and drawdown test shall:

4.3.3.8.1. be performed on every well;

4.3.3.8.2. have the method clearly indicated in specifications;

4.3.3.8.3. have pump capable of pumping at least one and a half times the quantity anticipated;

4.3.3.8.4. pump continuously over period indicated, (never less than thirty-six hours);

4.3.3.8.5. provide data as follows:

4.3.3.8.5.1. static water level;

4.3.3.8.5.2. pumping rate;

4.3.3.8.5.3. drawdown during test;

4.3.3.8.5.4. recovery water levels;

4.3.3.8.5.5. depth of pump setting;

4.3.3.8.6. provide for sample of water to be collected for quality determinations.

4.3.3.9. Chemical conditioning shall be included in specifications as to method, equipment, chemicals, testing for residual chemicals, disposal of waste, and inhibitors used.

4.3.3.10. Blasting procedures, if used, shall be included in specifications as to:

4.3.3.10.1. location, number and size of charges;

4.3.3.10.2. cleaning procedures.

4.3.3.11. Grouting Requirements:

4.3.3.11.1. Concrete Grout:

4.3.3.11.1.1. cement and sand 1:1, with not more than six gallons per sack of cement.

4.3.3.11.1.2. where large volumes are required to fill annular opening, gravel not larger than one-half inch in size may be added.

4.3.3.11.2. Neat Cement Grout

4.3.3.11.2.1. cement and water with not more than 6 gallons of water per sack of cement;

4.3.3.11.2.2. additives, up to 5 per cent by weight, may be used to increase fluidity.

4.3.3.11.3. Application

4.3.3.11.3.1. grout shall be installed by means of a grout pump from the bottom of annular opening upward in one continuous operation until annular opening is filled;

4.3.3.11.3.2. sufficient annular opening shall be provided to permit a minimum of 1½ inches of grout around protective casing, including couplings, if used;

4.3.3.11.3.3. bentonite, aquajel or similar materials may be added to the annular opening, in the manner indicated for grouting, prior to grouting;

4.3.3.11.3.4. when the annular opening exceeds 4 inches and concrete grout is used, it may be placed by gravity through a grout pipe installed to the bottom of annular opening.

4.3.3.11.4. Guides

4.3.3.11.4.1. protective casing must be provided with sufficient guides welded to casing to permit unobstructed flow and uniform thickness of grout.

4.3.3.12. Plumbness and Alignment Requirements:

4.3.3.12.1. every well shall be tested for plumbness and alignment;

4.3.3.12.2. test method shall be clearly stated in specifications;

4.3.3.12.3. kinks and bends shall not be acceptable;

4.3.3.12.4. information shall be submitted to the division of sanitary engineering prior to permanent pump installation.

4.3.3.13. Geological Data Shall

4.3.3.13.1. be determined from samples collected at 5-foot intervals and at each pronounced change in formation;

4.3.3.13.2. be recorded and submitted to the division of sanitary engineering;

4.3.3.13.3. be supplemented with information on accurate record of drillhole diameters and depths, assembled order of size and length of casings and liners, grouting depths, formations penetrated, water levels and location of any blast charges;

4.3.3.13.4. be supplemented with complete pumping test data.

4.3.3.14. Upper terminal of well, requirements:

4.3.3.14.1. protective casing for all ground water sources must project through a concrete platform that is a minimum of 4 inches thick and extending at least 2 feet in each direction from the exterior of the casing.

4.3.3.14.2. protective casing for all ground water sources must project not less than 6 inches, and preferably 12 inches, above pumphouse floor or the concrete platform.

4.3.3.14.3. site not subject to flooding must have floor of pumphouse and cover of every well at least one foot above original ground surface;

4.3.3.14.4. site subject to flooding must have cover of every well and

the floor of the pumphouse at least two feet above the highest known flood elevation and be surrounded by earth fill as required by the division of sanitary engineering.

4.3.3.15. Capping Requirements:

4.3.3.15.1. a properly fitted, firmly driven, solid wooden plug is the minimum acceptable method of capping a well until pumping equipment is installed;

4.3.3.15.2. a welded metal plate is preferred for capping a well;

4.3.3.15.3. well must be protected during construction;

4.3.3.15.4. approved pitless adapter shall be used where pipes are placed through casing wall.

4.3.3.16. Bacteriological Quality:

4.3.3.16.1. every new, modified or reconditioned ground water source shall be disinfected after placement of final pumping equipment;

4.3.3.16.2. Three or more water samples collected on separate days shall be submitted to the state hygienic laboratory or other approved laboratory for bacteriological analysis, with the results reported to the division of sanitary engineering.

4.3.3.17. Chemical Quality:

4.3.3.17.1. every new, modified or reconditioned ground water source shall be examined for chemical characteristics by tests of a representative sample in a laboratory satisfactory to the division of sanitary engineering, with the results reported to such agency;

4.3.3.17.2. samples shall be collected and tested as soon as practical;

4.3.3.17.3. determination of pH shall be made in the field;

4.3.3.17.4. in addition to standard tests, examination shall be made for hydrogen sulphide and methane where these gases are suspected.

4.3.3.18. Water Level Measurement:

4.3.3.18.1. provisions shall be made for periodic measurement of static and pumping water levels in completed well;

4.3.3.18.2. installation shall be made in such manner as to prevent entrance of foreign material.

4.3.3.19. Observation Wells:

4.3.3.19.1. shall be constructed in accordance with the requirements for permanent wells if to remain in service after completion of ground water supply;

4.3.3.19.2. shall be properly protected at the upper terminal to preclude entrance of foreign material.

4.3.3.20. Well Abandonment:

4.3.3.20.1. test wells and ground water sources which are not in use shall be sealed by such methods as to restore the controlling geological conditions which existed before they were constructed;

4.3.3.20.2. Wells to be abandoned shall:

4.3.3.20.2.1. be sealed to prevent exchange of water from one geological strata to another;

4.3.3.20.2.2. be preferably filled with concrete;

4.3.3.20.2.3. be any other method approved by the division of sanitary engineering.

Section 5. Treatment

5.1. General - The design of treatment processes and devices shall

depend on evaluation of the nature and quality of the particular water to be treated and the desired quality of the finished water.

5.2. Clarification

5.2.1. Plants designed for processing surface water should:

5.2.1.1. provide duplicate units for flocculation and sedimentation;

5.2.1.2. permit operation of basins in series or parallel;

5.2.1.3. be constructed to permit units to be taken out of service without disrupting operation;

5.2.1.4. provide multiple-stage treatment facilities when required by the division of sanitary engineering.

5.2.2. Presedimentation - Waters containing high turbidity may require pretreatment, usually sedimentation either with or without the addition of coagulation chemicals.

5.2.2.1. Basin Design - Sedimentation basins should have hopper bottoms or be equipped with continuous mechanical sludge removal apparatus.

5.2.2.2. Inlet - Incoming water shall be dispersed across the full width of the line of travel as quickly as possible; short circuiting must be prevented.

5.2.2.3. Bypass - Provisions for bypassing sedimentation basins shall be included.

5.2.2.4. Detention Time - Three hours detention is the minimum period recommended; greater detention may be required.

5.2.3. Mixing (Flash or Quick) - Mixing shall mean the rapid dispersion of chemicals throughout the water to be treated, usually by violent agitation.

5.2.3.1. Equipment - Basins should be equipped with mechanical mixing devices; other arrangements, such as baffling, are acceptable only under special conditions.

5.2.3.2. Mixing - The detention period should be not less than thirty seconds.

5.2.4. Flocculation (Slow Mixing) - Flocculation shall mean the agitation of water at low velocities for long periods of time.

5.2.4.1. Basin Design - Inlet and outlet design shall prevent short circuiting and destruction of floc. A drain should be provided.

5.2.4.2. Detention - Minimum flow-through velocity shall be not less than 0.5 nor greater than 1.5 feet per second with a detention time for floc formation of at least 30 minutes.

5.2.4.3. Equipment - Agitators shall be driven by variable speed drives with the peripheral speed of paddles ranging from 0.5 to 2.0 feet per second.

5.2.4.4. 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 nor greater than 1.5 feet per second. Allowances must be made to minimize turbulance at bends and changes in direction.

5.2.4.5. Other Designs - Baffling may be used to provide for flocculation in small plants only after consultation with the division of sanitary engineering. The design should be such that the velocities and flows noted above will be maintained.

5.2.5. 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 number of basins required is dependent upon the turbidity, color and colloidal matter and taste and odor causing compounds to be removed.

5.2.5.1. Detention Time - Plants with convention sedimentation shall provide a minimum of four hours of settling time.

5.2.5.2. 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 should be constructed across the basin close to the inlet end and should project several feet below the water surface to dissipate inlet velocities and provide uniform flows across the basin.

5.2.5.3. Outlet Devices - Outlet devices shall be designed to maintain velocities suitable for settling in the basin and to minimize shortcircuiting. The use of submerged orifices is recommended in order to make the volume above the orifices available for storage to "take up the slack" between the quantity of water pumped to the plant and that passed through the filters.

5.2.5.4. Overflow Rate - The rate of flow over the outlet weir shall not exceed 20,000 gallons per day per foot of weir length. Where submerged ports are used as an alternate for overflow weirs, they should be not lower than three feet below the flow line.

5.2.5.5. Drainage - Basins must be provided with a means for dewatering. Basin bottoms should slope toward the drain not less than one foot in twelve feet where mechanical sludge collection equipment is not required.

5.2.5.6. Covers - Covers are acceptable at specific plant locations; however, where basins have mechanical equipment, a super structure should be provided in place of a cover. Where covers are used, manholes shall be provided as well as drop light connections so that observation of the floc can be made at several points within the basin.

5.2.5.7. Velocity - The velocity through settling basins shall not exceed 0.5 feet per minute. The basins must be designed to minimize shortcircuiting. Baffles must be provided as necessary.

5.2.5.8. Overflow - An overflow weir (or pipe) should be installed which will establish the maximum water level desired on top of the filters. It shall discharge with a free fall at a location where the discharge will be noted.

5.2.5.9. Safety - Permanent ladders or handholds should be provided for safety on the inside walls of basins above the water level. Guard rails shall be included. Flushing lines or hydrants must not include interconnection of the potable water with non-potable water.

5.2.5.10. Sludge Collection - Mechanical sludge collection equipment should be provided.

5.2.5.11. Sludge Disposal - Facilities are required by the division of sanitary engineering for disposal of sludge. See 5.12. Provision shall be made for operator to observe or sample sludge being withdrawn from unit.

