ADEM Design Guidance

Plan Preparation and Design Guidance for Drinking Water Facilities

Alabama Department of Environmental Management

Water Division – Public Water Supply Branch

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December 1998

Introduction

Projects submitted for a permit must meet the latest edition of ADEM Division 7 Regulations. Projects must also meet Design Guidance Criteria unless written exclusion is provided by the Chief of the Water Supply Branch. Exceptions to the Design Guidance Criteria must be noted and supporting documentation provided to justify such exceptions. Water Supply Branch staff will use ADEM Administrative Code Division 7 and ADEM Design Guidance as a guide when reviewing all proposed construction projects.

TABLE OF CONTENTS

PART I

Project Documentation

PART II

Groundwater

PART III

Surface Water

PART IV

Pumping Stations

PART V

Finished Water Storage Facilities

PART VI

Distribution System

PART I

Project Documentation

Preliminary Engineering Reports

1. Submit a Preliminary Engineering Report a minimum of 60 days prior to submitting an application for a water supply permit for the construction of additions or a new facility, which includes the following:
    a) A general description of the existing system.
    b) A general description of the proposed additions, including the following:

i. General description of the nature and extent of the area to be served with water and any provisions for extending the water works system to serve additional areas, including future water facility needs,

ii. General description of existing and future industrial developments and industrial water supply,

iii. Description of population trends,

iv. Present and future water consumption as a basis for design,

v. Detailed description of the proposed source(s) of water supply to be developed and justification for selection to include:

1) Hydrological data, flow (maximum and minimum), a summary of the water quality, potential sources of pollution and its classification if a surface source is to be used,

2) Proposed water works structure sites with elevation information pertaining to geological formations expected to be encountered and any Alabama Geological Survey or United States Geological Survey recommendations,

3) Proposed plan to delineate the Source Water Assessment Area, and complete the

Contaminant Inventory for the proposed source, and

4) One year record of flow, turbidity and total/fecal coliform analytical data if the proposed source is a spring or surface supply.

5) Analytical data pertaining to the character and quality of the raw water supply being developed with special reference to changes in quality, effects of changing meteorological conditions, and other pertinent factors which establish the character and quality of the raw water.

vi. Description of the relationships of any sewage system, either proposed or existing, which may affect the quality of the supply,

vii. Discussion of each alternative when more than one option exists for providing public water supply facilities, feasibility of each and reasons for choosing the selected option,

viii. Summary of the proposed treatment processes,

ix. Discussion of the various waterworks structure sites including the proximity of residences and industrial establishments on adjacent property and advantages of the recommended sites,

x. General layout of the existing and proposed distribution system including main sizes, spot elevations, customer locations, water facility locations and adjacent water systems' lines and facilities (recommended scale one-inch = 2,000 feet minimum),

xi. Estimated cost of integral parts of the water works project including construction costs and estimated annual costs of operation and maintenance,

xii. A demonstration that water rates and connection fees for a new system are adequate to cover all operation and maintenance costs and mortgage payments,

xiii. Proposed methods of financing to include capital outlay and operating expenses,

xiv. Identification of flood prone areas, and

xv. Assurance of a sufficient source of supply, including existing system demand and availability. For purchase systems, attach a copy of the water purchase agreement(s).

General Permitting Requirements

1. All projects must be constructed as permitted unless otherwise approved by the Department.
2. A transmittal letter with the project description must be submitted with the permit application.

Plans

1. Submit bound plans in duplicate with a completed application and appropriate fee for a water supply construction permit.
2. Provide plans using a scale sufficient to show adequate detail on 24 by 36-inch sheets.
3. Include title sheet with the name of the water system or establishment served, date, name of engineer and the imprint of his/her professional stamp.
4. Include an Index of Drawings.
5. Include a layout sheet with the following information:
    a) North arrow,
    b) Location and size of existing water mains, the location, elevation and nature of existing water works structures related to or near the proposed improvements and static and residual pressures at all proposed interconnections,
    c) Proposed water mains, tanks, and booster stations, sources and treatment facilities, clearly identified with sizes and capacities,
    d) Delineation of service limits for municipality, water district or specified area to be served,
    e) Location of adjacent water systems with water lines and facilities in the vicinity of the proposed project,
    f) Tank overflow elevations, pump locations with elevations, and any additional spot elevations in the distribution system required to perform a hydraulic analysis,

6. Include detail sheets with the following information:
    a) Grading plan for all facilities,
    b) Water lines with proposed and potential customer locations (with legend),
    c) Water mains (type, size, class) and installation (depth of cover, distance to other utilities, tracer wire location),
    d) Bridge and stream crossings,
    e) Valve, fire hydrant, flush hydrant, customer connection, metering station, pressure reducing station, and others as needed.
    f) Plan and elevation views of all facilities.

Specifications

1. Submit bound documents in duplicate with plans and water supply permit application.
2. Include bid schedule or detailed material lists.
3. Provide detailed specifications of the integral parts of proposed project.

PART II

Groundwater

Materials of Construction

1. Use only chemicals meeting NSF standard 60 and equipment and coatings meeting NSF standard 61 and that are acceptable by the Department.
2. Use only non-metal materials unless basins/structures associated with water treatment can be taken out of service for at least 10 days without affecting the water supply to customers.

Discharge Permits

Apply for a NPDES Discharge permit through the Municipal Waste Branch of ADEM 180 days prior to expected date discharge is to begin or date water treatment plant is expected to begin operation.

Well Construction

1. Water used in the drilling and construction of wells must meet all drinking water standards and contain a minimum chlorine residual of 10 milligrams per liter (mg/l).
2. Assure plumbness and alignment of a constructed well.
3. Do not adversely impact the quality of water from the aquifer.

Gravel Wall Well

1. Use cleaned and disinfected siliceous type material, which is free of carbonates and foreign matter.
2. Provide a minimum 4-inch gravel wall around the screen and avoid leaking grout to the screen during the grouting operation.
3. Extend lap pipe from the top of the screen to a point at least 15 feet above the bottom of the adjacent well casing.

