NEW MEXICO
ENVIRONMENT DEPARTMENT

Construction Programs Bureau

Recommended Standards for Water Facilities

Policies for the design, review, and approval of
plans and specifications for
water supply systems and treatment works

2006 Edition

Recommended Standards for Water Facilities

Policies for the Design, Review, and Approval of Plans and Specifications for Water Supply Systems and Treatment Works

The guidelines set forth in this document, *Recommended Standards for Water Facilities; Policies for the Design, Review, and Approval of Plans and Specifications for Water Supply Systems and Treatment Works*, are intended solely for the guidance of employees of the New Mexico Environment Department (NMED). They are not intended to, nor do they, constitute regulations promulgated by NMED, the New Mexico Environmental Improvement Board, or the New Mexico Water Quality Control Commission, and are not enforceable as such. They may not be relied upon to create a right or benefit, substantive or procedural, enforceable at law or in equity, by any person.

The guidelines set forth in this document have been developed to assist NMED in consistently reviewing plans and specifications submitted for water supply systems and treatment works improvements and construction. They incorporate nationally recognized guidelines for engineering practices in furtherance of public health and environmental protection as modified by NMED to address New Mexico practices and particulars. They do not contain criteria required by NMED for approval of plans and specifications, and are not intended to supersede any grant or loan requirements or any policy, requirement, or regulation concerning water supply systems and treatment works improvements and construction. NMED will review all plans and specifications objectively and with professional judgment to establish whether they conform to applicable laws, regulations, and engineering requirements and practices. NMED encourages the development and implementation of new processes and equipment, and will favorably consider them with the appropriate demonstration of successful applications.

Comments concerning the guidelines set forth herein should be provided to: New Mexico Environment Department, Construction Programs Bureau Chief, PO Box 26110, Santa Fe, NM 87502

R Curry

Ron Curry, Cabinet Secretary

2/24/06

Date

TABLE OF CONTENTS

PART 1

SUBMISSION OF PRELIMINARY ENGINEERING REPORT AND PLANS

1.0 GENERAL

All reports, final plans and specifications should be submitted at least 30 calendar days prior to the date on which action by NMED is desired. Permits for construction, for waste discharges, for stream crossings, etc., may be required from other federal, state, or local agencies. The Preliminary Engineering Report (PER) should be submitted for review prior to the preparation of plans. No approval for construction can be issued until final, complete, detailed plans and specifications have been submitted to NMED and found to be satisfactory. Documents submitted for formal approval should include but not be limited to:

a. PER,

b. A summary of the basis of design,

c. Operation requirements, where applicable,

d. General layout,

e. Detailed plans,

f. Specifications, and

g. Cost estimates.

It is recommended that the engineer contact NMED to review the content and outline of any reports to determine what should be appropriate for the individual case. This should help ensure reports are relevant to the issues at hand and aid the engineer in determining appropriates fees for the work.

Where the Design/Build construction concept is to be utilized, special consideration must be given to: designation of a project coordinator; close coordination of design concepts and submission of plans and necessary supporting information to NMED; allowance for project changes that may be required by NMED; and reasonable time for project review by NMED.

1.1 PRELIMINARY ENGINEERING REPORT OR FACILITY PLAN CONCEPT

The PER identifies and evaluates drinking water related problems; assembles basic information; presents criteria and assumptions for the basis of design; examines alternate projects with preliminary layouts and cost estimates; describes financing methods, sets forth anticipated charges for users; reviews organizational and staffing requirements; offers a conclusion with a proposed project for client consideration; and outlines official actions and procedures to implement the project. The planning document should include sufficient detail to demonstrate that the proposed project meets applicable criteria and provide sufficient information for the decision maker to determine a reasonable course of action. The following information is intended as a guide, as applicable, for the preparation of the PER.

The concept (including process description and sizing), all non-structural proposed programs (defined as shared or regional operations that combine resources such as certified operators, but may not involve physical plants or construction), factual data, and controlling assumptions and considerations for the functional planning of drinking water facilities are presented for each process unit and for the whole system. These data form the continuing technical basis for the development of viable non-structural and structural alternatives including the detailed design and preparation of construction plans and specifications.

Architectural, structural, mechanical, and electrical designs are usually excluded from the PER. Sketches may be desirable to aid in the presentation of a project. Outline specifications of process units, special equipment, etc., are occasionally included.

PERs may be completed for minor distribution systems, pump stations, and storage projects. PERs should be completed for projects involving new, expanded, upgraded, or rehabilitated water treatment facilities and major distribution systems, pump stations, and storage projects that are part of the overall water resource plan accepted by the community. The determination of classification as major or minor distribution system, pump station, and storage projects should be made by NMED based on review of the recommended classification by the owner.

For federal or state financial grant or loan projects, additional requirements may apply.

1.2 PRELIMINARY ENGINEERING REPORT FORMAT AND CONTENT

The primary funding agencies for water projects in New Mexico *(NMED/Construction Programs Bureau; Department of Finance & Administration/Local Government Division; United States Department of Agriculture Rural Utility Service; and the New Mexico Finance Authority)* have agreed to a common format for PERs based on guidance provided by the USDA Rural Utility Service (RUS) Bulletin 1780 series. The bulletin for water is 1780-2 and can be obtained from the RUS website at www.usda.gov/rus/water/regs-bulletins.htm. PERs should be certified, signed and sealed by the responsible professional engineer and contain the following and other pertinent information as required by NMED:

1.2.1 Overview – Problem Defined

Describe the proposed project, background, and problems needing correction. Summarize the existing and previous local and regional water facility and related planning documents and other non-structural programs that may affect water quality, demand and capability of the water resource to meet demand.

1.2.2 Project Planning Area

Describe the planning area and existing and potential future service areas. State the planning period being considered. Project site information should include legal and natural boundaries, topography, soils, geologic conditions, depth to bedrock, groundwater level, floodway or floodplain considerations, and other pertinent site information, other water uses in the area such as individual wells, agricultural use, and septic tanks. The source water protection area should be identified.

1.2.3 Environmental Resources Present

Consideration should be given to minimizing any potential adverse environmental effects of the proposed project. If appropriate, compliance with planning requirements of federal, state, and local regulatory agencies should be documented. Information should be provided regarding the location and significance of important land resources such as prime farmland, watersheds, wetlands, floodplains, historic and cultural sites, and endangered species that should be considered in project planning.

1.2.4 Growth Areas and Population Trends

Present and predicted population should be based on a minimum 20-year planning period. Phased construction of water facilities should be considered in rapid growth areas. Distribution systems and other facilities with a design life in excess of 20 years should be designed for the extended period. Projections should be reasonable and based upon historical record or other justifiable sources such as the population projections developed by the Bureau of Business and Economic Research Institute at University of New Mexico.

1.2.5 Existing Facilities

1.2.5.1 Location Map

Drawings identifying the site of the project showing surface and watershed boundaries, groundwater boundaries and anticipated location and alignment of proposed facilities are required.

1.2.5.2 History

Provide information regarding the history of the community in terms of water use and availability and the existing facility. Water use should be expressed in gallons per connection per month.

1.2.5.3 Condition of Facilities

Provide a description of the existing facilities system including present condition, suitability for continued use, and evaluation of problems needing correction. Describe existing water rights and their status with the Office of the State Engineer (OSE) and adequacy for present and future projected use. The impact of the proposed project on all existing water facilities including distribution systems, booster stations, storage facilities, and treatment facilities should be evaluated. Describe the condition of the system in terms of loss to leakage and/or unaccounted for water loss, age of pipes and other infrastructure. Describe current and future compliance with applicable regulations and permits, such as OSE permits, Safe Drinking Water Act, and EPA NPDES.

1.2.5.4 Financial Status of any Operating Central Facilities

Provide information regarding rate schedules, annual operation and maintenance (O&M) cost, number of connections, tabulation of users by monthly usage categories, and revenue received for the last three fiscal years. Describe existing debt and required reserve accounts. Also show if reserve accounts have been set for equipment replacement, any accounts to establish a working capital reserve for emergencies, salaries, and operating and coverage ratios for the last three years.

1.2.6 Need for Project

1.2.6.1 Health and Safety

Describe concerns, noting any correspondence or communications from or to regulatory agencies regarding compliance issues. The New Mexico Environment Department (NMED) Drinking Water Bureau should be contacted for its assessment of the proposed project and any relevant regulations or permit conditions.

1.2.6.2 System Operation and Maintenance

Describe O&M concerns that necessitate and/or affect the proposed project, indicating those of greatest impact. Before proposing additional capacity, compare the cost and benefit of the correction of system deficiencies (such as water loss to leakage) coupled with water conservation to the costs and benefit of additional water sources or storage proposals and whether water loss, conservation, management adequacy, inefficient designs, and other operational or managerial problems have been investigated and addressed.

1.2.6.3 Growth

Provide information and justification regarding allowances for reasonable growth over the construction and planning periods, including phased projects as appropriate. Confirm the number of new customers committed to the project and the revenue stream necessary to support O&M.

1.2.7 Alternatives Considered

This section should contain a description of the reasonable structural and non-structural alternatives that were considered in planning a solution to meet the need(s) identified in Part 1.2.6. The process of selection of water treatment, use and conservation alternatives for detailed evaluation should be discussed. All water management alternatives considered, including no action, and the basis for the engineering judgment for selection of the alternatives chosen for detailed evaluation, should be included. NMED encourages the consideration of non-structural alternatives, such as water conservation, as viable alternatives. The description should include the following information for each alternative:

1.2.7.1 Design Criteria

Discuss and summarize the design parameters or basis of design that should be used to compare the alternatives considered. These should include permit limits, best management and engineering practice, and applicable laws and regulations such as Safe Drinking Water Act, New Mexico Water Quality

Regulations, Americans with Disabilities Act, and New Mexico Recommended Standards for Water Works, etc.

1.2.7.2 Description

A written description of all reasonable proposed alternatives is required. The alternatives should include feasible treatment technologies and associated distribution and storage facilities. All feasible water supply sources should be described as well as the associated water rights.

1.2.7.3 Soil, Groundwater and Watershed Conditions, and Foundation Problems, including, but not limited to a description of:

a. The character of the soil through which water mains are to be laid;

b. Foundation conditions prevailing at sites of proposed structures;

c. The approximate elevation of groundwater in relation to subsurface structures; and

d. General description of watershed and its relationship to the water resource.

1.2.7.4 Water Resource Data, including but not limited to:

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

b. Present water consumption and the projected average and maximum daily demands, including fire flow demand and how this compares to state averages or reasonable uses;

c. Water availability assessment:

1. For groundwater supplies, the following information should be included if available:

(a) Description of aquifer characteristics in the study area, including but not limited to, geologic cross-sections, saturated thickness of water bearing formations and type of material, storage coefficient (S) and transmissivity (T), minimum and maximum depth to water, minimum and maximum depth of existing wells, typical well yields in gallons per minute (gpm), response to climatic conditions, water quality, and any specific observations about the amount of water that is practicably recoverable. The amount of water that is practicably recoverable under existing conditions may be determined using the average depth of existing wells in the area to define the lower boundary of the saturated thickness from which water can be withdrawn.

(b) History, based on the period of record available, of annual water levels and yields (gpm) of water utility wells that reflects the impact of withdrawals on the water supply and the sustainability of the water source. Dividing the available water column by the average annual rate of decline yields an estimate of the productive life of the well.

(c) The available water column may be calculated by subtracting the lowest practical pumping level from the static water level and reducing this value by at least 20% as a margin of safety to account for seasonal fluctuations, drought, peak production requirements, and reduction of well efficiency over time. The lowest practical pumping level may be calculated by any of the following methods as appropriate.

i) By using the lowest water level reached during a recent on-site aquifer pump test;
ii) By setting the water level at the top of the uppermost screened interval;
iii) In wells completed in fractured rock aquifers, the lowest pumping water level may be above the top of the fractured zone; and
iv) In wells completed in alluvial aquifers, the lowest pumping water level may be defined by a maximum allowable drawdown equal to 70% of the initial water column defined as the difference between the static water level and the bottom of the well.

(d) In lieu of measured annual water level declines, projected declines in the water level in production wells over the planning period may be calculated using an appropriate groundwater model where sufficient geohydrologic information is available to establish reliable values for the aquifer storage coefficient and transmissivity.

(e) Sustainable yield of groundwater supplies if this can be determined. The sustainable yield of groundwater supplies (acre-feet per year) may be defined as the average annual recharge from snowmelt and precipitation, seepage from watercourses, and return flow from surface and groundwater withdrawals for water use activities. Sustainable yield may also be described as the annual withdrawal that does not result in a long-term decline in the water table. A seasonal decline in the water table may be acceptable provided that it returns to a pre-established level through replenishment from various sources of recharge during low-demand periods during the calendar year.

2. For surface water supplies, the following information should be included if available:

   (a) Description of the drainage basin, streamflow characteristics (ephemeral, perennial), and water quality.

   (b) Historical record, if available, of monthly and annual streamflows and discharges from springs (if used as a source of supply).

   (c) Description of reservoirs used to store surface water including the normal annual yield and the firm annual yield in acre-feet, and any problems or constraints that affect the operation of the reservoir.

   (d) Sustainable yield of surface water supplies. The sustainable yield (also referred to as the firm yield) of surface water supplies may be defined as the yield available from streams and reservoirs during one or more years of drought.

   (e) Summarize water quantity and quality of the raw water supply, considering fluctuations in quantity and quality.

   (f) Unusual occurrences such as inadequate storage, aging facilities, utilization of water rights, and redundancy.

1.2.7.5 Flow Requirements, including but not limited to:

a. Hydraulic analyses based on flow demands and pressure requirements (See Part 8.2.2); and

b. Fire flows, when fire protection is provided, meeting the recommendations of the Insurance Services Office or other similar agency for the service area involved.

1.2.7.6 Sewerage System Available

Describe the existing sewerage system and sewage treatment works, with special reference to its relationship to existing or proposed water works structures which may affect the operation of the water supply system, or which may affect the quality of the supply. Will this project create or increase the need for sewerage works?

1.2.7.7 Sources of Water Supply

Describe the proposed source or sources of water supply to be developed for this project, the reasons for their selection, and provide information as follows:

1. Sites considered;

2. Advantages of the site selected;

3. Sources of possible contamination such as sewers and sewerage facilities, highways, railroads, landfills, outcroppings of consolidated water-bearing formations, chemical facilities, waste disposal wells,

unplugged domestic wells, naturally occurring arsenic or radiation, etc.;

4. Source water protection issues or measures that need to be considered or implemented, (See Part 3.2.3.2 and 3.2.3.3); and

5. Capacity of resource to serve the existing and future water demand with and without water conservation.

1.2.7.8 Proposed Treatment Processes

Summarize and establish the adequacy of proposed processes and unit parameters for the treatment of the specific water under consideration also taking into account newly adopted regulations under the SDWA. Alternative methods of water treatment and chemical use should be considered as a means of reducing waste handling and disposal problems. Pilot studies may be required.

1.2.7.9 Waste Disposal

Discuss the various wastes from the water treatment plant, their volume, proposed treatment to meet applicable regulations and points of discharge.

1.2.7.10 Automation

Provide supporting data justifying automatic equipment, including the servicing and operator training to be provided. Manual override must be provided for any automatic controls. Highly sophisticated automation may put proper maintenance beyond the capability of the plant operator, leading to equipment breakdowns or expensive servicing. Adequate funding and training of the operators must be assured for maintenance of automatic equipment.

1.2.7.11 Project Sites, including but not limited to:

a. Discussion of the various sites considered and advantages of the recommended ones;

b. The proximity of residences, industries, and other establishments; and

c. Any potential sources of pollution that may influence the quality of the supply or interfere with effective operation of the water works system, such as sewage absorption systems, septic tanks, privies, cesspools, sink holes, sanitary landfills, refuse and garbage dumps, etc.

1.2.7.12 Future Extensions

Summarize planning for future needs and services.

1.2.7.13 Process Flow Diagram

A schematic layout or process flow diagram should be provided.

1.2.7.14 Environmental Impacts

Describe unique direct and indirect impacts on floodplains, wetlands, endangered species, cultural resources, etc. as they relate to a specific alternative. Other documents, such as an Environmental Information Document (EID), may be referenced for a more detailed discussion.

