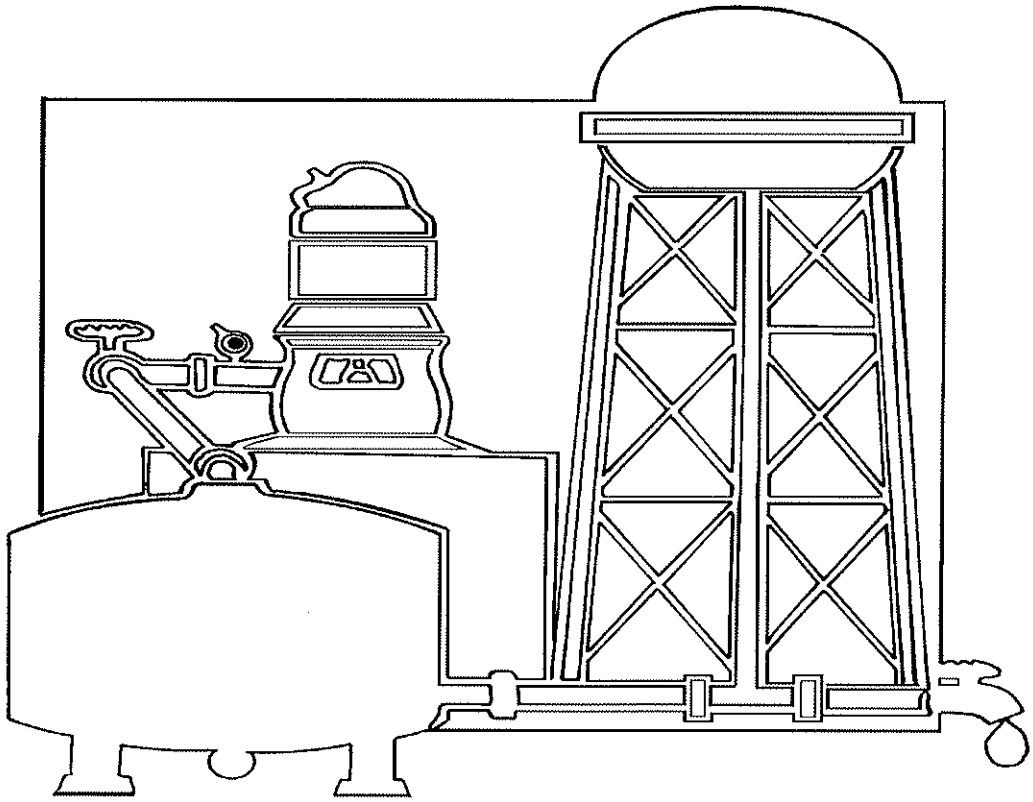
RECOMMENDED MINIMUM DESIGN CRITERIA
FOR
MISSISSIPPI PUBLIC WATER SYSTEMS



Mississippi State Department of Health
Division of Water Supply

August 2001

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Introduction

This document is a compilation of the minimum and recommended design criteria for public water systems in Mississippi. The purpose of these written standards is to serve as a guide to public water system officials, consulting engineers, Certified Waterworks Operators, and Division of Water Supply staff in designing new public water systems and in making modifications to existing public water systems.

It is recognized that every situation has not been addressed and that there may be situations where certain of these criteria do not apply. These instances will be handled on a case by case basis. The limitations of these design criteria are not meant to limit the scope of engineering design. Conversely, the development of new methods and innovative engineering design is encouraged. However, any new developments must be demonstrated to be satisfactory before approval can be given. These cases will be considered on an individual basis.

The 1997 Mississippi Legislature passed legislation revising the Mississippi Safe Drinking Water Act. This new law went into effect on July 1, 1997. One of the key provisions of this new law is a requirement that the engineering plans and specifications for extensions or modifications to public water systems must be approved by the Mississippi State Department of Health prior to beginning construction. The purpose of this new requirement is to protect the public health of all Mississippians by ensuring that all extensions or modifications to public water systems are designed and constructed in accordance with this agency's minimum design criteria. Violations of this law are subject to administrative penalties not to exceed $25,000 per day of violation. Additional information concerning our policy regarding when MSDH approval is required can be found on page 1 of this manual.

Questions or comments concerning this document or recommendations for improvement should be provided to the following address:

Director
Division of Water Supply
P. O. Box 1700
Jackson, MS 39215
Phone - (601)576-7518.
FAX - (601)576-7822

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Definitions

1. MSDH/DWS - Mississippi State Department of Health, Division of Water Supply

2. MSDH - Mississippi State Department of Health

3. Division of Water Supply - a division of the Office of Environmental Health, Mississippi State Department of Health

4. Public Water Supply or System - as defined in the Mississippi Regulations Governing Public Water Systems, promulgated under the Mississippi Safe Drinking Water Act