Straight Wall Well

1. Use straight wall construction when the formation is adequate to allow development of the screened formation without a gravel wall.
2. Use material for packers, which will not impart taste, odor, toxic substances or cause bacteriological contamination of water in the well.

Artesian Well

1. Extend the drill hole to the top of the artesian formation.
2. Set a protective casing.
3. Fill the annular space with grout.
4. Extend the drill hole into the formation.
5. Join the inner casing in a watertight manner to the protective casing where needed to prevent erosion of the confining bed by the flowing water.
6. Control the flow from artesian wells with valved pipe connections, watertight pump connections or receiving reservoirs set at an elevation corresponding to that of the artesian head.

Screens

1. Use screens made of material which cannot be damaged as a result of chemical action of the water.

2. Use stainless steel screens in community water supply wells.

Pump Installation and Water Level Monitoring

1. Install pumping equipment such that the point of water intake is not below the elevation of the upper most water source or formation used.
2. Install pumping equipment in a manner that allows the water level to be monitored during normal operation of the well.
3. Install an air line made of copper or approved extruded non-metal material with an inside diameter of at least 3/8 inch, extended to a point below the pump bowls with its exact length inscribed on the altitude gauge for each completed well.
4. Provide a 1-inch diameter opening with a removable cap to allow insertion of a measuring tape or probe into the well between the suction column and casing for an alternate means of water level measurement in each completed well.
5. Use continuous water level monitoring equipment in wells where the water level falls below the top of the pump bowls during normal operation.

Treatment

Chlorination and Equipment

1. Use solution feed gas type chlorinators for all groundwater sources, unless written approval for an alternate method is obtained from the Department.
2. Provide equipment sufficient to feed 5 mg/l of chlorine at the anticipated maximum flow rate of the water source.
3. Install automatic switchover units on chlorine cylinders.
4. Use a booster pump when sufficient differential water pressure is unavailable to satisfactorily operate solution feed gas type chlorinators.

5. Provide an adequate supply of finished water obtained approximately 30 feet downstream of the chlorinating point for solution feed gas type chlorinator equipment.
6. Provide a system for accurately weighing each chlorine cylinder.
7. Provide spare parts or duplicate chlorine feed equipment at each treatment site.
8. Locate chlorine cylinders and other equipment which contains chlorine away from electrical control panels and other equipment which could be damaged and render the facility inoperative should a gas leak occur.
9. In common wall construction provide a glass window for viewing of the treatment room.
10. Provide sufficient ventilation of the facility housing chlorinating equipment by using an exhaust fan.
11. Locate the air discharge from the chlorine room approximately 8-inches above the floor with the outside discharge pointing away from the entrance.
12. Locate electrical switches for operation of exhaust fans and lights outside the facility housing solution feed gas type chlorinating equipment.
13. Install a chlorine leak detector with an alarm system.
14. Provide doors with non-locking restrictions to allow opening from inside.
15. Provide controlled conditions inside chlorinator rooms to prevent extreme temperature changes.
16. Provide a self-contained breathing apparatus capable of supplying at least 15 minutes of usable air.
17. Provide proper safety equipment where it can be easily obtained in an emergency situation.

Fluoridation

1. Obtain ADEM authorization prior to the use of fluoride.
2. Administer fluoride chemicals under pressure to the finished water down stream of the meter.

3. Use heavy-duty positive displacement type pumps equipped with backflow prevention devices.
4. Provide scales for accurately weighing the fluoride.
5. Locate the fluoride containers and other equipment, which contains fluoride away from electrical control panels and other equipment which could be damaged and render the facility inoperative should a leak occur.
6. Provide appropriate fluoride testing equipment for determining the fluoride ion concentration in accordance with testing methods established by the Department.
7. Provide protective clothing to include rubber gloves for handling hydrofluosilicic acid.
8. Provide safety equipment to include showers and easily operable eye wash facilities.

Aeration

1. Use low maintenance aerator material not subject to adverse effects of changing environmental conditions and constructed in a manner which does not allow entrance of insects, dust, rain, and light.
2. Provide a blower or fan with a screened air inlet and weatherproof motor for forced draft aerators.
3. Use appropriate media configuration inside the aerator to optimize air/water contact.
4. Size the aerator to be consistent with manufacturer recommendations.

Corrosion Control

1. Chemical Stabilization
    a) Use lime, soda ash, caustic soda or sodium bicarbonate.
    b) Provide accurate and reliable feeding devices for chemical addition.
    c) Provide a method for keeping chemical solutions in suspension.

d) Provide an adequate supply of finished water to feeders equipped with appropriate backflow prevention.

2. Protective Film Application
    a) Provide adequate mixing of chemicals using reliable and accurate feeders.
    b) Adjust (using an alkali) the pH of the water to 7.0 or greater before chemical addition.
    e) Provide an adequate supply of finished water to feeders equipped with appropriate backflow prevention.

Iron and Manganese Removal

1. When the iron concentration is less than 2.0 mg/l and the manganese concentration is less than 0.3 mg/l provide:
    a) Aeration,
    b) Chlorine addition to the water after aeration,
    c) A mixing sump or a chemical contact chamber sized for 30 minutes retention to facilitate the maximum oxidation of iron and manganese, and
    d) Pressure sand filtration at a rate of 4 gpm/ft^2.
2. When the iron concentration of a source exceeds 2.0 mg/l and /or the manganese concentration exceeds 0.3 mg/l provide:
    a) Aeration,
    b) Rapid mixing of water with potassium permanganate, chlorine and alkali for a minimum of one minute (an inline, removable, static mixer may be used),
    c) Flocculation for a minimum of 30 minutes,
    d) Sedimentation for a minimum of four hours, or two hours if continuous sludge removal is available, and
    e) Pressure sand or rapid sand filtration with a filtration rate of 4 gpm/ft^2.
3. Department approval must be received prior to increasing the permitted filtration rate after one year of operation.