5.2.6. Solids Contact Unit - Units are acceptable for combined softening and clarification where water characteristics are not variable and flow rates are uniform. Before such units are considered as clarifiers without softening, specific approval of the division of sanitary engineering shall be

obtained. Clarifiers should be designed for the maximum uniform rate and should be adjustable to changes in flow which are less than the design rate and for changes in water characteristics. A minimum of two units is recommended.

5.2.6.1. Installation of Equipment - Supervision by a representative of the manufacturer shall be provided with regard to all mechanical equipment at the time of

5.2.6.1.1. installation, and

5.2.6.1.2. initial operation.

5.2.6.2. Operating Equipment - The following shall be provided for plant operation:

5.2.6.2.1. a complete outfit of tools and accessories;

5.2.6.2.2. necessary laboratory equipment;

5.2.6.2.3. adequate piping with suitable sampling taps so located as to permit the collection of samples of water from critical portions of the units.

5.2.6.3. Chemical Feed - Chemicals shall be applied at such points and by such means as to insure satisfactory mixing of the chemicals with the water.

5.2.6.4. Mixing - Mixing devices employed shall be so constructed as to

5.2.6.4.1. provide good mixing of the raw water with previously formed sludge particles, and

5.2.6.4.2. prevent deposition of solids in the mixing zone.

5.2.6.5. Flocculation - Flocculation equipment

5.2.6.5.1. shall be adjustable;

5.2.6.5.2. must provide for coagulation to occur in a separate chamber or baffled zone within the unit;

5.2.6.5.3. should provide the flocculation and mixing period to be not less than 30 minutes.

5.2.6.6. Sludge Concentrators - The equipment should provide either internal or external concentrators in order to obtain a concentrated sludge with a minimum of waste water.

5.2.6.7. Sludge Removal - Sludge removal design shall provide that:

5.2.6.7.1. sludge pipes shall be not less than three inches in diameter and so arranged as to facilitate cleaning;

5.2.6.7.2. entrances to sludge withdrawal piping shall prevent clogging;

5.2.6.7.3. valves shall be located outside the tank for accessibility;

5.2.6.7.4. operator may observe or sample sludge being withdrawn from the unit.

5.2.6.8. Cross-connections

5.2.6.8.1. blow-off outlets and drains must terminate and discharge at places satisfactory to the division of sanitary engineering;

5.2.6.8.2. cross-connection control must be included for the potable water lines used to backflush sludge lines.

5.2.6.9. Detention Period - The detention time shall be established on the basis of the raw water characteristics and other local conditions that affect the operation of the unit. Based on design flow rates, the minimum detention time shall be:

5.2.6.9.1. two hours for suspended solids contact clarifiers, and

5.2.6.9.2. one hour for the suspended solids contact softeners.

5.2.6.10. Suspended Slurry Concentrate - Softening units should be desinged so that continuous slurry concentrates of one per cent or more, by weight, can be satisfactorily maintained.

5.2.6.11. Water Losses

5.2.6.11.1. units shall be provided with suitable controls for sludge withdrawal;

5.2.6.11.2. total water losses should not exceed:

5.2.6.11.2.1. 5 per cent for clarifiers;

5.2.6.11.2.2. 3 per cent for softening units.

5.2.6.11.3. solids concentration of sludge bled to waste should be:

5.2.6.11.3.1. 3 per cent by weight for clarifiers;

5.2.6.11.3.2. 5 per cent by weight for softeners.

5.2.6.12. Weirs or Orifices - The units should be equipped with either overflow weirs or orifices. Weirs shall be:

5.2.6.12.1. adjustable;

5.2.6.12.2. at least equivalent in length to the perimeter of the tank;

5.2.6.12.3. constructed so that surface water does not travel over 10 feet horizontally to the collection trough.

5.2.6.13. Weir Loading

5.2.6.13.1. weir loading shall not exceed:

5.2.6.13.1.1. 20 gallons per minute per foot of weir length for units used for softeners;

5.2.6.13.1.2. 10 gallons per minute per foot of weir length for units used for clarifiers.

5.2.6.13.2. orifices shall produce uniform rising rates over the entire area of the tank.

5.2.6.14. Upflow Rates - unless supporting data is submitted to the division of sanitary engineering to justify rates exceeding the following, rates shall not exceed:

5.2.6.14.1. 1.75 gallons per minute per square foot of area at the slurry separation line, for units used for softeners;

5.2.6.14.2. 1.0 gallon per minute per square foot of area at the sludge separation line for units used for clarifiers;

5.2.6.14.3. If flow is subject to surges, an equalization tank should be provided.

5.3. Filtration - Recent developments in filtration and improvements in equipment have brought about the use of units and rates other than standard and which are not applicable under all conditions. The application of processes and equipment other than those described herein can be permitted only after presentation, in each individual case, of sufficient engineering data to satisfy the division of sanitary engineering as to the use of the process. Acceptable filters shall include, upon the discretion of the division of sanitary engineering, the following types:

a. rapid rate gravity filters;

b. rapid rate pressure filters, and

c. slow rate gravity filters.

The application of any one type must be supported by water quality data representing a reasonable period of time to characterize the variations in water quality. Experimental treatment studies may be required to

demonstrate the applicability of the method of filtration proposed.

5.3.1. Rapid Rate Gravity Filters

5.3.1.1. Pretreatment - The use of rapid rate gravity filters shall require pretreatment.

5.3.1.2. Number - At least two units shall be provided and, where the plant output is small (e.g. less than 100 gallons per minute), each filter shall be of plant capacity; provisions shall be made to assure continuity of service with a filter unit temporarily removed from operation.

5.3.1.3. Rate of Filtration - The permissible rate of filtration shall be determined by the quality of raw water, the degree of pretreatment provided, the filter media provided and other considerations required by the division of sanitary engineering. The nominal rate shall be two gallons per minute per square foot of filter area except as higher rates are justified by the designing engineer to the satisfaction of the division of sanitary engineering.

5.3.1.4. Structural Details and Hydraulics - The filter structure shall be so designed as to provide for:

5.3.1.4.1. vertical walls within the filter;

5.3.1.4.2. no protrusion of the filter walls into the filter media;

5.3.1.4.3. cover by superstructure as determined necessary under local climate;

5.3.1.4.4. head room to permit normal inspection and operation;

5.3.1.4.5. minimum depth of filter of 8½ feet;

5.3.1.4.6. minimum water depth over the surface of the sand of three feet;

5.3.1.4.7. trapped effluent to prevent backflow of air to the bottom of the filters;

5.3.1.4.8. prevention of floor drainage to the filter with a minimum 4-inch curb around the filters;

5.3.1.4.9. prevention of flooding by providing overflow;

5.3.1.4.10. maximum velocity of treated water in pipe and conduits to filters of two feet per second;

5.3.1.4.11. cleanouts and straight alignment for influent pipes or conduits where solids loading is heavy, or following lime-soda softening;

5.3.1.4.12. washwater drain capacity to carry maximum flow;

5.3.1.4.13. walkways around filters, to be not less than 24 inches wide.

5.3.1.5. Washwater Troughs - Washwater troughs shall be so designed as to provide:

5.3.1.5.1. the bottom elevation above the maximum level of expanded media during washing;

5.3.1.5.2. the top elevation above the filter surface, not to exceed 30 inches;

5.3.1.5.3. a 2-inch freeboard at the maximum rate of wash;

5.3.1.5.4. the top or edge to be level;

5.3.1.5.5. spacing so that each trough serves the same number of square feet of filter area;

5.3.1.5.6. maximum horizontal travel of suspended particles to reach trough not to exceed 3 feet.

5.3.1.6. Filter Material

5.3.1.6.1. Sand - The media shall be clean silica sand having:

5.3.1.6.1.1. a depth of not less than 24 inches and generally not more than 30 inches;

5.3.1.6.1.2. an effective size of from 0.45 mm to 0.55 mm, depending upon the quality of the raw water, and

5.3.1.6.1.3. a uniformity coefficient not greater than 1.65;

5.3.1.6.1.4. a 3-inch layer of torpedo sand should be used as a supporting media for the filter sand; such torpedo sand shall have:

5.3.1.6.1.4.1. an effective size of 0.8 mm to 2.0 mm, and

5.3.1.6.1.4.2. a uniformity coefficient not greater than 1.7.

5.3.1.6.2. Anthracite - Clean crushed anthracite or a combination of sand and anthracite may be considered as a filter media; such media shall have:

5.3.1.6.2.1. an effective size from 0.4 mm to 0.8 mm, and

5.3.1.6.2.2. a uniformity coefficient not greater than 1.7.

5.3.1.6.3. Gravel - Gravel, when used as the supporting media, shall consist of hard, rounded particles and shall not include flat or elongated particles. The coarsest gravel shall be 2¼ inches in size when the gravel rests directly on the strainer system, and must extend above the top of the perforated laterals or strainer nozzles. Not less than four layers of gravel shall be provided in accordance with the following size and depth distribution:

Size	Depth
2½ to 1½ inches	5 to 8 inches
1½ 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

Reduction of gravel depths may be considered upon justification to the division of sanitary engineering when proprietary filter bottoms are installed.

5.3.1.7. Filter Bottoms and Strainer Systems - Departures from these standards using proprietary bottoms may be acceptable. 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 be such as to:

5.3.1.7.1. minimize loss of head in the manifold and laterals;

5.3.1.7.2. assure even distribution of washwater and even rate of filtration over the entire area of the filter;

5.3.1.7.3. provide the ratio of the area of the final openings of the strainer systems to the area of the filter at about 0.003;

5.3.1.7.4. provide the total cross-sectional area of the laterals at about twice the total area of the final openings;

5.3.1.7.5. provide the cross-sectional area of the manifold at 1½ to 2 times the total area of the laterals.

5.3.1.8. Surface Wash - Surface wash facilities are required and may be accomplished with a 1½ to 2-inch pressure line conveniently located to

the filter plant operating floor and including a suitable length of 1-inch to 1½-inch pressure hose and nozzle. A system of fixed nozzles or a revolving type apparatus may also be used. All surface wash devices shall be designed with:

5.3.1.8.1. provisions for water pressures of 45 to 75 psi;

5.3.1.8.2. a vacuum breaker or other device to prevent back siphonage;

5.3.1.8.3. suitable rack for storage of hoses and other equipment;

5.3.1.8.4. a separate pump if settled but not filtered water is used.

5.3.1.9. Appurtenances - The following shall be provided for every filter:

5.3.1.9.1. sampling tap;

5.3.1.9.2. indicating loss of head gauge;

5.3.1.9.3. indicating flow rate control; a modified rate controller which limits the rate of filtration to a maximum rate may be used, however, 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 in each filter effluent line may also be used as the limiting factor for the rate of filtration only after consultation with the division of sanitary engineering.