1.2.7.15 Land Requirements

Describe land that should be required for the proposed alternatives and how it should be acquired (purchase, lease, easement, etc.). Note any difficulties that may be encountered in acquisition, such as the necessity to prepare an Environmental Impact Statement (EIS) to access federal lands.

1.2.7.16 Construction Problems

Discuss potential problems for construction, such as subsurface rock, karst terrain, high water table, or limited access. Note that if more than one acre of land will be disturbed, a Storm Water Pollution Prevention Permit (SWPPP) is required.

1.2.7.17 Cost Estimates

Cost estimates should present an equivalent comparison between alternatives. The estimates should be summarized in the report in a comparative table and a detailed line item estimate should be included as an appendix. The estimates should include but not be limited to the following:

a. Construction Costs

Construction and capital costs for all items necessary for a fully functional facility.

b. Non-Construction Costs (Indirect Project Costs)

Costs for other necessary items, such as mitigation measures, training of operators, engineering, legal, right-of-way, and permits (both construction and operational).

c. Annual Operation and Maintenance

Include annual costs for O & M of the proposed facility that should include a replacement schedule for items with an operating life of 15 years or less. The O & M costs should also have an inflation value added to the analysis equal to the prevailing inflation at the time of construction for both structural and non-structural items (such as salaries). As discussed above, the life cycle cost analysis should be presented for extended planning periods of projects with replacement expenses for short-lived items, such as pumps.

d. Present Worth

A present worth analysis should be presented for all project costs based on terms of the likely funding source, such as the Drinking Water State Revolving Fund (DWSRF) loan program with a discount rate of 2% and a term of 20 years. The calculations should assume no grant funding. The results should be reduced to a monthly cost per household and presented in a summary table for ease of reference.

1.2.7.18 Advantages/Disadvantages

Discuss the ability of each alternative to meet the design criteria and the owner's needs within the capacity of the water resource to meet those needs, financial and operational constraints. Include other relevant items, such as regulatory requirements, compatibility with existing comprehensive area-wide development plans, present and future utility rates, public concerns, and health and environmental issues. A matrix rating system can be useful in displaying the information.

1.2.8 Proposed Project

This section should contain a fully developed description of the proposed project based on the preliminary description under the evaluation of alternatives. The reasons for selection of the proposed alternative, location of proposed wells, booster station sites, storage facilities, feasibility, and how the project fits into a long-term plan, should be discussed. At least the following information should be included:

a. Design Criteria

A summary of complete design criteria should be submitted for the proposed project, containing but not limited to the following:

1. Long-term dependable yield of the source of supply;
2. Reservoir surface area, volume, and a volume-versus-depth curve, if applicable,
3. Impact on the watershed, if applicable;
4. Estimated average and maximum day water demands, with and without water conservation and water reuse application for the design period;
5. Number and types of proposed services;
6. Fire fighting requirements;
7. Flash mix, flocculation and settling basin capacities;
8. Retention times;
9. Unit loadings;
10. Filter area and the proposed filtration rate;
11. Backwash rate;

12. Feeder capacities and ranges; and

13. Annual preventive maintenance program and costs.

b. Cost Estimate

Provide an itemized estimate of the project cost based on the anticipated period of construction. Include development and construction, land and rights-of-way, legal, engineering, interest, equipment, contingencies, refinancing, and any other costs associated with the proposed project. (For projects containing both water and wastewater systems, provide a separate cost estimate for each system.)

c. Annual Operating Budget

1. Income

(a) Provide rate schedules, for both the present and after the project is completed. In addition, provide realistic project income based on user billings, water treatment contracts, reserve accounts that include at least a fifteen-year capital improvement replacement schedule, and working capital goal of 15%. Include inflation costs, in the rate analysis, over a five year period and other sources of income and expenses. If water conservation is considered as one of the non-structural alternatives, a block rate analysis should be used to assess the adequacy of income to support the system.

(b) In the absence of other reliable information, for budget purposes, base water consumption on 100 gallons per capita per day (gpcd) or less with a viable water conservation program.

(c) When large users are projected, the report should include facts to substantiate such projections and evaluate the impact of such users on the economic viability of the project. The number of users should be based on equivalent dwelling units (DU), which is the level of service provided to a typical rural residential dwelling.

2. Operation and Maintenance

Project O &M costs realistically. In the absence of other reliable data, base on actual costs of other existing facilities of similar size and complexity. Include facts in the report to substantiate operation and maintenance cost estimates. Include: salaries; wages; taxes; accounting and auditing fees; legal fees; training costs and fees for operators; debt repayment and related expenses; interest and inflation costs; utilities; gasoline, oil and fuel; insurance; repairs and maintenance for the design year; supplies; payment to repair and replacement accounts over the planning period; chemicals; office supplies and printing; and miscellaneous. Portions of the project that involve complex operation or maintenance requirements should be identified including laboratory requirements for operation and self-monitoring.

3. Capital Improvements

   Include all improvement costs including capital and non-structural costs.

4. Debt Repayment

   Describe existing and proposed project financing from all sources including the proposed rate structure. All estimates of funding should be based on loans, not grants.

5. Reserve

   Unless otherwise required, the reserve should be based on one-tenth (1/10) of the annual debt repayment requirement.

1.2.9 Conclusions and Recommendations

Provide any additional findings and recommendations that should be considered in development of the project. This may include recommendations for special studies, highlight the need for special coordination, a recommended plan of action to expedite project development, etc.

a. Conclusions

   Clearly state conclusions of report.

b. Recommendations

   Clearly state and summarize recommendations. Consider the use of tables.

c. Special Needs

   Identify any special needs.

1.3 PLANS AND SUPPORT DOCUMENTS

Submissions to NMED should include plans signed and sealed by a professional engineer, design criteria, the appropriate construction permit applications, review forms, and permit fee if required, and status of water facilities (NMED Drinking Water Bureau Sanitary Surveys).

1.3.1 Plan Title

All plans for water facilities should bear a suitable title showing the name of the municipality, water district, or institution. They should show the scale in feet or metric measure, a graphical scale, the north point, date, and the name and signature of the engineer, with the license number and imprint of the professional engineering seal. A space should be provided for signature and/or approval stamp of the appropriate reviewing authority.

1.3.2 Plan Format

The plans should be clear and legible (suitable for microfilming). They should be drawn to a scale that will permit all necessary information to be plainly shown. Generally, the size of the plans should not be larger than 22 inches x 34 inches (559 mm x 864 mm).

Datum used should be indicated. Locations and logs of test borings, when required, should be shown on the plans. Blueprints should not be submitted.

1.3.3 Plan Contents

Detail plans should consist of plan views, elevations, sections, and supplementary views, which, together with the specifications and general layouts, provide the working information for the contract and construction of the facilities. They should also include field bench marks, dimensions and relative elevations of structures, the location and outline form of equipment, location and size of piping, water levels, ground elevations, and all necessary easements.

1.3.4 Design Criteria

Design criteria should be included with all plans and specifications and a hydraulic profile should be included for all water treatment facilities. For distribution projects, information should be submitted to verify adequate pressure and flow capacity.

1.3.5 Operation During Construction

For treatment plant expansion projects, the project construction documents should specify in detail the procedure for operation during construction, so as to reliably produce sufficient treated water to meet water demands.

1.4 DETAILED PLANS, including but not limited to:

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

b. Profiles having a horizontal scale of not more than 100 feet to the inch and a vertical scale of not more than 10 feet to the inch, with both scales clearly indicated, location and size of the property to be used for the groundwater development with respect to known references such as roads, streams, section lines, or streets;

c. Topography and arrangement of present or planned wells or structures, with contour intervals not greater than two feet;

d. Elevations of the highest known flood level, floor of the structure, upper terminal of protective casings and outside surrounding grade, using United States Coast and Geodetic Survey, United States Geological Survey, or equivalent elevations where applicable as reference;

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

f. Location of all existing and potential sources of pollution which may affect the water source or underground treated water storage facilities;

g. Size, length, and identity of sewers, drains, and water mains, and their locations relative to plant structures;

h. Schematic flow diagrams and hydraulic profiles showing the flow through various plant units;

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

j. Locations of all chemical storage areas, feeding equipment and points of chemical application (see Part 5);

k. All appurtenances, specific structures, equipment, water treatment plant waste disposal units and points of discharge having any relationship to the plans for water mains and/or water works structures;

l. Locations of sanitary or other facilities, such as lavatories, showers, toilets, and lockers, when applicable or required by NMED;

m. Locations, dimensions, and elevations of all proposed plant facilities;

n. Locations of all sampling taps; and

o. Adequate description of any features not otherwise covered by the specifications.

1.5 SPECIFICATIONS

Complete certified, signed and sealed technical specifications should be submitted for the construction of waterlines, booster stations, storage tanks, water treatment plants, and all other appurtenances, and should accompany the plans. The primary funding agencies for water projects in New Mexico have agreed that the “Standard General Conditions of the Construction Contract” as prepared by the Engineer’s Joint Contract Document Committee (EJCDC) and as revised by the agencies, is an acceptable form of agreement. The contract documents must address compliance with applicable laws, such as the retainage act, public works minimum wage act, public works contractor registration, subcontractors fair practices act, etc.

The specifications accompanying construction drawings shall include, but not be limited to, all construction information not shown on the drawings which is necessary to inform the builder in detail of the design requirements for the quality of materials, workmanship, and fabrication of the project.

The specifications shall also include: the type, size, strength, operating characteristics, and rating of equipment; the complete requirements for all mechanical and electrical equipment, including machinery, valves, piping, and jointing of pipe; electrical apparatus, wiring, instrumentation, and meters; laboratory fixtures and equipment; operating tools, construction materials; special filter materials; miscellaneous appurtenances; chemicals when used; instructions for testing materials and equipment as necessary to meet design standards; and performance tests for the completed facilities and component units. It is suggested that these performance tests be conducted at design load conditions wherever practical.

Complete, detailed technical specifications shall be supplied for the proposed project, including:

a. A program for keeping existing water works facilities in operation during construction of additional facilities so as to minimize interruption of service;

b. A plan to disinfect and test the applicable portions of the project to ensure that the project meets bacteriological quality requirements of NMED prior to placing the project components into service;

c. Laboratory facilities and equipment;

d. The number and design of chemical feeding equipment (see Part 5.1); and

e. Materials or proprietary equipment for sanitary or other facilities including any necessary backflow or back-siphonage protection.

1.6 REVISIONS TO APPROVED PLANS

Any deviations from approved plans or specifications affecting capacity, hydraulic conditions, operating units, the functioning of water treatment processes, or the quality of water to be delivered, must be approved by NMED before such changes are made. Revised plans or specifications should be submitted in time to permit the review and approval of such plans or specifications before any construction work, which will be effected by such changes, is begun.

1.7 RECORD DRAWINGS

Record drawings clearly showing all alterations shall be submitted to NMED at the completion of the work and shall be made available in hardcopy and electronic formats.

1.8 ADDITIONAL INFORMATION REQUIRED

NMED may require additional information that is not part of the construction drawings, including but not limited to head loss calculations, proprietary technical data, copies of deeds, copies of contracts, etc.

PART 2

GENERAL DESIGN CONSIDERATIONS

2.0 GENERAL

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

2.1 SECURITY

Water System Security Vulnerability Assessments and Emergency Response Plans are required under the Public Health Security and Bioterrorism Preparedness Act of 2002 (the Bioterrorism Act). The entire Act may be found on EPA's website, http://cfpub.epa.gov/safewater/watersecurity/index.cfm. Drinking Water Security is addressed in Title IV. Community water systems serving greater than 3,300 persons must conduct an assessment of the vulnerability of its system to a terrorist attack or other intentional acts of sabotage. This Vulnerability Assessment shall have been submitted to USEPA by June 30, 2004 for systems serving 3,300 to 50,000 people. Systems must complete or update their Emergency Response Plan (ERP) based on the Vulnerability Assessment within six months of submitting the Assessment, and certify to USEPA that the ERP is updated. The New Mexico Office of Homeland Security can assist. Its website is http://www.governor.state.nm.us/homeland.php?mm=4. The New Mexico Rural Water Association offers training and assistance as well. Security information is available on its website at http://www.nmrwa.org/security.php.

2.2 DESIGN BASIS

The system, including the water source and treatment facilities, should be designed for maximum day demand at the design year. The design year being the year at which the system reaches build-out (ultimate demand) or a year in the future by which time the treatment facility will have been expanded. In other words, the treatment facilities should be sized to have adequate capacity to meet projected demands in the future.

2.3 PLANT LAYOUT

Design should consider:

a. Functional aspects of the plant layout;

b. Provisions for future plant expansion;

c. Compliance with applicable fire codes;

d. Provisions for plant waste treatment and disposal facilities;

e. All weather access roads;

f. Site grading;

g. Site drainage;

h. Walks;

i. Driveways and parking;

j. Chemical delivery;

k. Equipment access; and

l. Security.

2.4 BUILDING LAYOUT

Design should provide for:

a. Compliance with applicable building and fire codes;

b. Ventilation;

c. Lighting;

d. Heating;

e. Drainage;

f. Dehumidification equipment, if necessary;

g. Accessibility of equipment for operation, servicing, and removal;

h. Flexibility of operation;

i. Operator safety;

j. Convenience of operation;

k. Chemical storage and feed equipment in a separate room to reduce hazards and dust problems;

l. Separate motor control center rooms;

m. Accessibility to administration and other appropriate areas by disabled individuals;

n. Accessibility by the public to certain areas for tours; and

o. Security.

2.5 LOCATION OF STRUCTURES

Major structures should be aligned to:

a. Provide access of maintenance vehicles;

b. Not impede flood stream flows;

c. Provide for future expansion; and

d. Comply with applicable codes and environmental documentation to avoid noise, odor, and visual impacts.

2.6 ELECTRICAL CONTROLS

Main switch gear should be located above grade, in areas not subject to flooding, and with protection from the sun, at a minimum a sun roof. Appropriate protection from lightening should be provided. Motor control centers should be protected from the weather and chemical corrosion. Variable frequency drives should be equipped with a manual by-pass.

2.7 STANDBY POWER

A dedicated standby power unit should be provided so that water may be treated and/or pumped to the distribution system during power outages to meet the average day demand. NMED may consider alternatives to dedicated standby power, such as provisions for quick connection of a portable generator. The unit should be equipped so that it is regularly exercised.

2.8 SHOP SPACE AND STORAGE

Adequate facilities should be included for shop space and storage consistent with the designed facilities. A separate work area should be provided for meter testing and repair.

2.9 LABORATORY FACILITIES

Each public water supply should have its own equipment and facilities for routine laboratory testing necessary to ensure proper operation. Laboratory equipment selection should be based on the characteristics of the raw water source and the complexity of the treatment process involved. Laboratory test kits, which simplify procedures for making one or more tests, may be acceptable.

An operator or chemist qualified to perform the necessary laboratory tests is essential. Analyses conducted to determine compliance with drinking water regulations must be performed in an appropriately certified laboratory in accordance with Standard Methods for the Examination of Water and Wastewater or approved alternative methods. Persons designing and equipping laboratory facilities should confer with NMED before beginning the preparation of plans or the purchase of equipment. Methods for verifying adequate quality assurances and for routine calibration of equipment should be provided.

2.9.1 Testing Equipment

As a minimum, the following laboratory equipment should be provided:

a. Surface water supplies should provide the necessary facilities for microbiological testing of water from both the treatment plant and the distribution system. NMED may allow deviations from this requirement.

b. Surface water supplies should have a nephelometric turbidity meter meeting the requirements of Standard Methods for the Examination of Water and Wastewater.

c. Surface water supplies should have test equipment capable of testing for Total Organic Carbon. NMED may allow deviations from this requirement.

d. Each surface water treatment plant utilizing flocculation and sedimentation, including those that lime soften, should have a pH meter, jar test equipment, and titration equipment for both hardness and alkalinity.

e. Each ion-exchange softening plant, and lime softening plant treating only groundwater should have a pH meter and titration equipment for both hardness and alkalinity.

f. Each iron and/or manganese removal plant should have test equipment capable of accurately measuring iron to a minimum of 0.1 milligrams per liter, and/or test equipment capable of accurately measuring manganese to a minimum of 0.05 milligrams per liter.

g. Public water supplies should have test equipment for determining both free and total chlorine residual by methods in Standard Methods for the Examination of Water and Wastewater.

h. Public water supplies that fluoridate should have test equipment for determining fluoride by methods in Standard Methods for the Examination of Water and Wastewater.

i. Public water supplies that feed poly and/or orthophosphates should have test equipment capable of accurately measuring phosphates from 0.1 to 20 milligrams per liter.