<u>Pressure Sand Filtration</u>

1. Use a backwash flow rate of a minimum of 15 gpm/ft^2.
2. Provide an air release valve at the highest point of each filter.
3. Provide a backwash flow rate indicator that accurately monitors the flow during backwashing.
4. Provide a discharge sump with an air gap, which allows visual inspection of the backwash water.
5. Provide access manholes of a minimum of 24-inches in diameter to facilitate inspections and repairs.
6. Provide a separate rewash or filter to waste system for each filtration cell/filter.
7. Install flow control devices on the inlet or outlet of each filter.
8. Install loss of head gauges on each filter.
9. Use filter media consisting of 24 to 36 inches of clean sand or sand in combination with anthracite coal consistent with the following:
    a) Sand with an effective size of 0.4 to 0.6 millimeters and a uniformity co-efficient of 1.3 to 1.7,
    b) Graded anthracite free of iron sulfides, clay, shale and other extraneous matter composing no more than 50 percent of filter media with an effective size of from 0.6 millimeters to 0.8 millimeters and a uniformity co-efficient not greater than 1.8.
    c) Granite or other materials as approved by the Department.
10. Provide a supporting gravel bed in accordance with manufacturers recommendations or as follows:

Size			**Depth**
3/32″	to	3/16″	2″ to 3″
3/16″	to	½″	3″ to 5″
½″	to	¾″	3″ to 5″
¾″	to	1 ½″	5″ to 8″

Rapid Sand Filtration

Use a minimum of two filters designed to the provisions of the Filtration Section under Surface Water Treatment.

Sequestration

A waiver of filtration for the control of iron and/or manganese by sequestration may be granted when the concentration of iron does not exceed 0.6 mg/l and/or the manganese concentration does not exceed 0.1 mg/l and adequate data from a pilot study proves that adequate water quality is provided throughout the system.

Treatment for Control of Total and Fecal Coliform Bacteria and Removal of Turbidity

Type of Treatment	**Average Fecal Coliform (counts per 100 milliliters)**		**Average Total Coliform (counts per 100 milliliters)**		**Turbidity**
Pressure Sand Filtration	N/A	or	N/A	or	>5 NTU ≤ 15 NTU
Rapid Sand Filtration	>20 but <40	or	>100 but <200	or	>5 NTU ≤ 25 NTU
Surface Water Treatment	>40		>200	or	>25 NTU

1. When average turbidity does not exceed 5 NTU and the maximum turbidity at any time does not exceed 15 NTU, use:
    a) A chlorine concentration time (CT) of at least 60,
    b) Polymer or coagulant feed prior to inline mixing,
    c) Inline mixing, and
    d) Filtration through pressure sand filters at an initial rate of 4 gpm/ft^2 (see regulations for increased filtration rate requirements).

2. When fecal coliform levels exceed 20, but do not exceed 40 per 100 milliliters; total coliform levels exceed 100 but do not exceed 200 colonies per 100 milliliters; the average monthly turbidity exceeds 5 NTU, but the maximum turbidity at any time does not exceed 25 NTU, use:
    a) A chlorine concentration time (CT) of at least 90,
    b) Polymer or coagulant feed prior to inline mixing,
    c) Inline mixing,
    d) Mechanical flocculation with a minimum detention time of 20 minutes,
    e) Filtration through rapid sand filters at an initial rate of 4 gpm/ft^2 (see ADEM Division 7 Regulations for increased filtration rate requirements), and
    f) Operational controls to prevent the treatment process from producing finished water when the effluent turbidity exceeds a designated value or the chlorine residual in the finished water drops below a designated value.
3. When fecal coliform levels exceed 40 per 100; total coliform levels exceed 200 colonies per 100 milliliters; or the turbidity at any time exceeds 25 NTU, the source is considered surface water with respect to the type of treatment required. Part III – Surface Water Treatment shall apply.

Alternative/Innovative Treatment Techniques

Alternative and/or innovative treatment technology may be acceptable if tests demonstrate the ability of the new technology or facility to consistently provide water meeting all drinking water standards. Tests using the new treatment technique, process, or unconventional plant should be conducted when raw water quality is worst. Results should confirm the method of treatment would produce water quality on a continuous basis consistent with drinking water standards.

PART III

Surface Water

Supplemental Surface Source Information

1. Include with the report submitted prior to a water supply permit application to use a surface water source:

    a) Results of a sanitary survey detailing all man made and natural, existing and potential sources of contamination which could adversely affect the quality of the source to be used;

    b) Flow data to the location on the stream from which water is proposed to be withdrawn, existing users of the source which may adversely affect the proposed withdrawal, and minimum downstream flow required to be maintained, and expected average and maximum withdrawal capacity.

    c) Effects of siltation on withdrawal;

    d) Capacity of any impoundment to be used, with the highest and lowest recorded levels and capacities; and

    e) Results of a treatability study using a pilot plant of the type to be utilized on the source, which demonstrates a full size plant, will produce water meeting drinking water quality standards. Results of studies with an existing plant utilizing the source at a point where the water quality is the same as from the proposed withdrawal point may be adequate if the proposed treatment processes are the same or exceed those of the existing plant.

Materials of Construction

1. Use only chemicals meeting NSF standard 60 and equipment and coatings meeting NSF standard 61 and that are acceptable by the Department.
2. Use only non-metal materials unless basins/structures associated with water treatment can be taken out of service for at least 10 days without affecting the water supply to customers.

Discharge Permits

Apply for a NPDES Discharge permit through the Municipal Waste Branch of ADEM 180 days prior to expected date discharge is to begin or date water treatment plant is expected to begin operation.

Treatment

Rapid Mixing

1. Provide an inline static mixer or mechanical rapid mix basin, and include a spare motor when only a single mechanical mixer is used.
2. Provide for cleaning and draining of the rapid mix basin and for cleaning or removing inline mixer components without excavation.
3. Provide a rapid mix period of at least 30 seconds for mechanical mixers and use manufacturer's recommendations and/or studies using the raw water source for static mixer design.
4. Supply any pH-affecting chemical before coagulant chemical addition.