5. Shall or must - these are used to denote a mandatory requirement

7. Should - this is used to denote a recommended or desirable condition in most cases

8. AWWA - American Water Works Association

9. U.S. EPA - United States Environmental Protection Agency

10. ASME - American Society of Mechanical Engineers

11. OSHA - Occupational Safety and Health Administration, U.S. Department of Labor

12. NSF - National Sanitation Foundation

13. ASTM - American Society for Testing and Materials

14. gpm - gallons per minute

15. ID - inside diameter

16. OD - outside diameter

17. psi - pounds per square inch

18. Consecutive Supplies - any public water system that receives water from another public water system for distribution

19. SSPC - Steel Structures Painting Council

20. USDA - United States Department of Agriculture

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References

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2. "Community Public Water Systems Design Criteria", Division of Management, Tennessee Department of Health and Environment

3. Ground Water and Wells, Johnson Division, UOP, Inc., 1975

4. Handbook of PVC Pipe Design and Construction, Uni-Bell Plastic Pipe Association, 1979

5. "Recommended Standards for Water Works", Great Lakes - Upper Mississippi River Board of State Public Health & Environmental Managers, 1992

6. "Regulations Governing Public Water Supplies", Alabama Department of Environmental Management

7. "Regulations Governing Public Water Systems", Mississippi State Board of Health, 1997

8. "Rules Governing Public Water Supplies", Section 0600 through 2500 of the North Carolina Administrative Code, Title 10, Department of Human Resources, Chapter 10, Health Services: Environmental Health, Subchapter 10D, Water Supplies

9. "State of Illinois Rules and Regulations", Title 35: Environmental Protection, Subtitle F: Public Water Supplies, Chapter II: Environmental Protection Agency, Parts 651-654, Technical Policy Statement

10. "State of the Art of Small Water Treatment Systems", U.S. Environmental Protection Agency, Office of Water Supply, Washington, D.C. 20460, August, 1977

11. Unpublished data, Division of Water Supply, Mississippi State Department of Health

12. "Waterworks Operator Manual", Division of Water Supply, Mississippi State Department of Health

13. "Small Water Systems Serving the Public", Conference of State Sanitary Engineers, U.S. Environmental Protection Agency, July 1978

14. Secondary Maximum Contaminant Levels, Environmental Agency, Water Programs, Federal Register 42, Number 42, March 31, 1977, 17144-17146.

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Part I
Submission of Engineering Documents to MSDH

A. PRECONSTRUCTION REQUIREMENTS

1. Siting of Facilities (Preliminary)

Prior to the design or expansion of the source and treatment facilities of a public water system, the facility site plan should be submitted to the Division of Water Supply. Particular attention should be given to the location and protection from contamination of proposed new sources of water.

2. Plans and specifications approval

a. Prior to advertising for bids, or prior to beginning construction where bids are not received on a new public water system, or for extensions or modifications to an existing public water system, complete plans and specifications shall be approved in writing by the Division of Water Supply. The following general policy should be used to determine if MSDH/DWS approval is required for water supply extensions or modifications:

MSDH approval is required for:

- Water main extensions along public roads and any main extensions designed to serve more than one connection.
- Water treatment modifications that will change the chemical or biological quality of the drinking water provided to the customers.

If there are questions whether a water supply project must be approved, prior to employing a consulting engineer, system officials should submit a written description of the proposed project to this agency for review. Division staff engineers will review the proposed project and determine if MSDH approval is required. If MSDH approval is required, a consulting engineer must then be employed to develop engineering plans and specifications that must be submitted to the agency for review and approval prior to beginning construction.

b. Plans and specifications must be prepared, sealed and signed by a professional engineer licensed to practice in Mississippi in accordance with the requirements of the Mississippi State Board of Registration for Professional Engineers and Land Surveyors.

c. Incomplete and/or illegible documents will delay the review and approval process.

d. Separately bound specifications shall be submitted for public water systems. Standard specifications for projects may be approved and kept on file.

e. If requested, the MSDH/DWS will maintain, on file, a public water system's MSDH approved standard set of specifications for public water systems. The public water system's consulting engineer may then reference these "on file" approved specifications when submitting engineering projects for review and approval.

f. Plans and specifications submitted for review must be in accordance with Appendix C, "Information Needed for Division of Water Supply Review and Approval of Engineering Plans and Specifications for Mississippi Public Water Supplies".

B. POST CONSTRUCTION REQUIREMENTS

A letter of certification shall be submitted from the consulting engineer to the Division of Water Supply stating that the project was constructed in substantial compliance with the approved plans and specifications. Records of satisfactory microbiological results from an approved laboratory must be included with the certification. One set of as-built plans should be included if significant changes were made in the construction of the project. The Division of Water Supply, Mississippi State Department of Health must be notified of the final inspection in sufficient time to insure that a Division representative can be present.

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Part II
WATER USAGE REQUIREMENTS

A. The anticipated usage for a proposed system should be based on actual data from similar systems, taking into account agricultural and industrial usage, lot size, degree of urbanization, water loss and other factors influencing water usage.

B. The water system should be designed to supply all existing homes and lots in the certificated area, whether or not they have requested service. A reasonable growth factor should be included.

C. In the absence of actual data, water systems should be designed to supply the demands in Table 1.

D. Fire flows should be based upon the requirements of the lending agency or other appropriate authority, such as the Mississippi State Rating Bureau.

