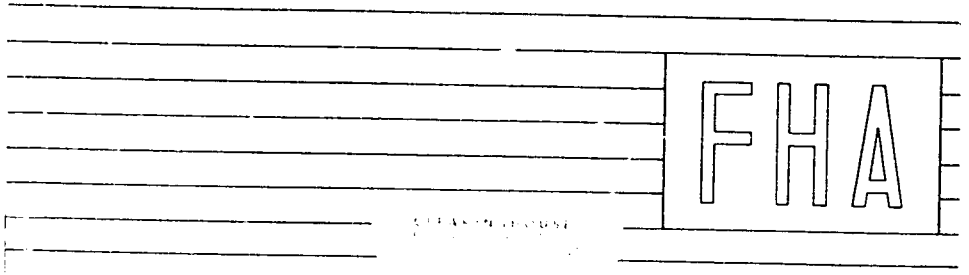
PB189258

MINIMUM DESIGN STANDARDS

FOR

COMMUNITY WATER SUPPLY SYSTEMS



U. S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Robert C. Weaver, Secretary
FEDERAL HOUSING ADMINISTRATION
Washington, D. C. 20410
FHA No. 731

Minimum design standards for community water supply.

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Standards for water supply production, treatment, pumping storage and distribution are set forth. These standards must be adhered to by all property owners recieving U.S. Federal Housing Administration (FHA) mortgage insurance. The objective of these standards is to establish ~~where~~ water supply facilities which will deliver under pressure, a satisfactory supply of water which complies with chemical, physical and bacteriological standards acceptable to FHA and at the same time will be palatable without being excessively hard or corrosive. These standards set forth in this publication have been used by AID Technicians in overseas economic development programs.

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MINIMUM DESIGN STANDARDS

for

COMMUNITY WATER SUPPLY SYSTEMS

U. S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Robert C. Weaver, Secretary
FEDERAL HOUSING ADMINISTRATION
Washington, D. C. 20410

July, 1965

FHA No. 751

PURPOSE

To set forth Minimum Design Standards acceptable to FHA for water supply production, treatment, pumping, storage, and distribution facilities to serve properties offered as security for mortgage insurance.

APPLICATION

These Minimum Design Standards apply to central water systems serving residential neighborhood developments and multifamily projects. Such systems are to be owned and operated by private organizations, Property Owners Associations, or public utility companies controlled by governmental authority

These standards apply to proposed community water systems, to community water distribution system extensions and to supply and treatment plant expansion. All exhibits included in the processing stages indicated under CW300, Submission of Exhibits, will be required for water systems proposed for construction. These standards shall also be applied to privately built water systems or additions to water systems which will be dedicated to public authorities for ownership and operation.

The design of existing systems and those which, due to unusual circumstances, are under construction at the time FHA consideration is requested shall comply with the objectives of these standards. The exhibits included under Final Planning and Construction Stages will be required to the extent applicable. "As-built" in lieu of "pre-construction" design plans and specifications are to be submitted for completed existing systems and for all finished stage construction that has been partially completed when FHA consideration is requested. The exhibits required for, and the application of these standards to the remaining uncompleted work shall be the same as for systems proposed for construction.

TABLE OF CONTENTS

SW100 OBJECTIVE

To provide water supply facilities which will deliver, under pressure, a satisfactory continuous supply of water which complies with chemical, physical and bacteriological standards acceptable to FHA and which will be palatable without being excessively hard or corrosive.

SW200 GENERAL ACCEPTABILITY

SW201 LOCAL CODES AND REGULATIONS

SW201-1 These minimum standards have been established to accomplish certain basic objectives for FHA mortgage insurance purposes and shall not be construed as relieving the builders of responsibility for compliance with local ordinances, codes and regulations including established requirements of a health authority having jurisdiction.

SW201-2 The Federal Housing Administration does not assume the responsibility for enforcing or determining compliance with local codes or regulations or make interpretations regarding their application in any specific instance.

SW201-3 Where the local code, regulation or requirement permits lower standards than required herein, these Minimum Design Standards shall apply. In the event, the local code, regulation or requirement precludes compliance with these standards, the property may be ineligible unless the stated objectives set forth herein are fully attained by the alternate means proposed.

SW202 REVISIONS TO APPROVED PLANS

Any deviations from the approved plans and specifications on which commitments for mortgage insurance were based must be approved in writing by the local FHA Insuring Office before the changes are made. A request for such approval shall be accompanied by written evidence that the proposed changes are acceptable to the State Department of Health and any other state or local authority having jurisdiction, and by a supplementary engineer's report describing the changes and stating reasons for them.

CW300 SUBMISSION OF EXHIBITS

CW301 FEASIBILITY STAGE

Prior to development of design plans and specifications, the project should be discussed with the local FHA Insuring Office and the FHA Sanitary Engineer. During this stage the feasibility of the project should be determined.

CW301-1 To the extent applicable not less than the following exhibits shall be submitted:

a. A general location map of the area (a printed topographic quadrangle map-United States Geological Survey or United States Army, where available) with the location of the development shown thereon.

b. A brief description of any existing water works facilities now serving the area.

c. A brief description of any sources of water pollution, such as sewage and industrial waste discharges, within at least a 500-foot radius of the proposed water supply.

d. A description of the area to be served setting forth the type and density of development contemplated.

e. A report of the ground water resources of the area (preferably from the United States Geological Survey or State Department of Conservation) setting forth data on the quantity and quality of the water available.

CW302 PRELIMINARY PLANNING STAGE

At this stage, submit the following exhibits, as applicable:

CW302-1 Preliminary engineering report giving the basic data on which the design of the system is to be developed. The report shall include:

a. Information on the proposed well or wells, such as the estimated well depth, diameter, size and material of casing, well screen, type and capacity of pumping facilities, and anticipated well yield. For a surface source of supply, submit hydrological data, characteristics of the drainage area, possible pollution sources and anticipated yield from the source.

b. To the extent known, submit information as the nature of the soil and underlying water-bearing stratum through which the well or wells will be installed.

c. Information on the type and capacity of the proposed water treatment facilities, type and size of water storage units, and size and layout of water distribution piping.

CW302-2 A statement from the State Department of Health and/or other authorities having jurisdiction that the general proposal is acceptable and that water diversion rights have been granted.

CW302-3 Information concerning the structure of the proposed organization which will own and operate the system, and the means by which continuous satisfactory operation and maintenance of the system at reasonable cost will be assured.

CW303 FINAL PLANNING STAGE

Before commitments for mortgage insurance are issued on any properties to be served, the FHA Insuring Office will determine the acceptability of all details of the proposed water supply system. A final engineering report, shall be submitted, containing detailed and specific information on the basic data from which the design of the system was developed, where such data varies from or were not included in the preliminary engineering report.

CW303-1 The following information shall be included unless previously submitted.

a. Extent of Water Works System - A description of the nature and extent of the area to be served by the water supply system, any provision for expansion of the system to include additional area, and an analysis of future requirements for service. Description shall also be submitted on any non-residential water supply needs which are to be met by the water system, or which are likely to be required in the near future.

b. Water Consumption - Based on available records, the estimated population to be served, description of the present and future water consumption values used in the design, and the present and future estimates of the safe yield of the sources of supply.

c. Meters - Individual water meters will be required for each property served except where unusual circumstances preclude their use. Justification for any proposal to eliminate meters shall be submitted to FHA for consideration.

d. Fire Flow Requirements: Submit information on the fire protection requirements of the State Fire Inspection Bureau and the extent of compliance with these requirements by the proposed design.

e. Possible Sources of Pollution: Describe any possible sources of pollution that may effect the various parts of the water system, such as existing sewage treatment plants, sewage lift stations, sewage plant effluent discharge, industrial waste disposal systems, discharge from individual sewage disposal systems, etc. When available, information shall be submitted on the minimum, maximum and average daily flows, for the past year, of existing sanitary sewerage systems in the area.

f. Sources of Supply: Describe the proposed source or sources of water supply to be developed.

g. Quality of Raw Water: Complete physical, chemical, and bacteriological analyses of water samples taken from the supply source, or from the test well if available.

h. Proposed Treatment: Describe the proposed treatment processes to be used to make the raw water safe and palatable; and to free it of objectionable characteristics, such as excessive corrosiveness, hardness, iron, manganese taste, odor, etc., which would interfere with its normal domestic uses.

i. Pumping Facilities: Describe the basis for design of all pumping facilities, including the physical and operational characteristics of the pumps and drive units, pump housing and related appurtenances.

j. Storage Facilities: Describe the type of construction and capacities of all proposed water storage facilities. Include the criteria for determining the amount of storage provided as well as those portions which will serve flow and pressure equalizing purposes and/or contingency reserves.

k. Distribution Piping: Describe the design criteria used in determining average and peak flow variations and related pressures and pipe sizes throughout representative parts of the piping system. The description of the soil in which the mains will be installed should include the chemical characteristics, physical nature in terms of unified soil classification - see FHA Bulletin #373 - and the maximum and minimum water table elevations in the area.

l. Stage Construction: The design computations and exhibits should cover the complete system. The report should clearly indicate the portion to be included for each stage of construction and the number of properties to be served.

m. Special Design Data: If unusual conditions are encountered which require the establishment of special design criteria and computations, such information shall be provided.

n. Details of the structural design of all structures included in the system as follows:

(1) Live load for floors and roofs.
(2) Elevations of the overflow or liquid level of all tank structures.
(3) Safe soil-bearing values at the elevation of the foundation of major structures.
(4) A description of the sub-soil at the sites of all major structures as determined by test borings and exploration pits. The data should include the kind and nature of the soil from the original ground surface to a depth below the foundation level equal to the diameter or width of the structure. Also include the "N" values or the number of blows per foot, in the standard penetration test (ASTM D1586). The Unified Soils Classification System is recommended for use in describing the soil.
(5) The steel stress for ring tension in reinforcing used in the design of cylindrical tank structures.
(6) The concrete mix and the compressive strength of concrete used in the design.
(7) Structural design assumptions and computations used in the design of the major structures.
(8) Gross weight of machinery or equipment supported by all major structures.
(9) The maximum elevation of seasonal and average ground water table.
(10) The thickness of concrete covering over reinforcing steel.

o. Topographic map of the land on which the system is to be constructed. If the well field, surface reservoir, treatment facilities or storage facilities are located outside the served area, these may be shown on separate topographic maps.

p. Complete working drawings of the system, including final structural details, of the well construction and development, intake structure, treatment facilities, pumping and storage facilities, and distribution piping and appurtenances. The plans and profiles of the distribution piping system shall show the location of existing sanitary sewers, storm drains, gas lines, other underground utilities, etc., according to the best information available.

q. Specifications covering the quality, kind, and grade of all materials, equipment, construction, workmanship, methods of assembly and installation. Where applicable, the specifications may refer to standard specifications issued by the American Water Works Association, the American Concrete Institute Code, the American Standards Association, the American Society for Testing Materials, the Federal Government, etc. The standard specifications referred to shall be appended to the project specifications.

r. Approval from the State Health Authority of the design of the system as described by these exhibits. Where approval by other local or state agencies is required, such approval shall also be submitted.

s. Complete details of the organizational structure for ownership and operation of the system including final drafts of all required legal documents.

CW304 CONSTRUCTION STAGE

Prior to final acceptance of any properties as security for mortgage insurance, construction of the water system shall be completed in a manner acceptable to FHA. To the extent they are applicable the following exhibits are required:

a. Written evidence that the system as constructed has been approved by the health authority and other state or local authorities having jurisdiction. In those areas where the health authority or other officials do not normally approve the specific installation the sponsor shall provide the Insuring Office with a written statement from the State Health Department indicating that they accept the responsibility for supervisory control over the operation of the system.

b. A written statement from the design engineer that the system has been constructed in substantial compliance with the approved design plans and specifications.

c. Evidence that an acceptable organization has been established which will assure the continuity of satisfactory service at reasonable rates.

d. Evidence that the finished water complies with the State Department of Health Standards for bacteriological and chemical quality. Compliance with the U.S. Public Health Service Drinking Water Standards will be required where State Department of Health Standards have not been adopted.

CW400 SOURCE OF SUPPLY

CW401 OBJECTIVE

To provide a continuous and adequate flow of water which is amenable to treatment, if necessary, to assure a supply of water satisfactory for all domestic and related uses of the connected properties.

CW402 GENERAL

These standards are applicable to ground water or surface water sources of supply.

CW402-1 Ground Water Sources - The general types of ground water sources are wells, springs and infiltration galleries. Except under unusual circumstances, dug, or bored wells, springs and infiltration galleries do not assure the continuous supply required and are subject to surface pollution by their very nature of construction. For these water sources consideration by FHA will only be given when it has been shown that geological conditions preclude the development of a more satisfactory source of supply and that special steps have been taken to assure continuous protection against pollution.

CW402-2 Selection of Site - The selection of the site shall be based on the type of ground water source to be utilized, depth to the water-bearing formation, types of subsurface soil formations to be penetrated in order to reach the water bearing formation, freedom from flooding or excessive surface wash water, and the relation to existing or potential sources of pollution. The best supply of water available in the area which will meet the quantitative and qualitative needs of the system shall be developed.

CW402-3 Surface Water Sources - Surface water supplies from streams, lakes, or reservoirs will be considered by FHA only when evidence is presented to show that the surface source can provide a continuous satisfactory supply. Submit the following data concerning the proposed surface supply source:

a. Hydrological data, such as stream flow, weather records, storage capacity, and other data used to determine the safe yield.

b. Size, physical characteristics, land use, and other factors concerning the drainage area.

c. Description, including the type, quantity and location, of all sources of pollution on the water shed.

d. A careful study should be made of all factors determining the safe yield of the proposed water source. Data should include geological location, storm paths, prevailing winds, type and intensity of precipitation, topography and size of basin, type of soil, type of vegetation, type and extent of artificial drainage, extent of other surface storage in the drainage area, character of the drainage area, evaporation, infiltration and other losses.

e. Evidence from the state and local governmental agencies having jurisdiction, approving the proposed surface water supply and granting authority to divert the required amount of water to assure a continuous, satisfactory supply for the proposed development.