5.3.1.9.4. provisions for draining the filter to waste with appropriate measures for backflow prevention. See 5.12.

5.3.1.10. Backwash - Provisions shall be made for washing filters as follows:

5.3.1.10.1. minimum rate of 15 gallons per square foot per minute,

consistent with water temperatures and specific gravity of the filter media; a rate of 20 gallons per square foot per minute to provide for a 50 per cent expansion of the sand bed is recommended;

5.3.1.10.2. filtered water provided at the required rate by washwater tanks, a washwater pump, from the high service main, or a combination of these;

5.3.1.10.3. washwater pumps in duplicate unless an alternate means of obtaining washwater is available;

5.3.1.10.4. not less than 15 minute wash of one filter at the design rate of wash;

5.3.1.10.5. washwater regulator or valve on the main washwater line to obtain the desired rate of filter wash with the washwater valves on the individual filters open wide;

5.3.1.10.6. rate-of-flow indicator on the main washwater line, located so that it can be easily read by the operator during the washing process.

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

5.3.2. Rapid Rate Pressure Filters - The use of these filters may be considered or iron and manganese removal and other clarification processes consistent with 5.3 above. Pressure filters shall not be used in the filtration of polluted waters or following lime-soda softening.

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

5.3.2.2. Rate of Filtration - The nominal rate shall be two gallons per minute per square foot of filter area.

5.3.2.3. Details of Design - The filters shall be designed to provide for:

5.3.2.3.1. loss of head gauges on the inlet and outlet pipes of each filter;

5.3.2.3.2. an easily readable meter or flow indicator on each battery of filters; a flow indicator is recommended for each filtering unit;

5.3.2.3.3. filtration and backwashing of each filter individually with an arrangement of piping as simple as possible to accomplish these purposes;

5.3.2.3.4. minimum side wall shell height of 5 feet; a corresponding reduction in side wall height is acceptable where proprietary bottoms permit reduction of the gravel depth;

5.3.2.3.5. the top of the washwater collection trough to be at least 18 inches above the surface of sand;

5.3.2.3.6. the underdrain system to collect efficiently the filtered water and to distribute the backwash water at a rate not less than 15 gallons per minute square foot of filter area;

5.3.2.3.7. location of flow indicators and controls that is easily readable while operating the control valves;

5.3.2.3.8. air release valve on the highest point of each filter;

5.3.2.3.9. accessible manhole to facilitate inspections and repairs;

5.3.2.3.10. means to observe the wastewater during backwashing;

5.3.2.3.11. construction to prevent cross-connection and/or back siphonage possibilities.

5.3.3. Slow Rate Gravity Filters - The use of these filters shall

require prior engineering studies to demonstrate the adequacy and suitability of this method of filtration for the specific raw water supply.

5.3.3.1. Quality of Raw Water - Slow rate gravity filtration shall be limited to waters having maximum turbidities of 50 units and maximum color of 30 units; such turbidity must not be attributable to colloidal clay. Raw water quality data must include examinations for algae.

5.3.3.2. Structural Details and Hydraulics - Slow rate gravity filters shall be so designed as to provide:

5.3.3.2.1. not less than two filter units;

5.3.3.2.2. cover as determined necessary under local climate;

5.3.3.2.3. headroom to permit normal movement by operating personnel for scraping and sand removal operations.

5.3.3.3. 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 as specific to the water to be treated. The nominal rate may be 45 to 150 gallons per day per square foot to 230 gallons per day per square foot acceptable when demonstrated to the satisfaction of the division of sanitary engineering.

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

5.3.3.5. Filtering Material

5.3.3.5.1. filter sand shall be placed on graded gravel layers for a

minimum depth of 30 inches;

5.3.3.5.2. the effective size shall be between 0.35 mm and 0.50 mm;

5.3.3.5.3. the uniformity coefficient shall not exceed 2.5;

5.3.3.5.4. the sand shall be clean and free from foreign matter.

5.3.3.6. Filter Gravel - The supporting gravel shall conform to the size and depth distribution provided for rapid rate gravity filters. See 5.3.1.6.3.

5.3.3.7. Depth of Water on Filter Beds - Design shall provide a depth of at least three to five feet of water over the sand. Influent water shall not scour the sand surfaces.

5.3.3.8. Control Appurtenances - Each filter shall be equipped with:

5.3.3.8.1. loss of head gauge;

5.3.3.8.2. an orifice, Venturi meter, or other suitable metering device installed on each filter to control the rate of filtration;

5.3.3.8.3. an effluent pipe located at an elevation to maintain the water level in the filter above the top of the sand.

5.4. Disinfection - Chlorine is an acceptable disinfecting agent. Other agents will be considered by the division of sanitary engineering, providing reliable feeding equipment is available and acceptable testing procedures for a residual are provided. Disinfection of all public water supplies will be required. Prechlorination is recommended for all water treatment plants where more than disinfection is required.

5.4.1. Equipment

5.4.1.1. Type - Solution-feed-gas-type chlorinators and hypochlorite feeders of the positive displacement type are acceptable. See Section 6.

5.4.1.2. Capacity - The chlorinator capacity shall be such that a free chlorine residual of at least 2 mg/1 can be attained in the water after a contact time of at least twenty minutes when maximum flow rates coincide with anticipated maximum chlorine demands. The equipment shall be of such design that it will operate accurately over the desired feeding range.

5.4.1.3. Standby Equipment - Where chlorination is necessary for protection of the supply, standby equipment of sufficient capacity shall be available to replace the largest unit during shut-downs.

5.4.1.4. Automatic Proportioning - Automatic proportioning chlorinators will be required where the rate of flow either is not reasonably constant or where the rate of flow of the water is not manually controlled.

5.4.2. Contact Time and Point of Application - Chlorine shall be applied at a point which will provide the maximum contact time. Consideration shall be given to the minimizing of short-circuiting. At plants treating surface water, provision should be made for applying chlorine to the raw water, applied water, filtered water and the high-lift pump suction. At plants treating ground water, provision shall be made for a covered chlorine contact basin. The disinfectant shall be applied at the inlet to this basin.

5.4.3. Residual Testing Equipment - The equipment shall enable measurement of residuals to the nearest 0.1 mg/1 in the range below 0.5 mg/1 and to the nearest 0.2 mg/1 between 0.5 mg/1 to 2.0 mg/1. Automatic chlorine residual recorders are indicated where the chlorine demand varies appreciably over a short period of time.

5.4.4. Split feeding of chlorine is permitted only with the consent of

the division of sanitary engineering, and if permitted, must include a chlorine metering device for each feed line.

5.4.5. Chlorinator Piping - The water supply piping shall be designed to prevent contamination of the treated water supply by the sources of questionable quality.

5.4.6. Housing - Adequate housing must be provided for the chlorination equipment and for storing the chlorine supply. See Section 6.

5.5. Softening - The softening process selected must 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 chemical and plant location. Applicability of process chosen shall be demonstrated.

5.5.1. Lime-Soda Process - The applicable design standards for mixing, flocculation and sedimentation are the same for the lime-soda process as for conventional clarification except that the minimum settleing time is two hours. Where softening is included as a treatment process in conjuction with clarification, the clarification criteria shall govern. See 5.2.3, 5.2.4, 5.2.5. For criteria pertaining to softening with solids contact units see 5.2.6.

5.5.1.1. Equipment - Mechanical sludge removal equipment should be provided in the sedimentation basin. See 5.12 for sludge disposal.

5.5.1.2. Aeration - Determinations should be made dor the CO_2 content of the raw water. When concentrations exceed 10 milligrams per liter, the economics of removal by aeration as opposed to removal with lime should be considered. See 5.6.

5.5.1.3. Stabilization - Equipment for stabilization of water softened by the lime-soda process is required. See 5.9 for stabilization.

5.5.1.4. Sludge Disposal - Provisions must be included for proper disposal of softening sludges. See 5.12.

5.5.1.5. Disinfection - The use of excess lime shall not be considered an acceptable substitution for chlorination or any other approved method of disinfection. See 5.4.

5.5.2. Cation Exchange Process - Iron, manganese, or a combination of the two, in the oxidized state or unoxidized state, should not exceed 0.3 milligrams per liter in the water as applied to the ion exchange material. Pretreatment is required when the content or iron, maganese, or a combination of the two, is one milligram per liter or more.

5.5.2.1. Design - The units may be of pressure or gravity type, of either an upflow or downflow design, using automatic or manual regeneration. Automatic regeneration is suggested for small plants.

5.5.2.2. Exchange Capacity - The design capacity for hardness removal should not exceed 20,000 grains per cubic foot when resin is regenerated with 0.3 pounds of salt per kilograin of hardness removed.

5.5.2.3. Depth of Media - The depth of the exchange material should not be less than 3 feet.

5.5.2.4. Flow Rates - The rate of softening should not exceed 7 gallons per square foot per minute and the backwash rate should be 6 to 8 gallons per square foot per minute.

5.5.2.5. Freeboard - The freeboard will depend upon the specific gravity of the media and the direction of water flow.

5.5.2.6. Underdrains and Supporting Gravel - The bottoms, strainer systems and support for the exchange material shall conform to criteria provided for rapid rate gravity filters. See 5.3.1.6. and 5.3.1.7.

5.5.2.7. Brine Distribution - Facilities should be included for even distribution of the brine over the entire surface of both upflow and downflow units. Backwash, installed in such a manner as to prevent any possibility of back-siphonage.

5.5.2.8. Bypass - A bypass should be provided around softening units to produce a blended water of desirable hardness. Meters should be installed on the bypass line and on each softener unit. An automatic proportioning or regulating device and shut-off valve should be provided on the bypass line. 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.

5.5.2.9. Additional Limitations - Waters having 5 units or more turbidity should not be applied directly to the cation exchange softener. Silica gel materials should be used for waters having a pH above 8.4 and should not be used when iron is present. When the applied water contains a chlorine residual the cation exchange material shall be a type that is not damaged by residual chlorine. Phenolic resin should not be used.

5.5.2.10. Sampling Taps - Smooth-nose sampling taps must be provided for the collection of representative samples for both bacteriological and chemical analyses. The taps shall be located to provide for sampling of the softner influent, softener effluent and the blended water. The sampling taps for the blended water shall be at least twenty feet downstream from the point of blending.

5.5.2.11. Brine and Salt Storage Tanks - Brine measuring or salt dissolving tanks and wet salt storage facilities must be covered. The make-up water inlet must have a free fall discharge of two pipe diameters above the maximum liquid level of the unit or be protected from back-siphonage. Water for filling the tank sould be distributed over the entire surface by pipes above the maximum brine level in the tank. The salt shall be supported on granduated layers of gravel under which is a suitable means of collecting the brine. Wet salt storage basins must be equipped with manhole or hatchway openings having raised curbs and watertight covers having overhanging edges similar to those required for finished water reservoirs. Overflows, where provided, must be turned down, have a proper free fall discharge and be protected with noncorrodible screens or self-closing flap valves.