Table 1
Water Demands

Type of User	Average Usage - gallons per day per connection	Peak Usage - gallons per day per connection	Peak Demand* gallons per minute per connection
Rural Homes	200	400	1
Urban Homes	400	600	1
Subdivisions	400	600	1
Rural Apartments and Trailers	133	267	2/3
Urban Apartments and Trailers	267	400	2/3
Recreational Vehicles	100	200	1/2
Unmetered	150% of rural or urban usage, whichever applies		
Chickens		0.1 per chicken	
Cattle or hogs		15 per head	Depends on waste system
Schools	15-20 per student	30- 40 per student	

*For less than 100 connections or units, the design peak demand is given by the demand curve in Appendix E, "Minimum Flow Requirements for Small Water Systems Without Fire Protection". For apartments and trailers, the design peak demand is 2/3 of the demand curve. For recreational vehicles, the peak demand is 50% of the demand curve. For unmetered connections, the design peak demand is 150% of the demand curve. For non-community water supplies refer to Appendix E.

Example Demand Calculation:

A school with 900 students - unmetered
Peak Demand (gpd)/400 gpcd = connections
Peak Demand = 40 gpd x 900 students = 36,000 gallons
36,000/400 = 90 connections
Since system is unmetered multiply connections by a factor of 1.5
so 90 x 1.5 = 135 connections
Therefore this school would be equivalent to a water system with 135 connections

Part III
WELLS

A. WELL DRILLER REQUIREMENTS

All wells for public water supplies shall be constructed by a water well contractor licensed by the Mississippi Department of Environmental Quality.

B. WELL PERMITS

All wells shall be permitted as required by the Department of Environmental Quality.

C. LOCATION

Well sites shall be approved by the Division of Water Supply/Mississippi State Department of Health. The following criteria shall be considered in determining an acceptable well site:

1. Susceptibility of flooding - the top of the well casing shall be at least 1 foot above the 100 year flood or the highest year flood, whichever is higher
2. Distance from existing wells (depends on characteristics of the formation)
3. Accessibility
4. Sources of pollution - Minimum distance of 100 feet
5. Potential for development of the surrounding area
6. Proximity of roads, railroads, power lines, underground pipelines, cathodic protection systems and other possible causes of damage
7. Degree of natural protection from surface water
8. The ability to obtain water that is free of sand and which meets the current U.S.

EPA primary and secondary drinking water standards.

D. TEST HOLES

Test holes are drilled primarily to locate the depth of the aquifers, determine their relative thickness and to take samples of the aquifers penetrated. All test holes which will be used subsequently as test wells should be a minimum of 8 inches in diameter. Upon completion of a successful test hole, the following information should be made available to all interested parties.

1. Sand samples of the aquifer taken at 10 foot intervals and for any change in formation.
2. Drillers log of the test hole.
3. Gamma ray log of the test hole.
4. Electric log.
5. Sieve analysis of the sand samples for each 10 foot interval of each aquifer penetrated.

A legible copy of each of the items listed above should be forwarded to the Division of Water Supply for the official record.

E. TEST WELLS

1. A water sample for chemical analysis should be obtained from each potential aquifer to be considered.
2. Test Well Design.
   a. Upper casing should have a minimum inside diameter of 6 inches to allow

for pump clearance.

b. Screens should be of wire wrap design with a minimum outside diameter of 4 inches and a minimum length of 20 feet. Slot size should retain from 45% to 60% of the aquifer material.

c. Non-lead packers should be installed above and below the aquifer to limit the influence of other aquifers pierced by the test hole.

d. The test well should be properly developed and water samples should be free of drilling mud and sand. **NOTE:** Only non-organic drilling mud should be utilized in the construction of water wells.

e. The well should be pumped at a minimum rate of 75 gpm or 20% of the final design capacity.

f. Drawdown measurements shall be made at regular intervals during the first 1500 minutes of pumping and afterward until the static water level in the well has recovered.

3. Physical and chemical analyses shall be made of the samples taken after the pumping test and analyzed by a Mississippi State Department of Health approved laboratory to determine the water's suitability for public water supply use. A legible copy of these analyses should be forwarded to the Division of Water Supply for the official record.

F. OBSERVATION WELLS

1. Observation wells for permanent use shall be properly protected from sources of contaminants in the same manner as permanent wells for a public water supply.

2. The casing should extend at least 1 foot above the expected 100 year flood and be provided with an overlapping, lockable cover with a lock.

G. ABANDONED HOLES, TEST WELLS AND WELLS

1. All abandoned wells, test wells, temporary observation wells and holes to or through any aquifer shall be filled with cement grout introduced at the bottom and pumped to the ground surface in one continuous operation.

2. A licensed Professional Engineer may be employed to design an alternate abandonment technique. Any alternate technique must be approved by the Division of Water Supply prior to its application. Written certification of completion from the engineer in charge of the abandonment procedure is required.

H. DESIGN OF WELLS SHOULD MEET THE REQUIREMENTS OF THE LATEST REVISION OF AWWA A100.

1. Capacity

A well or well field shall be designed to operate to prevent excessive depletion of the aquifer and to provide standby capacity.