CWL02-4 Quality of Surface Water Sources - To be acceptable to FHA it must be shown that the surface water source, with reasonable treatment, can provide a continuing and adequate supply of water meeting the objectives of CW100. Many surface supplies cannot be accepted because of the character, amount, or non-uniformity of the pollution load. Where more than one water source could provide sufficient water, the supply which requires the least treatment to make it satisfactory should be used. In those localities where soil poisoning has been practiced or can be anticipated, special care should be exercised to assure that the overlying geological formations will affectively prevent the soil poisons from reaching the water bearing formation.

CWL03 LOCATION FROM SOURCES OF POLLUTION

CWL03-1 Protective Horizontal Distances - Minimum horizontal protective distances between the well and common sources of pollution shall not be less than those specified in Table I. For wells terminating in creviced formations, or where the overlaying soil formation is highly permeable, greater distances may be required by the FHA.

CWL03-2 Protective Depths - The well shall be watertight to the depth necessary to seal off waterbearing formations that are or may be polluted or have undesirable characteristics. The annular opening outside the protective casing or curbing shall be sealed by means of cement grout, cement and sand grout, or other approved material, at least 1.5 inches thick to a depth designated herein under "grouting". The minimum protective casing depths for drilled wells in the typical type of subsurface soil formations encountered shall meet the requirements of Table II.

CWL04 WELL CONSTRUCTION METHODS

CWL04-1 Types of Installation

CWL04-1.1 Wells in Sand or Gravel Formations - Where the overlying formations are unstable, or of a caving nature for the full depth of the well, a replaceable screen shall be installed. The opening outside of the casing, made during construction shall be grouted to an acceptable depth. If clay, hardpan or shale overburden is encountered a double casing should be extended through such material. After placing the outer casing, it shall be withdrawn and set at a point at least five feet above the stable formation.

CWL04-1.2 Wells in Limestone or Creviced Formations - Formations that are channeled, creviced or fractured may yield unsafe or undesirable water and should be avoided as a source of supply unless overlain with an unconsolidated mantle of sufficient thickness and extensiveness for water supply development. The annular space between the casing and drill hole shall be sealed off by grouting for the full depth of the casing to assure watertight construction, and the minimum protective depth of casing shall meet the requirements in Table II. Particular care shall be exercised in localities where possible sources of pollution exist in or near the site. A supply which may be polluted will be accepted by FHA only if no alternate satisfactory supply is available and treatment facilities are provided which can render the water continuously safe and palatable.

TABLE I - Minimum Distances(1)

Type of Well

Distance From	Dug(3)	Bored	Driven	Drilled
Property Line	100'	50'	50'	20'
Improperly Abandoned Well or Sinkhole	Unacceptable			200'
Seepage Pit	400'	200'	200'	100'
Disposal Field or Bed	100'	200'	200'	100'
Industrial Lagoon	Unacceptable			(2)
Watertight Sewer Lines	50'	50'	50'	10'
Other Sewer Lines	100'	100'	100'	50'

(1) Any distances specified above shall be increased if necessary to meet the minimum requirements of the Health Authority.

(2) The minimum safe distance from a lagoon shall be specified depending upon the nature of the waste, geological surface and subsurface conditions, and the recommendations of the FHA and Health Authority.

(3) Radial water collectors, springs, and infiltration galleries shall comply with the minimum distances specified for dug wells.

TABLE II - Well Casing Depths

Protective Casing Depths Drilled Type Wells

Water bearing formation	Overlying material	Protective casing depth
Sand or Gravel	Sand, or mixture of sand and gravel	The depth of casing will be governed by the pumping level. For pumping levels 30 feet or less, the casing shall extend 10 feet below pumping level. For pumping levels greater than 30 feet the casing shall extend 5 feet below pumping level.
	Clay, or similar material, containing layers of sand or gravel.	The casing shall extend 5 feet below the pumping level, but through clay below any sand or gravel above the 30-foot depth.
	Clay, or similar material, only to depth of 35 feet or more.	The casing shall extend 5 feet below the pumping level.
Limestone, granite, or quartzite	Drift material, to a depth of at least 50 feet to a radius of 1 mile.	The casing shall be firmly seated in the rock formation.
	Drift material, to a depth less than 50 feet to a radius of 1 mile.	The casing shall extend 10 feet into unreviced rock below 40 feet.
Sandstone	Any material except limestone, to a depth of 35 feet or less.	The casing pipe shall be extended 15 feet into firm sandstone, or to 40-foot depth.
	Any material except limestone, to a depth greater than 35 feet.	The casing pipe shall be effectively seated into sandstone. Minimum cased depth shall be 40 feet.
	Limestone at variable depth.	The casing pipe shall be extended 15 feet into firm sandstone.

CWL04-1.3 Wells in Sandstone Formations - The protective casing shall be of watertight construction. The annular space between the drill hole and casing shall be made to the depth specified in Table II.

CWL04-1.4 Flowing Wells - Flowing wells shall be constructed so their flow can be controlled. The initial drill hole should extend into, but not through, the impervious formation containing the water under head, unless necessary for proper construction. The protective casing and annular grout shall be installed and allowed to set. Following the extension of the drill hole into the waterbearing formation, an inner casing shall be required if erosion of the confining bed by the flowing water can be expected to occur. This inner casing shall be joined in a watertight manner to the protective casing. Flow control from the well should consist of valved pipe connections, watertight pump connections, or receiving reservoirs, set at an altitude corresponding to that of the head. There shall be no direct connection between the discharge pipe and source of pollution such as a sewer, etc.

CWL04-1.5 Gravel Wall Construction - The outer casing should be of such diameter as to provide a minimum annular opening of 1.5 inches after placement of the gravel refill pipes. When gravel refill pipes are used, they shall terminate, above grade, in threaded capped outlets. All gravel used shall be clean, washed, and well-rounded, and the size carefully selected with reference to the character of the water-bearing formation to be packed. All gravel used shall be disinfected. Protective casing depths shall conform to the requirements in Table II.

CWL04-1.6 Driven Wells - The casing shall be watertight to the depths indicated in Table II and a drop pipe shall be provided to convey the water from the well point or screened sections to the surface.

CWL04-1.7 Other Ground Water Sources - Bored or dug wells, radial water collectors, springs and infiltration galleries will be considered only where geological conditions preclude the development of a satisfactory supply with drilled wells. The construction shall protect against surface pollution and the casing shall be watertight to a depth of at least 20 feet. The concrete wall and curbs installed in place shall be at least 6 inches thick, poured in one operation, preferably with a 1:2:4 mix. Walls and curbs of concrete pipe, vitrified pipe or other similar precast materials cannot be depended on to be watertight. When present units are used, they shall be grouted in a neat cement grout, not less than 6 inches thick, placed in one operation.

CWL04-2 General Construction Details

CWL04-2.1 Blasting and Chemical Conditioning - Specifications covering method, equipment, and controls for the blasting or chemical conditioning of wells shall be submitted. The applicable portions of the current AWWA Standard A100 should be followed.

CWL04-2.2 Setting of Screens - Well screens should be used in wells serving water from unconsolidated formations and shall be set so as to prevent exposure above the pumping water levels. Screens shall be designed to permit removal or replacement without adversely affecting the watertight construction of the well.

CWL04-2.3 Upper Settings of Curbs and Casings -

a. The pipe casing or well curbing shall terminate not less than 12 inches above the pump house floor or well apron.

b. The top of the pump house floor or well apron shall be at least 6 inches above the original ground elevation.

c. The top of a well station floor shall be at least 2 feet above the highest known flood level, surrounded by earth fill to a height of 1 foot above the flood level, and extending radially, at that height, 15 ft. from the casing. The well casing should be surrounded with a reinforced concrete envelope having a minimum thickness of 6 inches, extending from the upper terminal of the well to a point 10 feet below the original ground level. The station site shall be above the highest probable flood height, or shall be suitably protected against such a flood; and it shall be accessible at all times, regardless of floods or other hazards.

CWL04-2.4 Abandoned and Test Wells - Abandoned wells and test wells shall be sealed by restoring the controlling geological conditions which existed before the wells were drilled. These wells should be filled with concrete where feasible. The sealing method shall comply with current AWWA Standard A100 and the requirements of the state authority having jurisdiction.

CWL04-2.5 Capping - Wells retained as observation wells, or wells temporarily removed from service, shall have been constructed in accordance with these standards, and shall be sealed at the top with a watertight threaded or welded cap.

CW405 MATERIALS OF CONSTRUCTION

CW405-1 Well Screens

CW405-1.1 Size and Quality - The diameter of the screen shall be such that it can be properly installed in the well casing. The effective length of the well screen shall be adequate to intercept the thickness of water bearing strata required to yield the well output requirements. The well screen shall be manufactured of material specified in the applicable portions of the current AWWA Standard A100. Screen openings shall provide the maximum amount of open area consistent with strength and the grading of the water-bearing formations to permit maximum water transmission without clogging or jamming.

CW405-1.2 Fittings - The necessary fittings shall be provided to tightly seal the top of the screen to the casing and to close the bottom. When the screen is installed inside the casing, a lead packer seal shall be installed at the top, located to provide a 12 inch overlap of screen and casing. When the screen is attached to the casing, a suitable coupling shall be provided or the screen shall be welded to the casing. All couplings and fittings, except plugs and seals, used for joining sections of screen shall be of the same material as the screen.

CW405-2 Well Casings

CW405-2.1 General - Protective casings or curbings for dug and bored wells are covered in a previous section. The protective casing for other type wells shall comply with the applicable portions of the current AWWA Standard A100.

CW405-2.2 Material - Materials commonly used for well casings or liners are wrought iron, alloyed or unalloyed steel and ingot iron. Well casing pipe shall be capable of resisting both the strain to which the pipe will be subjected during installation and the corrosiveness of the water with which it will come in contact.

CW405-2.3 Joints - Casing and liner pipe joints shall be welded or threaded.

CW405-2.4 Grouting Guides - Casing that is to be grouted in the drill hole or annual hole opening shall be centered, using guides welded to the casing.

CW405-2.5 Light Weight Pipe - Temporary casings and liners installed without driving may be of lighter weight than specified in the casing specifications in the current AWWA Standard A100. Light-weight pipe shall have a minimum thickness of 0.25 inches.

CW405-2.6 Drive Shoes - Pipe which is to be driven shall be equipped with a drive shoe.

CW405-3 Grouting

CW405-3.1 General - Grout shall be applied in one continuous operation, from the bottom to the top of the space to be grouted. Annular openings shall be sufficient to assure a minimum grout thickness of 1½ inches.

CW405-3.2 Concrete Grout - The mixture shall consist of equal parts, by volume, of cement and dry sand with a maximum of 6 gallons of clean water per bag of cement (94 pounds).

CW405-3.3 Neat Cement Grout - The mixture shall consist of one bag of cement (94 pounds) to not more than 6 gallons of clean water.

CW405-4 Well Vents

CW405-4.1 Design and Location - All well vent openings shall be piped watertight to a point not less than 24 inches above any known flood water level, and, in any event, at least 12 inches above the finish ground surface. Such vent opening and piping shall be of sufficient size to avoid clogging and in no case less than one-quarter inch in diameter. The terminals of vent pipes shall be shielded, screened and turned down. If toxic or inflammable gases are vented from the well the vent shall extend to the outside atmosphere at a point where the gases will not produce a hazard. Openings in pump bases shall be sealed watertight.

CW406 TESTING, SAMPLES, AND REPORTS

CW406-1 Yield - Every well, before being accepted, shall be tested for safe yield and drawdown characteristics, preferably for a period of 72 hours. In no case should the test period be for less than 24 hours after the drawdown has stabilized. The test procedure shall be described in the specifications. The test pump should have a maximum capacity at least equal to the quantity of water anticipated and a minimum capacity of 20% of the maximum. The test pump should have the capability to operate continuously throughout the test period. Water level observations shall be made of the drawn down and recovery during the entire test.

CW406-2 Water Level Measurement - An airline, complete with a gauge, equipment for applying air, and check valve, should be permanently installed in the completed well. The airline, gauge, and check valve shall be securely fastened to the pumping unit in such a manner as to exclude foreign material.

CW406-3 Water Samples - After the ground water source of supply has been disinfected in accordance with the standards, one or more water samples from the source shall be submitted to an approved laboratory for physical, chemical, and bacteriological analysis. The analysis shall include sufficient data to determine if the water supply meets the objective of CW100. Additional data shall be submitted if required by the FHA or or Health Authority. If the ground water source is subject to continuous or intermittent pollution, provisions shall be made for appropriate treatment and disinfection.

CW406-4 Well-Drilling Samples and Records - Drill cuttings obtained at each change in formation shall be described in the well log submitted to FHA. FHA shall be supplied with an accurate record of the drill hole diameters, assembled order of sizes and lengths of casings and liners, screens, grouting depths, water levels, location of blast shots, and pumping tests.

CW406-5 Plumbing and Alignment - Every well, before being officially accepted, should be tested for plumbing and alignment. The test method to be followed should be described in the specifications. A 40-foot dummy, having an outer diameter $\frac{1}{2}$ inch smaller than the diameter of the casing or hole being tested, shall move freely throughout the length of casing or hole to the lowest anticipated pump setting. The well should not vary from the vertical in excess of two-thirds of the smallest inside diameter of that part of the well being tested, per 100 feet of depth.

CW406-6 Disinfection Upon Completion - Every new, modified, or reconditioned ground water supply source, including pumping equipment, shall be disinfected before being placed in service for general use. A solution containing at least 50 ppm chlorine should be applied in all parts of the well for a period of at least two hours. Satisfactory evidence shall be submitted to FHA that the system has been adequately disinfected.