5.5.2.12. Storage Capacity - Wet salt storage basins should have sufficient capacity to provide for at least thirty days of operation.

5.5.2.13. Stabilization - Stabilization for corrosion control shall be provided. See 5.9.

5.5.2.14. Waste Disposal - Suitable disposal must be provided for brine waste. See 5.12.

5.5.2.15. Construction Material - Pipes and contact materials must be resistant to the aggressiveness of salt.

5.5.2.16. Housing - Salt storage tanks and feed equipment should be enclosed and separated from other operating areas in order to prevent damage to equipment.

5.6. Aeration - Aeration treatment devices as described herein may be

used for oxidation, separation of gases or for taste and odor control.

5.6.1. Natural Draft Aeration - Design should provide that:

5.6.1.1. water is distributed uniformly over the top tray;

5.6.1.2. water is discharged through series of three or more trays with separation of trays not less than 6 inches.

5.6.1.3. trays are loaded at rate of 1 gpm to 5 gpm for each square foot of total tray area;

5.6.1.4. trays have slotted, woven wire cloth or perforated bottoms;

5.6.1.5. perforations, are 3/16 to 1/2 inches in diameter, spaced 1 to 3 inches on centers, when perforations are used;

5.6.1.6. 8 to 12 inches of inert media is used, such as coke or limestone, that will not disintegrate due to freezing cycles;

5.6.1.7. aerated water receives disinfection treatment.

5.6.2. Forced or Induced Draft Aeration - Devices shall be designed to:

5.6.2.1. provide adequate countercurrent of air through enclosed aeration column;

5.6.2.2. be insectproof and lightproof;

5.6.2.3. be such that air introduced into column shall be screened through insecttight screen and be as free of dust as possible;

5.6.2.4. insure that water outlet is adequately sealed to prevent unwanted loss of air;

5.6.2.5. be such that sections of the aerator can be easily reached and removed for maintenance.

5.6.3. Pressure Aeration - This method may be used for oxidation

purposed if pilot plant study indicates method is applicable; it is not acceptable for removal of dissolved gases. Filters following pressure aeration must have adequate exhaust devices for release of air. Pressure aeration devices shall be designed to:

5.6.3.1. give thorough mixing of compressed air with water being treated;

5.6.3.2. provide screened and filtered air, free of obnoxious fumes, dust, dirt and other contaminats.

5.6.4. Other Methods of Aeration - Other methods of aeration may be used if applicable to the treatment needs. Such methods include but are not restricted to spraying, diffused air and mechanical aeration. The treatment processes must be designed to meet the particular needs of the water to be treated and are subject to the approval of the division of sanitary engineering.

5.6.5. Protection from Wind - Aerators that discharge through the atmosphere should be protected by being placed in a louvered enclosure so designed as to provide easy access to the interior.

5.6.6. Protection from Contamination - Aerators that are used for oxidation or removal of dissolved gases from waters that will be given no further treatment other than chlorination shall be protected from contamination from insects and birds.

5.6.7. By-Pass - A by-pass should be provided for all aeration units.

5.7. Iron and Manganese Control - Iron and manganese control, as used herein, refers solely to treatment processes designed specifically for this purpose. The treatment process used will depend upon the character

of the raw water. The selection on one or more treatment processes must 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 division of sanitary engineerng. It may be necessary to operate a pilot plant in order to gather all information pertinent to the design.

5.7.1. Removal by Oxidation, Detention and Filtration

5.7.1.1. Oxidation - Oxidation may be by aeration, as indicated in 5.6., or by chemical oxidation with chlorine or potassium permanganate.

5.7.1.2. Detention - A minimum detention of 20 minutes shall be provided following oxidation by aeration in order to insure that the oxidation reactions are as complete as possible. This minimum detention shall 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 circuits. Sedimentation basins should be provided when treating water with high iron and/or manganese content or where chemical coagulation is used to reduce the load on the filters.

5.7.1.3. Filtration - Filters shall conform to 5.3.

5.7.2. Removal by Lime-Soda Process - See 5.5.1.

5.7.3. Removal by Units Using Continuous Potassium Permanganate "Regeneration" - This process, consisting of a continuous feed of potassium permanganate to the influent of a manganese greensand filter, is more applicable to the removal of manganese than to the removal of iron, due to economic consideration.

5.7.3.1. The permanganate should be applied as far ahead of the filter as practical.

5.7.3.2. 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.

5.7.3.3. Normal filtration rate is 3 gpm per sq. ft.

5.7.3.4. Normal wash rate is 8 to 10 gpm per sq. ft.

5.7.3.5. Air washing should be provided.

5.7.3.6. Sample taps should be provided:

5.7.3.6.1. prior to application of permanganate;

5.7.3.6.2. immediately ahead of filtration;

5.7.3.6.3. at point between anthracite coal media and the manganese treated greensand;

5.7.3.6.4. halfway down the manganese treated greensand;

5.7.3.6.5. for filter effluent.

5.7.4. Removal by Ion Exchange - This process of iron and manganese removal shall not be used for water containing more than 1.0 mg/1 of iron, manganese or combination thereof. This process is not acceptable where either the raw water or wash water contains dissolved oxygen.

5.7.5. Sequestration - This process is generally suitable only for low contents of iron and manganese, generally 1.0 mg/1. Where phosphate treatment is used, satisfactory chlorine residuals should be maintained in the distribution system.

5.7.5.1. Feeding equipment shall conform to requirements of Section 6.

5.7.5.2. Stock phosphate solution must be kept covered and disinfected by carrying approximately 10 mg/1 chlorine residual.

5.7.5.3. The point of application should be prior to any aeration or oxidation if no iron or manganese removal treatment is provided.

5.7.5.4. Phosphate chemicals must be food grade.

5.7.6. Sampling Equipment - 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.

5.7.7. Testing Equipment - 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 mg/1 and the manganese content to 0.05 mg/1.

5.8. Fluoridation - Commercial sodium fluride, sodium silicofluoride and hydrofluosilicic acid are suitable for the fluoridation of public water supplies. Other chemicals which may be made available must be approved by the division of sanitary engineering.

5.8.1. Fluoride Compound Storage - Compounds shall be stored in covered or unopened shipping containers. Storage units for hydrofluosilicic acid shall be vented to the atomsphere at a point outside any building.

5.8.2. Dry Conveyors - Provision must be made for the proper 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.

5.8.3. Chemical Feed Installations

5.8.3.1. shall conform to Section 5.

5.8.3.2. shall provide scales or loss-of-weight records for dry chemcial feeds;

5.8.3.3. shall have an accuracy that actual feed will be within five per cent of that intended;

5.8.3.4. shall be such that the point of application of hydrofluosilicic acid, if into a pipe, shall be in the lower half of the pipe and project upward.

5.8.3.5. shall be such as to provide a minimum of 20 strokes per minute at feeding rate, where fluoride is fed directly to the distribution system;

5.8.3.6. shall provide adequate anti-siphon devices for all fluoride feed lines.

5.8.4. Protective Equipment - Suitable protective equipment shall be provided. See 6.5.

5.8.5. Dust Control Equipment - Suitable equipment shall be provided for wet-mopping and hosing dust that might accumulate in the plant.

5.8.6. Testing Equipment - Equipment shall be provided for measuring the quantity of fluoride in the water. Such equipment shall be subject to the approval of the division of sanitary engineering.

5.9. Stabilization - Water that is unstable due either to natural causes or to treatment given the water should be stabilized.

5.9.1. Carbon Dioxide Addition

5.9.1.1. Recarbonation chamber design should provide:

5.9.1.1.1. detention for three to ten minutes;

5.9.1.1.2. depth about eight feet;

5.9.1.1.3. reaction tank with detention of twenty minutes.

5.9.1.2. Adequate precautions must be taken to prevent the possi-

bility of carbon monoxide entering plant from recarbonation and reaction chamber.

5.9.2. Sulphuric Acid

5.9.2.1. Feed equipment shall conform to Section 6.

5.9.2.2. Adequate precautions shall be taken for safety.

5.9.3. Polyphosphates - Applicable for sequestering calcium in lime softening.

5.9.3.1. Feed equipment shall conform to Section 6.

5.9.3.2. Phosphate chemicals must be food grade.

5.9.3.3. Stock phosphate solution must be kept covered.

5.9.3.4. Satisfactory chlorine residuals should be maintained in distribution system when phosphates are used.

5.9.4. "Split Treatment" - Under some conditions, a lime-soda water treatment plant can be designed using "split treatment" in which raw water is blended with lime treated water to partially stabilize the water. Treatment plants designed to utilize "split treatment" should also contain facilities for further stabilization by other methods.

5.9.5. Alkali Feed - Unstable water created by ion exchange process shall be stabilized by an alkali feed. An alkali feeder shall be provided for all ion exchange water softening plants except when exempted by the division of sanitary engineering.

5.9.6. Carbon Dioxide Reduction by Aeration - The carbon dioxide content of an agressive water may be reduced by aeration. Aeration devices shall conform to 5.6.

5.9.7. Other Treatment - Other treatment for controlling corrosive

waters by the use of sodium silicate and sodium bicarbonate, may be used where necessary. Any proprietary compound must receive the specific approval of the division of sanitary engineering before use. Chemical feeders shall be as required in Section 6.

5.9.8. 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 sulphides should be prevented by the maintenance of a chlorine residual thoughout the distribution system.

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

5.9.10. Cathodic Protection - May be used to prevent or minimize corrosion of the inner surfaces of water tanks and stand pipes and the outer surfaces of metal conduits.

5.10. Taste and Odor Control

5.10.1. Chlorination - Chlorination may be used for the removal of some objectionable odors. Adequate contact time must be provided to complete the chemical reactions involved.

5.10.2. Chlorine Dioxide - Chlorine dioxide has been generally recognized as a treatment for tastes caused by industrial wastes, such as phenols; however, chlorine dioxide may be used in the treatment of any taste or odor that is treatable by an oxidizing compound. Provision shall be made for proper storing and handling sodium chlorite, so as to eliminate any danger of explosion. See Section 6.

5.10.3. Powdered Activated Carbon

5.10.3.1. Powdered activated carbon may be added prior to coagulation to provide maximum contact time, although facilities to allow the addition at several points is preferred, but not near the point of chlorine application.

5.10.3.2. 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."