2. Well Casings

a. Well casings shall be installed to prevent the vertical migration or entrance of adjacent ground or surface water. They should be so constructed and

installed to prevent corrosion by aggressive water. They should be sufficiently sized and installed to allow installation, maintenance, or measurements of the pump, water levels, lap pipe and screen. Table 2 indicates recommended casing sizes for various yields, taking into account pump efficiency, head losses and adequate clearance for proper installation of 1760 rpm vertical turbine pumps. In some cases, the casing may need to be larger than indicated by the table to allow for pump settings in the lap pipe. The use of submersible pumps requires additional clearance to prevent excessive head losses in the annulus between the motor and the casing.

Table 2

Recommended Well Casing and Screen Diameters

Proposed well yield, gpm	Nominal size of pump bowls, inches	Optimum size of well casing, inches	Maximum screen size for gravel packed wells
50 - 150	6	10 ID	6
100 - 700	8	12 ID	8
250 - 1500	10	14 OD	10
700 - 2400	12	16 OD	12
900 - 3000	14	20 OD	16
3000 - 4500	16	24 OD	20

b. An annular space on the outside of the casing of at least 2-1/2 inches shall be sealed with cement grout for the full length of the casing. The well casing shall be cemented in place by the Halliburton or other satisfactory method. The Halliburton method requires forcing cement grout in the annular space between the casing and the drill hole from the bottom of the well to the top, thus assuring exclusion of all the water above the water-bearing stratum from which the supply is taken. The grout should be neat cement weighing at least 14 lbs/gal (13 lbs/gal is acceptable if grout contains 8 % bentonite gel).

c. The top of the well shall be sealed to prevent the entrance of contaminants. Properly protected vacuum relief openings should be provided except in the cases where prevented by artesian head.

d. The casing should be provided with an access pipe which is at least 2 inches in diameter to allow for water level measurements. If this is also used as the casing vent, it must be screened and elbowed.

e. The same size casing shall extend from above the top of the foundation to the top of the water bearing stratum.

f. Steel casings shall meet the requirements of the latest revision of the applicable AWWA standard.

g. PVC casings may be allowed provided the justification for their use outweighs the risk of failure. PVC casings shall be designed to withstand

the stresses of installation but shall be limited to the following depths:

SDR*	Depth, FT
26	125
21	250
17	500

* Check manufacturers nominal internal diameters

h. The interior of a mild steel outer casing, the interior/exterior of the lap pipe, pump column and tail pipe in wells with corrosive water should be protected with an EPA or NSF approved coating to prevent corrosion or constructed of corrosion resistant material such as stainless steel. Special attention should be given to sealing the column pipe, coupling, threads and joints.

i. A tight joint is required between well casing and pump head.

The pump head shall be connected to the outside casing by a water-tight threaded connection or by the outside casing being carried to a point not less than one inch above the pump head foundation. Before setting the pump head casing, the contractor shall provide a vacuum seal between the foundation and pump head casing where a partial vacuum will be created. Where submersible pumps are used, a satisfactory water-tight mechanical seal shall be provided.

j. The pump head shall be mounted on a chamfered concrete foundation not

smaller than 24 inches square at the top, extending not less than 18 inches into the solid ground and not less than 18 inches above the finished grade or the 100 year flood elevation.

3. **Well Screens**

Screens should be designed and installed in such a way as to maximize well efficiency, consistent with constraints of aquifer retention. Refer to Table 2.

a. Screen slot sizes should be designed based on the gradation of the adjacent gravel pack or aquifer material, as determined by sieve analysis.

b. Total open area of the screen should be such that the maximum entrance velocity is limited to 0.1 feet per second.

c. The screen shall be constructed of type 304 stainless steel, be rod-based and wire wrapped. Other materials when adequately justified will be considered on a case by case basis. Shutter screens are not acceptable.

d. The gradation of the gravel pack material should be based on the gradation of the adjacent aquifer material, as determined by sieve analysis. The thickness of the annular gravel envelope should be between 3 inches and 8 inches to allow complete development of the well.

e. The bottom of the screen should be fitted with a backwash valve if needed to permit washing of the screen and to prevent inflow of sand.

4. **Lap pipe**

The lap pipe should extend into the casing a distance sufficient to assure concentric

alignment of the screen and casing. This must be at least 60 feet for straight wall wells. For gravel packed wells, the lap pipe must be 60 feet or at least as long as the screen for alignment and for storage of additional gravel pack. The space between the lap pipe and the casing should be filled with specially graded gravel according to sieve analysis to prevent sand pumpage. Any deviation from these minimum lap pipe lengths must be approved by this agency prior to construction and will be considered strictly on a case-by-case basis.