CW500 WATER TREATMENT FACILITIES

CW501 OBJECTIVE

To provide water of acceptable bacteriological, chemical and physical quality in accordance with CW100.

CW502 GENERAL

These standards relate to the treatment equipment needed to alter the raw water characteristics to the degree necessary to comply with the objective herein. Only to the extent necessary on the basis of the analysis of the raw water will the treatment processes described be required.

CW503 LOCATION OF TREATMENT FACILITIES

In general, the plant should be constructed on a comparatively level stable site. If location on filled ground or a hillside cannot be avoided, special precautions shall be taken to assure adequate structural stability of all plant structures. A report shall be submitted, in such cases, by a soils engineer providing assurance that suitable, well-compacted fill material will be provided and that the underlying original soil will support the weight of the fill plus the weight of the structure without damaging settlement. In hillside construction, the wall footings shall be supported on original soil and a berm of at least 10 feet shall be provided from the bottom of the footing to the edge of the slope.

The site should be free from flooding or excessive surface wash conditions. Grading around the site shall be provided to divert and otherwise control excessive surface water accumulations. Ditches of adequate capacity to intercept and carry off storm water runoff should be provided for facilities on a hillside.

CW504 STRUCTURAL DESIGN AND MATERIALS

The structural design and materials used shall comply with applicable standards and design criteria accepted in engineering practice. All structures, tanks and equipment shall safely support all dead loads, live loads, liquid, hydrostatic and earth pressures which will be imposed. All treatment units, feeders and chemical storage bins shall be designed and constructed of materials which will not react with the water or chemicals in such a manner that the structural character of the facility will be impaired or that taste, odor or undesirable chemical constituents will be imparted to the water.

CW505 ESSENTIAL FACILITIES

CW505-1 Emergency Power Facilities - A standby power source shall be provided if the interruption of power for operation of treatment facilities may be reasonably expected to endanger the public health or cause serious damage.

CW505-2 Laboratory Facilities - A laboratory equipped to make the necessary determinations for adjustment of the treatment processes shall be provided.

CW505-3 Sanitary Facilities - A water closet and lavatory shall be provided. Plants requiring continuous operation or the use of toxic or dusty chemicals should be provided with a shower and clothes locker.

CW505-4 Water Flow Measurement - Facilities for measuring and recording the volume of water treated shall be provided.

CW505-5 Safety - Adequate provision should be made to protect the operator and any visitor from unnecessary hazards.

CW505-5.1 All units or structures which may endanger human life shall be suitably enclosed.

CW505-5.2 Hand rails shall be provided where there is a likelihood of accident to personnel.

CW505-5.3 First Aid equipment should be provided.

CW505-6 Grading, Landscaping and Fencing - Upon completion of the plant, the ground shall be properly graded. Concrete or gravel walkways should be provided for access to all units. Provision for landsceping should be made, particularly when the plant is located close to residences. The entire plant area shall be enclosed by a fence of suitable quality and height to prevent the entrance of unauthorized persons.

CW506 ALTERNATE TREATMENT PROCESSES

Treatment processes other than those described in the following sections are eligible for consideration on the basis of their proven and documented record of performance and operating experience. All treatment processes and equipment must be acceptable to the health and other control authorities having jurisdiction. In all instances treatment shall be provided to correct bacterial, chemical or physical quality to comply with CW100. When other treatment processes are proposed, a detailed description of each process and the design data shall be submitted. Such processes shall meet the objectives stated herein without imposing undue problems of supervision, operation, and control.

CW600 DISINFECTION

CW601 OBJECTIVE

To produce a water of continuous safe bacteriological quality in accordance with CW100.

CW602 GENERAL

CW602-1 Applicability - Continuous disinfections shall be provided in accordance with the recommendations of the state or local health authorities and the FHA. Disinfection by other than chlorine or chlorine compounds must be approved by the state and local authorities having jurisdiction and be acceptable to FHA.

CW602-2 Chlorination - Chlorine and chlorine compounds may be employed in treatment processes other than disinfection, where applicable.

CW603 FORMS OF CHLORINE USED

Disinfection may be accomplished with liquid chlorine, calcium or sodium hypochlorites, chlorine dioxide, or chloramines. The chemical should be selected after consideration of pumping rates, type of water supply, other types of treatment proposed, chlorine demand, pH of the water, cost of equipment, and the chemical, and the operational and maintenance conditions and requirements. The chemical used and the means of application shall produce a bacteriologically safe water in compliance with CW100.

CW604 CHLORINATION EQUIPMENT

CW604-1 Types - Solution-feed gas-type chlorinators should be used. For small supplies, the use of hypochlorite feeders of the positive displacement type will be considered.

CW604-1.1 Solution-Feed Chlorinator - In this type, chlorine gas is first dissolved in a minor flow of water and the resultant chlorine solution is fed to the desired point of treatment. Pressure feed and vacuum type chlorinators are acceptable, with the latter type preferred, since by its method of operation the chlorine is maintained under negative pressure at all points beyond the inlet valve to the discharge ejector and the possibility of chlorine leaks is decidedly less than in the pressure type chlorinator. The vacuum type provides a further safety feature in that the flow of chlorine gas from the chamber is automatically cut off in the event of water supply failure to the chlorinator.

CW604-1.2 Hypochlorinator - The feeder should use a positive displacement pump, utilizing either a diaphragm or piston as the main purping element.

CW604-2 Capacity - The chlorinator capacity should be such that a free chlorine residual of at least 2mg/l can be attained in the water after a contact time of at least 30 minutes. This condition must be attainable when maximum flow rates coincide with anticipated maximum chlorine demands.

CW604-3 Standby Equipment - Where chlorination is necessary for protection of the supply, and is not used as a safety factor only, standby equipment shall be available with sufficient capacity to replace the largest unit. Hypochlorinators of adequate capacity may temporarily replace gas-type chlorinators during shut-down periods. Spare parts should be available for all chlorinators, to replace parts which are subject to wear and breakage.

CW604-4 Contact Time and Point of Application - Due consideration shall be given to the contact time of the chlorine in the water, with relation to pH, ammonia content, taste-producing substances, temperature, and other pertinent factors. The chlorine should be applied at a point which will provide the maximum contact time. Adding ammonia to a water supply should be considered only with the approval of the health authority. A contact time of at least 30 minutes shall be provided. In certain cases where the pH is increased by other chemical treatment, either the contact period should be provided before adding the other chemicals, or chlorine dioxide treatment may be considered because of its effectiveness at high pH values.

CW604-5 Automatic Proportioning - Automatic proportioning chlorinators will be required if the rate of flow is not constant.

CW604-6 Weighing Scales - Scales shall be provided for weighing cylinders if liquid chlorine is used. Scales shall be of corrosion-resistant material and should be accurate to the nearest 1/4 pound.

CW604-7 Piping From Cylinders - The chlorine gas should be conducted through copper, iron, or steel pipe, of extra heavy weight. Piping shall slope upward from the cylinder to the chlorinator.

CW604-8 Water Supply for Chlorinator - An ample supply of water shall be available for operating the chlorinator. When a booster pump is required, duplicate equipment should be provided, and where necessary, standby power as well. Adequate protection shall be provided against back-siphonage where treated water is supplied to the chlorinator.

CW604-9 Testing and Safety Equipment

CW604-9.1 Residual Testing Equipment - Equipment shall be available for measuring chlorine residuals by the orthotolidine method. The equipment should enable measurement of residuals to the nearest 0.1 mg/l in the range of residuals used. When high residuals are anticipated, standards through 2.0 mg/l shall be provided. Where the chlorine demand varies appreciably, automatic chlorine residual recorders should be considered.

CW604-9.2 Chlorine Leak Detection - A bottle of ammonia water shall be available for testing for chlorine leaks.

CW604-9.3 Gas Masks - A gas mask of the canister 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. It shall be stored outside any room where chlorine is used or stored.

CW604-10 Housing

CW604-10.1 Separation of Rooms - Separate rooms for cylinders and equipment shall be provided. They should be on the ground floor, and shall permit easy access and exit. Ammonia and chlorine gas shall not be stored in the same room.

CW604-10.2 Ventilation - When chlorine gas is used, ventilation for each room shall be provided which will give one complete air change per minute. The air outlet from the room should be near the floor, and the point of discharge shall be so located as not to contaminate air inlets to any buildings. Air inlets should be through louvers near the ceiling, with air of such temperature that it will not affect the chlorination equipment adversely. Switches for fans and lights should be at the entrance outside of the room. The vent hose from the machine shall discharge to the outside atmosphere above grade.

CW604-10.3 Heat - Chlorinator rooms should be heated to 60° F. and protected from excess heat. Cylinder temperatures should be maintained at the same temperature as the chlorination equipment.

CW604-10.4 Inspection Windows - A clear glass window should be installed in the door or wall of the chlorinator room to permit inspection of the equipment without entering the room.

CW700 WATER CLARIFICATION

CW701 OBJECTIVE

To remove objectionable quantities of suspended solids (turbidity) and color.

CW702 GENERAL

The finished water shall not contain turbidity, bacteria, or other foreign material in amounts that will interfere with normal domestic use.

CW703 METHODS

Suspended clay, silt, or other finely divided particles can be removed by one or more of the following procedures:

a. Presettling - Separate basins can be economically utilized to remove, by settling, suspended material from highly turbid waters prior to applying other treatment processes.

b. Flocculation - The addition and mixing of certain chemicals with the raw water will cause the finely divided particles to clump into masses of sufficient size and density to permit effective settling.

c. Settling - A process whereby the flocculated substances settle to the bottom of the basin as a result of reduced turbulence and extended detention time.

d. Filtration - The removal of the residual suspended matter by straining through an appropriate filter media.

CW704 SELECTION OF TREATMENT METHODS

The specific steps required should be established after a careful engineering investigation of the local conditions. Pilot plant operations based on raw water conditions may be required, prior to formulating a basis of design where the water has unusual or variable characteristics.

CW705 PRESEDIMENTATION

CW705-1 Presedimentation basins should be provided where the removal of turbidity cannot be economically accomplished because of the unusual character or excessive amounts of turbidity encountered continuously or periodically.

CW705-2 Number - This will depend on the size of the plant, the frequency and duration of anticipated use. The engineer's report shall include a justification for the selection.

CW705-3 Construction Material - Basins should be of durable material that will not impart taste or color to the water.

CW705-4 Size and Shape - See requirements under sedimentation equipment - Section CW708.

CW705-5 Detention Period - The minimum detention period should be 6 hours. However, if it can be shown that effective removal can be accomplished in a shorter time without the addition of coagulents, the shorter time may be accepted.

CW705-6 Inlet and Outlet Devices - Inlet and outlet devices shall be designed to minimize turbulence and to prevent short circuiting.

CW705-7 Drainage - Drainage Requirements in Section CW708.

CW706 CHEMICAL FEED EQUIPMENT

CW706-1 The chemicals, whether added as a solution or in dry form, should be fed into the water in proportion to the flow, turbidity and flocculating characteristics of the raw water.

CW706-2 No. of Feeders - Minimum of two shall be provided.

CW706-3 Location - Feeders shall be so located in the treatment plant that chemical dusts will not enter the laboratory or the operation area. They shall be conveniently located near points of application of the chemical, and shall be accessible for easy maintenance. When located on top of a mixing basin, the feeder shall be constructed to prevent any spillage of chemical into the basin.

CW706-4 Types of Selection - Either solution or dry type feeders may be used. The characteristics of the chemical, convenience in handling, and volume of water to be treated will determine the type of feeder best suited for the installation.

CW706-5 Capacity - The feeder shall be able to supply at all times the necessary amounts of chemical for the intended treatment.

CW706-6 Solution Feeders - At least two solution tanks should be provided for each chemical used. The capacity of each tank shall be that which will assure operation for at least 3 hours.

CW706-6.1 Solution tanks for feeding lime shall be constructed of either steel or concrete. Concrete construction is required for tanks to feed aluminum sulphate or ferrous sulphate.

CW706-6.2 To assure uniform strength of the chemical solution, vigorous agitation of the chemicals shall be provided by paddles, equipment for agitation with air, or other approved mechanical means.

CW706-6.3 Float gages should be installed, so that the level of solution will be indicated.

CW706-6.4 Make-up water shall be from a safe source, and should have a free fall of at least 6 inches or two pipe diameters above the solution tank, whichever is greater.

CW706-6.5 All solution tanks shall be provided with a drain, with protection against backflow.

CW706-7 Dry Feeders - Either volumetric or gravimetric type feeders will be acceptable. Complete details of the type feeders used shall be provided, including the capacity range selected, applicability for the chemical used, and mechanical features.

CW706-8 Chemical Feed Lines - Lines should be as short as practical, constructed of a durable, corrosion-resistant material, easily accessible for cleaning and protected against freezing.

CW706-9 Chemical Storage - Provide storage space for not less than a one month supply of chemicals in a dry location, convenient for the handling of the chemicals.

CW707 MIXING BASIN

CW707-1 Applicability - Mixing consists of the rapid phase (quick or flash) whereby the chemical is dispersed throughout the water by violent agitation, and the slow phase whereby flocculation occurs at lower velocities for a longer period. Mixing and flocculation may take place in the same basin, or in separate basins.

CW707-2 Mechanical Mixing

CW707-2.1 Flash Mix - Mechanical mixing should be provided by high speed paddles, from 3 to 10 feet in diameter, which revolve on a vertical axis in a horizontal plane. Detention period should not exceed 30 seconds.

CW707-2.2 Flocculating Basin - A series of paddles should be provided transverse to the tank width. The paddles should have a peripheral speed ranging from 0.5 to 2.0 feet per second. The area of the paddles should be not less than 10 percent of the cross-sectional area of the tank.

CW707-3 Construction Material - Basins shall be constructed of reinforced concrete or steel. There shall be no common wall between water in the mixing basin and water in any final or filter-effluent storage structure.