5.10.3.3. Agitation is necessary to keep the carbon from depositing in the mixing chamber.

5.10.3.4. Provision shall be made for adequate dust control.

5.10.3.5. The required dosage of carbon in a water treatment plant depends upon the tastes and/or odors invloved, but provision shall be made for adding 1 mg/1 to at least 40 mg/1.

5.10.4. Granular Activated Carbon Adsorption Units - Granular activated carbon units shall not be used in place of filters described in 5.3. Rates of flow shall be consistent with the type and intensity of the problem. The rate used must generally be supported by the results of pilot plant studies.

5.10.5. Copper Sulphate 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 1.0 mg/1 as copper in the plant effluent or distribution system. Care shall be taken in obtaining a uniform distribution.

5.10.6. Aeration - See 5.6.

5.10.7. Potassium Permanganate - Application of potassium perman-

ganate may be considered providing the treatment shall be so designed that the products of the reaction shall not be present in the finished water.

5.10.8. Other Methods - The decision to use any other methods of taste and odor control should be made only after careful laboratory tests and on consultation and approval of the division of sanitary engineering.

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

5.11. 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 on filter systems. It shall not be used in place of filtration, when filtration is necessary to provide a satisfactory water, or coagulation in preparation of water for filtration.

5.11.1. Design

5.11.1.1. Shall give due consideration to:

5.11.1.1.1. nature of suspended matter to be removed;

5.11.1.1.2. corrosiveness of the water;

5.11.1.1.3. effect of chlorination, when required as pretreatment.

5.11.1.2. Shall provide:

5.11.1.2.1. durable, corrosion-resistant screen;

5.11.1.2.2. by-pass arrangements;

5.11.1.2.3. protection against back-siphonage when potable water is used for washing;

5.11.1.2.4. proper disposal of wash waters. See 5.12.

5.12. Waste Disposal - Provisions must be made for proper disposal of water treatment plant waste such as sanitary, laboratory, clarification, softening and ion sludges, filter backwash, and brines. Discharges shall be governed by the state department of health and the department of natural resources requirements.

5.12.1. Waste Water and Sludge - The following means of waste and sludge disposal may be considered:

5.12.1.1. Lagoons - Design should provide:

5.12.1.1.1. location free from flooding;

5.12.1.1.2. when necessary, dikes, deflecting gutters, or other means of diverting surface water;

5.12.1.1.3. a minimum depth of 4 to 5 feet;

5.12.1.1.4. 3 to 5 years solids storage volume;

5.12.1.1.5. multiple cells;

5.12.1.1.6. adjustable decanting devices;

5.12.1.1.7. convenient cleaning;

5.12.1.1.8. fenced.

5.12.1.2. Sludge Beds - Beds for lime softening sludges should provide for an application of slurry of at least 12 inches. Multiple beds should be provided so designed as to permit a minimum of one year's total storage. The storage capacity should be based on assumption that for each part per million of hardness removed there will be two parts per million of dry solids, and the accumulated sludge on the bed will contain 75 per cent moisture, the sludge density being 120 pounds per cubic foot. Distribution

channels are required for spreading sludge over the entire area. Provisions must be made for easy access and for paved loading ramps and underdrains. See 5.12.1.1 for provisions on flooding and surface water diversion.

5.12.1.3. Community Wastewater Treatment Facility - Discharges to sewer systems and their treatment facilities depend on type of treatment, rate of discharge, plant design capacity, character of waste, and local conditions.

5.12.1.4. Tank Truck - Trucking wet sludge to agricultural lands or disposal areas requires proper handling, vehicles, and equipment to permit hauling and spreading without creation of nuisances. It is necessary to provide sludge holding facilities for use during times that trucks cannot operate.

5.12.1.5. Other Methods - These include holding tanks, vacuum filters, centrifuging, and recalcining. Detailed studies should be made to justify their use.

5.12.2. Sanitary Waste - The sanitary waste from water treatment plants, pumping stations, etc., must receive treatment. Waste from these facilities must be discharged either directly to a sanitary sewer system or to an individual waste disposal facility providing suitable treatment. The effluent must be acceptable for discharge to the surface or gound waters.

Section 6. Chemical Application

6.1. General - No chemicals shall be applied to treat drinking waters unless specifically permitted by the division of sanitary engineering.

6.1.1. Plans and specification shall be submitted for review and

approval, as provided for in Section 2 and 3, and shall include:

6.1.1.1. descriptions of feed equipment, including maximum and minimum feed ranges;

6.1.1.2. location of feeders, piping layout and points of application;

6.1.1.3. storage and handling facilities;

6.1.1.4. specifications for chemicals to be used;

6.1.1.5. operating and control procedures;

6.1.1.6. descriptions of testing equipment and procedures.

6.1.2. Chemicals shall be applied to the water at such points and by such means as to:

6.1.2.1. assume maximum efficiency to treatment;

6.1.2.2. assure maximum safety to the consumer;

6.1.2.3. provide maximum safety to operators;

6.1.2.4. assure satisfactory mixing of the chemicals with the water;

6.1.2.5. provide maximum flexibility of operation through various points of application, when appropriate; and

6.1.2.6. prevent backflow or back-siphonage between multiple points of feed through common manifolds.

6.2. Feed Equipment

6.2.1. Number of Feeders

6.2.1.1. Where chemical feed is necessary for the protection of the supply, such as chlorination, coagulation or other essential process:

6.2.1.1.1. a minimum of two feeders shall be provided;

6.2.1.1.2. spare parts shall be available for all feeders to replace parts which are subject to wear and damage.

6.2.2. Design and Capacity - Design and capacity shall be such that:

6.2.2.1. feeders will be able to supply at all times, the necessary amounts of chemical at an accurate rate, thoughout the range of feed;

6.2.2.2. proportioning of chemical feed to rate of flow is provided;

6.2.2.3. solution feed pumps shall be of the positive displacement type, but shall not be used to feed chemical slurries;

6.2.2.4. chemcial solutions cannot be siphoned into the water supply, by:

6.2.2.4.1. assuring discharge at point of positive pressure; or

6.2.2.4.2. providing vacuum relief; or

6.2.2.4.3. providing a suitable air gap; or

6.2.2.4.4. other suitable means or combinations as necessary.

6.2.2.5. service water supply cannot be contaminated by chemical solutions, by:

6.2.2.5.1. equipping the supply line with backflow or back-siphonage prevention devices (see 6.2.8.3.); or

6.2.2.5.2. providing an air gap between supply line and solution tank.

6.2.2.6. chemcial-contact materials and surfaces are resistant to the aggressiveness of the chemical solution;

6.2.2.7. dry chemical feeders will:

6.2.2.7.1. measure chemicals volumentrically or gravimetrically;

6.2.2.7.2. provide effective solution of the chemical in the solution pot;

6.2.2.7.3. preferably provide gravity feed from solution pots;

6.2.2.7.4. completely enclose chemicals to prevent emission of dust to the operating room (see 6.3.3.4.)

6.2.2.8. no direct connection exists between any sewer and a drain or overflow from the feeder or solution chamber or tank.

6.2.3. Location - Chemical feed equipment:

6.2.3.1. shall be conveniently located near points of application to minimize length of feed lines;

6.2.3.2. shall be readily accessible for:

6.2.3.2.1. servicing and repair; and

6.2.3.2.2. observation of operation.

6.2.3.3. shall be located and protective curbings provided so that chemicals from equipment failure, spillage or accidental drainage shall not enter the water in conduits, treatment or storage basins.

6.2.4. Control

6.2.4.1. Feeders may be manually or automatically controlled, with automatic control reverting to manual control as necessary.

6.2.4.2. Process must be manually started following shutdown, unless otherwise approved by the division of sanitary engineering.

6.2.4.3. Feed rates proportional to flow must be provided.

6.2.4.4. Automatic chemical dose or residual analyzers may be approved for use and must provide:

6.2.4.4.1. alarms for critical values; and

6.2.4.4.2. recording charts.

6.2.5. Solution Tanks

6.2.5.1. Means shall be provided in a solution tank to maintain uni-

form strength of solution, consistent with the nature of the chemical solution; continuous agitation is necessary to maintain slurries in suspension.

6.2.5.2. Two solution tanks may be required for a chemical, of specific capacity, to assure continuity of supply in servicing a solution tank.

6.2.5.3. Each tank shall be provided with a drain:

6.2.5.3.1. No direct connection between any tank or drain and a sewer shall be permitted; and

6.2.5.3.2. Any drain must terminate at least two pipe diameters above the overflow rim of a receiving sump, conduit or waste receptacle.

6.2.5.4. Means shall be provided to indicate the solution level in the tank.

6.2.5.5. Make-up water shall enter the tank from above the maximum solution level, a distance of two pipe diameters but not less than six inches, or shall be protected with approved backflow prevention devices (see 6.2.8.3.).

6.2.5.6. Chemical solutions shall be kept covered.

6.2.5.6.1. Large tanks with access openings shall have such openings curbed and fitted with tight covers.

6.2.5.7. Subsurface locations for solution tanks shall:

6.2.5.7.1. be free from sources of possible contamination;

6.2.5.7.2. assure positive drainage for ground waters, accumulated water, chemical spills and overflows.

6.2.5.8. Overflow pipes, when provided, should:

6.2.5.8.1. be turned downward, with end screened;

6.2.5.8.2. have free discharge; and

6.2.5.8.3. be located where noticeable.

6.2.6. Weighing Scales

6.2.6.1. shall be provided for weighing cylinders, at all plants utilizing chlorine gas; for large plants, indicating and recording type are desirable;

6.2.6.2. may be required for fluoride solution feed;

6.2.6.3. should be required for volumetric dry chemical feeders;

6.2.6.4. should be accurate to measure increments of 0.5 per cent of load.

6.2.7. Feed Lines

6.2.7.1. should be short as possible in length of run, and:

6.2.7.1.1. of durable, corrosion resistant material;

6.2.7.1.2. easily accessible thoughout entire length;

6.2.7.1.3. protected against freezing; and

6.2.7.1.4. readily cleanable.

6.2.7.2. should slope upward from chemical source to feeder, when conveying gases;

6.2.7.3. should introduce corrosive chemicals in such manner as to minimize potential for corrosion;

6.2.7.4. shall be designed consistent with scale-forming or solids depositing properties of the water, chemical, solution or mixture conveyed;

6.2.7.5. shall not carry chlorine gas beyond chlorine feeder room.

6.2.8. Service Water Supply

6.2.8.1. Water used for dissolving dry chemicals, diluting liquid chemicals or operating chemical feeders shall be:

6.2.8.1.1. only from a safe, approved source;

6.2.8.1.2. protected from contamination by appropriate means (see 6.2.8.3.);

6.2.8.1.3. ample in supply and adequate in pressure;

6.2.8.1.4. provided with means for measurement when preparing specific solution concentrations by dilution;

6.2.8.1.5. properly treated for hardness, when necessry.