5. Pumping equipment

a. The pumping equipment should be designed to deliver the required flow and pressure at the maximum efficiency available.

b. Appurtenances on wells shall include:

i. 3/4 inch sampling faucet installed between the pump discharge flange and chlorination - if it is installed upstream of the check valve, it should be a non-hose bib design and should not be installed on the blind flange of the discharge tee.

ii. Provision for adequate shaft lubrication:

I. Water lubrication - line shaft vertical turbine pumps should be of the water lubricated type, if practical, to prevent problems resulting from the introduction of oil into the system.

a. The pre-lubricating water should be from an

approved source of water, preferably the well itself. If a foot valve is used to hold the pump column full of water, a simple bypass around the check valve is sufficient.

b. The pre-lubricating water should not be allowed to run continuously into the well. A normally open solenoid valve should be used so that an electrical failure will not prevent the flow of lubricating water.

II. If oil lubricated, a non-petroleum based product meeting USDA H1 standards should be used.

iii. Test tee.

iv. Check and gate valve.

v. Freeze protection where needed.

vi. A master meter shall be provided for all public water supply wells. It shall be installed downstream of the check valve according to the manufacturers recommendations and be properly sized to accurately determine well capacity and amount of water pumped.

vii. Lightning and phase failure protection for all three-phase equipment

viii. Anti-reverse ratchet to prevent backspin or a time delay.

ix. An air release valve prior to the check valve.

x. A screened and elbowed (double ell) casing vent. (For flowing

wells a check valve should be installed on the vent.)

xi. Single piece non-plastic air line gauge for water level measurements

xii. Casing access pipe of at least 2 inches in diameter for water level measurements.

c. The use of a submersible pump with a foot valve eliminates the need for item ii.

d. Corrosion resistant materials should be used for the pumping equipment if the corrosiveness of the water is expected to significantly reduce the life of mild steel components.

I. WELL CONSTRUCTION

1. An electrical resistivity and spontaneous potential log should be completed on each drilled hole and be evaluated in relation to other data prior to installation of the casing.

2. The well should be developed to its maximum practical efficiency and be free of visible sand and drilling mud. Turbidity due to the drilling process and/or construction of the well should not exceed 5 NTUs.

3. A pumping test of sufficient duration should be completed with the temporary pumping equipment on the final well to determine anticipated capacity and drawdown.

4. The permanent pump bowls should be set to maintain a 30 foot minimum submergence after pumping for 24 hours at open discharge.

5. After drawdown has stabilized on the well, the permanent pump should have step tests performed to determine capacity. The steps should be in increments no greater than 10 psi and should be from open discharge to shut-off head. Drawdown shall be measured after stabilization for each increment of pressure.

6. Well efficiency - should be minimum of 70% for wells utilizing at least 60% of formation.

7. Water samples should be collected and submitted to the Mississippi State Department of Health or a state approved laboratory for chemical analysis.

J. DISINFECTION

1. All water used in the drilling and construction process shall be obtained from sources of proven satisfactory quality and shall meet the primary standards of the Safe Drinking Water Act Regulations.

2. Gravel to be placed in a well should be disinfected with a solution of at least 50 mg/l free chlorine. A residual of no less than 5 parts per million of chlorine shall be maintained in any water used for development.

3. Upon completion of the well, the well and adjacent aquifer shall be disinfected as necessary using a solution of 50 mg/l free chlorine applied for 24 hours. After disinfection, the well shall be pumped until two consecutive chlorine-free samples are collected from the well which show no coliform bacteria and no confluent growth. The samples shall be collected, submitted and analyzed according to the Mississippi State Department of Health requirements. The second sample shall be

collected following at least two hours of continuous pumping after the first sample. A disinfectant must not be applied between samples.

The person collecting the official microbiological sample(s) must be a representative of the Mississippi State Department of Health, the Licensed Professional Engineer for the project, or the Certified Waterworks Operator for the public water supply.

4. If water from a private well is used, microbiological samples shall be examined prior to use. Routine samples from public supplies may be used as a basis for determining if a supply is satisfactory.

5. The disinfection procedure should meet the current AWWA standard (C654). A solution strength of 50 mg/l free chlorine applied for 24 hours is recommended.

6. When a well has been repaired, such as lowering or replacing the pump, the well should be disinfected. At least two (2) microbiological water samples, taken 2 hours apart with the well pumping continuously, must be obtained prior to placing the well back in service. No coliform bacteria should be present in these samples. If coliform is present, the well should be re-disinfected and re-sampled.

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Part IV
WATER TREATMENT

Treatment facilities shall be provided for all public water to the extent necessary to insure compliance with the Primary Drinking Water Standards established by the U.S. EPA. Treatment facilities should also be provided to the extent necessary to insure compliance with the Secondary Drinking Water Standards and to remove any other harmful or objectionable constituents or qualities. Refer to Appendix A and Appendix B.

A. DISINFECTION

Automatic chlorination equipment is required on all new public water supplies. Chlorination is required on all previously unchlorinated public water supplies at such time that improvements or extensions are made. Chlorination shall be required on those systems that have been unable to meet the microbiological standards of the Safe Drinking Water Act. Disinfectants other than chlorine may be approved on a case by case basis.

1. Gaseous chlorinators shall be of the type with the regulator mounted directly on the chlorine cylinder, which will eliminate any pressure tubing.
2. Chlorination equipment shall have the capacity to feed approximately a 4 mg/l dosage of chlorine and provide a free chlorine residual after the initial chlorine demand has been satisfied.
3. Chlorine cylinders and chlorine pressure tubing should be isolated from electrical equipment, motors, pumps and other materials and chemicals subject to corrosion or oxidation.