CW707-4 Detention Period - The mixing and flocculation period shall be at least 40 minutes. The minimum flocculating velocity shall not be less than 0.5 feet per second. Final determination of the period of mixing and the velocity of flow to form a good floc shall consider the type of water treated.

CW707-5 Flow From Basin - Velocity through pipes or conduits from the flocculating basin to the sedimentation basin should range from 0.5 to 1.5 feet per second. There should be no weir-action at the entrance of the sedimentation basin.

CW707-6 Drainage - A drain should be provided for the basin or basins, with protection against backflow. The point of discharge shall be acceptable to FHA and all agencies having jurisdiction in such matters.

CW707-7 Other Types of Mixing Devices - Mechanical mixing should be provided. Where the engineer can provide adequate justification that other types are necessary, consideration will be given to non-mechanical types such as horizontally baffled mixing tanks, vertically baffled mixing tanks, and the hydraulic jump method.

The standards stated herein shall apply, to the extent applicable, to non-mechanical equipment.

CW708 SEDIMENTATION BASIN

CW708-1 Applicability - Sedimentation basins shall be provided after chemical mixing, and are necessary to remove the natural and flocculated substances in order that the chemically treated water may be adaptable to the filtration process which follows sedimentation.

CW708-2 Number - This will depend on the size of the plant, amount of safe water storage, and mechanics of operation. The engineer's report shall include a justification of his selection.

CW708-3 Construction Material - Basins should be of reinforced concrete or steel.

CW708-4 Size and Shape - Basins should be either rectangular or circular and so designed that sludge-removal equipment can be easily and economically installed. Straight-line flow basins with a "depth-of-basins range" of 8 to 12 feet are preferable.

CW708-5 Detention Period - The minimum detention period should be 4 hours.

CW708-6 Inlet and Outlet Devices - Design objectives governing outlet devices from the mixing basins apply to the inlet devices for the sedimentation basins. The outlet devices should be designed to maintain velocities suitable for settling in the basin and to minimize short-circuiting. When a submerged weir is used, it should extend the entire width of the outlet end; a loss of head of 1 inch is sufficient to give uniform draft at all points of the weir. The rate of flow over the outlet weir should not exceed 50,000 gallons/day/foot of weir length; lower rates are desirable. Submerged ports may be used as an alternative for overflow weirs, but should be not lower than 3 feet below the flow line.

CW708-7 Drainage - All basins should be provided with an acceptable drain. Basin bottoms should be sloped toward the drain about 1 to 12, unless mechanical sludge-removal is provided.

CW708-8 Sludge Disposal - Pipes carrying sludge should be of such hydraulic design that sludge will move freely and not settle out. Pipes exposed to weather should be protected against freezing. Several disposal methods are available, but the health authority and the FHA should be consulted in advance as to type or types that will be accepted.

CW709 FILTRATION

CW709-1 Applicability - Filtration shall be provided after the sedimentation basin.

CW709-2 Type - Gravity type rapid mechanical filters shall be used.

CW709-3 Number of Units - At least two units should be provided. When plant output is small (e.g., 100 gallons per minute), each filter should equal plant capacity.

CW709-4 Rates of Filtration - The permissible rate of filtration shall be 2 gallons per square foot per minute, except when, in the opinion of the Health Authority and FHA, conditions will permit use of a higher rate.

CW709-5 Filters

CW709-5.1 Functional Arrangement - The sides of the filters shall be vertical and their entire area shall be covered by a superstructure, with sufficient headroom to permit inspection and operation.

CW709-5.2 Depth of Filter - Minimum depth shall be 9½ feet.

CW709-5.3 Hydraulic Considerations - Depth of water on the surface of the sand shall be not less than 3 feet. The elevation of water in the filter shall be at least 8 feet higher than the maximum water level in the clear well. Floorwash shall be prevented from entering the filter. An overflow must be provided at some point, to prevent water from rising above the walls of the filters. Water level should be below the filter operating floor, to prevent sweating of filter walls.

CW709-5.4 Piping - The velocity in filter effluent pipes or conduits should not exceed 2 feet per second at the design rate. Filter influent pipes and conduits should be straight, with crosses or clean-out chambers at changes in direction, in order to permit cleaning.

CW709-5.5 Wash-Water Troughs - The bottom of wash-water troughs should be above the level of the expanded filter media during washing. The distance of the top of the troughs above the sand surface should be equivalent to the rate of rise, in inches per minute, of the backwash, or approximately 24 to 30 inches. The capacity of the troughs shall be such that they will carry the maximum rate of wash-water with a 2-inch freeboard. The top of the troughs shall be level. Troughs should be spaced so that each trough serves the same number of square feet of filter area, and so that the maximum horizontal travel of suspended particles to reach a trough is not more than 3 feet.

CW709-5.6 Filtering Material - This shall consist of clean silica sand or clear, fine anthracite coal, supported on torpedo sand, and gravel. The applicable portions of AWWA B-100 should be used.

a. Silica Sand - Depth shall be not less than 24 inches and not more than 30 inches. Effective size shall be 0.35 to 0.80 mm., and shall have a uniformity co-efficient not greater than 1.7.

b. Torpedo Sand - A minimum 3-inch layer shall be provided, and should have an effective size between 0.80 mm. and 2.0 mm., and a uniformity co-efficient not greater than 1.7.

c. Gravel - Depth will vary according to the type of filter bottom and strainer used except that no gravel will be required in the case of porous bottoms. The depth of gravel should not be less than 15 inches except in the case of Wheeler, Leopold or other formed bottoms whereby the depth of gravel may be reduced. Gravel shall consist of hard, rounded particles; gravel with flat or elongated particles shall be rejected. The coarsest gravel should be 2½ inches in size when the gravel rests directly on the strainer system, and should extend above the top of the perforated laterals or strainer nozzles. Not less than four layers of gravel should be provided. The sizes and depths suggested are:

Range	Depth
2½ to 1½ inches	5 - 8 inches
1½ to 3/4 inches	3 - 5 inches
3/4 to ½ inches	3 - 5 inches
½ to 3/16 inches	2 - 3 inches
3/16 to 3/32 inches	2 - 3 inches
Total Depth.....	15 - 24 inches

CW709-5.7 Filter Bottoms and Strainer Systems - Caution should be exercised in the use of porous bottom filters when dealing with waters high in iron content, or with waters softened by lime, because of the possible clogging. In all types the design should be such that the loss of head is relatively small in the manifold and laterals. Practically all of the loss of head should occur at the final openings or strainers, where the wash-water discharges into the filter. This will insure even distribution of wash-water, and an even rate of filtration over the entire area of the filter. The ratio of the area of the final openings of the strainer system to the area of the filter should be about 0.003. The total cross-sectional area of the laterals should be about twice the total area of the final openings, and the cross-sectional area of the manifold should be at least 1½ times the total area of the laterals, in order to minimize friction losses and to give good distribution.

CW709-5.8 Filter Controls - A flow rate controller and an indicating loss-of-head gage shall be provided for every filter. A rate of flow gage of the indicating type is required. Provisions must be made for draining the filter to waste; the drain valve may be hand-operated.

CW709-5.9 Back-Wash - Provisions shall be made for washing filters at a rate of 15 to 21 gallons per square foot per minute. Filtered water shall be provided at the required rates by a wash water tank, a wash water pump, or from the high service main. Wash-water pumps should be in duplicate, unless an alternate source of wash-water is available. A wash-water tank should provide for at least a 10-minute wash of one filter at the design rate of wash. The bottom of the tank should be at least 25 feet above the top of the wash-water troughs. There should be a wash-water regulator, or an extra valve on the main wash-water line which can be adjusted and set to obtain the desired rate of filter wash, with the wash-water valve on the individual filter opened wide.

CW800 IRON AND MANGANESE REMOVAL

CW801 OBJECTIVE

To provide a water that does not have a metallic taste and which will not stain contacted surfaces.

CW802 GENERAL

CW802-1 Applicability - Iron and manganese removal practice has not been standarized beyond the point of establishing the upper concentration of iron should not exceed 0.3 mg/l and the concentration of manganese should not exceed 0.05 mg/l.

CW802-2 Methods - Iron and manganese are encountered in water supplies under varied conditions and can be categorized under four general methods of treatment:

a. Where iron alone is present, and oxidation and precipitation are readily accomplished by aeration prior to filtration, without chemical treatment or pH adjustment.

b. Where iron is present with a limited amount of manganese, and oxidation is not followed by prompt precipitation of the material, unless catalytic action is utilized or chemical treatment is practiced.

c. Where iron and manganese are bound with inorganic matter, and an alkali must be added to raise the pH value to about 9.0 in order to effect proper coagulation prior to filtration.

d. Where iron and/or manganese are present in hard waters and base-exchange or lime-soda softening is practiced.

CW802-3 Selection of Treatment Method - It is evident from the above that the selection of iron and manganese removal processes must be based upon due consideration of the character of the raw water such as interfering substances like carbon dioxide and organic matter. Therefore, the selection of a specific process should meet local conditions, based upon a careful engineering investigation which shall include a representative analysis of the water to be treated, and justification for the treatment process selected. The results of pilot plant operations may be needed to obtain pertinent information to be used as the basis of design.

CW803 AERATION

CW803-1 General - The amount of oxygen required to oxidize iron can be provided by limited aeration in some cases, however, more complete aeration is needed if removal of carbon dioxide is necessary to raise the pH to the level required for the oxidation of iron. The removal of carbon dioxide also assists in the oxidation of manganese by reducing the quantity of alkali-soda ash, etc., required to raise the pH needed for this reaction.

CW803-2 Contact Aerators - The absorption of oxygen from the air and the catalytic action of previously oxidized iron and manganese, may be obtained through the use of contact aerators consisting of beds of coarse coke, crushed stone, Anthrafilt, gravel and pyrolusite (manganese ore). Provision should be made to insure ventilation of the beds to the exterior. This may be accomplished by using a blower to draw or force air through the bed. Positive means should be provided for removing surplus precipitated iron and manganese from the units, preferably by the use of pans or shallow basins fitted with drains, and by providing washing facilities.

CW803-3 Pressure Aerators - Pressure aeration (which avoids double-pumping) is acceptable, provided the iron is readily oxidized and pilot plant tests indicate its applicability.

CW804 OXIDATION BY CHLORINATION

CW804-1 Applicability - Iron and manganese can be oxidized by chlorine without the need for aeration. Chlorine will alter complex organic compounds of iron and manganese, so precipitation may be obtained in the absence of catalytic action, or without adjustment of pH value by added alkali. The application of chlorination followed by pressure filtration usually is effective with concentrations of iron and manganese less than 1 ppm. Higher concentration of iron and manganese may cause premature filter clogging unless the filter is preceded by a sedimentation basin.

CW804-2 Equipment - Chlorination equipment is covered under the applicable portions of Section CW600, "DISINFECTION". Filtration and sedimentation equipment are covered under the applicable portions of Section CW700, "WATER CLARIFICATION".

CW805 COAGULATION WITH LIME

CW805-1 Applicability - Soluble iron in the form of ferrous bicarbonate can be precipitated as ferrous carbonate by the use of lime. The process eliminates the need for aeration and associated double pumping, and also minimizes or prevents corrosion from dissolved oxygen incidental to aeration.

CW805-2 Equipment - This process uses a lime feeder, enclosed mixing or sedimentation tanks, and a pressure filter. These units are applied in such a manner as to avoid aeration and air-borne contamination. Requirements pertaining to the lime feeder are covered under the portion pertaining to chemical feed equipment under Section CW300, "WATER SOFTENING". Mixing and sedimentation tanks are covered under the applicable portions of Section CW700, "WATER CLARIFICATION".

CW806 ION EXCHANGE

CW806-1 Applicability - The use of zeolite or other ion-exchange materials, both for softening and for iron and manganese removal, will be accepted provided:

a. The equipment is in accordance with the requirements specified for water softening.

b. The iron and/or manganese are in the reduced soluble state in raw water which is devoid of dissolved oxygen.

c. The concentration of iron and/or manganese is less than 1.5 mg/l.

CW806-2 Equipment - The requirements for the ion-exchange equipment are specified under Section CW300, (cation-exchange softeners) "WATER SOFTENING".

CW807 STABILIZING IRON AND MANGANESE

CW807-1 Applicability - Iron and manganese in the reduced state can be stabilized to remain in colloidal suspension when present in low concentrations. Stabilization can be accepted only when the engineering report contains data which indicates that staining can be controlled by this method and the water does not have a metallic flavor.

CW807-2 Equipment - Commercial glassy phosphate compound used in this process shall be applied by chemical feed equipment which has been selected to meet existing hydraulic conditions and which has a capacity capable of applying 5 parts of phosphate compound for each part of iron and/or manganese present in the water being treated. The phosphate solution should be sterilized with 10 mg/l of chlorine.

The equipment shall be installed so that the phosphate solution will not carry entrained air into the water being treated. The point of application of the chemical should be selected so that the water, as treated, will be devoid of oxygen. (The point of application may be in the well below the tailpipe of the pump).

CW808 SEDIMENTATION

CW808-1 Applicability - Sedimentation shall be used when chemical coagulation is used to precipate iron and manganese or the iron content is 3 mg/l or more.

CW808-2 Design - The engineering design should establish the period required for sedimentation or reaction prior to filtration, to insure effective iron and manganese removal. Detailed requirements for sedimentation basins are specified under Section CW706.

CW809 FILTRATION

CW809-1 Applicability - Filters to be used solely for iron and manganese removal are not subject to all the restrictions governing filtration plants where removal of turbidity, color and bacteria is involved. Therefore, conventional pressure filters and various patented modifications of filters may be satisfactory, provided that the treatment process and equipment are selected with due regard to the type of water being treated.

CW809-2 Design Rate - Rate of filtration of 3 gallons per minute per square foot of filter area may be acceptable, but the rates shall be selected in each instance with regard to the amount of iron and/or manganese to be removed, and the amount of washwater to be used.