6.2.8.2. Where a booster pump is required, duplicate equipment should be provided and, when necessary, standby power.

6.2.8.3. Back-flow prevention shall be achieved by appropriate means such as:

6.2.8.3.1. an air gap between fill pipe and maximum flow line of solution or dissolving tank equivalent to two pipe diameters but not less than six inches; or

6.2.8.3.2. an approved reduced pressure zone backflow preventer, consistent with the degree of hazard, aggressiveness of chemical solution, back pressure sustained, and available means for maintaining and testing the device; or

6.2.8.3.3. a satisfactory vacuum relief device.

6.3. Chemicals

6.3.1. Quality

6.3.1.1. Chemical containers shall be fully labeled to include:

6.3.1.1.1. chemcial name, purity and concentration; and

6.3.1.1.2. supplier name and address.

6.3.1.2. Chemicals shall meet american water works association specifications, where applicable.

6.3.1.3. Provisions may be required for assay of chemicals delivered.

6.3.1.4. Chemicals having a distinguishing color may be used, providing the coloring material is not toxic in concentrations used and will not impart taste, odor or color to the water supply.

6.3.2. Storage

6.3.2.1. Space should be provided for:

6.3.2.1.1. at least thirty days of chemical supply;

6.3.2.1.2. convenient and efficient handling;

6.3.2.1.3. dry storage conditions.

6.3.2.2. Cylinders of chlorine gas should be:

6.3.2.2.1. isolated from operating areas;

6.3.2.2.2. restrained in position to prevent upset;

6.3.2.2.3. stored in rooms separate from ammonia storage.

6.3.2.3. Liquid chemical storage tanks must:

6.3.2.3.1. have a liquid level indicator;

6.3.2.3.2. have an overflow and a receiving basin or drain capable of receiving accidental spills or overflows.

6.3.2.4. Special precautions must be taken with:

6.3.2.4.1. sodium chlorite, to eliminate any danger of explosion; avoid heat, flame and shock;

6.3.2.4.2. activated carbon, which is a potentially combustible material, requiring isolated, fireproof storage and explosion-proof electrical outlets, lights and motors in areas of dry handling.

6.3.2.5. Chemicals shall be stored in covered or unopened shipping containers, unless the chemical is transferred into an approved covered storage unit.

6.3.2.6. Solution storage or day tanks supplying feeders directly should have sufficient capacity for one day of operation.

6.3.2.7. Acid storage tanks must be vented to the outside atmosphere, but not through vents in common with day tanks.

6.3.3. Handling

6.3.3.1. Provisions shall be made for measuring quantities of chemicals used to prepare feed solutions.

6.3.3.2. Storage tanks and pipelines for liquid chemicals shall be specific to the chemicals and not for alternates.

6.3.3.3. Chemicals that are incompatible shall not be fed, stored or handled together.

6.3.3.4. Provision must be made for the proper transfer of dry chemcials from shipping containers to storage bins or hoppers, in such a way as to minimize the quantity of dust which may enter the room in which the equipment is installed; control should be provided by use of:

6.3.3.4.1. vacuum pneumatic equipment or closed conveyor systems; or

6.3.3.4.2. facilities for emptying shipping containers in special enclosures; or

6.3.3.4.3. exhaust fans and dust filters which put the hoppers or bins under negative pressure.

6.3.3.5. Precautions shall be taken with electrical equipment to pre-

vent explosions, particularly in the use of sodium chlorite and activated carbon.

6.3.3.6. Acids shall:

6.3.3.6.1. be kept in closed, acid-resistant shipping containers or storage units;

6.3.3.6.2. not be handled in open vessels, but should be pumped in undiluted form from original containers, through suitable hose, to the point of treatment or to a covered day tank.

6.3.3.7. Carts, elevators and other appropriate means shall be provided for lifting chemical containers to minimize excessive lifting by operators.

6.3.3.8. Provisions shall be made for disposing of empty bags, drums or barrels, either by burning in an approved incinerator or by some other approved procedures which will minimize exposure to dusts.

6.4. Housing

6.4.1. Structures, rooms and areas accommodating chemical feed equipment shall provide convenient access for:

6.4.1.1. servicing and repair;

6.4.1.2. observation of peration.

6.4.2. Floor surfaces shall be smooth and impervious, slip-proof and well-drained with 2.5 per cent slope, minimum.

6.4.3. Open basin, tanks nd conduits shall be protected from chemical spills or accidental drainage.

6.4.4. Chlorine gas feed and storage shall be:

6.4.4.1. enclosed and separated from other operating areas in order

to prevent injury to personnel and damage to equipment; separate chlorine feed and storage may be required for large installation;

6.4.4.2. provided with an inspection window to permit viewing of the interior of the room and the equipment;

6.4.4.3. provided with doors assuring ready means of exit; doors opening to the buildng exterior should be provided.

6.4.5. Where chlorine gas is used, ventilation for each room shall be provided for one complete air change per minute; and

6.4.5.1. the air outlet from the room shall be near the floor and the point of discharge shall be so located as not to contaminate air inlets to any rooms or structures, or adversely affect the surrounding environment;

6.4.5.2. air inlets should be through louvers near the ceiling, and temperature controlled to prevent adverse affect on chlorinators;

6.4.5.3. switches for fans and lights should be outside of the room, at the entrance; signal light indicating fan operation should be provided at each entrance when fan can be controlled from more than one point;

6.4.5.4. vents from feeders and storage shall discharge to the outside atmosphere, above grade.

6.4.6. Chlorinator rooms should be heated to 60°F., but should be protected from excess heat; cylinders and gas lines should be protected from temperatures above that of the feed equipment.

6.5. Operator Safety

6.5.1. Gases from feeders, storage and equipment exhausts shall be conveyed to the outside atmosphere, above grade and remote from air intakes.

6.5.2. Special provisions shall be made for ventilation of chlorine feed and storage rooms (see 6.4.5.).

6.5.3. Gas masks of the cannister type, designed for chlorine gas and meeting the requirements of the U. S. Bureau of Mines, shall be available at all installations where chlorine gas is handled, and shall be stored outside every room where chorine is used or stored; as an alternate, oxygen-supplying equipment or air-supplying equipment may be considered or required by the division of sanitary engineering.

6.5.4. A bottle of ammonium hydroxide shall be available for chlorine leak detection; where ton cylinders are used, leak repair kits shall be provided.

6.5.5. A plastic bottle of hydrochloric acid (muriatic acid, in commerical form) shall be available for ammonia leak detection where ammonia gas is used or stored.

6.5.6. At least one pair of rubber goves with long gauntlets, a dust respirator of a type approved by the U. S. Bureau of Mines for toxic dusts, and an apron or other protective clothing shall be provided for each operator in any shift who will handle dry chemicals.

6.5.7. Rubber gloves, clothing protection and goggles shall be provided for each operator preparing chemical solutions.

6.5.8. Facilities shall be provided for washing of face, gloves and protective equipment.

6.5.9. Safety sign shall be posted in all areas where necessary.

Section 7. Pumping Facilities

7.1. General - Pumping facilities shall be designed to maintain the

sanitary quality of pumped water. Subsurface pits or pump rooms and inaccessible installations should be avoided. No pumping station shall be subject to flooding.

7.2. Location - The pumbing station shall be so located that the proposed site will meet the requirements of the sanitary protection of the water quality, hydraulics of the system and be protected against interruption of service by fire, flood or any other hazard.

7.2.1. Site Protection - The station shall be:

7.2.1.1. elevated to a minimum of one foot above highest recorded flood elevation, or protected to such elevation;

7.2.1.2. accessible at all times unless permitted to be out of service for period of inaccessibility;

7.2.1.3. graded around station so as to lead surface drainage away from the station;

7.2.1.4. protected to prevent vandalism and entrance by unauthorized persons or animals.

7.3. Ground Water Facilities - Where pumping facilities are used, wells and springs shall be vented by properly hooded and screened pipe extending at least 12 inches above the pump floor or ground surface. Where necessary, provision shall be made for lubricating the pump from a point at least 6 inches above the top of the well cover, by means which will prevent contamination of the water supply.

7.3.1. Dug Well - Pumping stations located over dug wells shall have a watertight concrete floor. Entrance hatch in the pump floor shall:

7.3.1.1. be located adjacent to and inside of the well perimeter;

7.3.1.2. have a curb at least 4 inches high;

7.3.1.3. have edge of cover extending down over the curb at least 2 inches;

7.3.1.4. be kept locked when not in use.

7.3.2. Driven or Drilled Wells - Pumping stations located over driven or drilled wells shall:

7.3.2.1. have riser pipe or casing extending at least 6 inches, and preferably 12 inches, above the floor, and be equipped with flange or suitable stuffing box;

7.3.2.2. have riser pipe or casing firmly connected to the pump structure or have casing inserted into a recess extending at least 1 inch into the base of the pump, if a watertight connection is not provided;

7.3.2.3. have base of pump not less than 6 inches above pump room floor;

7.3.2.4. have pump foundation and base designed to prevent water from coming into contact with the joint.

7.3.3. Submersible Pumps - Where a submersible pump is used, the top of the casing shall be effectively sealed against entrance of water under all conditions of vibration or movements of conductors or cables.

7.3.4. Discharge Piping - Discharge piping should be provided with means to pump to waste but shall not be directly connected to a sewer. The discharge line shall:

7.3.4.1. have control valves located above pump floor;

7.3.4.2. be protected against freezing;

7.3.4.3. be valved to permit testing and control of each well;

7.3.4.4. have watertight joints;

7.3.4.5. have all exposed valves protected.

7.4. Surface Water Facilities

7.4.1. Pump stations normally associated with surface water sources, either as raw or finished water pump stations, shall:

7.4.1.1. have adequate space for the installation of additional units if needed, and for the safe servicing of all equipment;

7.4.1.2. be of durable character, fire and weather resistant and with outward opening doors;

7.4.1.3. have floor elevation of at least 6 inches above finished grade;

7.4.1.4. have underground structure waterproofed;

7.4.1.5. have all floors drained without imparing the quality of water being handled and if equipment is contained on the floor, the floor shall slope at least 3 inches in every 10 feet to the point of drainage;

7.4.1.6. provide suitable outlet for drainage from pump glands without discharging onto the floor.

7.4.2. Suction Well - Suction wells shall:

7.4.2.1. be watertight;

7.4.2.2. have floors sloped to permit removal of water and entrained solids;

7.4.2.3. be covered or otherwise protected against contamination, including pump lubricants.