4. Walk-in chlorinator and chlorine rooms shall have positive ventilation of at least one fresh air change per minute. Ventilation at the floor level should be provided for chlorinator and chlorine storage rooms.

5. Walk-in chlorine storage and chlorinator rooms shall not have locking restrictions when opening from the inside. The doors should swing open to the outside.

6. 100 and 150 lb. chlorine cylinders must be secured in an upright position.

7. Installation and controls for the chlorinator should be as indicated in Appendix H memo.

B. FLUORIDATION

1. Fluoridation facilities shall be capable of maintaining a uniform fluoride concentration in the water between 0.8 mg/l and 1.2 mg/l.

2. To facilitate precise control, fluoridation equipment shall not have excessive capacity over that required to maintain 4 mg/l fluoride in the treated water.

3. Automatic controls shall be provided which prevent excessive feed rates. The fluoridation unit shall be wired so that it can run only when the well or service pump runs. **Manual fluoridation controls are not acceptable**.

4. The fluoridation systems shall be designed to prevent back-siphonage or uncontrolled flow of fluoride into the water supply.

C. CORROSION CONTROL AND STABILIZATION

1. Corrosion control plants should be capable of adjusting the pH to the $CaCO_3$ stability point.
2. Sampling faucets prior to chemical addition must be provided on the degasifiers (aerators).
3. Aerators should reduce the CO_2 content of the water to 10 mg/l or less.
4. The maximum loading rate should be 10 gallons per minute per square foot for natural draft aerators and 20 gallons per minute per square foot for induced draft and force draft aerators.
5. All aerators without subsequent filtration shall be screened with corrosion resistant material and properly protected from insects and other contaminants.
6. All natural draft aerators should have an alternate chlorine application point prior to the aerator distribution tray to allow periodic treatment with chlorine to control algae growth.
7. Corrosion control plants should have a minimum detention time of 30 minutes to allow for an adequate chlorine contact time and for dissolution of chemicals.
8. Re-carbonation basins should have a minimum detention time of 20 minutes.
9. Phosphates may be used for corrosion control on a case by case basis.

D. CLARIFICATION

This is a combination of the processes of mixing, coagulation, flocculation and sedimentation to remove unwanted solids and to reduce the filter loading. These processes may be carried out in

a single unit, the upflow clarifier. Tube settlers may be used to enhance sedimentation efficiency. The treatment scheme should be based on the chemistry of the water and the degree of treatment required, with the aid of jar tests, bench tests and pilot plants. The following criteria should be used as guidelines:

1. **Rapid mix**

   a. Detention time: 10-60 seconds

   b. Minimum velocity gradient: 300 ft./sec./ft.

      Note: For surface water using metal coagulants, uniform mixing for less than 10 seconds is recommended.

2. **Flocculation**

   a. The basin should be designed to prevent short circuiting and destruction of floc.

   b. Detention time: 30-45 minutes

   c. Peripheral paddle speed: 0.5 - 3.0 ft./sec.

   d. Flocculation and sedimentation basins should be as close together as possible. The velocity of flocculated water through pipes or conduits should be between 0.5 and 1.5 ft./sec.

3. **Sedimentation**

   a. Conventional

      i. Detention time: As determined by bench and pilot plant testing

      ii. Velocity: 0.5 - 1.0 ft./min.

iii. Maximum overflow rate: 0.25 - 0.38 gpm/ft.^{2}

iv. Outlet weir loading: 8 - 15 gpm/ft. The higher rates are for heavier floc such as that obtained from lime-soda softening.

Note For Surface Water:

* Length to width ratio should be 4 to 1 minimum.

* Length to depth ratio should be 15 to 1 minimum.

Detention Time should range from 1.5 to 4 hours.

b. Tube settlers - Tube settlers may offer advantages over conventional sedimentation in many cases. Proposals for tube settlers should be supported by adequate data from pilot plant or full scale demonstrations.

c. Sludge handling and disposal - Adequate provisions should be made for automatic removal and approved disposal of water treatment plant sludge. Alternative methods of water treatment and chemical use should be considered as a means of reducing sludge handling and disposal problems.

4. Upflow Clarifiers

These are acceptable for clarification or softening where water characteristics and flow rates are uniform.

a. Upflow rate - The maximum upflow rates used vary from 0.75 gpm/ft.^{2} to 1.25 gpm/ft.^{2}. The lower rates are for iron removal and surface water and the higher rates are for heavier floc such as for softening.

b. Maximum weir loading.

i. Clarification: 10 gpm/ft.

ii. Softening: 20 gpm/ft.

E. FILTRATION

Filter units may be either gravity filters or pressure filters, depending on the degree of pre-treatment required. Pressure filters are normally used to remove small amounts of iron and manganese, where clarification is not economical or practical. Gravity filtration shall be used on all surface water sources. Filtration shall be required on all new spring or surface water supplies.