CW809-3 Filtering Material - Filtering material for iron and manganese removal should be selected for the specific treatment process used. Coarse sand, crushed anthracite coal (Anthrafilt), and pyrolusite, are acceptable as filter media under appropriate conditions. The reasons for the selection of a specific medium shall be indicated in the engineering report. Filter sand and Anthrafilt usually will retain sufficient precipitated iron and/or manganese to provide catalytic action, in a manner similar to pyrolusite or manganese zeolite. Calcite may be mixed with filter sand, in lieu of pretreatment with some other alkali, so as to increase the alkalinity to the point required for iron removal. The adequacy of alkali treatment with calcite alone must be established, otherwise provision should be made to pre-treat with an alkali, to insure effective iron and/or manganese removal.

CW900 WATER SOFTENING

CW901 OBJECTIVE

To produce a finished water, free of excessive hardness, for domestic and related purposes. Consideration shall be given to the quality of water service in the area and the economics involved.

CW902 GENERAL

CW902-1 Applicability - The practice of water softening varies appreciably in different parts of the country. The benefits obtained by softening do not become readily apparent in waters with a total hardness content of less than 150 mg/l calculated as calcium carbonate. Most water softening operations for domestic purposes do not produce finished water of extremely low hardness and water with a hardness of between 50 and 100 mg/l is generally acceptable.

CW902-2 Methods - The common water softening methods employed are the lime-soda process and the cation-exhange process.

CW902-3 Selection of Treatment Method - The method selected shall be based upon the quality of the raw water, the required quality of the finished water, economics involved, and plant location.

CW903 LIME SODA PROCESS

CW903-1 Applicability - This process will remove the carbonate hardness consisting of calcium and magnesium bicarbonates (sometimes called "temporary hardness"), and the non-carbonate hardness consisting of calcium and magnesium sulphates, chlorides and nitrates (sometimes called "permanent hardness"). Generally, the lime reacts to remove the temporary or carbonate hardness, and the soda ash removes the permanent or non-carbonate hardness.

The calcium and magnesium which are found in raw water in the form of bicarbonate compounds may be removed by treatment with lime only.

The equipment includes the devices for mixing the softening chemicals with the water, sedimentation basins in which the softening reactions take place and the insoluble precipitates formed may settle out, filters for the final clarification of the water, and in some instances for feeding stabilizing chemicals to prevent incrustation or deposition of scale.

CW903-2 Chemical Feed Equipment - Either hydrated or quicklime may be used. However, quicklime shall be slaked before introduction into the raw water. The chemicals, whether added as a solution or in dry form, should be fed into the water in proportion to the flow, hardness of the raw water, and desired quality of the finished water. The equipment shall comply with chemical feed equipment - Section CW705.

CW903-3 Mixing Basin - See Section CW707.

CW903-4 Sedimentation - See Section CW805.

CW903-5 Stabilization

CW903-5.1 Applicability - Stabilization may be required to prevent incrustation or deposition of scale resulting from the chemicals used in the process, and to prevent caustic tastes. This may be accomplished by the addition of carbon dioxide sulphuric acid, or polyphosphates. In some cases, polyphosphates may be used to supplement carbon dioxide or sulphuric acid stabilization.

CW903-5.2 The point of application of stabilizing chemicals shall be ahead of the filters.

CW903-6 Carbon Dioxide

CW903-6.1 Source - Carbon dioxide may be manufactured at the water plant or may be obtained commercially in liquid form, or in solid form as dry ice. The engineering report shall describe the factors of supply, availability and cost.

CW903-6.2 Recarbonation Basin - The basin should be constructed of concrete. It may be a baffled part of the sedimentation basin. The depth of the basin shall be not less than 10 feet and the detention period shall be from 1 to 10 minutes. Precautions shall be taken to prevent the release of carbon dioxide gas from the basin where personnel may be exposed to asphyxiating effects.

CW903-6.3 Spray Impingement or Low-Pressure Application - For the spray impingement and other low-pressure methods of application, the pump should be a low-pressure type (about 5 pounds per square inch). The basin shall have a water depth of about 8 feet, and a flow-through period of about 1 minute.

CW903-6.4 Diffuser System - This system should consist of a galvanized iron, steel, or brass pipe grid system. The header shall be fitted with 3/4-inch laterals spaced 1 foot apart. The holes in the lateral shall be 1/8-inch in diameter and spaced 1 foot center-to-center. The total area of the holes should be approximately 80% of the area of the header. Porous plates or tubes also may be used as a grid system. The grid system should be submerged to a depth of 8 feet.

CW903-6.5 Carbon Dioxide Generator - The generator should be located immediately before or after the compressor; if before, a washer or scrubber should be used. The compressor shall be protected against possible back-surge from the diffuser system.

CW903-7 Sulphuric Acid

CW903-7.1 Use - The use of this acid will usually depend on cost and the type of water. Generally, its use will be justified only at small plants.

CW903-7.2 Application - The acid, in concentrated solution, should be fed ahead of the filter.

CW903-7.3 Equipment - A solution feeder and feed line of non-corrosive material shall be provided. No elaborate feeder or mixing is required, but provisions shall be made for safety in handling.

CW903-8 Polysulphates

CW903-8.1 Types - Several types of polyphosphates, containing variable amounts of alkali, are available for stabilization. The selection of the type to be used should be based on experience, or on a pilot study.

CW903-8.2 Application - The usual dosage is 1 to 2 mg/l. The stock solutions should be kept covered and disinfected by carrying approximately 10 mg/l chlorine residual.

CW903-8.3 Equipment - When applied after filtration, feeding equipment should be so constructed as to prevent entrance of dust, dirt, and other contaminants into the filtered water.

CW903-9 Filtration

CW903-9.1 Applicability - Filtration shall be used for lime or lime-soda softened waters and shall be installed after the sedimentation basin.

CW903-9.2 Types - Gravity type rapid mechanical filters or pressure type filters shall be used.

CW903-9.3 Number of Units - At least two units should be provided. When plant output is small (e.g., 100 gallons per minute), each filter should equal plant capacity.

CW903-9.4 Rates of Filtration - The permissible rate of filtration shall be 2 gallons per square foot per minute, except when, in the opinion of the Health Authority, and FHA, conditions will permit use of a higher rate.

CW903-9.5 Gravity Filters - See Filters, Section CW709-5.

CW903-9.6 Pressure Filters

a. Applicability - Pressure filters may be used in small water plants, where the raw water is supplied under pressure, where it is desired to filter and deliver the water without further pumping, or for other reasons acceptable to the FHA.

b. Design - The same principles used for gravity sand filters apply except that the under drains, and filter media are placed in a cylindrical tank and the water is passed through the filter under pressure.

CW904 CATION-EXCHANGE SOFTENING

CW904-1 Applicability - The mineral quality of the raw water must be given consideration when softening by the cation-exchange method since the total sodium-ion content will be larger after the softening process. It is usually not possible for waters containing iron, acid waters excepted, to reach the ion-exchange material without oxidization of part of the iron, resulting in a shortened life of the ion-exchange material. When the total iron and/or manganese content of the raw water exceeds 1.5 mg/l, pretreatment should be provided for the removal of iron and/or manganese. There should be no iron in the oxidized state.

The finished softened water should contain not more than 0.3 mg/l iron and 0.05 mg/l manganese. Treatment of by-passed water may be necessary to obtain these results.

CW904-2 Additional Limitations - Waters having 5 mg/l or more of turbidity should not be applied directly to cation-exchange softeners. Waters with a pH above 8.4 should not be applied to silica gel materials. Waters containing less than 12 ppm of silica as silicon dioxide should not be applied to siliceous cation material. When the applied water contains a chlorine residual, the cation-exchange material should be of a type that is not damaged by residual chlorine. Phenolic resin exchange materials should not be used, unless approved methods are utilized for stabilizing and disinfecting the material prior to use.

CW904-3 Types of Equipment - The pressure type or open-type exchanger may be used. When the open gravity type is used, chlorination shall be employed. Up-or-down-flow type will be acceptable.

CW904-4 Design

CW904-4.1 Rate of Softening - Should not exceed 6 gallons per square foot per minute.

CW904-4.2 Backwash Rate - Should be 6 to 8 gallons per square foot per minute.

CW904-4.3 Underdrainage System - Should be 0.16 to 0.18 percent of the area of the softener. Manifolds with laterals and perforated strainers should be provided.

CW904-4.4 Media

a. Depth of cation-exchange material - Should be at least 30 inches.

b. Gravel Support - Three or more layers of gravel graded from 1/8-inch to 1-inch, with a total depth of 15 inches, should be provided to support the cation-exchange material.

CW904-4.5 Freeboard - Should be 30 to 50 percent, depending upon the specific gravity of the media and the direction of the water flow.

CW904-4.6 Regeneration - Either automatic or manual regeneration is acceptable. Provision should be made for even distribution of brine.

CW904-4.7 Protection against Back-Siphonage - Backwash, rinse, and air relief discharge pipes shall be installed in order to prevent any possibility of back siphonage; usually, a-free-fall discharge of 6 inches or 2 pipe diameters, whichever is greater, will be satisfactory.

CW904-4.8 Meters - Flow meters shall be installed on the by-pass line and on each softening unit.

CW904-4.9 Sampling Taps - Smooth-nosed sampling taps should be provided for the collection of representative samples for both bacteriological and chemical analyses. The taps should be so located as to provide for sampling of the softener influent and of the blended water when any hard water is by-passed. The blended water sampling tap should be at least 20 feet downstream from the point of blending, to assure obtaining a representative sample.

CW904-4.10 Brine and Salt-Storage Tanks

a. Protection - When salt storage facilities are located below ground, they shall be located a safe separating distance from sources of pollution such as non-watertight sewers. Brine-measuring or salt-dissolving tanks and wet-salt storage facilities shall be covered.

b. Piping and Appurtenances - The make-up water inlet should have a free-fall discharge of 6" or 2 pipe diameters, whichever is greater, above the maximum liquid level of the unit. Overflows, if provided, should be turned downward, and should be protected with a non-corrodible fine screen or a self-closing flap valve.

c. Measurement - Brine pumps equipped with meters, in lieu of brine-measuring tanks, should be used.

d. Access - Wet-salt storage basins should be equipped with manhole or hatchway openings having raised curbs and watertight covers with overhanging edges, similar to those required for finished water reservoirs.

e. Salt Requirement - Salt storage areas should have sufficient capacity to permit economical salt purchasing. Approximately 0.3 pounds of salt for resinous base exchanges and 0.5 pounds for all other zeolites will be needed for each 1,000 grains of hardness removed.

CW904-4.11 Corrective Treatment

a. Applicability - Waters softened by the cation-exchange process are frequently corrosive and corrective treatment may be required.

b. Method - Alkalies such as soda ash, caustic soda, caustic silicate, or a combination of these or other alkali should be fed by corrective treatment equipment. Positive-feed pumps should be used for this purpose.

CW904-4.12 Cation-Exchange Waste Disposal

a. Acceptable Methods - Brine wastes can be discharged directly into a sanitary sewer system if it has been determined that the sewer system is of adequate size. Discharge piping shall be installed to prevent any possibility of back-siphonage.

b. Unacceptable Method - Discharge of brine waste in the vicinity of water wells is unacceptable.

c. Approvals Required - Approval shall be obtained from the agency or agencies having jurisdiction concerning the method of brine wastes disposal to be used.

CW904-5 Caution - Softening processes that result in an increase in the sodium ion content of the water i.e., soda-ash treatment or cation-exchange processes may be objectionable because of the adverse effect that sodium ions have on cardiac-vascular patients. Where applicable, the FHA may require a statement from the State Health Authority advising that they have no objection to the softening process as designed even if the water is used by persons so afflicted.

CW1000 CORROSION CONTROL

CW1001 OBJECTIVE

To provide water which will not corrode or damage pipe or other metal surfaces.

CW1002 GENERAL

CW1002-1 Applicability - In accordance with the objectives of these standards, the finished water shall not be excessively corrosive for normal domestic and related uses.

CW1002-2 Methods - Corrosion control methods usually consist of the application of enough alkali to increase the alkalinity and pH of the treated water to equilibrium with calcium carbonate; the application of a polyphosphate to prevent corrosion of exposed metals by rendering the surface "passive" to the action of the water; the use of chlorine residual throughout the distribution systems; or cathodic protection.

CW1003 FREE CARBON DIOXIDE REMOVAL

CW1003-1 Applicability - Carbon dioxide, down to about 5 mg/l can be removed by aeration. However, aeration introduces dissolved oxygen, and thereby increases the corrosiveness of soft waters of low alkalinity. Carbon dioxide may also be removed by an alkali, the required dose being materially reduced by pre-aeration. The addition of an alkali following aeration is unnecessary when alkalinity of the raw water is greater than 110 mg/l.

CW1004 DEPOSITION OF PROTECTIVE CALCIUM CARBONATE FILM

CW1004-1 Applicability - A protective coating, sufficient to minimize corrosion without undue deposition of scale, may be obtained through the use of lime with either soda ash or caustic soda. The desired calcium carbonate film may be obtained by using either soda ash or caustic soda when the alkalinity of the water exceeds about 30 mg/l. Soft waters should be treated with lime to provide the required calcium. Soft waters which also have a low carbon dioxide or bicarbonate content may need a mixture of lime and soda ash, to provide both calcium and carbonate for the calcium carbonate film.

CW1005 PHOSPHATE FILM

CW1005-1 Applicability - Commercial polyphosphates may be used for corrosion control. Doses of 4 to 6 ppm are used for initial treatment; after 1 to 2 months, the dose is usually reduced to 2 ppm.

CW1006 CHLORINATION

CW1006-1 Applicability - The maintaining of residual chlorine throughout the distribution system can prevent or minimize the corrosive action caused by decomposition of organic matter in water (especially in dead-ended mains), the biochemical action within tubercles, and sulphides.