2.9.2 Physical Facilities

Sufficient bench space, adequate ventilation, adequate lighting, storage room, laboratory sink, and auxiliary facilities should be provided. Air conditioning may be necessary.

2.10 MONITORING EQUIPMENT

Water treatment plants should be provided with continuous monitoring equipment (including recorders) to monitor water being discharged to the distribution system as follows:

a. Monitoring equipment should be provided to allow full compliance with the requirements of the State and Federal Drinking Water Regulations, per Title 20, Chapter 7, Part 10 of the New Mexico Administrative Code, as amended, and any other applicable law.

b. Additionally, plants treating surface water should have the capability to continuously monitor and record turbidity data from each filter or discrete filtration unit for membrane systems.

c. Additionally, plants treating groundwater, using lime for softening, should have the capability to continuously monitor and record turbidity, pH, and chlorine residual at the entry point of the water into the distribution system.

d. Additionally, plants treating groundwater for iron removal and/or ion exchange softening should have the capability to continuously monitor and record chlorine residual at the entry point of the water into the distribution system.

2.11 SAMPLE TAPS

Sample taps should be provided so that water samples can be obtained from each water source and from appropriate locations in each unit operation of treatment. Taps should be consistent with sampling needs and should not be of the petcock type. Taps used for obtaining samples for bacteriological analysis should be of the smooth-nosed type without interior or exterior threads, should not be of the mixing type, and should not have a screen, aerator, or other such appurtenance.

2.12 FACILITY WATER SUPPLY

The facility water supply service line and the plant finished water sample tap should be supplied from a source of finished water at a point where all chemicals have been thoroughly mixed, and the required disinfectant contact time has been achieved (see Part 4). There should be no cross-connections between the facility water supply service line and any piping, troughs, tanks, or other treatment units containing wastewater, treatment chemicals, raw or partially treated water.

2.13 WALL CASTINGS

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

2.14 METERS

All water supplies should have an acceptable means of metering the finished water.

2.15 PIPING COLOR CODE

To facilitate identification of piping in plants and pumping stations it is recommended that the following color scheme be utilized:

Water Lines	
Raw	Olive Green
Settled or Clarified	Aqua
Finished or Potable	Dark Blue

Chemical Lines

Primary Coagulant - Alum, Ferric Chloride	Orange
Ammonia	White
Carbon Slurry	Black
Caustic	Yellow with Green Band
Chlorine (Gas and Solution)	Yellow
Fluoride	Light Blue with Red Band
Lime Slurry	Light Green
Ozone	Yellow with Orange Band
Phosphate Compounds Coagulant Aids Permanganate	Light Green with Red Band Polymers or Orange with Green Band Potassium Violet
Soda Ash	Light Green with Orange Band Sulfuric Acid Yellow with Red Band
Sulfur Dioxide	Light Green with Yellow Band

Waste Lines

Backwash Waste	Light Brown
Sludge	Dark Brown
Sewer (Sanitary or Other)	Dark Gray

Other

Compressed Air	Dark Green
Gas	Red
Other Lines	Light Gray

In situations where two colors do not have sufficient contrast to easily differentiate between them, a six-inch band of contrasting color should be on one of the pipes at approximately 30-inch intervals. The name of the liquid or gas should also be on the pipe. In some cases it may be advantageous to provide arrows indicating the direction of flow.

2.16 SIGNAGE and TAGGING

All major equipment, chemical handling and other designated areas should be signed. Hazardous areas should be labeled and MSDS sheets posted. All electrical conductors should be tagged at each termination point.

2.17 DISINFECTION

All wells, pipes, tanks, and equipment that can convey or store potable water should be disinfected in accordance with current American Water Works Association (AWWA) procedures. Plans or specifications should outline the procedure and include the disinfectant dosage, contact time, and method of testing the results of the procedure.

2.18 OPERATION AND MAINTENANCE MANUAL

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

2.19 OPERATOR INSTRUCTION

Provisions should be made for operator instruction at the start-up of a plant or pumping station. Depending on the individual equipment, video taping of training presentations may be required.

2.20 OTHER CONSIDERATIONS

Consideration must be given to the design requirements of other federal, state, and local regulatory agencies for items such as safety requirements, plumbing and electrical codes, US Army Corps of Engineers 404 Permit for construction in the flood plain, etc. A NPDES permit may be required for waste streams discharged to surface waters, a Groundwater Discharge Plan may be required for waste impoundments, and the Safe Drinking Water Act backwash rule must be observed. Design of reservoirs and storage ponds must comply with requirements of the Office of the State Engineer (OSE), Dam Safety Bureau. Adequate water rights for the project must be verified by the OSE.

PART 3

SOURCE DEVELOPMENT

3.0 GENERAL

3.0.1 In selecting the source of water to be developed, the design engineer must prove to the satisfaction of NMED that an adequate quantity of water will be available, and that the water which is to be delivered to the consumers will meet the current requirements of NMED with respect to microbiological, physical, chemical and radiological qualities. Each water supply should take its raw water from the best available source, which is economically reasonable and technically possible.

3.0.2 Office of the State Engineer

The New Mexico Office of the State Engineer (OSE) should be contacted regarding the latest rules and regulations governing the drilling of wells and appropriation and use of groundwater and/or surface water. The adequacy of all necessary water rights should be verified with the OSE.

3.1 SURFACE WATER

A surface water source includes all tributary streams and drainage basins, natural lakes and artificial reservoirs or impoundments above the point of water supply intake. Any groundwater source, such as an infiltration gallery or shallow well that is determined to be under the direct influence of surface water should be treated as a surface water source for purposes of design and treatment required. A source water protection plan for continued protection of the watershed from potential sources of contamination should be provided as determined by NMED.

3.1.1 Quantity

The quantity of water at the source should:

a. Be adequate to meet the maximum projected water demand of the service area as shown by calculations based on the extreme drought of record while not significantly affecting the ecology of the water course downstream of the intake;

b. Have the capacity to meet the system's maximum daily demand (MDD), and the system should be able to supply a minimum of four (4) hours of peak hourly demand (PHD) with source capacity and storage capacity. Both the MDD and PHD requirements should be met in the system as a whole and in each individual pressure zone;

c. Provide a reasonable surplus for anticipated growth; and

d. Be adequate to compensate for all losses such as silting, evaporation, seepage, etc., and be adequate to provide ample water for other legal users of the source.

3.1.2 Quality

A sanitary survey and study should be made of the factors, both natural and artificial, which may affect quality. Such survey and study should include, but not be limited to:

a. The requirements of the State and Federal Drinking Water Regulations, per Title 20, Chapter 7, Part 10 of the New Mexico Administrative Code as amended;

b. Determining possible future uses of impoundments or reservoirs;

c. Determining degree of control of watershed by owner;

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

e. Assessing all waste discharges (point source and non-point sources) and activities that could impact the water supply. The location of each waste discharge should be shown on a scaled map;

f. Obtaining samples over a sufficient period of time to assess the microbiological, physical, chemical and radiological characteristics of the water;

g. Assessing the capability of the proposed treatment process to reduce contaminants to applicable standards; and

h. Consideration of currents, wind and ice conditions, and the effect of confluencing streams.

3.1.3 Minimum Treatment Requirements

a. The design of the water treatment system should be done to allow reliable compliance with all drinking water regulations as per Title 20, Chapter 7, Part 10 of the New Mexico Administrative Code as amended;

b. The design of the water treatment system must consider the worst conditions that may exist during the life of the facility;

c. NMED should determine the minimum treatment required; and

d. Filtration, preceded by appropriate pretreatment, should be provided for all surface waters and groundwaters under the direct influence of surface water.

3.1.4 Structures

3.1.4.1 Design of intake structures should provide for:

a. Withdrawal of water from more than one level if quality varies with depth;

b. Incorporate features to protect fish and other aquatic life;

c. Incorporate features to protect recreational users and other persons;

d. Separate facilities for release of less desirable water held in storage;

e. Where frazil ice may be a problem, holding the velocity of flow into the intake structure to a minimum, generally not to exceed 0.5 feet per second;

f. Inspection manholes every 1,000 feet for pipe sizes large enough to permit visual inspection;

g. Occasional cleaning of the inlet line;

h. Adequate protection against rupture by dragging anchors, ice, etc.;

i. Ports located above the bottom of the stream, lake or impoundment, but at sufficient depth to be kept submerged at low water levels;

j. Where shore wells are not provided, a diversion device capable of keeping large quantities of fish or debris from entering an intake structure;

k. Where deemed necessary, provisions should be made in the intake structure to control the influx of aquatic nuisances; and

l. When buried surface water collectors are used, sufficient intake opening area must be provided to minimize inlet head loss. Particular attention should be given to the selection of backfill material in relation to the collector pipe slot size and gradation of the native material over the collector system.

3.1.4.2 Shore Wells should:

a. Have motors and electrical controls located above grade, and protected from flooding as required by NMED;

b. Be accessible;

c. Be designed to prevent flotation;

d. Be equipped with removable or traveling screens before the pump suction well;

e. Provide for introduction of chlorine or other chemicals in the raw water transmission main if necessary for quality control;

f. Have intake valves and provisions for back flushing or cleaning by a mechanical device and testing for leaks, where practical; and

g. Have provisions for withstanding surges where necessary.

3.1.4.3 An up-ground reservoir is a facility into which water is pumped during periods of good quality and high stream flow for future release to treatment facilities. Up-ground reservoirs should be constructed to assure that:

a. Water quality is protected by controlling runoff into the reservoir;

b. Dikes are structurally sound and protected against wave action and erosion and meet the requirements of the OSE;

c. Intake structures and devices meet requirements of Part 3.1.4.1;

d. Point of influent flow is separated from the point of withdrawal;

e. Separate pipes are provided for influent to and effluent from the reservoir; and

f. All dam safety requirements should be met.

3.1.5 Impoundments and Reservoirs

3.1.5.1 Site preparation should provide where applicable:

a. Removal of brush and trees to high water elevation;

b. Protection from floods during construction; and

c. Abandonment of all wells that should be inundated, in accordance with requirements of NMED and OSE.

3.1.5.2 Construction may require:

a. Approval from the appropriate regulatory agencies of the safety features for stability and spillway design; and

b. A permit from an appropriate regulatory agency for controlling stream flow or installing a structure on the bed of a stream or interstate waterway.

3.2 GROUNDWATER

A groundwater source includes all water obtained from dug, drilled, bored or driven wells, and infiltration lines not under the direct influence of surface water.

3.2.1 Quantity

3.2.1.1 Source Capacity

a. The total developed groundwater source capacity should equal or exceed the design maximum day demand and equal or exceed the design average day demand with the largest producing well out of service.

b. A system's water source(s) should have the capacity to meet the system's maximum daily demand (MDD), and the system should be able to supply a minimum of four (4) hours of peak hourly demand (PHD) with source capacity and storage capacity.

c. Both the above-described MDD and PHD requirements should be met in the system as a whole and in each individual pressure zone.

3.2.1.2 Number of Sources

A minimum of two sources of groundwater should be provided.

3.2.1.3 Standby Power

a. To ensure continuous service when the primary power has been interrupted, a "standby" power supply should be provided through

1. Connection to at least two independent public power sources; or,

2. Portable or in-place auxiliary power.

b. When automatic pre-lubrication of pump bearings is necessary, and an auxiliary power supply is provided, the pre-lubrication line should be provided with a valved by-pass around the automatic control, or the automatic control should be wired to the emergency power source.

3.2.2 Quality

3.2.2.1 Microbiological Quality

After disinfection of each new, modified or reconstructed groundwater source, one or more water samples should be submitted to a laboratory satisfactory to NMED for microbiological analysis with satisfactory results reported to such agency prior to placing the well into service.

3.2.2.2 Physical and Chemical Quality

a. Every new, modified or reconditioned groundwater source should be examined for applicable physical and chemical characteristics by tests of a representative sample in a laboratory satisfactory to NMED, with the results reported to NMED.

b. Samples should be collected at the conclusion of the test pumping procedure and examined within prescribed hold times.

c. Field determinations of physical and chemical constituents or special sampling procedures may be required by NMED.

3.2.2.3 Radiological Quality

Every new, modified or reconditioned groundwater source should be examined for radiological activity as required by NMED by tests of a representative sample in a laboratory satisfactory to NMED, with results reported to such agency.

3.2.3 Location

3.2.3.1 Well Location

a. NMED should be consulted prior to design and construction regarding a proposed well location as it relates to required separation between existing and potential sources of contamination and groundwater development. The well location should be selected to minimize the impact on other wells and other water resources.

b. New wells should be located at least two hundred feet horizontally from any known source of contamination, to the extent practical. Sources of contamination are those that could adversely affect the quality of drinking water, such as livestock confinement, industrial activity, and residential cesspools.

c. New wells should be located in an area not subject to flooding and outside of the 100-year floodplain, to the extent practical.

3.2.3.2 Continued Sanitary Protection

Continued sanitary protection of the well site from potential sources of contamination should be provided either through ownership, zoning, easements, leasing or other means acceptable to NMED. Fencing of the site may be required by NMED.

3.2.3.3 Wellhead Protection

A wellhead protection plan for continued protection of the wellhead from potential sources of contamination should be provided as determined by NMED.

3.2.3.4 Groundwater Under the Direct Influence of Surface Water

a. "Groundwater under the direct influence of surface water" should be considered the same as a surface water supply, as described above.

b. "Groundwater under the direct influence of surface water" means any water beneath the surface of the ground with significant occurrence of insects or other macro-organisms, algae, or relatively large diameter pathogens, such as *Giardia* or *Cryptosporidium*, or significant and relatively rapid shifts in water characteristics, such as turbidity, temperature, conductivity, or pH, which closely correlate to climatological or surface water conditions.

3.2.4 Testing and Records

3.2.4.1 Yield and Drawdown Tests should:

a. Be performed on every production well after construction or subsequent treatment and prior to placement of the permanent pump;

b. Have the test methods clearly indicated in the project specifications;

c. Have a test pump capacity, at maximum anticipated drawdown, at least 1.5 times the quantity anticipated;

d. Provide for continuous pumping for at least 24 hours at the design pumping rate or until stabilized drawdown has continued for at least six hours when test pumped at 1.5 times the design pumping rate;

e. Provide the following data:

1. Test pump capacity-head characteristics,
2. Static water level,
3. Depth of test pump setting,
4. Time of starting and ending each test cycle, and
5. The zone of influence for the well or wells; and

f. Provide recordings and graphic evaluation of the following at one-hour intervals or less as may be required by NMED:

1. Pumping rate,
2. Pumping water level,
3. Drawdown, and
4. Water recovery rate and levels.

3.2.4.2 Plumbness and Alignment Requirements

a. Every well should be tested for plumbness and alignment in accordance with AWWA standards.

b. The test method and allowable tolerance should be clearly stated in the specifications.

c. If the well fails to meet these requirements, it may be accepted by the engineer if it does not interfere with the installation or operation of the pump or uniform placement of grout.

3.2.4.3 Geological Data

a. Geological data should be determined from samples collected at 5-foot intervals and at each pronounced change in formation.

b. Geological data should be recorded and samples submitted to NMED and OSE.

c. Geological data should be supplemented with information on accurate records of drillhole diameters and depths, assembled order of size and length of casing and liners, grouting depths, formations penetrated, water levels, and location of any blast charges.

3.2.5 General Well Construction

3.2.5.1 Drilling fluids and additives should:

a. Not impart any toxic substances to the water or promote bacterial contamination; and

b. Be acceptable to NMED and OSE.

3.2.5.2 Minimum Protected Depths

Minimum protected depths of drilled wells should provide watertight construction to such depth as may be required by NMED and OSE, to

a. Exclude contamination, and

b. Seal off formations that are, or may be, contaminated or yield undesirable water.

3.2.5.3 Temporary Steel Casing

Temporary steel casing used for construction should be capable of withstanding the structural load imposed during its installation and removal.