1. A bypass should be constructed on all single unit filters to allow for maintenance. Multiple units with no bypasses shall be used for surface water treatment.
2. Where potassium permanganate is used prior to filtration, the chlorine application point should be as far as possible upstream of the permanganate application point.
3. The influent water should be baffled to prevent upset of the media.
4. The filter tank should be of sufficient height to allow the necessary media expansion required for adequate backwashing without loss of media.
5. Air wash facilities should be provided where manganese zeolite filter media is used.
6. Surface wash facilities should be used on gravity filters treating surface water.
7. A sufficient quantity of water should be provided for a minimum backwash time of 20 minutes while still maintaining adequate flow to the system.
8. A means of measuring loss of head through the filter should be provided on each filter unit.
9. Filter to waste piping must be provided, along with provisions for automatically maintaining normal flow while filtering to waste.

10. A positive means of automatically controlling the backwash flow rate should be provided. A means of easy observation of the backwash water should be provided.
11. A means of sampling the influent and effluent of each filter unit shall be provided.
12. A means of monitoring filter effluent must be provided for each cell.
13. An automatic air release valve and a man hole which is at least 18 inches in the smallest dimension should be provided on pressure filters.
14. The filter media size, filter rate, backwash rate and media depth should be within the guidelines in Table 3. The higher filtration rates pertain to multimedia filters or anthracite filters with low solids loading. Dual media filters with 12 - 18 inches of anthracite are recommended.
15. In placing media in multimedia filters, each successive type of media shall be backwashed at least twice and skimmed to remove fine particles prior to placement of the next type of media.
16. The underdrains shall provide uniform backwash distribution over the entire area of the filter. They may be of the header and lateral type with graded gravel or they may be the false bottom type, with properly designed strainers in relation to the support and filter media proposed.
17. Settling ponds should be considered for backwash water and other waste discharges in order to meet Mississippi Department of Environmental Quality requirements.
18. Provisions should be made for recycling backwash water.

Table 3
Filter Design Criteria

Parameter		Media	
	Sand	Anthracite	Mn Greensand
effective size, mm.	0.45 - 0.55	0.7 - 1.2	-----
maximum uniformity coefficient	1.5	1.5	-----
filter rate, gpm/ft.^{2}	2 - 4	2 - 4	2 - 4
backwash rate, gpm/ft.^{2}	15 - 18	10 - 12	8 - 10
media depth, ft. * (excluding gravel)	2-3	2	1.5

* for single media filters

F. WATER WITH LOW IRON AND MANGANESE CONCENTRATIONS

Water with low iron and manganese concentrations (0.3 - 1.5 mg/l Fe, 0.05 - .30 mg/l Mn) may not require clarification prior to filtration. A detention time of 30 minutes should be provided to allow for complete oxidation, unless potassium permanganate is used as an oxidant.

G. CHEMICALS

1. Chemical containers should be labeled to provide the following information:
   a. Chemical name, purity and concentration
   b. Name and address of supplier
   c. Expiration date where applicable

2. Chemicals should meet the latest revision of the applicable AWWA standards and have NSF approval for use in potable water.

3. Chemical additions to the water shall be compatible under recommended dosages and should not impair the efficiency of disinfection.

H. DISINFECTION OF TREATMENT FACILITIES

The disinfection procedure should meet the current AWWA standard (C653). A solution strength of 50 mg/l free chlorine applied for 24 hours is recommended. The discharge of highly chlorinated water will require a permit from the Department of Environmental Quality/Office of Pollution Control. At least one clear microbiological water sample shall be collected by a representative of the Mississippi State Department of Health, the Licensed Professional Engineer in charge of the project, or the Certified Operator for the public water supply. Samples with "No Coliform Present" shall constitute acceptable sample(s) when analyzed by the Mississippi State Department of Health or a laboratory certified by the State.

I. OTHER

1. Process diagrams may be required for certain complex treatment processes.

2. All plant piping should be color coded in accordance with recommendations published in "Recommended Standards for Water Works", 1992 issue.

3. All controls for sources, water levels, etc. should be accessible from the treatment plant.

4. An alternate power source should be considered in case of power loss.

5. Any discharges from water treatment facilities will be regulated by the Mississippi Department of Environmental Quality/Office of Pollution Control.

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Part V
WATER DISTRIBUTION

A. DISTRIBUTION SYSTEM DESIGN

1. Pressures

The distribution system should be so designed as to maintain a minimum dynamic pressure of 20 psi and a maximum static pressure of 80 psi. Higher pressures may be considered on a case by case basis provided individual pressure reducers are used on the services.

2. Pipe sizes

All water mains should be designed based on hydraulic analysis using an appropriate friction coefficient.

a. The maximum Hazen-Williams C value to be used is 120.

b. The minimum main size shall be 4 inches regardless of the results of the hydraulic analysis. Smaller lines may be considered on a case by case basis.

c. The minimum main size supplying fire hydrants with pumper connections should be as determined by hydraulic analysis using fire flows, but not less than 6 inches. Flushing (2-way) hydrants may be installed on 4 inch lines if the hydraulic analysis demonstrates satisfactory pressure under fire flow conditions.

d. The maximum velocity in all source, treatment and distribution system piping should be limited to 5 feet per second to minimize friction loss.