Flocculation

1. Prevent floc destruction through inlet and outlet devices.
2. Provide drains for adequate cleaning.
3. Use no common walls between any filtered effluent storage structure and unfiltered water.
4. Design for a flow through velocity from 0.5 to 1.5 feet per minute and a detention time of at least 30 minutes.
5. Design mechanical flocculators such that the cumulative area of the paddles is between 10 and 25 percent of the cross sectional area of the flocculation basin.
6. Provide variable speed motors capable of varying the peripheral speed of paddles between .5 and 2 feet per second when mechanical agitators are used.
7. Use baffles as necessary to prevent short-circuiting.
8. Prevent velocities of flocculated water through pipes or flume to settling basin from exceeding 5 feet per second.
9. Do not provide a bypass around the flocculator basin.

Sedimentation

1. Use a minimum of two basins.
2. Reduce the settling basin entrance velocity such that the velocity of water through the settling basin does not exceed one foot per minute.
3. Avoid weir action of coagulated water at the entrance to the settling basin.
4. Minimize short-circuiting.
5. Provide a minimum settling period using the volume of the basin from the stilling wall to the outlet device consistent with the following:

Length to Width Ratio	3:1	2:1	1:1*
Settling time (hours)**	2	4	8

* Avoid Circular basins.

** Add two hours of settling time to those above when continuous sludge removal is not provided.

6. Provide for a surface overflow rate not to exceed 550 gallons per day per square foot of basin area.
7. Provide drains from basins and locate water under pressure near basins to facilitate cleaning.
8. Design settling basins such that the weir overflow rate from basins does not exceed 30,000 gallons per day per linear foot of weir length.
9. Use a settled water conduit to the filter that creates a water velocity of no greater than 5 feet per second at any point between the settling basin and the submerged outlet onto the filter.
10. Provide overflow devices that can easily be observed by the operator at elevations lower than the elevation of the filter wall and that are capable of accommodating plant design flow.

Filtration

1. Filters
    a) Use a minimum of two filters.
    b) Use a filtration rate of 2 gpm per square foot of filter area.
    c) Provide sufficient headroom for inspection of the filter when covered by a superstructure.
    d) Provide a minimum of nine feet between the normal operating water level in the filter and the bottom of the underdrains and a minimum of four feet between the water surface and filter media.
    e) Design for a normal elevation of water in the filter to be at least eight feet higher than the clearwell elevation.
    f) Construct a minimum four-inch high curb around the filters to prevent floor drainage from entering.
    g) Prevent run off from roof drains from entering the settling basin or the filter.
2. Filter Piping and Accessories

a) Submerge the inverted discharge onto the filter media to prevent movement of the media by free falling or cascading water.

b) Construct the filter effluent piping such that air is not allowed to enter the filter bottom.

c) Use continuous monitoring and recording turbidimeters to accurately monitor the effluent from each filter.

d) Use a filter flow rate controller or flow control method, which will maintain a constant rate of flow with varying head loss.

e) Maintain a minimum available head of 0.5 feet or the amount recommended by the manufacturer on the discharge side of the control device.

f) Provide a filter control panel for each filter with flow rate and head loss indicators.

g) Provide variable operated valves to minimize rapid changes in filter velocities.

Wash Water Troughs

1. Install wash water trough bottoms at an elevation above the maximum elevation of the expanded media during backwashing.
2. Level the top or edge of each wash water trough to allow uniform flow into the wash water trough.
3. Size troughs to carry the maximum wash water rate with a two-inch free board.
4. Position wash water troughs in the filter to receive equal amounts of back wash water.
5. Provide for a horizontal travel to wash water trough not to exceed three feet.

Filter and Support Media

1. Use clean silica sand or sand in combination with fine anthracite coal having a minimum bed depth of 27 inches.

2. Use sand with an effective size of 0.4 to 0.6 millimeters and a uniformity coefficient of 1.3 to 1.7 or in accordance with manufacturer's recommendations.
3. Use anthracite with an effective size of 0.6 to 0.8 millimeters, a uniformity co-efficient not to exceed 1.8, free of iron sulfides, clay, shale and other extraneous matter and which composes no more than 50 percent of the filter media or in accordance with manufacturers recommendations.
4. Use 15 to 24 inches of gravel with size distribution and depth in accordance with manufacturer's recommendation for use with proposed filter media and underdrain system.
5. Use filter bottoms, which provide uniform flow during backwash and filtration and prevent passage of media during filtration.

Filter Washing Equipment

1. Use rotating type wash equipment
2. Provide adequate pressure in accordance with manufacturer's specifications for devices used.
3. Install backflow/backsiphonage devices.
4. Equip sweep supply lines with directional movement indicators.
5. Provide a backwash capability of at least 18 gallons per minute per square foot of filter area.
6. Use a pump, wash water tank or combination of the two to provide filtered water or finished water to the filter for washing.
7. Provide adequate facilities to accommodate a minimum filter wash of 20 minutes duration and allow daily washing of all filters.
8. Use a variable flow wash water controller or valve on the main wash water line to regulate flow.
9. Equip backwash piping with air relief mechanisms to prevent entrance of air to the filter during the backwash cycle.
10. Design filter piping such that all remaining filters are capable of continuous operation while one filter is being washed.
11. Provide a filter to waste or rewash line and valve for each filter.