3.2.5.4 Permanent Steel Casing Pipe should:

a. Be new single steel casing pipe meeting AWWA Standard A-100, ASTM or API specifications for water well construction;

b. Have minimum weights and thickness indicated in Table 3-1;

c. Have additional thickness and weight if minimum thickness is not considered sufficient to assure reasonable life expectancy of a well;

d. Be capable of withstanding forces to which it is subjected;

e. Be equipped with a drive shoe when driven; and

f. Have full circumferential welds or threaded coupling joints.

3.2.5.5 Nonferrous Casing Materials

a. Approval of the use of any nonferrous material as well as casing should be subject to special determination by NMED and OSE prior to submission of plans and specifications;

b. Nonferrous material proposed as a well casing must be resistant to the corrosiveness of the water and to the stresses to which it will be subjected during installation, grouting and operation; and

c. Must meet AWWA Standard A-100, ASTM, or API specifications for water well construction.

3.2.5.6 Packers

Packers should be of material that will not impart taste, odor, toxic substances or bacterial contamination to the well water. Lead packers should not be used.

3.2.5.7 Screens

a. Screens should be constructed of materials resistant to damage by chemical action of groundwater or cleaning operations.

b. Screens should have size of openings based on sieve analysis of formation and/or gravel pack materials.

c. Screens should be of sufficient length and diameter to provide adequate specific capacity and low aperture entrance velocity. Usually the entrance velocity should not exceed 0.1 feet per second.

d. Screens should be installed so that the pumping water level remains above the screen under all operating conditions.

e. Screens should, where applicable, be designed and installed to permit removal or replacement without adversely affecting water-tight construction of the well.

f. Screens should be provided with a bottom plate or washdown bottom fitting of the same materials as the screen.

3.2.5.8 Grouting Requirements

All permanent well casing, except driven Schedule 40 steel casing, with the approval of NMED and OSE, should be surrounded by a minimum of 1½ inches of grout to the depth required by NMED and OSE. All temporary construction casings should be removed. Where removal is not possible or practical, the casing should be withdrawn at least five feet to insure grout contact with the native formation.

a. Neat Cement Grout

1. Cement conforming to ASTM standard C150 and water, with not more than six gallons of water per sack of cement, must be used for 1½ inch openings.
2. Additives may be used to increase fluidity subject to approval by NMED and OSE.

b. Concrete Grout

1. Equal parts of cement conforming to AWWA A100 Section 7, and sand, with not more than six gallons of water per sack of cement, may be used for openings larger than 1½ inches.
2. Where an annular opening larger than four inches is available, gravel not larger than one-half inch in size may be added.

c. Clay Seal

Where an annular opening greater than six inches is available, a clay seal of clean local clay mixed with at least 10 per cent swelling bentonite may be used when approved by NMED and OSE.

d. Application

1. Sufficient annular opening should be provided to permit a minimum of 1½ inches of grout around permanent casings, including couplings.
2. Prior to grouting through creviced or fractured formations, bentonite or similar materials may be added to the annular opening, in the manner indicated for grouting.
3. When the annular opening is less than four inches, grout should be installed under pressure by means of a grout pump from the bottom of the annular opening upward in one continuous operation until the annular opening is filled.

4. When the annular opening is four or more inches and less than 100 feet in depth, and concrete grout is used, it may be placed by gravity through a grout pipe installed to the bottom of the annular opening in one continuous operation until the annular opening is filled.

5. When the annular opening exceeds six inches, is less than 100 feet in depth, and a clay seal is used, it may be placed by gravity.

6. After cement grouting is applied, work on the well should be discontinued until the cement or concrete grout has properly set.

e. Guides

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

3.2.5.9 Upper Terminal Well Construction

a. Permanent casing for all groundwater sources should project at least 12 inches above the pumphouse floor or concrete apron surface and at least 18 inches above final ground surface.

b. Where a well house is constructed, the floor surface should be at least six inches above the final ground elevation.

c. Sites subject to flooding should be provided with an earth mound to raise the pumphouse floor to an elevation at least two feet above the highest known flood elevation, or other suitable protection as determined by NMED and OSE.

d. The top of the well casing at sites subject to flooding should terminate at least three feet above the 100 year flood level or the highest known flood elevation, whichever is higher, or as NMED and OSE directs.

3.2.5.10 Sanitary Well Seals

a. Sanitary well seals should be provided for all well installations in order to prevent contamination from the top of the casing.

b. The well casing should be equipped with a watertight cap.

c. The ground surface at the wellhead should be protected by a concrete pad measuring 4 ft. by 4 ft., a minimum of 4 inches thick and should slope away from the casing (a minimum of 0.5%). The pad should be constructed to be flush against the casing and to prevent surface infiltration.

d. Continuous protection from surface infiltration should be maintained between the base of the concrete pad and the upper terminus of the annular well seal.

e. When an above ground pump is used for pumping a well, the pump base should be located at least 12 inches above the pump station floor and should be sealed to the top of the casing to prevent contamination of the well.

3.2.5.11 Development

a. Every well should be developed to remove the native silts and clays, drilling mud or finer fraction of the gravel pack.

b. Development should continue until the maximum specific capacity is obtained from the completed well.

c. Where chemical conditioning is required, the specifications should include provisions for the method, equipment, chemicals, testing for residual chemicals, and disposal of waste and inhibitors.

d. Where blasting procedures may be used, the specifications should include the provisions for blasting and cleaning. Special attention should be given to assure that the grouting and casing are not damaged by the blasting.

3.2.5.11 Disinfection

Disinfection of every new, modified or reconditioned groundwater source should:

a. Be provided after completion of work, if a substantial period elapses prior to test pumping or placement of permanent pumping equipment; and

b. Be provided after placement of permanent pumping equipment.

3.2.5.13 Capping Requirements

a. A welded metal plate or a threaded cap is the preferred method for capping a well.

b. At all times during the progress of work, the contractor should provide protection to prevent tampering with the well or entrance of foreign materials.

3.2.5.14 Well Abandonment

a. Test wells and groundwater sources that are not in use should be sealed by such methods as necessary to restore the controlling geological conditions that existed prior to construction or as directed by NMED and OSE.

b. Wells to be abandoned should:

   1. Be sealed to prevent undesirable exchange of water from one aquifer to another;

   2. Preferably be filled with neat cement grout; and

   3. Have fill materials other than cement grout or concrete, disinfected and free of foreign materials.

c. When abandoned wells are filled with cement grout or concrete, these materials should be applied to the well hole through a pipe, tremie, or bailer.

d. Well abandonment procedures may vary based on the local geology and water quality conditions.

3.2.6 Aquifer Types and Construction Methods -- Special Conditions

3.2.6.1 Sand or Gravel Wells

a. If clay or hardpan is encountered above the water bearing formation, the permanent casing and grout should extend through such materials.

b. If a sand or gravel aquifer is overlaid only by permeable soils the permanent casing and grout should extend to at least 20 feet below original or final ground elevation, whichever is lower.

c. If a temporary outer casing is used, it should be completely withdrawn as grout is applied.

3.2.6.2 Gravel Pack Wells

a. Gravel pack should be well rounded particles, 95 per cent siliceous material, that are smooth and uniform, free of foreign material, properly sized, washed and then disinfected immediately prior to or during placement.

b. Gravel pack should be placed in one uniform continuous operation.

c. Gravel refill pipes, when used, should be Schedule 40 steel pipe incorporated within the pump foundation and terminated with screwed or welded caps at least 12 inches above the pump house floor or concrete apron.

d. Gravel refill pipes located in the grouted annular opening should be surrounded by a minimum of 1½ inches of grout.

e. Protection from leakage of grout into the gravel pack or screen should be provided.

f. Permanent inner and outer casings should meet requirements of Part 3.2.5.4 and/or Part 3.2.5.5. Minimum casing and grouted depth should be acceptable to NMED and OSE.

3.2.6.3 Radial Water Collector

a. Locations of all caisson construction joints and porthole assemblies should be indicated.

b. The caisson wall should be reinforced to withstand the forces to which it will be subjected.

c. Radial collectors should be in areas and at depths approved by NMED and OSE.

d. Provisions should be made to assure that radial collectors are essentially horizontal.

e. The top of the caisson should be covered with a watertight floor.

f. All openings in the floor should be curbed and protected from entrance of foreign material.

g. The pump discharge piping should not be placed through the caisson walls. In unique situations where this is not feasible, a watertight seal must be obtained at the wall.

3.2.6.4 Infiltration Lines

a. Infiltration lines may be considered where geological conditions preclude the possibility of developing an acceptable drilled well.

b. The area around infiltration lines should be under the control of the water purveyor for a distance acceptable to or required by NMED and OSE.

c. Flow in the lines should be by gravity to the collecting well.

3.2.6.5 Dug Wells

a. Dug wells may be considered only where geological conditions preclude the possibility of developing an acceptable drilled well.

b. A watertight cover should be provided.

c. Minimum protective lining and grouted depth should be at least ten feet below original or final ground elevation, whichever is lower.

d. Openings should be curbed and protected from entrance of foreign material.

e. Pump discharge piping should not be placed through the well casing or wall.

3.2.6.6 Limestone or Sandstone Wells

a. Where the depth of unconsolidated formations is more than 50 feet, the permanent casing should be firmly seated in un-creviced or unbroken rock. Grouting requirements should be determined by NMED and OSE.

b. Where the depth of unconsolidated formations is less than 50 feet, the depth of casing and grout should be at least 50 feet or as determined by NMED and OSE.

3.2.6.7 Naturally Flowing Wells

a. Flow should be controlled.

b. Permanent casing and grout should be provided.

c. If erosion of the confining bed appears likely, special protective construction may be required by NMED and OSE.

3.2.7 Well Pumps, Discharge Piping and Appurtenances

3.2.7.1 Line Shaft Pumps

Wells equipped with line shaft pumps should:

a. Have the casing firmly connected to the pump structure or have the casing inserted into a recess extending at least one-half inch into the pump base;

b. Have the pump foundation and base designed to prevent water from coming into contact with the joint;

c. Avoid the use of oil lubrication at pump settings less than 400 feet; and

d. Use food-grade oil where oil lubrication is required.

3.2.7.2 Submersible Pumps

Where a submersible pump is used:

a. The top of the casing should be effectively sealed against the entrance of water under all conditions of vibration or movement of conductors or cables, and

b. The electrical cable should be firmly attached to the riser pipe at 20-foot intervals or less.

3.2.7.3 Discharge Piping

a. The discharge piping should:

1. Be designed so that the friction loss should be low;
2. Have control valves and appurtenances located above the pumphouse floor when an above-ground discharge is provided;
3. Be protected against the entrance of contamination;
4. Be equipped with a check valve, a shutoff valve, a pressure gauge, a means of measuring flow, and a smooth nosed sampling tap located at a point where positive pressure is maintained;
5. Where applicable, be equipped with an air release-vacuum relief valve located upstream from the check valve, with exhaust/relief piping terminating in a down-turned position at least 18 inches above the floor and covered with a 24 mesh corrosion resistant screen;
6. Be valved to permit test pumping and control of each well;
7. Have all exposed piping, valves and appurtenances protected against physical damage and freezing;
8. Be properly anchored to prevent movement; and

9. Be protected against surge or water hammer.

b. The discharge piping should be provided with a means of pumping to waste, but should not be directly connected to a sewer.

3.2.7.4 Pitless Well Units

a. NMED and OSE must be contacted for approval of specific applications of pitless units.

b. Pitless units should:

1. Be shop-fabricated from the point of connection with the well casing to the unit cap or cover;
2. Be threaded or welded to the well casing;
3. Be of watertight construction throughout;
4. Be of materials and weight at least equivalent and compatible to the casing;
5. Have field connection to the lateral discharge from the pitless unit of threaded, flanged or mechanical joint connection; and
6. Terminate at least 18 inches above final ground elevation or three feet above the 100-year flood level or the highest known flood elevation, whichever is higher, or as NMED directs.

c. The design of the pitless unit should make provision for:

1. Access to disinfect the well;
2. A properly constructed casing vent meeting the requirements of Part 3.2.7.5;
3. Facilities to measure water levels in the well (see Part 3.2.7.6);
4. A cover at the upper terminal of the well that should prevent the entrance of contamination;
5. A contamination-proof entrance connection for electrical cable;
6. An inside diameter as great as that of the well casing, up to and including casing diameters of 12 inches, to facilitate work and repair on the well, pump or well screen; and
7. At least one check valve within the well casing or in compliance with requirements of NMED and OSE.

d. If the connection to the casing is by field weld, the shop-assembled unit must be designed specifically for field welding to the casing. The only field welding permitted will be that needed to connect a pitless unit to the casing.

3.2.7.5 Casing Vent

Provisions should be made for venting the well casing to the atmosphere. The vent should terminate in a downturned position, at or above the top of the casing or pitless unit in a minimum 1½ inch diameter opening covered with a 24 mesh, corrosion resistant screen. The pipe connecting the casing to the vent should be of adequate size to provide rapid venting of the casing.

3.2.7.6 Water Level Measurement

a. Provisions should be made for easy periodic measurement of water levels in the completed well.

b. Where pneumatic water level measuring equipment is used, it should be made using corrosion resistant materials attached firmly to the drop pipe or pump column and in such a manner as to prevent entrance of foreign materials.

3.2.7.7 Observation Wells should be:

a. Constructed in accordance with the requirements for permanent wells if they are to remain in service after completion of a water supply well; and

b. Protected at the upper terminal to preclude entrance of foreign materials.

3.3 SECURITY

Security should be a consideration in the selection and development of any water source. The New Mexico Office of Homeland Security can assist. See Part 2.1.

TABLE 3-1 - STEEL PIPE

SIZE	DIAMETER		THICKNESS (inch) (nominal)	WEIGHT PER FOOT (lbs)	
	OUTSIDE	INSIDE		WITH THREADS AND COUPLINGS	PLAINS ENDS
6 id	6.625	6.065	0.280	18.97	19.18
8	8.625	7.981	0.322	28.55	29.35
10	10.750	10.020	0.365	40.48	41.85
12	12.750	12.000	0.375	49.56	51.15
14 od	14.000	13.250	0.375	54.57	57.00
16	16.000	15.250	0.375	62.58	
18	18.000	17.250	0.375	70.59	
20	20.000	19.250	0.375	78.60	
22	22.000	21.000	0.500	114.81	
24	24.000	23.000	0.500	125.49	
26	26.000	25.000	0.500	136.17	
28	28.000	27.000	0.500	146.85	
30	30.000	29.000	0.500	157.53	
32	32.000	31.000	0.500	168.21	
34	34.000	33.000	0.500	178.89	
36	36.000	35.000	0.500	189.57	

PART 4

TREATMENT

4.0 GENERAL

The design of treatment processes and devices should depend on the evaluation of the nature and quality of the particular water to be treated, including seasonal variations. Drinking water treatment systems should be designed to reliably meet the regulatory requirements set forth in New Mexico Administrative Code Title 20, Chapter 7, Part 10, as amended, and any other applicable law.

The purpose of this Part is to set forth general design criteria for the construction of drinking water treatment systems that are considered “best practice” for the use of NMED in the review of engineering submittals. Drinking water treatment system design requires the input of an experienced design engineer that is licensed as a Professional Engineer in the State of New Mexico. The design criteria and other information provided in this Part should not relieve the design engineer from the responsibility of preparing proper preliminary design, detailed design, and construction documents that will provide the system user with a plant that reliably treats the specific raw water source to produce potable water meeting all drinking water regulations.

Please refer to Part 5 – CHEMICAL STORAGE AND FEED, for specific information on the handling, storage, use, and disposal of specific treatment chemicals referenced in this Part.

Systems for treating surface water and groundwater under the direct influence of surface water should use the multiple-barrier approach to removing and inactivating pathogenic microorganisms.

Materials in contact with water during and after treatment should be approved by the National Sanitation Foundation (NSF) and/or the United States Federal Drug Administration (FDA).