3. Materials

All materials not specifically referenced in these guidelines shall be non-toxic and approved for use in potable water systems by AWWA, U.S. EPA, Underwriters Laboratory, National Sanitation Foundation or other appropriate organization.

a. Cast iron, ductile iron and steel pipes and fittings shall comply with the latest applicable standards issued by the American Water Works Association.

b. PVC pipe shall bear the National Sanitation Foundation seal for potable water and meet the requirements of ASTM D 1784 for Class 12454 A or 12454 B compounds. The pipe shall meet the latest revision of the applicable AWWA or Commercial Standards. To provide a safety factor for the surges in PVC pipe using Commercial Standards the maximum pressure should be limited to one-half of the manufacturers pressure rating of the pipe.

c. For static pressures up to 80 psi, 160 psi pipe (SDR 26) may be used. For static pressures greater than 80 psi, 200 psi pipe (SDR 21) should be used.

d. Asbestos cement pipe will not be approved by this office. Existing asbestos cement pipe should be replaced as soon as possible.

4. Consecutive Public Water Systems

Water supplies which meter water through a master meter should use a compound meter unless flows are continually maintained at a rate which will register

accurately on the meter.

B. INSTALLATION

1. Pipe laying

Pipe installation should comply with generally accepted standards of good workmanship, including applicable AWWA and industry standards, along with, but not limited to the following:

a. A continuous uniform bedding should be provided, free of stones and debris within 6 inches of the pipe in the bedding and cover material.

b. There should be a minimum of 30 inches of cover.

c. While under construction, unattended exposed pipelines must have the ends capped. All materials to be used in construction shall be stored above the ground in a manner that will minimize the possibility of contamination.

d. Adequate separation from other utilities for maintenance and/or repair should be provided.

e. Detectable marking tape should be installed on all new pvc water mains to aid in the location of these lines in the future. It is recommended that the tape be blue in color.

2. Separation of Water and Sewer Mains

a. Water mains shall be located on opposite sides of the street from sewers where possible.

b. Adequate separation of water and sewer lines shall be based on the

following factors:

i. Materials and type of joints for water and sewer pipe.

ii. Soil conditions.

iii. Natural drainage and subsurface flow.

iv. Any other local condition affecting the construction, maintenance or future integrity of the installation.

c. Water mains located near sewer lines.

i. Water mains shall be laid at least 10 feet horizontally **and** 18 inches vertically from any sanitary sewer or manhole. The bottom of the water line should be at least 18 inches from the top of the sewer line. (Water lines should always be constructed above sewer lines. Under extraordinary circumstances, the Division of Water Supply may approve the construction of a sewer line above a water line provided the design engineer meets special construction requirements as determined by the Division.

ii. Where local conditions prevent adequate horizontal and vertical separation, the Division of Water Supply may allow the water line to be laid closer to the sewer line if supported by adequate data from the design engineer. Each situation will be reviewed on a case by case basis. A detailed drawing shall be included in the plans for the water line construction submitted to the Division of Water

Supply for review and approval.

Where adequate horizontal and/or vertical separation cannot be maintained, the following requirements shall apply:

I. If the 10 foot horizontal separation between water and sewer lines cannot be maintained then the water line should be ductile iron with water line joints located at the maximum distance possible from sewer line joints. PVC pipe may be used if it is protected by a steel casing. Also the water and sewer lines must be in separate trenches with adequate space for maintenance. In some cases, special sewer line construction procedures may be required.

II. Where the 10 foot horizontal **and** 18 inch vertical separation cannot be maintained, condition I. must be met **and** the sewer line shall be constructed according to water main standards.

NOTE: Where water lines cross sewer lines, the above requirements will be waived if pipe segments are centered to provide maximum spacing of the joints of both water and sewer lines and a vertical separation of at least 18 inches (water over sewer) is maintained.

d. Water lines and sewer lines should be shown on the same layout

sheet whether sewer lines are existing or proposed.

e. Potable water lines shall be clearly and permanently identified where pressure sewer systems exist or where sewers are constructed of water pipe.

3. **Surface Water, Ditch and Roadway Crossings**

a. Water lines crossing ditches and/or streams where less than 30 inches of cover is maintained should be ductile iron pipe or protected by a steel casing. Adequate support and anchorage should be provided on both sides of the ditch.

b. Exposed stream crossings should be above the 100 year flood.

c. PVC pipe crossing roadways should be protected by a steel casing. This office recommends ASTM A252 or ASTM A139 Grade B or better. Pipe should be 35,000 psi ultimate strength.

d. Recommended casing size should be two diameter sizes larger than the pipe to allow for future expansion.

4. All water users should be individually metered.

5. A sufficient number of valves should be provided for line maintenance, repairs and isolation of fire hydrants.

6. Flushing hydrants should be installed on all dead end lines, low areas and in other places that might require flushing. They should be installed in areas where 2.5 ft/sec. velocity can be obtained for adequate flushing.