CW1006-2 Equipment - Chlorination shall be applied in accordance with the requirements in Section CW600, "DISINFECTION".

CW1007 CATHODIC PROTECTION

CW1007-1 Applicability - Cathodic protection is effective for the inner surface of watertanks and standpipes. It may also be used to minimize the corrosion of the outer surfaces of metal conduits, especially where corrosive solid or stray electrical currents prevail. It shall only be used when designed and installed by competent technical personnel and when the equipment can be properly maintained.

CW1007-2 Engineering Report Required - If cathodic protection is proposed, the engineering report shall describe the method in detail and provide an estimate of the economic factors involved, i.e., the cost of installation and operation compared to the added economic life of the protected portions of the system.

CW1100 TASTE AND ODOR CONTROL

CW1101 OBJECTIVE

To provide water which is free of taste and odor producing substances.

CW1102 GENERAL

CW1102-1 Applicability - In accordance with the objectives of these standards, treatment of the water shall be required when taste and/or odor-producing substances effect the palatability of the finished water or otherwise impart objectionable characteristics for normal domestic and related uses. Objectionable tastes and odors may be caused by certain chemicals in the water such as phenols, hydrogen sulphide and other gases, or as a result of the combined chlorine reacting with organic compounds present.

CW1102-2 Methods - The commonly used methods include oxidation by chlorine, mechanical removal by means of aeration, and activated carbon treatment.

CW1102-3 Selection of Method - A specific determination of the source of tastes and odors is necessary before the most effective method of control is selected. An explanation of these sources and the results of pilot studies showing the effectiveness of proposed control processes shall be included in the engineering report.

CW1103 CHLORINATION

CW1103-1 Applicability - Simple chlorination can be used for the removal of some objectionable odors (especially those due to hydrogen sulphide) and organic matter. Chlorine in combined form, such as chloramine may be applicable in special cases. The process of chlorination may require dechlorination methods.

CW1103-2 Equipment - The requirements of Section CW600, "DISINFECTION", shall be followed for application of chlorine. For other chemicals, the applicable provisions of these standards shall be followed.

CW1103-3 Free Residual Chlorination - In some cases, tastes and/or odors due to organic matter, and other substances can be oxidized by heavy applications of chlorine. Adequate contact time must be provided to complete the chemical reactions involved. In some cases, this may be 5 to 12 hours. Free residual chlorine, in many cases, will eliminate tastes from combined chlorine residuals.

CW1103-4 Chloramine Application - In special cases, chlorine-ammonia treatment may be indicated, but should be used only with the approval of the Health Authority.

CW1103-5 Dechlorination - Where dechlorination is necessary, equipment acceptable to HA should be provided for adding sulphur dioxide, sodium thiosulphate, activated carbon, or sodium bisulphite.

CW1104 CHLORINE DIOXIDE

CW1104-1 Applicability - Chlorine dioxide, although used for the removal of various tastes, is generally recognized as a specific for industrial wastes such as phenols.

CW1104-2 Application - To determine the point of application of chlorine dioxide, a thorough study should be made of existing taste-producing substances. In some cases, it may be necessary to apply the chlorine dioxide to the raw water. In other cases, more economical results may be obtained with post-treatment.

CW1104-3 Equipment - Chlorine dioxide may be generated by injecting a sodium chlorite solution into the discharge line of a solution feed gas type chlorinator followed by mixing in a reaction chamber where the pH is 4.0 or less.

CW1104-3.1 Equipment must be available to add acid to the chlorine solution to lower the pH if hypochlorite is used.

CW1104-3.2 Requirements concerning chemical feeders are covered in other sections of these standards and shall be followed to the extent applicable.

CW1104-3.3 Chemical hose, to convey the chlorine dioxide solution, shall be made of plastic, glass, or suitable rubber.

CW1104-3.4 To eliminate any danger of explosion, special precautions shall be used in storing and handling sodium chlorite.

CW1105 ACTIVATED CARBON

CW1105-1 Applicability - Activated carbon removes tastes and odors by absorption.

CW1105-2 Application - Activated carbon may be fed at any point before filtration. For continuous feed in the filter plant, it should be added early in treatment to provide maximum contact time, although addition at one or more other points prior to filtration may be indicated in certain cases. The carbon may be added as a pre-mixed suspension, or by means of a dry-feed machine. Agitation is necessary, to keep the carbon from depositing in the mixing chamber. There should be adequate forced draft ventilation of the feed equipment.

CW1105-3 Dosage - The required dosage of carbon in a water treatment plant depends on the tastes and/or odors involved. Provision should be made for adding as much as 50 mg/L when unusual problems exist.

CW1105-4 Precautions - A. W. W. A. Standard Specifications for Powdered activated Carbon, B600-53, Sec. 2A states: "Powdered activated carbon should be handled as a potentially combustible material. It should be stored in a building or compartment as nearly fireproof as possible. Nothing else should be stored in the same building or compartment. Quicklime chlorine, hypochlorites, and potassium permanganate are especially dangerous in contact with carbon. Carbon feeder rooms should be equipped with explosion-proof electrical outlets, lights, and motors."

CW1106 AERATION

CW1106-1 Applicability - Aeration may be used for the removal of tastes and odors due to hydrogen sulphide, certain micro-organisms and decomposing organic matter.

CW1106-2 Limitations - Aeration generally is not an efficient method for the removal or reduction of taste and odors because many of the undesirable substances are not sufficiently volatile. However, highly volatile or easily oxidizable substances can be removed or altered by this process. Oxygen disolved in the water during aeration may cause corrosion of the piping.

CW1106-3 Design Considerations - Consideration shall be given to:

a. Source of air which is free of contaminants.

b. Discharge of gases so that they will cause no hazard or nuisance.

c. Size of air inlet and outlet to provide sufficient aeration.

d. Screening of air inlet and outlet with screen of 24-mesh or smaller to exclude insects.

CW1106-4 General Methods - Aeration may be accomplished by the following methods:

a. Cascade aerators, using trays.

b. Spray aerators, using fixed nozzles on a pipe distribution grid system.

c. Diffused-air aerators using rectangular concrete tanks with perforated pipes, porous diffuser tubes or plates, and a source of compressed air.

d. Combinations of the above.

CW1106-5 Pilot Plant Studies - In certain cases, pilot plant studies will be required to demonstrate the effectiveness of aeration, and to determine the need for pH control and chlorination.

CW1107 OTHER METHODS

Use of any other method of taste and odor removal should be made only after careful laboratory tests and upon consultation with the Health Authority and FHA.

CW1200 PUMPING AND STORAGE FACILITIES

CW1201 OBJECTIVE

To provide a sufficient and continuous supply of water at adequate pressure that will satisfy all domestic and related needs under all conditions of demand.

CW1202 GENERAL

To meet the above objective, the design of the pumping and storage facilities must be properly integrated so as to obtain effective service with the most economical design from the standpoint of initial and future investment and operating costs. Pumping can be provided in various ways, such as lowlift and highlift pumping stations, booster stations or combinations thereof. Storage can be provided by elevated tanks floating on the system, ground storage tanks, clear wells, pressure tanks, or combinations thereof.

CW1203 LOCATION OF FACILITIES

Pumping stations, reservoirs and tanks shall be located on level sites except where hillside installations can be proven to be advantageous. If location is on filled ground or a hillside, special precautions shall be taken to assure adequate structural stability. A report to the extent applicable shall be submitted providing assurance that suitable, well-compacted fill material will be provided, and that the underlying original soil is adequate to support the weight of the fill plus the weight of the structure without damaging settlement. For hillside construction, the footings shall be supported on original soil and a berm of at least 10 feet shall be provided from the bottom of the footing to the edge of the slope.

The site should be free from flooding or excessive surface wash conditions. The pumping station shall be accessible by all weather roads. Establishment of elevations of structures with respect to flood levels is specified under the applicable headings herein. Adequate grading around the site of the structures shall be provided to divert and otherwise control surface water. Ditches of adequate capacity to divert and carry off storm water runoff should be provided for facilities on a hillside.

CW1204 STRUCTURAL DESIGN AND MATERIALS

CW1204-1 The structural design and the materials used shall conform to the applicable standards and design criteria stated herein and shall comply with accepted engineering practice. When it is necessary to apply special criteria because of local conditions, the reason for such application shall be fully explained in the engineering report and manufacturers' technical reports, brochures, etc. submitted for FHA consideration. All structures shall be designed to safely sustain all dead, live and liquid loads, and hydrostatic, earth and wind pressures that will be imposed. The excavation of the building foundation shall extend below the frost line and into firm original soil having a uniform bearing value over the area of the structure. All portions of the structure below the ground surface forming part of a compartment, shall be waterproofed concrete or other impervious material.

CW1204-2 Applicable Standards

AWWA D-100 - AWWA Standard for Steel Tanks, Standpipes, Reservoirs, and Elevated Tanks, for Water Storage.

American Concrete Institute Code 318 for Reinforced Concrete Tanks and Reservoirs.

American Standard Building Code - ASA A58.1

CW1205 WATER SUPPLY DEMANDS

CW1205-1 Fire Protection Provided - Fire protection facilities which comply with the current requirements of the state fire insurance rating bureau should be provided.

CW1205-2 Residential and Related Demands

CW1205-2.1 Experience Data Available - The annual average demand should be ascertained on the basis of records of existing systems of similar nature in the area.

CW1205-2.2 No Experience Data Available - In the absence of reliable experience records, the following minimum criteria may be used:

a. Average daily demand - 100 gallon per capita per day.

b. Maximum daily demand - twice the average daily demand.

c. Maximum hourly demand - five times the average daily demand except in areas where extensive lawn irrigation is commonly practiced, where a rate of seven or more times the average daily demand should be applied.

d. 4 persons per living unit.

CW1205-2.3 Pressure Requirements - The system shall be so balanced that the demand peaks can be met with a minimum water pressure of 20 psi at the house service connection. The maximum service pressure should not exceed 100 psi. Normal pressure variations in the distribution system should range between 30 and 70 psi. Any variation from the above shall be fully explained and justified in the engineering report.

CW1206 PUMPING STATIONS

CW1206-1 Protection From Flooding - Sites should be located in areas free from flooding. Where this is not possible, adequate protection shall be provided by locating the top of every pumping station floor at least 2 feet above the highest known flood level, surrounded by earth fill 1 foot above the flood level. The station site shall be accessible at all times, by all weather roads.

CW1206-2 Cross-Connections - There shall be no cross-connections between a potable water supply and any supply which is not of equal quality as determined by the Health Authority and FHA.

CW1206-3 Essential Facilities

CW1206-3.1 General - Design of the station shall be that which will assure maintenance of the sanitary quality of the water passing through the station and which will facilitate a sanitary and continuous operation. Floors, dry wall, meter pits, and other compartments not intended to contain water shall be provided with a positive gravity drainage system, protected against backflow, for the disposition of condensation, drippage, spillage or clean-up water.

CW1206-3.2 Architectural Treatment - The pumping station construction and grounds should be designed to conform to the general architectural features of the area, insofar as practical.

CW1206-3.3 Location and Equipment - Except where servicing can be done wholly from outside the pumping facility, the housing shall be large enough for pumping equipment and all accessories. Equipment and piping shall be installed and arranged in a manner which will provide ample space, for servicing, for removal and/or replacement of valves or similar parts with a minimum disturbance to the main system, and for additional equipment which may be needed in the near future. Special consideration shall be given to service space around all moving, mechanical and electrical equipment to insure safety of service personnel.

CW1206-3.4 Servicing Facilities - Crane-ways, hoist beams, eyebolts, or other facilities should be provided for servicing or removing pumps, motors and other heavy equipment. When necessary, openings shall be provided in the station roofs, floors, or wherever needed for service purposes.

CW1206-3.5 Stairways and Ladders - Safe stairways shall be provided between all floors, where practical, otherwise ladders with handrails and non-skid treads shall be provided. Similar stairways or well-anchored metal ladders shall be installed in all pits or compartments which must be entered.

CW1206-3.6 Heating - Pump stations shall be equipped with heating units to prevent freezing of piping and equipment. If the station is manned, additional heat for the comfort of the personnel may be advisable.

CW1206-3.7 Ventilation - The building shall be well ventilated by means of windows and doors, roof ventilators, or other means. All rooms, compartments, pits and other enclosures below the grade floor, which must be entered and in which an unsafe atmosphere may develop, or where excessive heat may build up, shall have forced ventilation. Switches which control the forced ventilation should be conveniently operated from outside such compartments.

CW1206-3.8 Lighting - The pump station should be lighted throughout by means of natural or artificial lighting facilities, or both. All electrical work shall conform to the requirements of NFPA No. 70, National Electric Code, and to the applicable State Codes. Control switches, where needed, shall be conveniently placed at the entrance to each room or compartment.

CW1206-3.9 Sanitary and Other Conveniences - Except in the case of small remote controlled automatic stations, or where such facilities are otherwise available, each station should be provided with potable water, lavatory and toilet facilities. All wastes shall be safely disposed of without danger of polluting the water pumped by the station.

CW1206-3.10 Entrances - All doors shall open outward, be of adequate size and be equipped with locking devices unless the station is continuously manned. Pumping stations built on a hillside or partially underground should have side-wall door entrances. Where stations are built underground and the only practical access is through the roof, a manhole or scuttle shall be framed at least 4 inches, and preferably 6 inches, above the surface of the roof at the opening, and shall be fitted with a solid watertight cover which overlaps the framed opening and extends down around the frame at least 2 inches. The cover should be hinged at one side and provided with a locking device. In areas subject to heavy snows the cover should project not less than 12 inches above the roof.

CW1206-3.11 Grading, Landscaping and Fencing - Upon completion of the plant, the ground shall be properly graded. Concrete or gravel walkways shall be provided for access to all units. Provision for landscaping should be made, particularly when the plant is located close to residences. The entire plant area shall be enclosed by a fence of suitable quality and height to preclude entrance by unauthorized persons.