4.1 FLASH MIX

4.1.1 Flash Mix for Coagulant Dispersal

Flash mix means the rapid dispersion of treatment chemicals throughout the water to be treated, usually by violent agitation. The engineer should submit the design basis for the flash mix system selected, considering the chemicals to be added, water temperature, color, and other related water quality parameters.

a. General - For the most effective flash mixing, the key is uniform distribution at high mixing energy, resulting in near instantaneous dispersion of the coagulant chemical in the water.

b. Equipment - Mechanical mixing devices (e.g., hydraulic jet mixers) are the preferred flash mix system. Static mixing may be considered if treatment flow does not variable more than a 1 to 1.5 ratio (for example, 5 to 7.5 mgd) and can be justified by the design engineer. In-line static mixers, including orifice plates, can be considered if justified by the design engineer.

c. Mixing - For primary coagulant (e.g., alum or ferric) dispersal, an energy gradient G, of between 500 and 1500 sec^{-1} should be used, where G represents the velocity gradient. The mixing zone time should be less than 3 seconds. For hydraulic jet mixers, approximately 2 percent of the plant flow should be pumped through the mixing nozzle. If a vertical shaft mixer is employed, then approximately 0.4 horsepower per million gallons per day treated should be used. If static mixing devices are used, then a minimum of 2 feet of headloss should occur across the mixer at the lowest plant water flow rate.

d. For secondary coagulant (e.g., cationic polymer) dispersal, a lower mixing energy (300 to 500 sec^{-1}) may be suitable.

e. Location -The flash mix and flocculation basins should be as close together as practical, so as to not have a prolonged delay (>30 sec) between the two processes.

4.1.2 Flash Mix for Other Treatment Chemical Dispersal

a. For dispersing other chemicals into the water, such as disinfectants, pH adjustments, etc., the mixing regime does not have to be as rigorous as with coagulant chemicals. However, complete mixing should occur over a short period of time.

b. Mixing - A mixing energy gradient, G, of about 500 sec^{-1} is recommended.

c. Air mixing is a simple and reliable mixing method, especially where aeration is also required. Evaluation of surface scum formation potential should be addressed before deciding to use air mixing.

4.2 CLARIFICATION

Clarification is a general term used to describe a number of unit processes designed to remove suspended and sometimes dissolved materials from water through gravity settling, chemical precipitation, or other mechanisms. Clarification includes pre-sedimentation, coagulation, flocculation, and sedimentation. Clarification is normally required prior to filtration in a drinking water treatment system, but can also be used to treat groundwater in certain circumstances.

For effective clarification, coagulant chemicals, such as alum, ferric, and polymers are fed to the raw (untreated) water at a flash mix facility. Following flash mix, a period of gentle mixing (coagulation and flocculation) is applied to the water to develop conglomerations of particles that can be removed through a sedimentation process.

a. Several different clarification designs are available, including the following:

1. Conventional horizontal flow sedimentation basins;
2. Plate and tube settling units;
3. Ballasted flocculation-clarification;
4. Suspended media contact clarifiers;

5. Dissolved air flotation; and
6. Radial-upflow clarifiers.

b. The design engineer is responsible for selecting and designing clarification units that are suitable for the application and that should reliably provide good quality clarified water, suitable for filtration.

c. A clarified water turbidity less than 3 NTU should be used as a goal for clarification for surface water treatment applications.

d. Clarification facilities should at a minimum have the following features:

1. A raw (i.e., untreated) water flow meter to measure the water flow into the treatment system and by which treatment chemical feed rates can be controlled;
2. A flash mixing system for effective dispersal of coagulant chemicals into the raw water;
3. A minimum of two units each for flocculation and clarification in-parallel, so as to allow the plant to operate at approximately ½-capacity with one set of flocculation-clarification units out-of-service;
4. The units should be constructed to allow one set of units to be taken out of service without disrupting operation, and with drains or pumps sized to allow dewatering in a reasonable period of time;
5. The plant should be started manually following shutdown (Note: manual start-up may be via the plant instrumentation and control system); and
6. The plant design should minimize hydraulic head losses between units to allow future anticipated changes in processes without the need for repumping. For example, if ozone disinfection is likely to be added in the future, then hydraulic capacity should be incorporated into the initial plant design to accommodate the future installation of ozone contact basins.

e. Clarification facilities designed for processing surface water should have the following additional features:

1. The plant should provide multiple-stage (barrier) treatment facilities (i.e., including two removal processes for suspended materials) when required by NMED; and
2. The plant should incorporate monitoring locations after each unit process to allow water quality (turbidity) to be measured.

4.2.1 Presedimentation

Waters containing high turbidity may require pre-sedimentation, either with or without the addition of coagulation chemicals. Design considerations should include:

a. Basin design - Presedimentation basins should have hopper bottoms or be equipped with continuous mechanical sludge removal apparatus, and provide arrangements for dewatering;

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

c. Bypass - Provisions for bypassing presedimentation basins should be included;

d. Velocity – Basin design should reduce water velocity below 2 feet per second (fps) under peak operating flows; and

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

4.2.2 Flocculation

Flocculation means the agitation of water at low velocities for relatively long periods of time.

a. Basin Design - Inlet and outlet design should prevent short-circuiting and destruction of floc. A drain and/or pumps should be provided to handle dewatering and sludge removal. At least three stages of flocculation should be provided with baffles to prevent short-circuiting between stages.

b. Detention - The flow-through velocity should be not less than 0.5 nor greater than 1.5 feet per minute with a detention time for floc formation of at least 30 minutes. A lesser detention time may be used if justified by the design engineer.

c. Equipment - Agitators should be driven by variable speed drives with the peripheral speed of paddles ranging from 0.5 to 3.0 feet per second. The units should allow tapered mixing energies between the stages, with the most gentle mixing in the final stage prior to sedimentation and filtration. The mixing energy gradient should range between 20 – 70 sec^{-1}.

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

e. Other Designs - Baffled channel flocculation may be used in lieu of mechanical flocculation to provide for flocculation after consultation with NMED. The design should be such that the velocities and flows noted above should be maintained.

f. Superstructure - A superstructure over the flocculation basins may be required, especially in locations subject to continuous freezing temperature levels.

4.2.3 Sedimentation

Sedimentation, or clarification, is the process of removing settle-able solids. This process can be independently or in conjunction with a chemical flocculation process.

a. A superstructure over the basins may be required, especially in locations subject to continuous freezing temperature levels.

b. Chemical Feed - Chemicals should be applied at such points and by such means as to insure satisfactory mixing of the chemicals with the water. Multiple chemical feed locations may be necessary to insure adequate process control.

c. Flushing Lines - Flushing lines or hydrants should be provided and must be equipped with backflow prevention devices acceptable to NMED.

d. Installation of Equipment - Supervision by a representative of the manufacturer should be provided with regard to all mechanical equipment at the time of installation and initial operation (start-up).

e. Operating Equipment - The following should be provided for plant operation:

   1. A complete outfit of tools and accessories;
   2. Necessary laboratory equipment; and
   3. Adequate piping with suitable sampling taps so located as to permit the collection of samples of water from critical portions of the units.

4.2.3.1 Conventional Horizontal Flow Sedimentation Basins

a. Surface Loading Rate - A maximum surface loading rate of 0.5 gpm per square foot is recommended.

b. Detention Time - The detention time for effective clarification is dependent upon a number of factors related to basin design and the nature of the raw water, including temperature. The design of sedimentation basins should provide a minimum of four hours of settling time. Reduced sedimentation time may also be approved when equivalent effective settling is demonstrated.

c. Inlet Devices - Inlets should be designed to distribute the water equally and at uniform velocities. A diffuser wall with submerged ports or similar entrance arrangements is recommended. A diffuser wall should be designed to dissipate inlet velocities and provide uniform flows across the basin.

d. Outlet Devices - Outlet weirs or launders with submerged orifices should maintain velocities suitable for settling in the basin and minimize short-circuiting. The use of submerged orifices can provide a volume above the orifices for storage when there are fluctuations in flow. Outlet weirs and submerged orifices should be designed as follows:

   1. The rate of flow over the outlet weirs or through the submerged orifices should not exceed 20,000 gallons per day per foot of the outlet launder.
   2. Submerged orifices should not be located lower than three (3) feet below the flow line.
   3. The entrance velocity through the submerged orifices should not exceed 0.5 feet per second.

e. Velocity – The velocity through settling basins should not exceed 0.5 feet per minute. The basins must be designed to minimize short-circuiting. Fixed or adjustable baffles may be provided as necessary to achieve the maximum potential for clarification.

f. Overflow - An overflow weir or pipe designed to establish the maximum water level desired on top of the filters should be provided. The overflow should discharge by gravity with a free fall at a location where the discharge will be noted.

g. Backfill Valves - It is recommended that backfill valves be included to allow settled water from an operating basin(s) to fill an empty basin.

h. Superstructure - If there is no mechanical equipment in the basins and if provisions are included for adequate monitoring under all expected weather conditions, a cover may be provided in lieu of a superstructure.

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

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

k. Safety - Permanent ladders or handholds should be provided on the inside walls of basins above the water level. Guardrails should be included. Compliance with other applicable safety requirements, such as OSHA, is required.

l. Sludge Removal - Sludge removal design should provide that:

   1. Sludge pipes should be not less than three inches in diameter and so arranged as to facilitate cleaning;

   2. Entrance to sludge withdrawal piping should prevent clogging;

   3. Valves should be located outside the tank for accessibility; and

   4. The operator may observe and sample sludge being withdrawn from the unit.

m. Sludge disposal - Facilities should contact NMED to obtain required permits for sludge disposal.

4.2.3.2 Tube and Plate Settlers

Proposals for settler unit clarification should include pilot plant and/or full-scale demonstration data on water with similar quality, prior to the preparation of final plans and specifications for approval. Settler units consisting of variously shaped tubes or plates which are installed in multiple layers and at an angle to the flow may be used for sedimentation, following flocculation. The manufacturer of the plate or tube settlers should be consulted on proper design using their products.

General Criteria

a. Inlet and outlet considerations - Design to maintain velocities suitable for settling in the basin and to minimize short-circuiting. Plate units should be designed to maximize distribution across the units.

b. Drainage - Drain piping from the settler units must be sized to facilitate a quick flush of the settler units and to prevent flooding of other portions of the plant.

c. Hydraulic Loading Rate for Tube Settlers - A maximum loading rate of 2.0 gpm per square foot of cross-sectional area for tube settlers, assuming 2” x 2” x 24” long tubes, set at 60 degrees from horizontal. Higher rates may be used if successfully shown through pilot plant or in-plant demonstration studies.

d. Hydraulic Loading Rate for Plate Settlers - A maximum loading rate of 0.5 gpm per square foot based on 80% of the projected horizontal plate area.

4.2.3.3 Ballasted Flocculation/Clarification Units

Proprietary units using the ballasted flocculation/clarification process (e.g., Actiflo®) are available for use in clarifying drinking water. A pilot study may be required to demonstrate this process on a given water, unless the manufacturer can provide data to NMED demonstrating successful operation on another similar water source.

This type of clarifier is not suitable for lime softening applications.

4.2.3.4 Suspended Media Contact Clarifiers (a.k.a., contact adsorption clarifiers)

Proprietary units using suspended media contact-clarification process are available for use in clarifying drinking water. A pilot study may be required to demonstrate this process on a given water, unless the manufacturer can provide data to NMED demonstrating successful operation on another similar water source.

a. Normally, this clarification technology is acceptable for waters with raw water turbidity not exceeding 30 NTU for a prolonged period of time.

b. Upflow rates should not exceed 5gpm/sq ft., unless supporting data, satisfactory to NMED, justifies higher rates.

c. This type of clarifier is not suitable for lime softening or iron and manganese removal applications.

4.2.3.5 Dissolved Air Flotation

Dissolved air flotation is a potential process for use in clarifying drinking water, especially water sources with high algae levels. A pilot study must be performed to demonstrate successful operation of this process on a specific water.

a. This clarification process is acceptable for waters with a raw water turbidity not exceeding 50 NTU for a prolonged period of time. Total Organic Carbon levels should also not exceed 8 mg/l.

b. The surface loading rate should be 4-6 gpm/ft2, which is much higher than traditional sedimentation.

c. Due to the nature of dissolved air flotation, the basins need to be particularly deep to be effective, approximately 12-15 ft for flocculation and 8-9 ft. deep for sedimentation.

4.2.3.6 Solids Contact Units

Units of this type are generally acceptable for combined softening and clarification where water characteristics, especially temperature, do not fluctuate rapidly, flow rates are uniform and operation is continuous. Before such units are considered as clarifiers without softening, specific approval of NMED should be obtained. Clarifiers should be designed for the maximum uniform rate and should be adjustable to changes in flow, which are less than the design rate and for changes in water characteristics. A minimum of two units is required for surface water treatment. A superstructure over the basins may be required, especially in locations subject to continuous freezing temperature levels. The following should be considered in the design process.

a. Mixing

A rapid mix device or chamber ahead of solids contact units may be required by NMED to assure proper mixing of the chemicals applied. Mixing devices employed should be so constructed as to provide good mixing of the raw water with previously formed sludge particles, and prevent deposition of solids in the mixing zone.

b. Flocculation

Flocculation equipment should be adjustable (speed and/or pitch), must provide for coagulation in a separate chamber or baffled zone within the unit, and should have a flocculation and mixing period not less than 30 minutes.

c. Sludge Concentrators

The equipment should provide either internal or external concentrators in order to obtain a concentrated sludge with a minimum of wasted water. Large basins should have at least two sumps for collecting sludge located in the central flocculation zone.

d. Sludge Removal

Sludge removal design should provide that:

1. Sludge pipes should be not less than three inches in diameter and so arranged as to facilitate cleaning;
2. Entrance to sludge withdrawal piping should prevent clogging;
3. Valves should be located outside the tank for accessibility; and
4. The operator may observe and sample sludge being withdrawn from the unit.

e. Cross-Connections

1. Blow-off outlets and drains must terminate and discharge at places satisfactory to NMED; and
2. Cross-connection control must be included for the potable water lines used to backflush sludge lines.

f. Detention Period

The detention time should be established on the basis of the raw water characteristics and other local conditions that affect the operation of the unit. Based on design flow rates, the detention time should be:

1. Two to four hours for suspended solids contact clarifiers and softeners treating surface water; and
2. One to two hours for the suspended solids contact softeners treating only groundwater. The NMED should review detention times proposed.

g. Suspended Slurry Concentrate

Softening units should be designed so that continuous slurry concentrates of one per cent or more, by weight, can be satisfactorily maintained.

h. Water Losses

Units should be provided with suitable controls for sludge withdrawal. Total water losses should not exceed five percent for clarifiers and three percent for softening units. Solids concentration of sludge bled to waste should be three percent by weight for clarifiers and five percent by weight for softening units.

i. Weirs or Orifices

1. The units should be equipped with either overflow weirs or orifices constructed so that water at the surface of the unit does not travel over 10 feet horizontally to the collection trough.
2. Weirs should be adjustable, and at least equivalent in length to the perimeter of the tank.
3. Weir loading should not exceed 10 gpm per foot of weir length for units used for clarifiers and 20 gpm per foot of weir length for units used for softeners.
4. Where orifices are used, the loading rates per foot of launder rates should be equivalent to weir loadings. Either should produce uniform rising rates over the entire area of the tank.

j. Upflow Rates

Unless supporting data justifies rates exceeding the following, rates should not exceed:

1. 0.5 gpm per square foot of area at the sludge separation line for units used for clarifiers. Higher loading rates may be used if data indicates settled water turbidity goals can be met; and
2. 1.75 gpm per square foot of area at the slurry separation line, for units used for softeners.

4.3 FILTRATION

The following types of filtration systems are available for drinking water treatment:

a. Standard Rapid Rate Gravity Filters;

b. Deep-Bed, Rapid Rate Gravity Filters;

c. Membrane Filtration (reverse osmosis, nanofiltration, and ultrafiltration);

d. Slow Sand Filtration;

e. Direct Filtration;

f. Rapid Rate Pressure filters (groundwater treatment only); and

g. Bag and Cartridge Filtration.

The application of a particular type of filtration system for drinking water production must be supported by water quality data representing a reasonable period of time to characterize the variations in water quality. Pilot studies may be required to demonstrate the applicability of the method of filtration proposed.

The filtration system used for treating surface water must meet the requirements set forth in New Mexico Administrative Code Title 20, Chapter 7, Part 10, as amended, and any other applicable law. The filter design should have a goal of being able to reliably produce filtered water with a turbidity level of 0.10 NTU or lower.