Chlorination and Equipment

1. Use solution feed gas type chlorinators for all sources, unless written approval for an alternate method is obtained from the Department.
2. Provide equipment capable of achieving a free chlorine residual of at least 2 mg/l in the water after a contact time of at least 60 minutes.
3. Use one-ton cylinders when average daily chlorine consumption is anticipated to be greater than 150 pounds.
4. Use a manifold system with multiple 150-pound cylinders when anticipated daily use is less than 150 pounds.
5. Provide an ample supply of finished water for operating the gas chlorination system.
6. Provide equipment to measure chlorine residuals and which continuously monitor and record results representative of water at a point just after it leaves the clearwell.
7. Provide a system for accurately weighing each chlorine cylinder.
8. Locate chlorinators and cylinders in rooms separated from other equipment.
9. In common wall construction provide a glass window for viewing of the treatment room.
10. Provide adequate ventilation to the room housing the chlorinator and cylinders so that one complete air change in 10 minutes is available.
11. Install the ventilation intake at floor level with the discharge located such that exhaust will not contaminate air inlets to buildings or other areas occupied by people or containing equipment.
12. Locate electrical switches for operation of exhaust fans and lights outside the facility housing solution feed gas type chlorinating equipment.
13. Provide chlorine gas leak detection equipment in both the chlorinator room and the chlorine cylinder room.
14. Provide doors with non-locking restrictions to allow opening from inside.
15. Provide equipment in chlorinator rooms to prevent extreme temperature changes from occurring.
16. Provide a self-contained breathing apparatus capable of supplying at least 15 minutes of usable air.
17. Provide proper safety equipment where it can be easily obtained in an emergency situation.

Disinfectant Concentration Time (CT)

Design clearwell facilities and finished water transmission lines from surface water treatment plants to provide CT in accordance with ADEM Division 7 Regulations, Disinfection of Surface Water Sources and the *Guidance Manual for Compliance with filtration and Disinfection Requirements for Public Water Systems Using Surface Sources – Criteria and Standards Division-EPA.*

Fluoridation

Use fluoridation under Groundwater Sources and Treatment.

Corrosion Control

Use corrosion control under Groundwater Sources and Treatment.

Taste and Odor Control

1. Provide aeration facilities to remove objectionable odors present in surface water consistent with groundwater aeration facility design criteria.
2. When potassium permanganate is used to oxidize chemicals that cause taste and odor, provide for feeding chemicals in solution form at no greater than 15% strength, using a heavy duty positive displacement metering pump.
3. When powdered activated carbon is used for the absorption and removal of organics related to taste and odor:
    a) Locate application points for activated carbon to avoid interference with chlorine, and
    b) Provide equipment capable of adding a dose of 40 mg/l carbon.
4. When chlorine dioxide is used to oxidize organic chemicals that can cause taste and odor problems:
    a) Generate chlorine dioxide on site,

b) Provide equipment for routine monitoring of chlorine dioxide,

c) Provide for proper storing and handling of sodium chlorate to eliminate the danger of explosions, and

d) Provide analysis instrumentation or equipment to allow chlorite and chlorate to be analyzed in the finished water.

Chemical Feed Equipment

1. Provide a minimum of two feeders where chemical feed is necessary for the treatment of the supply such as chlorination, coagulation and other essential processes.
2. Use feeders capable of supplying at all times the necessary amounts of chemical at an accurate rate throughout the range of chemical addition.
3. Proportion the chemical feed rate to the rate of flow.
4. Use positive displacement type solution pumps to feed liquid chemicals under pressure.
5. Protect the water supply against contamination from chemical solutions by equipping the supply line with backflow prevention devices or providing an air gap between the supply line and solution tank.
6. Use materials on surfaces with chemical contact that are resistant to the aggressiveness of the chemical.
7. Enclose dry chemical feeders to prevent emission of dust.
8. Measure chemicals volumetrically.
9. Provide thoroughly mixed solutions.
10. Provide gravity feed of the solution from the solution container to the application point where possible.
11. Do not directly connect any sewer or drain with the overflow from a feeder or solution chamber or tank.
12. Locate chemical feed equipment as near to the point of application as practical to minimize chemical transporting distance.
13. Locate equipment so it is readily accessible for repair, servicing and observation of its operation.

14. Provide protective curbing so that chemicals from equipment failure, spillage or accidental drainage do not enter the water in conduits, treatment or storage basins.
15. Provide scales for weighing the following:
    a) Gas chlorine,
    b) Liquid solution and
    c) Dry chemicals.

Chemical Use and Storage

1. Provide space for a minimum of 30 days storage of chemicals.
2. Isolate cylinders of liquid chlorine form all operating areas and restrain in position to prevent upset.
3. Equip liquid chemical storage tanks with liquid level indicators, secondary containment, and temperature protection when required for proper operation and an overflow to a receiving basin capable of handling accidental spills or overflows.
4. Design solution storage or day tanks supplying feeders directly with sufficient capacity for at least one day of operation.
5. Properly vent storage facilities for acids to the atmosphere outside of the operation area and facility.

Alternative/Innovative Treatment Techniques

Alternative and/or innovative treatment technology may be acceptable if tests demonstrate the ability of the new technology or facility to consistently provide water meeting all drinking water standards. Tests using the new treatment technique, process, or unconventional plant should be conducted when raw water quality is worst. Results should confirm the method of treatment would produce water quality on a continuous basis consistent with drinking water standards.

PART IV

Pumping Stations

General Criteria

Design pumping station(s) in accordance with the following:

1. Place pumping stations finished floor elevation a minimum of three feet above the 100-year flood elevation or suitably protect to that elevation.
2. Provide accessibility to the pumping station at all times.
3. Construct a fence with lockable gate around the pumping station site,
4. Provide the pumping station with ample space for any anticipated future expansion.
5. Provide ample space in the interior of the pumping station for adequate maintenance.
6. Provide crane-ways, hoist beams, eyebolts, or other facilities and equipment for servicing or removing pumps, motors and other heavy equipment.
7. Install adequate lighting to provide for the necessary observation of equipment operation.

Surface Water Pumping Stations

Raw Water Suction Well and Intake Structure

1. Use adequate size suction pipe and construct the suction well to a depth and configuration so that air is not drawn into the raw water.
2. Design the conduit for raw water so that a minimum velocity of three feet per second is provided.