CW1206-4 Pumps and Appurtenances

CW1206-4.1 Basic Requirements - Pumps shall be of suitable type and have adequate capacity for their intended purpose, and shall be installed in accordance with the manufacturer's directions. They shall be so designed, constructed and equipped that they will deliver water from the point of intake to discharge without impairment of its quality.

CW1206-4.2 Selection of Pumps - Pumps should be designed and selected so as to operate with the highest efficiency and greatest economy under normal demand conditions. The pump characteristic curves showing capacity-head-horsepower relationships at various efficiencies should be submitted along with the other basic design data.

CW1206-4.3 Number of Pumps

a. Except when wells are used, provide a minimum of two pumping units, complete, with controls, each capable of delivering the average demand load. Two or more wells should be required in all but the smallest systems to insure continuity of service during repairs or breakdowns.

b. In stage development, one pump may be accepted if sufficient spare parts, and the tools for making all necessary repairs and service are readily available.

c. When more than two pumping units are installed, they should be selected so that if any unit is out of service, the others can deliver the maximum required output of the installation.

CW1206-4.4 Booster Pumps - Booster pumping is usually required to serve elevated areas or remote houses. Pumps shall be located or controlled so that they will not produce a negative pressure on their suction lines. Normal intake pressure should be at least 20 pounds per square inch. If the intake pressure falls to 5 pounds per square inch, the pumps shall be automatically cut off.

CW1206-4.5 Pump Suction and Seals - Pumps shall be set so they will not exceed the practical suction limit for the temperatures and atmospheric pressures encountered at the site. Unless the pumps have a positive head on their suction lines, or are self-priming, they shall have suitable foot valves which are screened where necessary and have a net valve area of at least 2½ times that of the suction piping. They shall have positive means of priming with water which is equal in sanitary quality to that delivered by the pump. Each pump shall have an individual suction line from the supply, unless the suction lines are so manifolded as to provide hydraulic conditions which will insure that each pump will operate in accordance with its design conditions.

Water for all water seals shall be equal in quality to the water which the pump is handling. If a pump handling non-potable water is sealed with potable water, the seal shall be supplied from a tank which is fed by a water line terminating at least 6 inches above the tank overflow.

CW1206-4.6 Valves - Each pump (except well pumps) should have an easily accessible shut-off valve of appropriate type in its suction line, and a similar valve in its discharge line. A positive acting check valve should be installed in the discharge line between the pump and the gate valve.

CW1206-4.7 Pressure Reliefs - Each discharge line and each suction line which is subject to surging flows shall be protected against excessive pressure or vacuum, and provision shall be made to remove entrained air, by means of relief valves, surge tanks, or other dependable means.

CW1206-4.8 Gages - Each pump shall have a pressure gage on its discharge line, and a similar gage should be provided, where necessary, on its suction line.

CW1206-4.9 Flow Measurement - Means should be provided for measuring the total water pumped. Among the devices applicable are venturi and orifice meters, propeller or turbine velocity meters. The following cold-water-meter specifications are applicable: AWWA C700 - Displacement Type, AWWA C701 - Current Type, C702 - Compound Type, AWWA C703 Fire Service Type, and AWWA C704, Current Type - Propeller Driven. Manufacturer's specifications and installation instructions shall be followed. The registers accompanying the meters should be equipped to indicate, record and integrate the flows in gallons or cubic feet.

CW1206-4.10 Prime Movers - Each pump shall be driven by a prime mover of proper capacity for the maximum heads, discharge rates, and temperatures which may be encountered. Whatever its type may be, the prime mover shall be installed in accordance with the instructions of its manufacturer. All necessary facilities for its proper operation and maintenance should be installed in a convenient place.

CW1206-4.11 Controls - The pumps, their prime movers and accessories shall be positively and accurately controlled as to speed, pressure, quantities of discharge, operating temperatures, lubrication, voltages and all other factors essential to proper operation, by apparatus which is appropriate to the service, and which has proven satisfactory in actual service. Where more than one pump is used, the controls shall provide for alternation of the pumps and prime movers in service.

CW1206-5 Intakes - This section refers to intake facilities from wells and springs, which include the pumps, stations, piping and controls not covered in the previous sections. The intake shall be of a type appropriate to the pump and shall protect the sanitary quality of the water pumped.

CW1206-5.1 Intake Vent - The intake should be vented by means of a properly hooded and screened pipe, which extends at least 12 inches above the operating floor, and is protected against pollution.

CW1206-5.2 Pump Connections - When connections between the well and the pump are located above the floor, any penetration of the floor shall be designed to prevent the entrance of external drippage or other contaminating substances. In general, the connection shall be made by means of a rigidly anchored riser pipe, or by extending the casing at least 6 inches above the floor, and providing it with a flange, stuffing box, or other device which will make a watertight connection between the riser pipe or casing and the base of the pump. Where a watertight connection is not provided, the casing shall be inserted into a recess extending at least 1 inch into the base of the pump. The base of the pump shall be at least 6 inches above the pump room floor. The design of the pump foundation and the pump base shall keep water away from this connection.

Where a submersible pump is used, the top of the casing shall be effectively sealed against the entrance of water around the conductors or cables.

CW1206-5.3 Piping

a. Suction Pipes - Suction pipes connected to individual wells or to a series of wells located outside of the building, shall be protected against freezing, shall be valved to permit testing and control of each well, and shall be watertight from the well to the pump. All external valves shall be protected by curb boxes or other acceptable means.

b. Discharge Pipes - The discharge line and its control valves should be located above the pump house floor.

CW1206-5.4 Receiving and Pressure Tanks - All receiving tanks forming part of the pump house equipment shall have appropriate devices for indicating the water level in the tank; be located, supported, and protected by covers, and vented to prevent contamination of the water.

CW1206-6 Automatic and Remote-Controlled Stations - All automatic stations should be provided, with automatic signalling apparatus which will indicate when the stations are out of service. All remote-controlled pumping stations shall be electrically operated and controlled.

CW1206-7 Power - A dependable source of power shall be provided for operating all pumping equipment and accessories, preferably by means of two independent sources. When power shutdowns of a duration longer than that which the system can be permitted to be out of service may occur, a reliable independent emergency source of power of sufficient capacity to provide for at least minimum essential service should be available. In lieu of an emergency power source, consideration may be given to the use of distribution storage on the system to provide the necessary service, provided the engineering report justify the reliability of such storage.

CW1206-7.1 Conformance to Codes - The installation and operation of the power supply equipment for prime movers and their accessories, shall conform to the requirements of the appropriate National, State, local or trade code.

CW1206-7.2 Electric Power - When the station is electrified, all electrical equipment and work shall conform to requirements of the National Fire Protection Association Electrical Code, No. 70, National Electrical Manufacturers' Association and the related State or local codes.

CW1207 STORAGE FACILITIES

CW1207-1 General Benefit - The provision of distribution storage in a community water system will augment the capabilities of the source of supply, treatment facilities, and pumping equipment to assure a fully balanced system capable of meeting the demand requirements of the integrated system.

The chief advantages are that:

a. Demands on the sources of supply, the production works and distribution mains can be more nearly equalized. The sizes or capacities of these system elements can be reduced.

b. System flows and pressures are improved and stabilized to serve the users throughout the service area.

c. Reserve supplies are provided in the distribution system for contingencies such as fire fighting, power failure or equipment repairs.

CW1207-2 Types - Storage may be in ground storage reservoirs, elevated tanks, standpipes, equalizing reservoirs or pressure tanks, depending on the design needs for the area to be served by the water system. Hydropneumatic pressure tanks provide relatively limited storage capacity within the operating pressure limits, and should be considered only in stage construction on small systems or for service to isolated sections where such tanks may be the most feasible method available.

CW1207-3 Location Considerations - The location, size, and type of reservoir, tank or standpipe to be designed for any given water supply shall be integrated with the distribution system. The design shall provide uniform pressures with no pressure drop below 20 pounds per square inch when the system is operating at peak demand.

CW1207-4 Protection Against Pollution

CW1207-4.1 Reservoir Covers - A reservoir for finished water storage shall have a suitable roof or cover which is watertight, dust proof and vermin proof.

CW1207-4.2 Separation from Pollution - If the bottom of a reservoir is at a lower elevation than sewers, drains, privies, standing surface water, or other sources of pollution, the reservoir should be no closer than 50 feet. (Class 100 or better mechanical joint water pipe, tested to 50 pounds per square inch, may be used as a sewer or drain at lesser distances provided that the health authority gives approval.)

CW1207-4.3 Unsafe Water In Contiguous Compartments - Unsafe water shall not be stored adjacent to a finished water compartment if only a single wall separates the compartments.

CW1207-4.4 Ground Water or Flood Levels - Bottom of a ground-level reservoir should be located above the ground water table and at a ground level above flooding. Top of the reservoir should not be less than 2 feet above the normal ground surface.

CW1207-5 Structural Design - Materials shall be durable, impervious and of adequate structural strength. The design should consider utility, public health, safety and architectural beauty.

CW1207-5.1 American Water Works Association Standard Specification D100 - Steel Tanks, Standpipes, Reservoirs, and Elevated Tanks, For Water Storage and the American Concrete Institute Code 318 for Reinforced Concrete Tanks and Reservoirs shall be followed to the extent applicable.

CW1207-6 Elevated Tanks and Standpipes

CW1207-6.1 Limiting Heights - The desirable maximum variation of working levels in storage facilities which float on a distribution system should not exceed 30 feet. This limits the effective capacity of a standpipe to approximately the top 30 feet, or elevated tanks should not exceed 30 feet from the top of the pipe riser to the tank overflow.

Standpipes may be considered in any situation that would employ elevated storage on legs up to 60 feet above the ground. When costs are comparable, the advantage of having the additional storage capacity below the top 30 feet for emergency or fire use will be considered.

CW1207-6.2 Altitude-Control Valves - Altitude-control valves or telemeter equipment should be used where any appreciable variation in head loss occurs between the source and the storage facility, or in the case of multiple units set at different elevations, either actual or effective.

CW1207-6.3 Freezing of Riser Pipe - In cold climates, protection shall be provided to prevent freezing in the riser pipe.

CW1207-6.4 Overflow and Cleaning - Provision should be made for cleaning and overflow on all structures. The overflow pipe of an elevated tank should be screened and extend to 6" of the ground. Overflows on all structures should have free-fall discharges that are in plain view and be constructed in such a manner that the discharge will flow away from the foundations.

CW1207-7 Reservoirs

CW1207-7.1 Surface Water Protection - The area surrounding a ground level reservoir should be graded to prevent surface water from standing within 50 feet of the structure.

CW1207-7.2 Manholes or Scuttles - A manhole or scuttle above the water line shall be framed at least 4 inches, above the surface of the roof at the opening and shall be fitted with a solid watertight cover which overlaps the framed opening and extends down around the frame at least 2 inches. The cover should be hinged at one side and should be provided with a locking device. In areas subject to heavy snows, the manhole should extend 12 inches above the roof. On a ground level reservoir covered with earth, a similar elevation of the manhole above the sod is required.

CW1207-7.3 Pipe Openings in Tank Wall - Any pipes running through the shell of the structure should be welded or gasketed in metal tanks, or should be connected to standard wall castings which are poured in place during the construction of the concrete structure. These wall castings shall have a flange or flanges imbedded in the concrete, for rigidity and to prevent seepage along the outer face of the fitting.

CW1207-7.4 Drainage of Roof - The roof of the structure should be well drained. Downspouts may not enter the reservoir to connect to the overflow. Parapets, or similar construction which would hold water or snow on the roof are not acceptable.

CW1207-7.5 Vents, Overflows, and Warning Lights - Vents, overflows, and warning lights should be constructed to exclude dust, birds, animals and insects from the reservoir. Direct connection between overflow and any drain or sewer is unacceptable. A ground level vent should terminate in an inverted U with the opening at least 24 inches above finish grade.

CW1207-7.6 Valve Stems Through the Roof - Valve stems or similar projections through the roof of a reservoir will be accepted if designed with a wall sleeve set in a curbed opening, or welded to a cover plate, which is in turn covered by an overlapping turned-down hood welded to the valve stem.

CW1207-8 Pressure Tanks

CW1207-8.1 Special consideration must be given to local laws relating to structural design and safety devices. A tank located above the normal ground surface should be protected against freezing. Drainage from the housing should be discharged to ground surface with no direct connection to a sewer.

CW1207-8.2 Complete details of design and construction shall be submitted, including provisions for control equipment such as pressure gage, sight glass, automatic or manual blow-off for excess air, and mechanical means for adding air.

CW1207-9 Level Controls and Alarms - Pressure-control switches or telemeter equipment should be provided, with warnings or alarms in appropriate places, so that high and low water levels will be immediately reported.

CW1207-10 Painting and/or Cathodic Protection

CW1207-10.1 Type Paint - American Water Works Association Standard D102 should be considered, however, epoxy, vinyl, or other special paints may be used if approved by the health authority and acceptable to the FHA.

CW1207-10.2 Cathodic Protection - Cathodic protection for metal surfaces is a recognized procedure when the individual project is designed and installed by competent technical personnel, and when the equipment is properly maintained.

CW1207-11 Disinfection - A reservoir or tank shall be disinfected before being put into service for the first time, and after it has been entered for cleaning, repair or painting. Chlorine doses stronger than those normally carried for water disinfection will be required. The final criterion is satisfactory bacteriological samples. AWWA C601 - AWWA Standard For Disinfecting Water Mains provides general criteria which should be applied.

CW1300 DISTRIBUTION SYSTEM

CW1301 OBJECTIVE

To provide facilities which will assure an adequate, continuous, economical supply of safe and palatable water at satisfactory pressure throughout the area to be served.

CW1302 GENERAL

These standards apply to the distribution system for water used for domestic and fire-fighting purposes.