4.3.1 Standard Rapid Rate Gravity Filters

Standard rapid rate gravity filters are filters using one or more layers of filter materials. Filters can either be single media, dual media, or multi-media. Media materials are sand, anthracite coal, and garnet sand. The most common filter type is a dual media filter using a layer of anthracite over a layer of sand filter media. Typical media designs for this type of filter include 20 inches of anthracite and 10 inches of sand.

4.3.1.1 Pretreatment

a. Pretreatment of surface water and groundwater under the direct influence of surface water should include flash mixing of coagulants, flocculation, and clarification.

b. For treating groundwater for iron and/or manganese, pretreatment may consist of oxidation and reaction time prior to filtration.

c. Other pretreatment for groundwater will depend on the water quality parameters to be addressed.

4.3.1.2 Rate of Filtration

The filtration rate for standard rapid rate gravity filters should not exceed 5.0 gpm/sq ft. The design rate of filtration should be determined through consideration of such factors as raw water quality, degree of pretreatment provided, filter media, water quality control parameters, competency of operating personnel, and other factors as required by NMED. In any case, the design filter rate must be proposed and justified by the design engineer to NMED prior to the preparation of final plans and specifications.

4.3.1.3 Number of Filters

Normally, at least four filter units should be provided. For plants with treatment capacities of more than 20 million gallons per day (mgd), a minimum of six filters is recommended. For small plants (2 mgd or less), a minimum of two filters may be suitable. However, where only two units are provided, each should be capable of meeting the plant design capacity (normally the projected maximum daily demand) at the approved filtration rate. Where more than two filter units are provided, the filters should be capable of meeting the plant design capacity at the approved filtration rate with one filter removed from service. Where declining rate filtration is provided, the variable aspect of filtration rates, and the number of filters must be considered when determining the design capacity for the filters.

4.3.1.4 Filter Media Design

Filter media should conform to the requirements of ANSI/AWWA B100. The media should be sieved and sized to meet specific design criteria including effective size (ES), uniformity coefficient (UC), and depth to diameter ratio (L:d). The media should be matched so that they expand an equal percentage during backwash.

a. The effective size range of the silica sand should normally be in the range of 0.45 mm to 0.55 mm and have a uniformity coefficient of less than 1.5.

b. The effective size range of the anthracite should normally be in the range of 0.9 to 1.1 mm and have a uniformity coefficient of less than 1.5.

c. The effective size range of the garnet sand should normally be in the range of 0.15 to 0.35 mm and have a uniformity coefficient of less than 1.5.

d. The D_{60} media particle size (ES x UC) of the media should be such that the media expand to the same percentage during a backwash, when the wetted specific gravity of the media is factored in. Refer to Kawamura, Integrated Design of Water Treatment Facilities, 1991.

e. The final sizes and depths of the media layers should be such that a combined L:d of 1,000 or more is achieved, where L is the depth of the media layer in millimeters (mm) and d is the ES of the media in millimeters.

f. Underdrain Systems - New filters should not use gravel support layers only, without justification by the design engineer and acceptance by NMED. If gravel support layers are used, then a 3-inch layer of torpedo sand should be used between the upper surface of the gravel and the lower surface of the filter sand. Information on sizing the torpedo sand should be submitted to NMED.

g. Gravel - Gravel, when used as the supporting media should consist of cleaned and washed, hard, durable, rounded silica particles and should not include flat or elongated particles. The coarsest gravel should be 2 ½ inches in size when the gravel rests directly on a lateral system, and must extend above the top of the perforated laterals.

4.3.1.5 Structural Details and Hydraulics

The filter structure should be designed to provide for:

a. Waterstop and joint sealant to prevent water leakage and cross connections between filtered and unfiltered water;
b. Vertical walls within the filter;
c. No protrusion of the filter walls into the filter media;
d. Cover by superstructure where required by weather conditions;
e. Head room to permit normal inspection and operation;
f. Minimum depth of filter box of 8 feet;
g. Minimum water depth over the surface of the filter media of three feet;
h. Trapped effluent to prevent backflow of air to the bottom of the filters;
i. Prevention of floor drainage to the filter with a minimum 4-inch curb around the filters;
j. Prevention of flooding by providing overflow;
k. Maximum velocity of treated water in pipe and conduits to filters of two feet per second;
l. Cleanouts and straight alignment for influent pipes or conduits where solids loading is heavy or following lime-soda softening;
m. Washwater drain capacity to carry maximum flow;
n. Walkways around filters, to be not less than 36 inches wide;
o. Safety handrails or walls around all filter walkways; and
p. Construction to prevent cross connections between potable and non-potable water.

4.3.1.6 Washwater Troughs

Washwater troughs should be constructed to have:

a. The bottom elevation above the maximum level of expanded media during washing;
b. A two-inch freeboard at the maximum rate of wash;
c. The top edge level and all at the same elevation;

d. Spacing so that each trough serves the same number of square feet of filter area; and

e. Maximum horizontal travel of suspended particles to reach the trough not to exceed three feet.

4.3.1.7 Filter Bottoms and Strainer Underdrain Systems

The design of filter underdrain filtrate collection and backwash distribution systems should:

a. Minimize loss of head in gullets, manifolds and laterals;

b. Ensure even rate of filtration over the entire area of the filter;

c. Ensure even distribution of washwater during a backwash. Calculations should be prepared by the underdrain system manufacturer showing a flow uniformity of ±5 percent of average gpm/sq ft of filter surface at all backwash flow rates; and

d. Porous plate bottoms should not be used where iron or manganese may clog them or with waters softened by lime

4.3.1.8 Surface Wash and/or Subsurface Wash

Surface or subsurface wash facilities should be used except for filters used exclusively for iron or manganese removal, and may be accomplished by a system of fixed nozzles or a revolving-type apparatus. All devices should be designed with:

a. A provision for adequate water pressures for the systems being used;

b. A properly installed approved backflow prevention device to prevent back siphonage if connected to the treated water system; and

c. A minimum rate of flow of 3.0 gallons per minute per square foot of filter area with fixed nozzles or a minimum of 0.5 gallons per minute per square foot with revolving arms.

4.3.1.9 Air Scour Backwash

Air scouring can be used in place of surface wash:

a. Air flow for air scouring the filter must be between 3 and 5 actual cubic feet per minute (acfm) per square foot of filter area when the air is introduced in the underdrain;

b. A method for avoiding excessive loss of the filter media during backwashing must be provided;

c. Air scouring must be followed by a fluidization wash sufficient to restratify the media;

d. Air must be free from contamination;

e. Air scour distribution systems should be placed below the media and supporting interface; if placed at the interface the air scour nozzles should be designed to prevent media from clogging the nozzles or entering the air distribution system;

f. Piping for the air distribution system should not be flexible hose which will collapse when under air pressure and should not be a relatively soft material which may erode at the orifice opening with the passage of air at high velocity;

g. Air delivery piping should not pass down through the filter media nor should there be an arrangement in the filter design which would allow short circuiting between the applied unfiltered water and the filtered water;

h. Consideration should be given to maintenance and replacement of air delivery piping;

i. The backwash water delivery system must be capable of 15 gallons per minute per square foot of filter surface area; however, when air scour is provided the backwash water rate must be variable and should not exceed 8 gallons per minute per square foot, if a combined water backwash - air scour step is included in the backwash sequence, unless operating experience shows that a higher rate is necessary to remove particles from filter media surfaces;

j. The filter underdrains should be designed to accommodate air scour piping when the piping is installed in the underdrain; and

k. The provisions of Part 4.3.1.11 should be followed.

4.3.1.10 Appurtenances

a. The following should be provided for every filter:

1. Influent and effluent sampling taps;
2. Individual turbidimeters and recorders to continuously monitor and provide a permanent record of the effluent turbidity from each filter;
3. A combined filter effluent turbidimeter and recorder to continuously monitor and provide a permanent record of the combined effluent turbidity from the different filters;
4. A monitoring system to indicate loss of head;
5. An applied water channel level monitor;
6. Water level monitors in each filter box;
7. An indicating rate-of-flow meter. A modified rate controller which limits the rate of filtration to a maximum rate may be used;
8. In lieu of individual effluent flow meters, influent splitting to each filter box may be used; however, the design should be done so as to reliably

split the flow evenly to the on-line filters so as to prevent higher than acceptable filtration rates. The method of splitting should allow for adjustment by the operator. NMED should be consulted on the flow splitting design prior to finalization;

9. All new filters and existing filters that have undergone significant rehabilitation, should be equipped with a filter-to-waste system that allows the filter effluent from individual filters to be kept separate from the other filters' effluent. The purpose of the filter-to-waste system is to divert the filtrate from a filter that has just been backwashed. The filters and filter-to-waste system should be designed with a filtered water turbidity goal of 0.10 NTU prior to returning the filter to on-line status. The system should be designed to allow a filter-to-waste flow rate of at least equal to the maximum filtration rate of the filters; and

10. All requirements of the State and Federal Drinking Water regulations should be met.

b. It is recommended the following be provided for every filter:

1. Wall sleeves providing access to the filter interior at several locations for sampling or pressure sensing;

2. A 1½ inch pressure hose and storage rack at the operating floor for washing filter walls; and

3. Particle monitoring equipment as a means to enhance overall treatment operations where used for surface water.

4.3.1.11 Backwash

Provisions should be made for washing filters as follows:

a. A minimum flow rate per filter bed area to allow a minimum 25 percent expansion of the filter media, considering the range of water temperatures and specific gravity of the filter media. (Refer to Kawamura, <u>Integrated Design of Water Treatment Facilities</u>, 1991) Normally, the backwash system should be able to achieve a rate of 15 - 20 gallons per minute per square foot of filter area;

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

c. A standby washwater pump should be provided, unless an alternate means of obtaining washwater is available;

d. Water capacity to allow at least 15 minutes of backwash of one filter at the design rate of wash;

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

f. A rate-of-flow indicator, preferably with a totalizer, on the main washwater line, with a transmitter to allow the operator to monitor the washing process;

g. Design to prevent rapid changes in backwash water flow; and

h. Backwash should be operator initiated. Automated systems should be operator adjustable.

4.3.1.12 Filter-Aid Polymer System

A filter-aid polymer system may be included in the design of filters. The filter-aid polymer system should be able to feed a polymer to the applied water channel or pipe upstream of the filters, so that the polymer is fully mixed with the water being applied to the different filters. Typically, a non-ionic type polymer is fed as a filter-aid.

4.3.1.13 Miscellaneous

Roof drains should not discharge into the filters or basins and conduits preceding the filters.

4.3.2 Deep-Bed, Rapid Rate Gravity Filters

4.3.2.1 Deep-bed, rapid rate gravity filters, as used herein, generally refers to rapid rate gravity filters with filter media depths greater than 48 inches. Filter media sizes are typically a little larger (i.e., larger effective size) than those listed in Part 4.3.1.4.

4.3.2.2 The final filter design should comply with Part 4.3.1, after accounting for the increased depth of media, filter boxes, and water depth over the media, except as indicated in the following paragraphs of Part 4.3.2.

4.3.2.3 Filter Media Design

Filter media should conform to the requirements of ANSI/AWWA B100. The media should be sieved and sized to meet specific design criteria including effective size (ES), uniformity coefficient (UC), and depth to diameter ratio (L:d). The media should be matched so that they expand an equal percentage during backwash.

a. The effective size range of the silica sand should be less than 0.60 mm and have a UC of less than 1.4.

b. The sand layer should be at least 10 inches thick.

c. The effective size range of the anthracite media should have a UC of less than 1.4 and have a size and layer thickness so as to achieve a L:d of at least 1,250, without accounting for the sand layer, where L is the depth of the media layer in millimeters (mm) and d is the ES of the media in millimeters.

d. The D_{60} media particle size (ES x UC) of the media should be such that the media expand to the same percentage during a backwash, when the wetted specific gravity of the media is factored in. Refer to Kawamura, Integrated Design of Water Treatment Facilities, 1991.

e. The final sizes and depths of the two media layers should be such that a combined L:d of 1,700 or more is achieved, where L is the depth of the media layer in millimeters (mm) and d is the ES of the media in millimeters.

f. Other media - Other media, such as granular activated carbon (GAC) or tri-media designs using garnet will be considered for use by NMED. The design engineer should submit adequate data based on pilot studies and/or operating experience on similar waters.

g. Underdrain Systems - New filters should not use only gravel support layers, without justification by the design engineer and acceptance by NMED. If gravel support layers are used, then a 3-inch layer of torpedo sand should be used between the upper surface of the gravel and the lower surface of the filter sand. Information on sizing the torpedo sand should be submitted to NMED.

h. Gravel - Gravel, when used as the supporting media should consist of cleaned and washed, hard, durable, rounded silica particles and should not include flat or elongated particles. The coarsest gravel should be 2½ inches in size when the gravel rests directly on a lateral system, and must extend above the top of the perforated laterals.

4.3.2.4 Rate of Filtration

The filtration rate for deep-bed, rapid rate filters should not exceed 6.0 gpm/sq ft. The design rate of filtration should be determined through consideration of such factors as raw water quality, degree of pretreatment provided, filter media, water quality control parameters, competency of operating personnel, and other factors as required by NMED. In any case, the design filter rate must be proposed and justified by the design engineer to NMED prior to the preparation of final plans and specifications.

4.3.2.5 Deep-bed, rapid rate filters may require pilot studies. NMED should be consulted prior to proceeding with design of this type of filter.

4.3.3 Membrane Filtration

Membrane filtration consists of a number of different technologies, which can be classified according to the driving force used to promote water treatment. Pressure driven technologies consist of Microfiltration (MF), Ultrafiltration (UF), Nanofiltration (NF), and Reverse Osmosis (RO). Electrical voltage driven technologies consist of Electrodialysis (ED) and Electrodialysis Reversal (EDR).

4.3.3.1 Although similar, each technology has differing operational criteria and filtration size ranges. For design purposes, the following information should be considered:

a. MF has an operating pressure range of 15 – 30 psi and a nominal particle removal range of 0.1 – 3.0 microns.

b. UF has an operating pressure range of 20 – 75 psi and a nominal particle removal range of 0.01 – 0.1 microns.

c. NF has an operating pressure range of 50 – 150 psi and a nominal particle removal range of 0.001 – 0.01 microns, or an approximate Molecular Weight (MW) of 200 - 400.

d. RO has an operating pressure range of 150 – 1200 psi and a nominal particle removal range of 0.0001 – 0.001 microns, or an approximate MW of 50 - 200.

e. ED and EDR have an operating pressure range of 40 – 60 psi and a nominal particle removal range of 0.0001 – 0.001 microns, or an approximate MW of 50 - 200.

4.3.3.2 The effectiveness (log removal credit) of the different manufacturer's MF or UF systems for removing microorganisms from raw or clarified water requires demonstration through pilot studies on natural waters. NMED will grant log removal credit for a proposed membrane filtration technology based upon submission of pilot- or full-scale removal data for *Cryptosporidium*, *Giardia*, and viruses. NMED may require additional pilot demonstration studies, if existing data are insufficient.

ED and EDR do not remove electrically neutral substances, such as silica and particulate matter because product water does not pass through a membrane barrier. As such, ED and EDR receive no log removal credit for purposes of compliance with the surface water treatment rule.

4.3.3.3 The maximum flux rate (rate of filtered water permeate per unit membrane surface area) for a specific manufacturer's membrane filtration technology should also be based on the demonstration studies per Paragraph 4.3.3.2. If higher flux rates are proposed, then additional data should be provided to NMED demonstrating log-removal performance at the higher flux rates.

4.3.3.4 Source Water Quality

Due to the sensitive nature of membrane systems, pretreatment of the feed water is required to condition the water for effective particle removal and to prevent membrane plugging, fouling, and scaling. Design of membrane filtration units must include the following pre-treatment processes, as applicable, unless pilot studies or other information can show that they are not necessary or if the manufacturer specifies alternate criteria.

a. Suspended Solids Control. All membrane processes must have a treatment process to remove excess suspended solids.