3. Construct the intake line or conduit on a continuous grade such that abrupt changes in elevation are avoided.
4. Protect the intake structure against clogging by aquatic growth, sediment, debris or ice and against flotation by wind and wave pressure; provide means of flushing or removing sand/silt from the suction wells.
5. Design the intake port such that the water velocity does not exceed two feet per second.
6. Design the intake structure to permit the withdrawal of water from the source at three different levels should the quality of water vary with depth or should one or more of the remaining ports become blocked.
7. When no other practical alternative exists and a single level intake is used, locate the port such that the minimum submergence is equal to at least three times the diameter of the port opening and has a minimum of two ports.
8. Provide at least two sets of removable or cleanable stationary screens or a travelling screen.
9. Provide a watertight suction well structure with the floors sloped to permit removal of water and solids.

Raw Water Pumps

1. Provide a minimum of two pumps with each pump capable of meeting plant design capacity.
2. Ensure the remaining pumps can supply the plant capacity with the larger unit out of service.
3. Equip pumps with a positive acting check valve and a pressure gauge located on the discharge side of the piping between the pump and shutoff valve.
4. Place a shutoff valve on the discharge side of each pump.
5. Install air relief valves where necessary.
6. Incorporate into design provisions for preventing surge or water hammer damage.
7. Control conditions inside enclosed pumping stations to prevent extreme temperature changes.

8. Equip discharge piping from the pumping station with a device capable of measuring and totaling the flow.

Finished Water Pumping Stations

1. Provide adequate space for expansion.
2. Place the floor elevation at least six inches above the finished site grade.
3. Provide a watertight pumping well.
4. Install floor drains, which do not impair the finished water quality.
5. Provide suitable drainage outlets from pump glands, which do not discharge onto the floor.
6. Provide floor hatches with raised edges and overlapping covers.
7. Provide adequate ventilation.
8. Install a minimum of two pumping units sized so plant capacity can be supplied by the remaining pumping units when the largest pumping unit is out of operation.
9. Install a shutoff valve, check valve and air release valve on each pumping unit.
10. Provide surge control where needed.
11. Equip discharge piping from the pumping station with a device capable of measuring and totaling the flow.
12. Provide pressure gauges on the discharge piping.

Groundwater Pumping Stations

Well Pumps

1. Use weatherproof pumps for outside locations. Provide a means for removing and servicing any pumps located inside.
2. Include with discharge piping the following:

a) A raw water tap between the pump and the check valve,

b) A pressure gauge,

c) An air release valve,

d) A check valve,

e) A pump to waste line of adequate length and of adequate elevation to facilitate flow testing and sample collection for water quality determination,

f) A shutoff valve, and

g) An easily accessible device capable of measuring and totaling the flow.

3. Locate control valves above the floor.
4. Protect the discharge piping from freezing.
5. Provide surge control protection when necessary.
6. Use durable material for pump houses including a concrete floor.
7. Extend the floor or apron around the well at least three feet in all directions.
8. Slope the apron away from the well if located inside a pump house.
9. Provide floor drains for pumping facilities.
10. Provide separate rooms for solution feed gas type chlorinators.
11. Control conditions inside the facility to prevent extreme temperature changes.

Finished Water Pumping Stations

Must meet the same requirements as the Surface Water finished water pumping stations.

Distribution Booster Pumping Stations

1. Design booster pumping stations to pump from elevated or ground storage tanks into an elevated storage tank, a ground storage tank, or a hydropneumatic tank.

2. Where no practical alternatives exist, inline constant pressure pumps and underground pumping stations may be used if concurrence is obtained from ADEM prior to the submittal of plans for installation.
3. Install a minimum of two pumping units sized so plant capacity can be supplied by the remaining pumping units when the largest pumping unit is out of operation.
4. Provide a low-pressure cutoff on the suction side of the pumps.
5. Locate booster station site and design booster pump capacity such that the pressure at any proposed or existing customer down gradient of the pump station is not reduced below 20 psi.
6. Control conditions inside the pump stations to prevent extreme temperature changes.
7. Equip piping with inlet and outlet pressure gauges.
8. Provide adequate drainage to prevent the accumulation of water inside the pump station.
9. Use supplemental chlorination facilities where there is a possibility of insufficient chlorine residual being maintained beyond the location of the booster pumping station.
10. Provide surge control where appropriate.
11. Design booster stations to be adequately locked and secured.
12. Equip discharge piping from the pumping station with a device capable of measuring and totaling the flow.
13. Provide hour meters for each pump.
14. Provide adequate fencing for booster stations to prevent unauthorized entry.

PART V

Finished Water Storage Facilities

General Criteria

1. Use materials that provide stability and durability as well as protect the quality of the stored water and that conform to AWWA standards.
2. Locate the bottom elevation of above ground storage reservoirs and standpipes above the maximum known flood elevation.
3. If the facility is to be below normal ground elevation, select a site such that sources of contamination are a minimum of 50 feet away.
4. Locate in-ground reservoirs such that the top and overflow pipe discharge are a minimum of 2 feet above the normal ground surface (clearwells constructed under filters are exempted from this criteria when the overall design provides the same protection).
5. Design in-ground reservoirs such that the normal low, water elevation is above outside ground level.
6. Provide finished water storage structures with suitable watertight roofs or covers to exclude birds, animals, insects and excessive dust.
7. Provide access hatches in accordance with the following:
    a) Frame structure at least four inches above the surface of the roof at the opening,
    b) Fit opening with a solid watertight cover which overlaps the frame opening and extends down around the frame a minimum of two inches,
    c) Equip cover with a hinge at one side, and
    d) Equip cover with a locking device.
8. Design storage structures with the capability to be drained while causing minimal adverse effect on system operation.
9. Provide the storage facility with piping to allow draining.