CW1303 MATERIALS

All materials to be used shall be described in the specifications. Materials and appurtenances shall be of acceptable quality, free of defects and suitable to accomplish the stated objectives for community water systems. Pipe fittings, valves and appurtenances shall be manufactured in conformity with the latest standard specifications issued by the American Water Works Association, the American Standards Association or the Federal Government.

CW1303-1 Water Pipe and Appurtenances - No one material will resist the deleterious action of all waters, soils and field conditions that may be encountered. Therefore, the distribution system should be designed after the water and soil characteristics have been determined and the field conditions established. The design and material may then be selected to assure satisfactory, durable, economical service.

CW1303-1.1 The applicable specifications include:

a. Cast Iron

Federal Specification WW-P-421a - Pipe Cast Iron, Bell and Spigot Water.
AWWA C100 - Cast-Iron Pressure Fittings.
ASA A21.1 - Manual for the Computation of Strength and Thickness of Cast Iron Pipe.
ASA A21.4 - Cement Mortar Lining for Cast Iron Pipe and Fittings.
ASA A21.51 - Ductile - Iron Pipe Centrifugally Cast in Metal Molds, or Sand-Lined Molds for Water or Other Liquids.
ASA A21.6 - Cast Iron Pipe Centrifugally Cast in Metal Molds, for Water or Other Liquids.
ASA A21.8 - Cast Iron Pipe Centrifugally Cast in Sand-Lined Molds, for Water or Other Liquids.
ASA A21.10 - Short-Body Cast Iron Fittings, 3" to 12", for 250-PSI Water Pressure plus Water Hammer.

b. Asbestos-Cement

ASTM C296 - Standard Specifications and Methods of Test for Asbestos-Cement Pressure Pipe.
Federal Specification SS-P-351a - Pipe, Asbestos-Cement (Pressure).

c. Concrete

Reinforced Concrete Federal Specification - SS-P-381 - Pipe, Pressure, Reinforced Concrete, Pretensioned Reinforcement (Steel Cylinder Type).
AWWA C300 - Reinforced Concrete Water Pipe-Steel Cylinder Type, Not Prestressed.
AWWA C301 - Reinforced Concrete Water Pipe-Steel Cylinder Type, Prestressed.

CW1303-2 Corrosion Protection - Cast iron pipe shall be factory-coated with exterior and interior coatings meeting the American Standards Association A21.4 - Cement Mortar Lining for Cast Iron Pipe and Fittings.

CW1303-3 Pipe Joints - The method of making joints and the material used shall be included in the specifications.

CW1303-3.1 Acceptable pipe joints include:

a. Cast Iron Pipe - Bell and spigot, flanged, universal, mechanical, and flexible ball. The mechanical joint and rubber-gasketed bell-and-spigot slip joints should be used to provide watertightness, flexibility and economy of installation.

b. Asbestos-Cement Pipe - Use Roll-on rubber gasket coupling as specified by the pipe manufacturer.

c. Concrete Pipe - Rubber-gasketed bell-and-spigot joints similar to those now used with cast-iron pipe.

CW1303-3.2 The applicable specifications include:

a. Cast Iron

ASA A21.11 - A mechanical joint for Cast Iron Pressure Pipe and Fittings.
AWWA C600 - Installation of Cast Iron Water Mains Sections.

b. Concrete Pipe

Reinforced Concrete Federal Specification - SS-P-381 - Pipe, Pressure, Reinforced Concrete, Pretensioned Reinforcement (Steel Cylinder Type).
AWWA C300 - Reinforced Concrete Water Pipe-Steel Cylinder Type, Not Prestressed.
AWWA C301 - Reinforced concrete Water Pipe-Steel Cylinder Type, Prestressed.

c. Asbestos-Cement

ASTM C296 - Standard Specifications and Method of Test for Asbestos-Cement Pressure Pipe.
Federal Specifications SS-P-351a - Pipe, Asbestos-Cement (Pressure).

CW1303-4 Hydrostatic and Leakage Tests - These tests shall be made upon completion of the pipe system, in accordance with the test procedure stated in the current AWWA Standard AWWA C600 or alternate acceptable procedure described in the project specifications. The recommended tests are as follows:

CW1303-4.1 Hydrostatic Test - The valved section of the main being tested should be filled with water, and air should be expelled from the line through hydrants or taps made at the high points. The test should be made by means of a pump and test gage and at a test pressure at least 50 per cent greater than the design working pressure in the line. Test pressure should be maintained for at least 1 hour and an examination should be made of the line for visible leaks or pipe movement. Obvious defects shall be fixed before the leakage test is made.

CW1303-4.2 Leakage Test - The leakage test should be made after the pressure test is completed. The amount of water which enters the test section under normal working pressures for a period of at least 2 hours should be measured through a calibrated meter. The leakage result shall comply with specifications prescribed in the current Standard AWWA C600, otherwise the installation will not be accepted.

CW1304 DESIGN

CW1304-1 General - Pipe and special fittings used in water distribution systems shall be designed to withstand internal water pressure induced by static and kinetic pressures and shock pressures from water hammer. They shall be designed to withstand external pressures acting on them, such as from trench loads and live loads resulting from heavy traffic and impact. The engineering report shall include information on the basis of design for the piping system with respect to all hydraulic and structural conditions involved.

CW1304-2 Water Main Sizes - Sizes will depend upon factors such as the demand requirements, the degree to which fire-fighting supply will be provided, the pressure requirements in the distribution system, and plans for expansion of the system.

CW1304-2.1 Provision For Fire-Fighting - The standards of the state fire insurance rating bureau shall be followed to the extent applicable. The minimum pipe size shall be 6 inches for runs not exceeding 600 feet. If future fire fighting supply service can be expected the system should be sized in accordance with the state fire insurance bureau standards.

CW1304-2.2 No Provision for Fire-Fighting - Water distribution lines which are not a part of a fire-fighting network shall be sized to provide sufficient capacity to supply the peak demand without an excessive pressure drop.

CW1304-2.3 Pipe sizes less than 4 inches should not be used unless the engineer's report indicates that no future extensions are possible, pressure conditions will be adequate under normal and peak flow conditions, and the chemical characteristics of the water supply are not such that detrimental depositing of chemicals, or other interior pipe reactions such as tuberculation can be expected so as to reduce effective interior pipe diameters.

CW1303-3 Layout of Piping System

CW1304-3.1 General - The piping shall be looped and valved to permit shutting off of service to only a small number of connections for repairs or maintenance. Preferably, disruption of service should be limited to one block. Looped mains shall be provided in all locations except cul de sacs, ribbon developments, or scattered properties. The design and construction shall include the placement of tees, crosses, etc., where future development indicates looping will be required.

CW1304-3.2 Dead Ends - Unlooped mains shall be equipped with a fire hydrant, flushing hydrant, or, under unusual circumstances, a blow-off. The flushing hydrant or blow-off valve shall be at least the size of the main or four inches, whichever is smaller. No flushing device shall be directly connected to a sanitary sewer or storm drain.

CW1304-3.3 Installation of Mains - All main installations should be made in accordance with the AWWA Standard for Installation of Cast Iron Water Mains - AWWA C600 or other appropriate nationally accepted standards. Reference in the specification making the applicable standards an integral part of the specification and attaching a copy to the specification, will be an acceptable procedure. Installation procedures which digress from such standards may be accepted if explained in the engineering report and the FHA concurs that such installation procedure is appropriate to the site.

The depth of cover of the main shall be no less than the maximum frost penetration in the area, and shall be sufficient to safely sustain all anticipated live and dead loads in conjunction with the pipe material design.

CW1304-4 Valves and Appurtenances

CW1304-4.1 Gate Valves

a. Location - Valves shall be uniformly located in some standard area such as street or curb line to facilitate their location. A valve box, with its cover at the street grade, shall always be placed over a buried valve. A sufficient number of valves should be placed in the distribution system so that a short section of main may be repaired or serviced without interruption of service to more than one block. Valves should be located on all branches from feeder mains and between distributors and fire hydrants. Three valves should be used at crosses and two valves at tees; the valves should be placed on the smaller lines at each cross or tee. On arterial mains and minor distributors, valves should be placed at least every 1,200 ft.

b. Material - Gate valve construction and materials shall comply with the current AWWA Standard C500 - Gate valves for Ordinary Water Service.

CW1304-4.2 Air Relief and Blow-Off Valves

a. Applicability - Air-relief valves and blow-off valves should not be used except in locations where fire hydrants are not practical. Air-relief valves shall be located at high points on the line and blow-off valves shall be placed at low points.

b. Installation - These valves shall not be connected directly to any storm or sanitary sewer, whether installed in a pit, chamber, or by other means. Drainage should be made to the ground if possible, or to approved underground absorption pits.

c. Material - Details shall be submitted showing compliance with nationally acceptable standards or approved equal.

CW1304-4.3 Other Type Valves - Other type valves used, such as butterfly valves, pressure-relief valves, cone valves, etc., shall comply with nationally acceptable standards and be acceptable to FHA and any agencies having jurisdiction.

CW1304-5 Fire Hydrants

CW1304-5.1 Location - Hydrants should be spaced in accordance with the nature and characteristics of the area to be served, and comply to the extent applicable with the requirements of the fire insurance rating bureau. The current standards of the National Board of Fire Underwriters may be referred to as a guide.

CW1304-5.2 Material - The applicable specifications include:

AWWA C502 - Fire Hydrants for Ordinary Water Works Service.
AWWA C503 - Wet-Barrel Fire Hydrants for Ordinary Water Works Service.

CW1304-5.3 Drainage - Drainage from fire hydrants shall not be connected to Sanitary Sewers or storm drains. Acceptable methods will include drainage to the ground surface or to absorption pits provided exclusively for this purpose.

CW1304-6 Thrust Blocks

CW1304-6.1 Applicability - All plugs, caps, tees and bends deflecting $22\frac{1}{2}$ degrees or more on mains 8-inches in diameter or larger shall be provided with a reaction backing.

CW1304-6.2 Methods - The reaction backing should be concrete of a mix not leaner than 1 cement: $2\frac{1}{2}$ sand; 5 stone, and having a compressive strength of not less than 2,000 psi at 28 days. Backing shall be placed between solid ground and the fitting to be anchored; the area of bearing on the pipe and on the ground in each instance shall be shown on the plans. Other methods proposed shall be subject to acceptance by FHA.

CW1304-6.3 Standard - The current AWWA Standard C600, is applicable. Alternate methods will be considered.

CW1304-7 Water Pressure in System

CW1304-7.1 Design Criteria

a. Minimum working pressure in any part of the system shall be 20 pounds per square inch. This pressure pertains to the point of delivery of water to the consumer at the house service line, and for residences not exceeding two stories. A minimum working pressure of 30 psi should be provided wherever possible.

b. Normal working pressures under average conditions of flow should range between 30 and 70 psi.

c. Maximum pressures in excess of 100 psi should be avoided. Where topographic conditions prevent this, consideration shall be given to the installation of pressure reducing valves or establishment of pressure zones in the system. The engineer's report shall fully describe the methods to be employed.

CW1304-8 Meters

CW1304-8.1 Applicability - Meters shall be provided on each service connection. The measuring of the amount of water supplied each property will allow equitable service rates to be established.

CW1304-8.2 Materials - The applicable specifications include:

AWWA C700 - Cold Water Meters - Displacement Type.
AWWA C701 - Cold Water Meters - Current Type.
AWWA C702 - Cold Water Meters - Compound Type.
AWWA C704 - Cold Water Meters - Current Type Propeller Driven.
AWWA C703 - Cold Water Meters - Fire Service Type.

CW1305 PROTECTION OF WATER SUPPLIES

CW1305-1 Separation of Water Mains

CW1305-1.1 Horizontal Separation - Whenever possible, water mains shall be laid at least 10 feet, horizontally, from any existing or proposed sewer. Should local conditions prevent a lateral separation of 10 feet, a water main may be laid closer than 10 feet to a sewer if:

a. It is laid in a separate trench.

b. It is laid in the same trench with the sewer provided that the water main is located on an undisturbed earth shelf located on one side of the sewer.

c. In either case the elevation of the bottom invert of the water main is at least 18 inches above the top (crown) of the sewer.

CW1305-1.2 Vertical Separation - Whenever sewers cross under water mains, the water main shall be laid at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer. This vertical separation shall be maintained for that portion of the water main located within 10 feet horizontally of any sewer it crosses.

CW1305-1.3 Special - When it is impossible to obtain proper horizontal and vertical separation, both the water main and sewer shall be constructed with water-tight joints and pressure tested to assure water-tightness before backfilling. The sewer shall be tested at a pressure of not less than 15 pounds per square inch.

CW1305-2 Relation to Sewer Manholes - No water main shall pass through, or come into contact with any part of a sewer manhole.

CW1305-3 Cross Connections - There shall be no physical connection between the distribution system and any pipes, pumps, hydrants, or tanks which are supplied or may be supplied with a water that is, or may be contaminated except as approved in writing by the State Health Department and acceptable to FHA.

CW1305-4 Water Mains Near or Crossing Obstructions - Water mains within 10 feet of railroad tracks or crossing under railroad tracks shall be equipped with clamps or other acceptable provisions to minimize the affect of vibration. Mains crossing under waterways shall be laid with flexible water-tight joints, and valves shall be located at both ends of such crossing to permit isolation for repair, and testing of the section. Sampling taps shall be provided to facilitate sanitary control. These taps shall not be subject to flooding.

CW1306 WATER SERVICES AND PLUMBING

CW1306-1 Water services and plumbing shall conform to local and state codes or to the National Plumbing Code ASA A40.8, and be acceptable to FHA.

CW1307 DISINFECTION OF WATER MAINS

CW1307-1 For disinfecting newly laid mains or after repairs to the system, the mains shall be disinfected in accordance with AWWA Standard for Disinfecting Water Mains-C601 or the requirements of the State Health Department.