1. For MF and UF, pretreatment must include strainers or filters rated in the 100 – 500 micron range and incoming turbidity should not exceed 10 NTU.
2. RO, NF, ED, and EDR must include pretreatment filters rated below 25 microns and incoming turbidity should be below 1.0 NTU for RO and NF and below 3.0 NTU for ED and EDR.

b. Scaling Control. Initial design studies should include an analysis of the feed water for calcium carbonate scaling ($CaCO_3$), sulfate scaling ($CaSO_4$, $SrSO_4$, $BaSO_4$) and silica scaling (SiO_2).

c. Microbial Control. Microbial growth must be controlled to prevent membrane fouling and plugging. Chlorination is the preferred method for microbial control, although the chlorine dosage rate must be carefully monitored because most membranes are susceptible to strong oxidants. Depending on the manufacturer's design criteria, a chlorination-dechlorination process may be required.

d. Hydrogen Sulfide Control. Initial design studies should include an analysis for the presence of hydrogen sulfide. In an oxidizing environment, H_2S can form colloidal sulphur which will permanently foul membrane systems.

e. Iron and Manganese Control. Initial design studies should include an analysis for the presence of iron and manganese. In an oxidizing environment, iron and manganese can cause depositional fouling. ED and EDR are especially susceptible and iron should be less than 0.3 mg/l and manganese less than 0.1 mg/l.

f. pH Control. All membrane systems have specific pH ranges in which they should operate. Initial design studies should evaluate the manufacturer's specifications and ensure that the influent pH is within the recommended range or include pH control as a pre-treatment process.

4.3.3.5 Membrane Cleaning System

All membrane system designs should include a membrane cleaning system. The cleaning system should include:

a. A provision for periodic backwash cycles using treated water;

b. An automatic flushing system to flush membrane modules after planned or unplanned shutdowns; and

c. A dedicated cleaning system designed to prepare and circulate chemical solutions through all or some of the membrane modules. Cleaning systems typically consist of the following components:

   1. Tanks with mixers for cleaning solutions;

2. A pump system for circulation. System design should include a head loss evaluation to provide sufficient head to circulate the solution through the membranes; and
3. A filter to intercept any suspended solids;

4.3.3.6 The final filter design should comply with Part 4.3.1, as applicable, and fully comply with the requirements of the State of New Mexico and Federal drinking water regulations.

4.3.3.7 NMED should be contacted prior to beginning any pilot studies or design work on membrane filtration systems intended to be used for producing drinking water. Preliminary water quality and design data should be submitted for NMED review and acceptance prior to beginning any pilot study or design work.

4.3.4 Slow Sand Filters

The use of these filters will require prior engineering studies to demonstrate the adequacy and suitability of this method of filtration for the specific raw water supply. Slow sand filtration is not acceptable for use with groundwater supplies or other raw water sources without sufficient nutrients for the development and maintenance of a healthy schmutzdecke.

4.3.4.1 Quality of Raw Water

a. Slow rate gravity filtration should be limited to waters having maximum turbidities of 10 units and maximum color of 15 units. Raw water quality data must include examinations for algae.
b. Raw water should also have iron and manganese at levels less than 1 mg/l to avoid fouling of the media.

4.3.4.2 Number of Units

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

4.3.4.3 Structural Details and Hydraulics

Slow rate gravity filters should be so designed as to provide:

a. A cover;
b. Headroom to permit normal movement by operating personnel for scraping and sand removal operations;
c. Adequate access hatches and access ports for handling of sand and for ventilation;

d. Filtration to waste;

e. An overflow at the maximum filter water level; and

f. Protection from freezing.

4.3.4.4 Rates of Filtration

The permissible rates of filtration will be determined by the quality of the raw water and will be on the basis of experimental data derived from the water to be treated. The nominal rate may be 45 to 100 gallons per day per square foot of sand area, with somewhat higher rates acceptable when demonstrated to the satisfaction of NMED.

4.3.4.5 Under-drains

Each filter unit should be equipped with a main drain and an adequate number of lateral under-drains to collect the filtered water. The under-drains should be so spaced that the maximum velocity of the water flow in the under-drain should not exceed 0.75 feet per second. The maximum spacing of laterals should not exceed 3 feet if pipe laterals are used.

4.3.4.6 Filtering Material

a. Filter sand should be placed on graded gravel layers for a minimum depth of 30 inches.

b. The effective size should be between 0.15 mm and 0.30 mm.

c. The uniformity coefficient should not exceed 2.5.

d. The sand should be cleaned and washed free from foreign matter.

e. The sand should be re-bedded when scraping has reduced the bed depth to no less than 19 inches. Where sand is to be reused in order to provide biological seeding and shortening of the ripening process, re-bedding should utilize a "throw over" technique whereby new sand is placed on the support gravel and existing sand is replaced on top of the new sand.

4.3.4.7 Filter Gravel

The supporting gravel should be similar to the size and depth distribution provided for rapid rate gravity filters. See 4.3.1.4.f.

4.3.4.8 Depth of Water on Filter Beds

Design should provide a depth of at least three to six feet of water over the sand. Influent water should not scour the sand surface.

4.3.4.9 Control Appurtenances

Each filter should be equipped with:

a. Loss of head gauge;

b. An orifice, Venturi meter, or other suitable means of discharge measurement installed on each filter to control the rate of filtration; and

c. An effluent pipe designed to maintain the water level above the top of the filter sand.

4.3.4.10 Ripening

Slow sand filters should be operated to waste after scraping or re-bedding during a ripening period until the filter effluent turbidity falls to consistently below 0.3 NTU.

4.3.5 Direct Filtration

4.3.5.1 Direct filtration, as used herein, refers to the filtration of a surface water following chemical coagulation and flocculation but without prior settling (Refer to the Federal Code of Regulations, 40 CFR 141.2, for a definition of direct filtration). This filtration technology is normally suitable for treating very high quality raw waters with a maximum turbidity of less than 15 NTU, a color of less than 25 platinum color units (pcu), and stable raw water quality. Additionally, direct filtration plants are likely to require higher levels of operator attention and/or instrumentation to allow reliable, continuous operation.

4.3.5.2 A full scale direct filtration plant should not be designed without prior pilot studies which are acceptable to NMED.

4.3.5.3 Engineering Report

In addition to the items considered in Part 1.2, "PRELIMINARY ENGINEERING REPORT FORMAT AND CONTENT", the report should include a historical summary of meteorological conditions and of raw water quality with special reference to fluctuations in quality, and possible sources of contamination. The following raw water quality parameters should be evaluated in the report:

a. Color;

b. Turbidity;

c. Total and fecal coliform concentration;

d. Microscopic biological organisms;

e. Temperature;

f. Total suspended solids;

g. General inorganic chemical characteristics; and

h. Additional parameters as required by NMED.

The report should also include a description of methods and work to be done during a pilot plant study or, where appropriate, an in-plant demonstration study.

4.3.5.4 Pilot Plant Studies

After approval of the engineering report, a pilot study or in-plant demonstration study should be conducted. The study must be conducted over a sufficient time to treat all expected raw water conditions throughout the year. The study should emphasize but not be limited to, the following items:

a. Chemical mixing conditions including shear gradients and detention periods;
b. Chemical feed rates;
c. Use of various coagulants and coagulant aids;
d. Flocculation conditions;
e. Filtration rates;
f. Filter gradation, types of media and depth of media;
g. Filter breakthrough conditions;
h. Adverse impact of recycling backwash water due to solids, algae, trihalomethane formation and similar problems; and
i. Prior to the initiation of design plans and specifications, a final report including the engineer's design recommendations should be submitted to NMED.

The pilot plant filter must be of a similar type and operated in the same manner as proposed for full scale operation. The pilot study must demonstrate the minimum contact time necessary for optimum filtration for each coagulant proposed.

4.3.5.5 Pretreatment - Rapid Mix and Flocculation

The final rapid mix and flocculation basin design should be based on the pilot plant or in-plant demonstration studies augmented with applicable portions of Part 4.1, "Flash Mix" and Part 4.2.2, "Flocculation."

4.3.5.6 Filtration

a. Filters should be the rapid rate, deep-bed design described in Part 4.3.2. The final filter design should be based on the pilot plant or in-plant demonstration studies. Pressure filters or single media sand filters should not be used.
b. A continuous recording turbidimeter should be installed on each filter effluent line and on the composite filter effluent line.
c. Additional requirements on the design, continuous monitoring, and chemical feed control of this filtration technology may be set by NMED.

4.3.5.7 Siting Requirements

The plant design and land ownership surrounding the plant should allow for the installation of conventional sedimentation basins should it be found that such are necessary.

4.3.6 Pressure Filters (groundwater treatment only)

4.3.6.1 Pressure filters, as used herein, refers to filter media enclosed inside a metal pressure vessel. The normal use of these filters is for iron and manganese removal from groundwaters. Pressure filters should not be used in the filtration of surface water, groundwater under the direct influence of surface water, or following lime softening.

4.3.6.2 General

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

4.3.6.3 Rate of Filtration

The rate should not exceed 3 gpm/sq ft of filter area except where testing, as approved by NMED, has demonstrated satisfactory results at higher rates.

4.3.6.4 Details of Design

The filters should be designed to provide the following:

a. Loss of head gauges on the inlet and outlet pipes of each filter;
b. An easily readable meter or flow indicator on each battery of filters. A flow indicator is recommended for each filtering unit;
c. Filtration and backwashing of each filter individually with an arrangement of piping as simple as possible to accomplish these purposes;
d. Minimum side wall shell height of five feet. A corresponding reduction in side wall height is acceptable where proprietary bottoms permit reduction of the gravel depth;
e. The top of the washwater collectors to be at least 18 inches above the surface of the media;
f. The filter underdrain system to efficiently collect the filtered water and to uniformly distribute the backwash water at a rate not less than 15 gallons per minute per square foot of filter area. Higher rates of backwash may be required depending on the filter media used;
g. Backwash flow indicators and controls that are easily readable while operating the control valves;
h. An air release valve on the highest point of each filter;

i. An accessible manhole to facilitate inspection and repairs for filters 36 inches or more in diameter. Sufficient handholes should be provided for filters less than 36 inches in diameter. Manholes should be at least 24 inches in diameter where feasible;

j. Means to observe the waste washwater during backwashing; and

k. Construction to prevent cross-connection with the potable water supply.

4.3.7 Bag and Cartridge Filtration Technologies

4.3.7.1 Bag and cartridge technology has been used for some time in the food, pharmaceutical and industrial applications. This technology may be suitable for use by very small public water supplies for treatment of drinking water. A number of states, including New Mexico, have accepted bag and cartridge technology as an alternate technology for compliance with the filtration requirements of the Surface Water Treatment Rule.

4.3.7.2 This technology is generally only suitable for treating relatively high quality surface water supplies (i.e., raw water turbidity less than 5 NTU and low virus hazard). The particulate loading capacity of these filters is low, and once expended the bag or cartridge filter must be discarded. This technology is designed to meet the low flow requirement needs of very small systems. The demonstration of filtration is specific to a specific housing and a specific bag or cartridge filter. Any other combinations of different bags, cartridges, or housings should not be considered.

4.3.7.3 Information on the proposed use of this filtration technology must be submitted to NMED for review and approval prior to any pilot testing or installation for use in producing drinking water.

4.3.7.4 Information to be submitted to NMED:

a. The operational and maintenance cost of bag and cartridge replacement must be considered when designing a system; and

b. The filter housing and bag/cartridge filter must demonstrate a minimum filter efficiency of 2-log reduction in particles size 2 micron and above. NMED will decide whether or not a pilot demonstration is necessary for each installation. This filtration efficiency may be accomplished by:

1. Microscopic particulate analysis, including particle counting, sizing and identification, which determines occurrence and removals of micro-organisms and other particles across a filter or system under ambient raw water source condition, or when artificially challenged;

2. *Giardia*/*Cryptosporidium* surrogate particle removal evaluation in accordance with procedures specified in NSF Standard 53 or equivalent. These evaluations can be conducted by NSF or by another third-party whose certification would be acceptable to NMED;

3. "Particle Size Analysis Demonstration for *Giardia* Cyst Removal Credit" procedure presented in Appendix M of the EPA Surface Water Treatment Rule Guidance Manual; and

4. "Nonconsensus" live *Giardia* challenge studies that have been designed and carried out by a third-party agent recognized and accepted by NMED for interim evaluations. At the present time uniform protocol procedures for live *Giardia* challenge studies have not been established. If a live *Giardia* challenge study is performed on site there must be proper cross-connection control equipment in place and the test portion must be operated to waste (i.e., methods other than these that are approved by NMED).

4.3.7.5 General Design Considerations

a. A disinfection system must be included to provide a minimum of 1.0-log inactivation of *Giardia* based on the CT concept (see Part 4.4.4 for concentration/contact time).

b. System components such as housing, bags, cartridges, membranes, gaskets, and O-rings should be evaluated under NSF Standard 61 or equivalent, for leaching of contaminants. Additional testing may be required.

c. The source water or pre-treated water should have a turbidity less than 5 NTU.

d. It is recommended that the flow rate through the treatment process be monitored. The flow rate through the bag/cartridge filter must not exceed 20 gpm, unless documentation at higher flow rates demonstrates that it will meet the requirements for removal of particles.

e. Pretreatment to provide a more constant water quality to the bag/cartridge filter may be required by NMED. Examples of pretreatment include media filters, larger opening bag/cartridge filters, and infiltration galleries. Location of the water intake should be considered in the pretreatment evaluation.

f. Particle count analysis can be used to determine what level of pretreatment will be provided. It should be noted that particle counting is a 'snap shot' in time and that there can be seasonal variations such as algae blooms, lake turnover, spring runoff, and heavy rainfall events that should give varied water quality.

g. It is recommended that chlorine or another disinfectant be added at the head of the treatment process to reduce/eliminate the growth of algae, bacteria, etc., on the filters. The impact on disinfection-by-product formation should be considered.

h. A filter-to-waste cycle is required for any pretreatment pressure sand filters at the beginning of each filter cycle and/or after every backwash of the prefilters. A set amount of water should be discharged to waste before water flows into the bag/cartridge filter.

i. If pressure media filters are used for pretreatment they must be designed according to Part 4.3.

j. A sampling tap should be provided ahead of any treatment so a source water sample can be collected.

k. Pressure gages and sampling taps should be installed before and after the media filter and before and after the bag/cartridge filter.

l. An automatic air release valve should be installed on top of the filter housing.

m. Frequent start and stop operation of the bag or cartridge filter should be avoided. To avoid this frequent start and stop cycle the following options are recommended:

   1. A slow opening and closing valve ahead of the filter to reduce flow surges.
   2. Reduce the flow through bag or cartridge filter to as low as possible to lengthen filter run times.
   3. Install a recirculating pump that pumps treated water back to a point ahead of the bag or cartridge filter. Care must be taken to make sure there is no cross connection between the finished water and raw water. A minimum of two bag or cartridge filter housings should be provided for water systems that must provide water continuously.
   4. Each filter housing should be capable of meeting the plant design capacity (normally the projected maximum daily demand) at the approved filtration rate. Where more than two filter units are provided, the filters should be capable of meeting the plant design capacity at the approved filtration rate with one filter removed from service.
   5. A pressure relief valve should be incorporated into the bag or cartridge filter housing.
   6. Complete automation of the treatment system is not required. Automation of the treatment plant should be incorporated into the ability of the water system to monitor the finished water quality. It is important that a qualified water operator is available to run the treatment plant.
   7. A plan of action should be in place should the water quality parameters fail to meet EPA or the local reviewing authorities standards.

4.3.7.6 Operations

a. The filtration and backwash rates should be monitored so that the prefilters are being optimally used.

b. The bag and cartridge filters must be replaced when a pressure difference of 30 psi or other pressure difference recommended by the manufacturer is observed. It should be noted that bag filters do not load linearly. Additional observation of the filter performance is required near the end of the filter run.

c. Maintenance (o-ring replacement) should be performed in accordance with the manufacturer's recommendations.

d. The following parameters should be monitored:

1. Flow rate, instantaneous;
2. Flow rate, total;
3. Operating pressure;
4. Pressure differential;
5. Turbidity;
6. Chlorine residual; and
7. Disinfection achieved.

4.4 DISINFECTION AND OXIDATION

4.4.1 Oxidation

Chemical oxidants play several roles in water treatment and may be added at several locations in the treatment process. Oxidants can be added for a number of purposes: disinfection, control of biological growth, color removal, control of tastes and odors, reduction of specific organic contaminants, precipitation of metals, and coagulant aids. Oxidants include chlorine, chlorine dioxide, chloramines, ozone, ultraviolet light (UV), potassium permanganate, and hydrogen peroxide.