7.4.3. Equipment Servicing - Pump stations shall be provided with:

7.4.3.1. crane-ways, hoist beams, eyebolts, or other adequate facili-

ties for servicing or removal of pumps, motors or other heavy equipment;

7.4.3.2. openings in floors, roofs or wherever else needed for removal of heavy or bulky equipment;

7.4.3.3. a convenient tool board or other facilities, as needed for proper maintenance of the equipment.

7.4.4. Stairways and Ladders

7.4.4.1. Stairways or ladders shall:

7.4.4.1.1. be provided between all floors, in pits or compartments which must be entered;

7.4.4.1.2. have handrails on both sides, and treads on nonslip material.

7.4.4.2. Stairs are preferred in areas where there is frequent traffic or where supplies are transported by hand. They shall have risers not exceeding 9 inches and treads wide enough for safety.

7.4.5. Heating

7.4.5.1. Provision shall be made for adequate heating for:

7.4.5.1.1. the comfort of the operator;

7.4.5.1.2. the safe and efficient operation of the equipment.

7.4.5.2. In pump houses not occupied by personnel, only enough heat need be provided to prevent freezing of equipment or treatment process.

7.4.6. Ventilation - Ventilation shall conform to existing local and/or state code. Adequate ventilation shall be provided for all pumping stations. Forced ventilation of at least six changes of air per hour shall be provided for:

7.4.6.1. all rooms, compartments, pits and other enclosures below grade floor;

7.4.6.2. any area where unsafe atmosphere may develop or where excessive heat may be built up.

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

7.4.8. Lighting - Pump stations shall be adequately lighted throughout. All electrical work shall conform to the requirements of the national electrical code and related agencies and to relevant state and/or local codes.

7.4.9. Sanitary and Other Conveniences - Except in the cases of small automatic stations or where such facilities are otherwise available, all pumping stations shall be provided with potable water, lavatory and toilet facilities. Plumbing must be so installed as to prevent contamination of a public water supply. Wastes shall be discharged in accordance with Section 5.12.2 of these standards.

7.4.10. Pumps - At least two pumping units shall be provided except where ample time will be available between pumping periods for necessary repairs. If only two units are provided, each shall be capable of carrying the peak demand. If more than two units are installed, they shall have sufficient capacity so that any one pump can be taken out of service and the remaining pumps are capable of carrying the peak demand. The pumping units shall:

7.4.10.1. have ample capacity to supply the peak demand without dangerous overloading;

7.4.10.2. be driven by a prime mover able to operate against the

maximum head and air temperature which may be encountered;

7.4.10.3. have spare parts and tools readily available.

7.4.11. Suction Lift

7.4.11.1. Suction lift shall:

7.4.11.1.1. be avoided, if possible;

7.4.11.1.2. be within allowable limits, preferably less than 15 feet.

7.4.11.2. If suction lift is necessary, provision shall be made for priming the pumps.

7.4.12. Priming - Prime water must not be of lesser sanitary quality than that of the water being pumped. Means shall be provided to prevent backsiphonage in accordance with 6.2.8.3. of these standards. When an air-operated ejector is used, the screened intake shall draw clean air from a point at least 10 feet above the ground or other source of contamination, unless the air is filtered by apparatus approved by the division of sanitary engineering. Vacuum priming may be used.

7.5. Booster Pumps

7.5.1. Booster pumps shall be located or controlled so that:

7.5.1.1. they will not produce negative pressure in their suction line;

7.5.1.2. the intake pressure shall be at least 20 psi when pump is in normal operation;

7.5.1.3. automatic cutoff pressure shall be at least 5 psi in the suction line;

7.5.1.4. automatic or remote control devices shall have a range between the start and cutoff pressure which will prevent excessive cycling.

7.5.2. Inline Booster Pumps - In addition to the other requirement of

this section, inline booster pumps shall be accessible for servicing and repairs.

7.6. Automatic and Remote Controlled Stations - All automatic stations shall be provided with automatic signaling apparatus which will report 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 national electrical code, and state and/or local codes.

7.7. Appurtenances

7.7.1. Valves - Pumps shall be adequately valved 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 $2\frac{1}{2}$ 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 shutoff valve.

7.7.2. Piping - In general piping shall:

7.7.2.1. be designed so that the friction head will be low;

7.7.2.2. not be subject to contamination;

7.7.2.3. be sloped in one direction to drains;

7.7.2.4. have adequate cleanouts;

7.7.2.5. have watertight joints;

7.7.2.6. be protected against surge or water hammer;

7.7.2.7. be such that each pump has an individual suction line or the lines shall be so manifolded that they will insure similar hydraulic and operation conditions.

7.7.3. Gauges and Meters

7.7.3.1. Each pump shall:

7.7.3.1.1. have a standard pressure gauge on its discharge line;

7.7.3.1.2. have a compound gauge on its suction line;

7.7.3.1.3. have recording gauges and meters in the larger stations;

7.7.3.1.4. have means for measuring the discharge.

7.7.3.2. The station shall have indicating and totalizing metering of the total water pumped.

7.7.4. Water Seals - Water seals shall not be supplied with water of a lesser sanitary quality than that of the water being pumped. Where pumps are sealed with potable water and are pumping water of lesser sanitary quality the seal shall:

7.7.4.1. be provided with a break tank open to atmospheric pressure;

7.7.4.2. have an air gap between feeder line and spill line of the tank, at least six inches or two pipe diameters, whichever is greater.

7.7.5. Controls - Pumps, their prime movers and accessories, shall be controlled in such a manner that they will operate at rated capacity without dangerous overload. Where two or more pumps are installed, provision shall be made for proper alternation. Provision shall be made to prevent operation of the pump during the backspin cycle. Electrical controls should be located above grade.

7.7.6. Power - When power failure would result in cessation of minimum essential service, power supply shall be provided from at least two independent sources or standby or auxiliary source shall be provided.

7.7.7. Auxiliary Power Supply - 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 by-pass around the automatic control.

Section 8. Finished Water Storage

8.1. 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 american water works association 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 Section 8.

8.1.1. Location

8.1.1.1. The bottom of ground-level reservoirs and standpipes should be placed at the normal ground surface and above maximum flood level.

8.1.1.2. Where the bottom must be below normal ground surface, it should be placed above the ground water table. Sewers, drains, standing water, and similar sources of contamination must be kept at least fifty feet from the reservoir. Mechanical-joint water pipe, pressure tested in place to 50 psi without leakage, may be used for gravity sewers at less separations.

8.1.1.3. The top of a ground-level reservoir should not be less than two feet above normal ground surface and any possible flood level. Clearwells constructed under filters may be excepted from this requirement when the total design gives the same protection.

8.1.2. Protection - All new finished water storage structures shall have suitable watertight roofs or covers which exclude birds, animals, insects, and excessive dust.

8.1.3. Protection from Trespassers - Fencing, locks on access manholes, and other necessary precautions shall be provided to prevent trespassng, vandalism, and sabotage.

8.1.4. Drains - No drain on a water storage structure may have a direct connection to a sewer or storm drain.

8.1.5. Overflow - The overflow pipe of a water storage structure shall be brought down near the ground surface and discharged over a drainage inlet structure or a splash plate. No overflow may be connected directly to a sewer or storm drain. The outlet of the overflow pipe shall be screened, or otherwise protected to exclude birds and animals.

8.1.5.1. When an internal overflow pipe is used, it shall be located in the access tube.

8.1.5.2. The overflow of a ground-level structure shall be high enough above normal or graded ground surface to prevent the entrance of surface water.

8.1.6. Access - Finished water storage structures shall be designed with reasonably convenient access to the interior for cleaning and maintenance. Manholes on scuttles above waterline:

8.1.6.1. shall be framed at least four inches, and preferably six inches, above the surface of the roof at the opening; on ground-level structures manholes should be elevated 24 to 36 inches above the top or covering sod;

8.1.6.2. shall be fitted with a solid watertight cover which overlaps the framed opening and extends down around the frame at least two inches;

8.1.6.3. should be hinged at one side;

8.1.6.4. shall have a locking device.

8.1.7. Vents - Finished water storage structures shall be vented by special vent structures. Open construction between the sidewall and roof is not permissible. These vents:

8.1.7.1. shall prevent the entrance of surface water;

8.1.7.2. shall exclude birds and animals;

8.1.7.3. should exclude insects and dust, as much as this function can be made compatible with effective venting; for elevated tanks and standpipes, four mesh noncorrodible screen may be used;

8.1.7.4. shall, on ground-level structures, terminate in an inverted U construction, the opening of which is 24 to 36 inches above the roof or sod and is covered with twenty-four mesh noncorrodible screen cloth.

8.1.8. Roof and Sidewall - The roof and sidewalls of all structures must be watertight with no openings except properly constructed vents, manholes, overflows, risers, drains, pump mountings, control ports, or piping for inflow and outflow.

8.1.8.1. Any pipes running through the roof or sidewall of a finished water storage structure must be welded or properly gasketed in metal tanks, or should be connected to standard wall castings which were poured in place during the forming of a concrete structure; these wall castings should have flanges imbedded in the concrete.

8.1.8.2. 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 slop water to the structure.

8.1.8.3. Valves and controls should be located outside the storage structure so that valve stems and similar projections will not pass through the roof or top of the reservoir.

8.1.9. Drainage for Roof or Cover - The roof or cover of the storage structure should be well drained, but downspout pipes shall not enter or pass through the reservoir; parapets, or similar construction which would tend to hold water and snow on the roof, will not be approved.

8.1.10. Safety - The safety of employees must be considered in the design of the storage structure. As a minimum, such matters shall conform to pertinent state and/or local laws and regulations.

8.1.10.1. Ladders, ladder guards, balcony railings, and safe location of entrance hatches shall be provided where applicable.

8.1.10.2. Elevated tanks with riser pipes over eight inches in diameter shall have protective bars over the riser openings inside the tank.

8.1.11. Freezing - All finished water storage structures and their appurtenances, especially the riser pipes, overflows, and vents, shall be designed to prevent freezing which will interfere with proper functioning.

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

8.1.13. Grading - The area surrounding a ground-level structure should be graded in a manner that will prevent surface water from standing within 50 feet of the structure.

8.1.14. Painting and/or Cathodic Protection - Proper protection should be given to metal surfaces by paints or other pretective coatings,

by cathodic protective devices, or by both. Paint systems consistent with current american water works association standards, or otherwise acceptable to the division of sanitary engineering shall be used.