10. Do not directly connect any storage structure drain to any sewer or storm drain.
11. Provide overflow in accordance with the following:
    a) Provide an air gap,
    b) Locate discharge to prevent the entrance of surface water,
    c) Prevent entrance of birds, animals and insects into overflow piping,
    d) Terminate overflow piping in an inverted U construction on ground structures with the opening above the roof and covered with 24 mesh corrosion resistant screen cloth,
    e) Screen overflow from structure and provide a flap valve, and
    f) Provide an adequate splash pad or box to prevent erosion.
12. Provide convenient access to the interior of finished water storage structure for cleaning and maintenance.
13. Design roof and sidewalls of storage structures to be watertight with no openings except properly constructed vents, hatches, overflows, risers, drains, pump mountings, control ports, or piping for inflow and outflow.
14. Construct the roof or cover for storage structures in a manner, which prevents it from retaining water.
15. Incorporate safety into the design of storage structures in accordance with OSHA standards.
16. Design finished water storage structures and their appurtenances to prevent extreme temperature changes from effecting normal operation.
17. Grade the area around ground storage structure to prevent water from standing within 50 feet of the structure.
18. Disinfect all new or reconditioned storage structures used for potable water.
    a) Fill the structure with a solution of at least 50 PPM chlorine and retain in structure for at least 24 hours, drain, refill with potable water, collect and submit two samples to a certified bacteriological laboratory (Repeat procedure until sample results are coliform absent), or
    b) Spray the interior surface of the structure with a solution of at least 200 ppm chlorine, drain, fill with potable water, collect and submit two samples to a certified bacteriological

laboratory (Repeat procedure until sample results are coliform absent), or

c) Add sufficient chlorine solution to the storage structure 1/3 filled with potable water such that when completely filled, a minimum chlorine residual of 5 mg/l is present. After 24 hours, collect and submit two samples to a certified bacteriological laboratory (Repeat procedure until sample results are coliform absent).

19. Design storage tanks sufficient to provide a minimum 20 psi residual at all customer meters served by the tank within normal tank level fluctuations.
20. Design storage facilities of sufficient size and in a manner so that excessive retention of water is avoided and all CT requirements are met.
21. Do not provide single wall separation between any compartment where unfinished water is retained and clearwells for finished water storage.
22. Design all pump sumps, wet walls or other basins containing finished water as finished water storage structures.
23. Encase conduit for electrical wiring in concrete or use conduit material, which is resistant to corrosive conditions within the storage structure. Place only essential electrical wiring in clearwells.
24. Construct a fence with lockable gate around the storage facility site.
25. Provide an exterior ladder with removable lower section (except in the design of hydropillar or fluted design).
26. Provide a level indicator.
27. Provide a sampling tap.
28. Vent structure adequately.
29. Provide an interior access ladder.

Hydropneumatic Storage Tanks

1. Hydropneumatic storage tanks may be considered where the number of connections is less than 50, unless otherwise approved by ADEM.
2. Provide a volume using the following formula and which is at least 10 times the volume of water that can be pumped in one minute to the tank unless the calculated volume equals or exceeds peak demand.

V_R = (Instantaneous Flow – Pump Capacity) x

(20 Minutes/. 25)

Where,

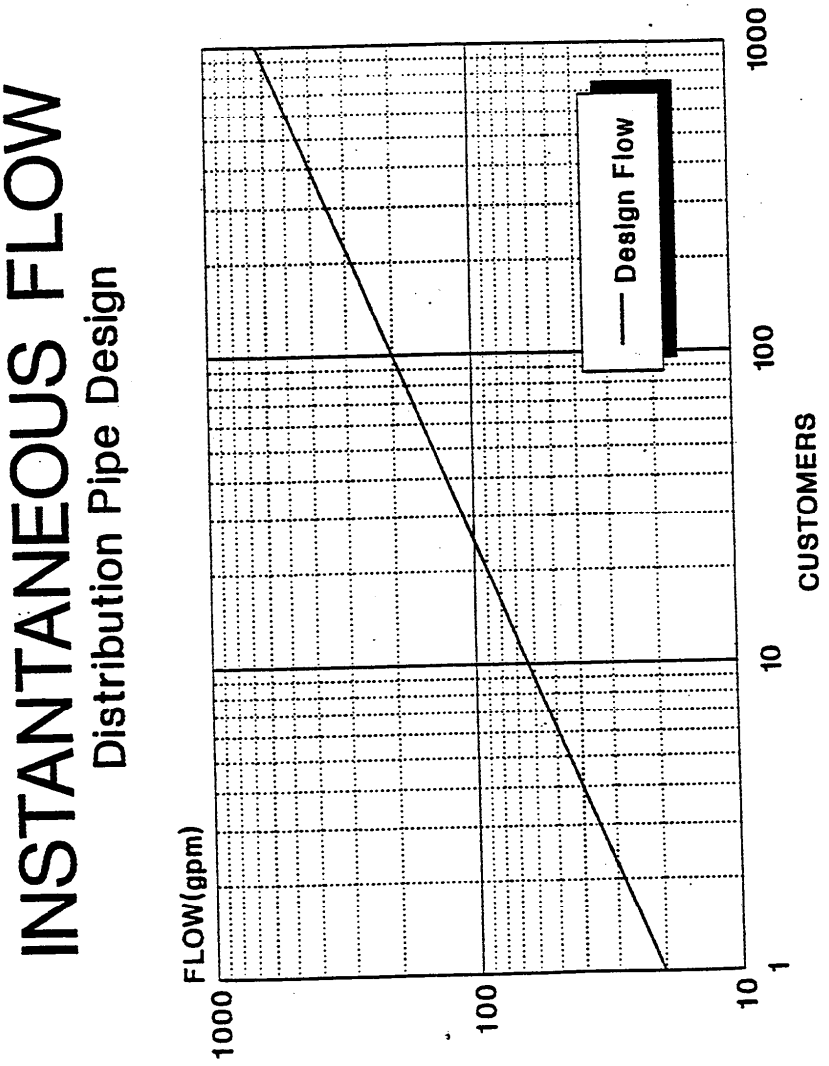
V_R = total required volume of tank in gallons

Pump Capacity = Rated capacity of pump in gpm under normal operating conditions

Instantaneous Flow - from Table 1, Page 33

3. Do not provide a bypass around the tank.
4. Provide control equipment including a pressure gauge, pressure switch, a tank level indicator, automatic blow-off for excess air, and mechanical means for adding air.
5. Provide the tank with an access manhole and a drain.
6. Alternate and/or innovative pumping techniques must have prior approval of the Department.