8.1.14.1. Cathodic protection shall be designed and installed by competent technical personnel.

8.1.15. Disinfection - Finished water storage structures shall be disinfected before being put into service. The detailed procedures to be followed, equivalent to those outlined in the current american water works association standard D102 for painting and repairing steel tanks, standpipes, reservoirs, and elevated tanks, shall be written into the specifications by the designing engineer.

8.1.15.1. Three or more successive sets of samples, taken at 24-hour intervals, shall indicate bacteriologically satisfactory water before the facility is released for use.

8.2. Plant Storage - The applicable design standards of Section 8.1 shall be followed for plant storage.

8.2.1. Washwater Tanks - Washwater tanks shall be sized, in conjunction with available pump units and finished water storage, to give the backwash water required by Section 5.3.1.10.

8.2.1.1. Consideration must be given to the possibility of having to wash more than one filter at a time, or several filters in succession.

8.2.2. Clearwell - Clearwell storage should be sized, in conjuction with distribution system storage, to relieve the filters from having to follow fluctuations in water use or meet peak demands, including filter backwash water.

8.2.2.1. When finished water storage is used to provide proper contact time for chlorine (see 5.4.2.), special attention must be given to size and baffling.

8.2.3. Adjacent Compartment - Finished water shall not be stored or conveyed in a compartment adjacent to unsafe water when the two compartments are separated by a single wall.

8.2.4. Basins and Wet-Wells - Receiving basins and pump wet-wells for finished water shall be designed as finished water storage structures.

8.2.5. Pressure Tanks - Hydropneumatic (pressure) tanks may be acceptable in some small water systems. When used, they shall meet ASME code requirements or equal which comply with the requirements of state and local laws and regulations for the construction and installation of unfired pressure vessels.

8.2.5.1. The tank should be located above normal ground surface and be completely housed, or earth-mounded with one end projecting into an operating house, to prevent freezing.

8.2.5.2. The tank should have bypass piping to permit operation of the system while the tank is being repaired or painted.

8.2.5.3. Each tank should have an access manhole, a drain, and control equipment consisting of pressure gage, water sight glass, automatic or manual air blow-off, mechanical means for adding air, and pressure-operated start-stop controls for the pumps.

8.2.5.4. The capacity of the wells and pumps in a hydroneumatic system should be at least six times the average daily consumption rate of the community.

8.2.5. The gross volume of the hydropneumatic tank, in gallons, should be ten times the capacity of the largest pump, rated in gallons per minute. For example, a 250 gpm pump should have minimum 2,500 to 3,750 gallon pressure tank.

8.3. Distribution Storage - The applicable design standards of Section 8.1. shall be followed for distribution storage.

8.3.1. Finished water storage facilities shall be equal to at least peak consumption rate of the entire water system, plus that quantity required by the national board of fire underwriters for fire fighting purposes.

8.3.2. Pressure Variation - The maximum variation between high and low levels in storage structures which float on a distribution system should not exceed 30 feet.

8.3.3. Drainage - Storage structures which float on the distribution system should be designed to drain for cleaning or maintenance without necessitating loss of pressure in the distribution system. The drains should discharge to the ground surface with no direct connection to a sewer or storm drain.

8.3.4. Level Controls - Adequate controls shall be provided to maintain levels in distribution system storage structures.

8.3.4.1. Telemeter equipment should be used when pressure-type controls are employed and any appreciable head loss occurs in the distribution system between the source and the storage structure.

8.3.4.2. Altitude valves or equivalent controls may be required for a second and subsequent structures on the system.

8.3.4.3. Overflow and low-level warnings or alarms should be located

at places in the community where they will be under responsible surveillance on a 24-hour basis.

Section 9. Distribution System

9.1. Materials

9.1.1. Pipe selected shall have been manufactured in conformity with the latest standards issued by the american water works association, if such standards exist, and be acceptable to the division of sanitary engineering.

9.1.2. In the absence of such standards, pipe meeting applicable commercial standards and acceptable to the division of sanitary engineering may be selected.

9.1.3. Used water mains that meet these standards may be used again, after the pipe has been thoroughly cleaned and restored practically to its original condition.

9.1.4. Packing and jointing materials used in the joints of pipe shall meet the standards of the american water works association or the division of sanitary engineering.

9.1.5. Mechanical joints or slip-on joints with rubber gaskets are preferred.

9.1.6. All plastic pipe must bear the seal of the national sanitation foundation.

9.2. Minimum Pipe Size

9.2.1. The minimum size of pipe should be six-inch diameter.

9.2.2. The standard grading schedule of the american insurance association and related agencies should be followed in other cases.

9.2.3. Any departure in sizing shall be justified by hydraulic analysis

and future water use and can be considered only in special circumstances.

9.2.4. Supply mains not intended to carry fire-flows should not be connected to fire hydrants.

9.3. System Design

9.3.1. Dead ends shall be minimized by looping of all mains.

9.3.2. Where dead-end mains occur they should be provided with a fire hydrant, flushing hydrant or blow-off for flushing purposes.

9.3.3. No flushing device shall be directly connected to any sewer.

9.4. Installation of Mains

9.4.1. All pipe and fittings must be laid, installed, and tested in conformity with the latest standards issued by the american water works association. In the absence of such standards, the manufacture's instructions for installation and testing shall be adhered to, and any proposed deviation must be approved by the division of sanitary engineering.

9.4.2. For routine laying, installing, and testing of pipe, standard specifications may be submitted for prior approval. Upon approval these specifications must be adhered to, and any deviation must be approved by the division of sanitary engineering prior to the initiation of any construction.

9.4.3. The specifications shall include:

9.4.3.1. pressure testing of the installed pipe;

9.4.3.2. allowable leakage of the installed pipe;

9.4.3.3. reference to applicable american water works association standards and/or manufacture's recommended installation procedures.

9.5. Separation of Water Mains and Sewer

9.5.1. General - The following factors should be considered in providing adequate separation:

9.5.1.1. materials and type of joints for water and sewer pipes;

9.5.1.2. soil conditions;

9.5.1.3. service and branch connections into the water main and sewer line;

9.5.1.4. compensating variations in the horizontal and vertical separations;

9.5.1.5. space for repair and alterations of water and sewer pipes;

9.5.1.6. off-setting of pipes around manholes.

9.5.2. Parallel Installation

9.5.2.1. Normal Conditions - Water mains shall be laid at least ten feet horizontally from any sanitary sewer, storm sewer or sewer manhole, whenever possible; the distance shall be measured edge-to-edge.

9.5.2.2. Unusual Conditions - When local conditions prevent a horizontal separation to 10 feet, a water main may be laid closer to a storm or sanitary sewer provided that:

9.5.2.2.1. the bottom of the water main is at least 18 inches above the top of the sewer;

9.5.2.2.2. where this vertical separation cannot be obtained, the sewer shall be constructed of materials and with joints that are equivalent to water main standards of construction and shall be pressure tested to assure water-tightness prior to backfilling.

9.5.3. Crossings

9.5.3.1. Normal Conditions - Water mains crossing house sewers,

storm sewers or sanitary sewers shall be laid to provide a separation of at least 18 inches between the bottom of the water main and the top of the sewer, whenever possible.

9.5.3.2 Unusual Conditions - When local conditions prevent a vertical separation as described in 9.5.3.1, the following construction shall be used:

9.5.3.2.1. Sewer passing over or under water mains should be constructed of materials described in 9.5.2.2.2.

9.5.3.2.2. Water mains passing under sewers shall, in addition, be protected by providing:

9.5.3.2.2.1. a vertical separation of at least 18 inches between the bottom of the sewer and the top of the water main;

9.5.3.2.2.2. adequate structural support for the sewers to prevent excessive deflection of joints and settling on and breaking the water main;

9.5.3.2.2.3. that the length of water pipe be centered at the point of crossing so that the joints will be equidistant and as far as possible from the sewer.

9.5.4. Sewer Manholes - No water pipe shall pass through or come into contact with any part of a sewer or sewer manhole.

9.6. Valve, Air Relief, Meter and Blow-Off Chambers

9.6.1. Air and sediment accumulations may be removed through a standard fire hydrant, and compressed air and pumping may be used for dewatering mains through hydrants.

9.6.2. Chambers or pits 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.

9.6.3. Such chambers or pits shall be drained to the surface of the ground where they are not subject to flooding by surface water, or to absorption pits underground.

9.6.4. The open end of an air-relief pipe should be extended from a manhole or enclosing chamber to a point at least one foot above ground and provided with a screened, downward-facing elbow.

9.7. Hydrants

9.7.1. Hydrant drains should be plugged and the barrels pumped dry during freezing weather; this plugging shall be mandatory when ground water rises above the drain port.

9.7.2. Where hydrant drains are not plugged they shall drain to the ground surface or to dry wells provided exclusively for that purpose.

9.7.3. Hydrant drains shall not be connected to or located within 10 feet of sanitary sewers or storm drains.

9.7.4. Fire hydrants shall be connected only to water mains adequately sized to carry fire flows.

9.8. Surface Water Crossings - Surface water crossings, both over and under water, present special problems which should be discussed with the division of sanitary engineering before final plans are prepared.

9.8.1. Above-water Crossings - The pipe shall be:

9.8.1.1. adequately supported;

9.8.1.2. protected from damage and freezing;

9.8.1.3. accessible for repair or replacement.

9.8.2. Underwater Crossings

9.8.2.1. The pipe shall be of special construction, having flexible, watertight joints.

9.8.2.2. Valves shall be provided at both ends of water crossings so that the section can be isolated for test or repair; the valves shall be easily accessible and not subject to flooding.

9.8.2.3. Sampling taps should be available at each end of the crossing.

9.8.2.4. Permanent taps should be made for testing and locating leaks.

9.9. Cross Connections

9.9.1. There shall be no physical 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.

9.9.2. The approval of the division of sanitary engineerig shall be obtained for interconnections between potable water supplies.

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

9.10. Water Services and Plumbing - Water services and plumbing shall conform to relevant local and/or state plumbing codes, or to the national plumbing code.

9.11. Water Pressure in System - The system shall be designed to maintain a minimum pressure of 20 pounds per square inch at all points in the distribution system under all conditions of flow.

9.12. Disinfection of Water Mains - The specifications shall include detailed procedures for the adequate flushing, disinfection, and bacteriological testing of all water mains. Such specifications and procedures shall

be in compliance with the laws and regulations of this state pertaining to public water supplies.

9.13. Cover

9.13.1. All distribution mains of less than eight inches in diameter shall be provided with a minimum of thirty-six inches of earth covering.

9.13.2. All mains of less than eight inches in diameter within five feet of a heavily traveled highway shall be provided with at least forty-two inches of cover.

9.13.3. All other mains must have at least thirty inches of cover.

9.14. Metering - Each service connection should be metered.