TABLE 1


INSTANTANEOUS FLOW
Distribution Pipe Design
FLOW(gpm)
1000
100
10
1
10
100
1000
CUSTOMERS
Design Flow

Protective Exterior and Interior Coating Systems

1. Apply interior and exterior coating systems on all materials subject to corrosion under normal operating condition in conformance to ADEM Division 7 Regulations.
2. Sandblast the surface of metal material on which the coating system is to be applied to SSPC– SP10 for the interior and SSPC – SP6 for the exterior finish prior to the coating application.
3. Provide for curing of the paint system (both interior and exterior) in accordance with the coating manufacturer recommendations and provide forced air ventilation to promote proper interior curing.

PART VI

Distribution System

General Criteria

1. Consider all existing and potential customers to ensure a minimum residual pressure of 20 psi can be provided at each customer meter under normal flow conditions. Do no add customer service to existing lines were no more than 20 psi residual pressure can be provided.
2. Use the instantaneous flow curve in Table 1, page 33 for design of distribution systems. This curve can be approximated by the following formula

$Q = 20\ (c)^{1/2}$,

Where,

Q = flow in gpm

C = cumulative number of customers served.

Distribution Pipe Materials

1. Use only concrete, ductile iron and steel water mains, which meet AWWA Standards.
2. Use only slip joint polyvinyl chloride (PVC) water pipe with rubber gaskets. Do not exceed 75 percent of the pressure rating of the pipe unless the pipe conforms to AWWA C-900 Standards.
3. Avoid solvent welded PVC pipe or asbestos cement pipe since these construction materials may contaminate and otherwise allow deterioration of the water quality.
4. Submit information justifying the use of any other materials proposed for the transmission of drinking water in distribution systems and

confirmation the material to be used is in compliance with ADEM Division 7 Regulations.

Water Main Installation

1. Use installation procedures in accordance with standards of the American Water Works Association, the Ductile Iron Pipe Research Foundation and the Uni-Bell PVC Pipe Association.
2. Install, bed and support pipe as specified by the manufacturer.
3. Provide 30 inches of cover, except a minimum of 24 inches may be used where the blasting of rock is required.
4. Prior to placing into use any installed water mains, provide pressure and leak test results to the Department in accordance with the following methods:
    a) Conduct a pressure test for at least six hours on covered pipe and two hours on uncovered pipe,
    b) Use a recording pressure gauge and provide records of the pressure tests before the final inspection,
    c) Conduct pressure test at 150 percent of the expected operating pressure but not less than 100 psi or more than the pressure rating of the pipe, and
    d) Do not specify allowable leakage during testing that is more than the value calculated using the following formula:

$$L = [SD(P)^{1/2}] / 133200$$

L = Allowable leakage in gallons per hour

S = Length of pipeline (or section of pipeline) in feet

D = Normal diameter of pipe in inches

P = Average test pressure during test in psig

e) Provide pipe sizes, lengths tested and the amount of water required to bring the pressure in the pipe back to the initial pressure prior to the test with results of leakage tests.

5. Install detectable metal tape or wire approximately 18 inches above the top of all non-metal pipe.
6. Flush adequately all water mains after installation. If the main is 12-inches or greater, the main should be pigged and then flushed at the scouring velocity.
7. Disinfect water mains in accordance with methods included in the American Water Works Standards.
8. Test bacteriological quality by submitting to a certified bacteriological laboratory one sample from each dead end line or every 7,000 feet of water main installed, whichever is greater, and repeat this procedure as necessary until bacteriological results are negative for coliform bacteria.
9. Obtain authorization from ADEM prior to placing installed water lines in service.

Water Main Location

1. Provide a minimum horizontal separation of five feet between water lines and sanitary sewer lines. Where crossings are necessary, case one of the pipes with a continuous pipe of sufficient length, located such that a minimum five-foot separation exists between each end of the casing pipe and the uncased pipe.
2. Where possible, install pipe such that the top elevation of the sewer line is a minimum of 18 inches below the bottom elevation of the water line.
3. Unless adequately cased to protect against contamination, do not install any water main such that it comes in contact with any part of a sewer manhole, septic tank field lines, or soil saturated with organic solvents or gasoline.

Metering

Install meters complying with the standards of the latest American Water Works Association with each service connection in such a way that the water used by the customer is accurately recorded.

Fire Hydrants and Flush Valves

1. Locate fire hydrants and flush valves such that the distribution system can be adequately flushed.
2. Install fire hydrants only on water mains six inches in diameter or greater.
3. Provide a fire hydrant, flush valve or blowoff on each dead end line such that flushing the line at a velocity of at least 2.5 feet per second can be achieved.
4. Provide a valve on the branch line between the main and the fire hydrant.

Surface Water Crossing

1. Adequately support and protect from freezing all pipe used in crossings and provide accessibility for repair or replacement.
2. For underwater crossings of year-round streams use ductile iron water main unless directional boring is involved where polyethylene or PVC pipe with steel casing may be used.
3. When conditions merit the use of ball joint river crossing pipe the following are applicable:
    a) Provide easily accessible valves at each end of the crossing pipe to isolate the section for test and repairs,

b) Provide sample taps on each end of the crossing pipe between the valve and the body of water, and

c) Metering at crossings to aid in leak detection is recommended.

Valves

Provide a minimum of one valve per mile so that various parts of the system can be isolated for testing or repair without affecting a large number of users. Avoid using valve markers in locations where their sites may be altered by the normal operation and maintenance of the highway or street.

Cross Connection Control Devices

1. Include a minimum of a dual check valve backflow prevention device with service installations.
2. Provide cross-connection control devices for commercial/industrial uses in accordance with the *Manual of Cross-Connection Control* (Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California), *AWWA M-14* (Manual for Cross Connection Control by the American Water works Association), or equivalent cross-connection control manuals.