Precipitation of Metals

a. Oxidation may be by aeration, as indicated in Part 4.6, or by chemical oxidation with chlorine, potassium permanganate, ozone or chlorine dioxide.

b. A minimum detention time of 30 minutes should be provided following oxidation to insure that the oxidation reactions are as complete as possible. This minimum detention may be omitted only where a pilot plant study indicates no need for detention. The detention basin may be designed as a holding tank without provisions for sludge collection but with sufficient baffling to prevent short-circuiting.

4.4.2 Disinfection

a. Disinfection is required at all surface water, groundwater under the direct influence of surface water, and any groundwater supply of questionable sanitary quality or where other treatment is provided. For these applications, continuous disinfection is required by NMED.

b. Disinfection of surface water or groundwater under the direct influence of surface water may be accomplished using gaseous chlorine, calcium or sodium hypochlorite, chlorine dioxide, ozone, or mixed oxidants. Typically, chloramines should be used only as a residual disinfectant in the distribution system. It should be noted that potassium permanganate and hydrogen peroxide, while oxidants, are not approved for use as a disinfectant.

c. Ultraviolet radiation will likely be an alternative disinfectant for surface water in the future.

d. NMED may allow ultraviolet radiation to be used for groundwater disinfection, if the groundwater is not under the direct influence of surface water.

4.4.3 Disinfection Requirements

a. Disinfection requirements for surface water and groundwater under the direct influence of surface water are described in the New Mexico Administrative Code Title 20, Chapter 7, Part 10, and referenced documents therein.

b. NMED may apply the disinfection requirements per Paragraph 4.4.2.a to any groundwater supply of questionable sanitary quality.

4.4.4 CT Concept of Disinfection

a. The CT concept of disinfection should be used for designing and operating disinfection systems for surface water, groundwater under the direct influence of surface water, and any groundwater supply of questionable sanitary quality.

b. The CT concept is the disinfection system where “C” is the concentration of the disinfectant in milligram/liter (mg/L) and “T” is the effective contact time or T_{10}. The procedure for determining the CT required and provided is described in the United States Environmental Protection Agency (USEPA) Guidance Manual for the Surface Water Treatment Rule (SWTR - EPA #57019-89-018). Refer to this guidance manual for determining disinfection requirements.

4.4.5 Contact Time and Point of Application

a. Due consideration should be given to the contact time of the disinfectant in water with relation to pH, ammonia, taste-producing substances, temperature, bacterial quality, disinfection by-product (e.g. trihalomethanes) formation potential, and other pertinent factors. The disinfectant should be applied at a point which will provide adequate contact time. All basins used for disinfection must be designed to minimize short circuiting. Additional baffling can be added to new or existing basins to minimize short circuiting and increase contact time.

b. At plants treating surface water, provisions should be made for applying the disinfectant to the raw water, settled water, filtered water, and water entering the distribution system.

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

d. The amount of contact time provided will depend on the type of disinfectant used along with the parameters mentioned in Part 4.4.4. As a minimum, the system must be designed to meet the CT standards set by NMED in accordance with the State and Federal Drinking Water Regulations. If primary disinfection is accomplished using ozone, chlorine dioxide, or some other chemical that does not provide a residual disinfectant, then chlorine must be added to provide a residual disinfectant.

e. Multiple points of application may be required if chlorine dosages exceeding 4.0 mg/l would be required to meet CT values.

4.4.6 Chlorine

Free chlorine (liquid/gaseous chlorine, sodium hypochlorite, and calcium hypochlorite) is the most common disinfectant for both primary and residual disinfection. Chlorine and hypochlorites are hazardous materials. The services of an experienced, qualified design engineer should be employed in the design of storage and feed facilities for these treatment chemicals.

4.4.6.1 Type

Vacuum-type, solution-feed gas chlorinators or hypochlorite feeders of the positive displacement type must be provided. See Part 5.

4.4.6.2 Capacity

The chlorinator capacity should be such that a free chlorine residual of at least 2 milligrams per liter can be maintained in the water after contact time of at least 30 minutes when maximum flow rate coincides with anticipated maximum chlorine demand. The equipment should be of such design that it will operate accurately over the desired feeding range.

4.4.6.3 Standby Equipment

Where chlorination is required for protection of the treated water supply, standby equipment of sufficient capacity should be available to replace the largest unit. Spare parts should be made available to replace parts subject to wear and breakage. If there is a large difference in feed rates between routine and emergency dosages, a gas metering tube should be provided for each dose range to ensure accurate control of the chlorine feed.

4.4.6.4 Automatic Switch-over

Automatic switch-over of chlorine cylinders should be provided, where necessary, to assure continuous disinfection.

4.4.6.5 Automatic Proportioning

Automatic proportioning chlorinators will be required where the rate of flow or chlorine demand is not constant.

4.4.6.6 Eductor

Each eductor must be selected for the point of application with particular attention given to the quantity of chlorine to be added, the maximum injector waterflow, the total discharge back pressure, the injector operating pressure, and the size of the chlorine solution line. Gauges for measuring water pressure and vacuum at the inlet and outlet of each eductor should be provided.

4.4.6.7 Injector/diffuser

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

4.4.6.8 Chlorine Testing Equipment

a. Chlorine residual test equipment recognized in the latest edition of Standard Methods for the Examination of Water and Wastewater should be provided and should be capable of measuring residuals to the nearest 0.1 milligrams per liter. It is recommended that larger systems, as a minimum, use the DPD method that utilizes the digital readout with a self-contained light source.

b. Automatic chlorine residual recorders should be provided where the chlorine demand varies appreciably over a short period of time.

c. All surface and groundwater treatment plants should have equipment to measure chlorine residuals continuously entering the distribution system.

4.4.6.9 Chlorinator Piping

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

b. Pipe Material. The pipes carrying elemental liquid or dry gaseous chlorine under pressure must be Schedule 80 seamless steel tubing or other materials recommended by the Chlorine Institute (never use PVC). Rubber, PVC, polyethylene, or other materials recommended by the Chlorine Institute must be used for chlorine solution piping and fittings. Nylon products are not acceptable for any part of the chlorine solution piping system.

4.4.6.10 Hypochlorite Piping

a. Suitable materials must be used for handling and conveying sodium and calcium hypochlorite solutions. When using PVC or CPVC, solvent cement that is suitable for high pH solutions should be used, as recommended by the piping manufacturer.

b. Hypochlorite piping should be double-contained.

c. Hypochlorite piping should be designed so as not to create high spots where gas can be trapped resulting in disruption of the hypochlorite solution flow to the point of application.

4.4.6.11 Housing and Ventilation

Adequate housing and ventilation must be provided for the chlorination equipment and for storing the chlorine and hypochlorites. See Part 5.

4.4.6.12 Chlorine Scrubbers

As required by the local fire department, other regulating agency, or codes, chlorine gas scrubbing equipment should be installed. The scrubbing equipment should be sized to neutralize chlorine gas due to a leak from a liquid chlorine cylinder of the largest size present, so as to prevent a discharge of chlorine gas into the atmosphere.

4.4.7 Ozone

Ozone is a more powerful disinfectant than chlorine and may be required for treating certain water sources. Ozone is a hazardous material. The services of an experienced, qualified design engineer should be employed in the design of the feed gas, ozone generation, feed, and contact facilities.

4.4.7.1 Capacity

When ozone is being used as the primary disinfectant for surface water and groundwater under the direct influence of surface water or groundwaters with significant microbiological parameters of concern, at least two ozone generators should be used. Each generator should be sized to produce the full design disinfectant dose for the facility at the facility’s firm capacity.

4.4.7.2 Automatic Shut-down

The ozone generation system should have automatic shut-down capability designed into the control system. As a minimum, automatic shut-down should occur under the following circumstances:

a. High ambient ozone level in the air inside the generator room, ozone gallery, or other locations within the plant;

b. High ambient oxygen level in the air inside the generator room, ozone gallery, or other locations within the plant;

c. Off-gas destruction equipment not operating or malfunctioning; and

d. Ozone system equipment malfunctions, as recommended by the ozone system supplier.

4.4.7.3 Standby Equipment and Spare Parts

a. As described in Part 4.4.7.1, an installed, ready to use, standby ozone generator should be provided to allow continuous operation of the disinfection system.

b. The feed gas system should have standby units, including oxygen vaporizers and filters, to allow continuous operation of the system.

c. As described in Part 4.4.7.7, an installed, ready to use, standby off-gas destruction unit should be provided to allow continuous operation of the disinfection system.

d. Spare parts, as recommended by the ozone system supplier (OSS) should be provided and maintained.

4.4.7.4 Automatic Switch-over

Automatic switch-over to the standby generator should be provided in the control of the ozone generation system.

4.4.7.5 Automatic Proportioning

The ozone system should be provided with sufficient automation to continuously monitor ozone residuals, feed gas flow rate, ozone gas concentration, and ozone feed rate as well as plant flow rates so as to allow adjustments in ozone production. The purpose is to allow continuous disinfection at the required level.

4.4.7.6 Ozone Contact Basins

a. At least two parallel contact basins should be provided. Each basin may be sized to have one-half the capacity of the treatment plant.

b. The basins should be baffled into multiple cells to minimize short-circuiting and maximize the ratio of effective contact time (t_{10}) to hydraulic residence time (HRT), where HRT is the volume of the contact basin divided by the basin flow rate.

c. The inlet to each basin should be designed to evenly distribute the water across the full width of the basin and prevent uneven flow distribution.

d. The basins should be deep enough to achieve high rates (>90%) of ozone gas transfer into the water at the maximum anticipated dose.

e. The basins should be constructed using Type 316 stainless steel, suitable for ozone service.

f. Each basin should be equipped with sample lines and taps to allow samples to be withdrawn from the center of each cell of the basin so as to allow a complete profile of ozone residual to be produced.

g. Each basin should be equipped with at least two continuous aqueous ozone residual monitors. One monitor should be able to continuously monitor the ozone residual leaving the first cell of the contact basin where the ozone gas is transferred into the water. The second and other monitors should be available to monitor the ozone residual at downstream locations in the basin.

h. After construction, water and air tests should be conducted to verify that the basins do not leak.

i. Provisions for adding thiosulfate or another ozone residual neutralizing chemical should be provided at the outlet of each contact basin.

j. If a gallery is provided at the ozone contact basins, ambient oxygen and ozone gas concentration monitors, with local horns and beacons should be provided to alert staff of unhealthy and dangerous levels of these gases in the air.

k. A set of tracer studies is recommended to verify the effective contact time (t_{10}) of the basins at different flow rates.

4.4.7.7 Off-Gas Destruction Units

a. A set of ozone off-gas destruction units should be provided to withdraw and destroy residual ozone in the gas space above the ozone contact basins.

b. A minimum of two off-gas destruction units should be provided for each pair of ozone contact basins.

c. Each off-gas destruction unit should have adequate capacity to withdraw and destroy residual ozone from a pair of ozone contact basins operating at their maximum capacities.

d. The maximum ozone residual in the gas discharged from the off-gas destruction units should be less than 0.1 ppm by volume, unless a lower level is required by NMED. Confirm the requirement prior to designing the system.

e. The off-gas destruction units should maintain a vacuum inside the gas space above the ozone contact basins, so as to prevent the escape of ozone gas into the surrounding atmosphere.

f. The off-gas destruction units should be equipped with analytical equipment to monitor the ozone residual in the off-gas of each contact basin, the ozone residual in the discharge from the off-gas destruction units, vacuum levels in each ozone contact basin, and other parameters as recommended by the ozone system supplier.

g. Instrumentation and controls should be provided to prevent the ozone generators from starting and continuing to operate if an off-gas destruction unit is not on and not operating properly.

h. The off-gas discharge piping should be routed to a location where it is safe to discharge. Note: the off-gas will contain high levels of oxygen which is a fire hazard. The discharge should be located at least 7 feet above the top deck of the ozone contact basins and in an area where the off-gas will be dispersed into the surrounding atmosphere and not concentrate.

4.4.7.8 Ozone and Oxygen Monitoring and Testing Equipment

a. The type of on-line, continuous ozone and oxygen monitoring and testing equipment should be provided as recommended by the Ozone System Supplier.

b. The plant staff should be equipped with portable testing equipment for monitoring the aqueous ozone residual in samples withdrawn from the ozone contact basins, so as to verify the on-line instruments for calculating the CT achieved. The aqueous ozone residual testers should use the indigo method and employ an electronic spectrophotometer to measure the residual ozone.

c. The plant staff should be equipped with portable testing equipment to verify the readings from the on-line, continuous ambient ozone and oxygen levels in the air.

d. Ambient oxygen and ozone gas monitors should be provided in the Ozone Generation Room, Ozone Contact Basin Gallery, and any other locations where the potential for oxygen and/or ozone gas can leak and concentrate to unhealthy or dangerous levels. The gas monitors should have local horns and beacons and should be hardwired to the ozone generator power supply units to shut down the generators upon sensing a high level of either of these gases.

4.4.7.9 Ozone and Oxygen Piping

a. Piping Materials. Ozone and oxygen piping must be of suitable materials for these services. Ozone piping should be Type 316 stainless steel. Gaskets and other sealants must be suitable for these services.

b. Piping Type. The ozone and oxygen piping should have welded or flanged connections. Swaged connections may be suitable for small diameter sample lines.

c. Pipe Cleaning. The piping and all associated in-line instruments, valves, etc. used for both ozone and oxygen must be properly cleaned for oxygen service by qualified, experienced professionals prior to use.

d. All piping should be pressure tested and determined to be free of leaks prior to placing into service.

4.4.7.10 Housing and Ventilation

Adequate housing and ventilation must be provided for the ozonation and off-gas destruction equipment. The ozone generators should be placed in a separate room or building with its own ventilation system so as to prevent ozone or oxygen leaks from contaminating other building areas. Continuous ventilation should be provided in the Ozone Generation Room, Ozone Contact Basin Gallery, or any other rooms/buildings where oxygen or ozone may leak. Proper floor drainage is required to prevent water puddles around the electrical powered equipment. Other state and local building and fire code requirements should be met.

4.4.8 Chlorine Dioxide

Chlorine dioxide is another more powerful disinfectant than chlorine that may be required for treating certain water sources. Chlorine dioxide is a hazardous material. The services of an experienced, qualified design engineer should be employed in the design of the feed chemicals, chlorine dioxide generation, and feed facilities.

The design engineer should submit a report to NMED addressing design criteria, including safety requirements for review and approval.

4.4.9 On-site Generation of Sodium Hypochlorite

On-site generation of chlorine includes a number of technologies that use an electrolytic process to electrochemically produce chlorine and other oxidants through the use of brine. Although other oxidants can be produced, such as ozone, chlorine dioxide, hydrogen peroxide, and others, the primary component produced is free chlorine.

4.4.9.1 Contact Time

On-site generation is limited by the upper concentration of the chlorine solution produced, generally less than 1% chlorine. Design should account for concentration limit where contact time is required. Contact time is determined from free chlorine concentration only.

4.4.9.2 Ventilation

A by-product of on-site generation is the formation of hydrogen gas. Sufficient passive or active ventilation should be provided to ensure removal of the hydrogen gas. Ventilation should be designed to take suction from as near the ceiling as practical.

4.4.9.3 Pretreatment

In order to avoid fouling of the electrolytic cell, a water softener or other pretreatment is required to prevent scaling during the process.

4.4.9.4 Brine Solution

The salt used for the brine should be high grade (99% pure) and must be certified for use by NSF for electrochlorination (NSF Standard 60).

4.4.9.5 Waste Disposal

Generation of on-site sodium hypochlorite will create a waste stream that must be accounted for. Design should include a means to properly dispose of the waste stream.

4.4.10 Chloramines

Chloramines are only suitable as a residual disinfectant. In some instances, part of the primary (i.e., CT) disinfection requirements can be achieved using chloramines. As with chlorine, the planning and design of ammonia storage and feed facilities requires the services of an experienced, qualified design engineer.

4.4.11 Residual Disinfectant

Minimum free chlorine residual in a water distribution system should be 0.2 to 0.5 milligrams per liter. Minimum combined chlorine residuals, if appropriate, should be 1.5 to 2.0 milligrams per liter at distant points in the distribution system. Higher residuals may be required depending on pH, temperature and other characteristics of the water.

4.4.12 System Installation, Start-up and Operator Training

The services of the disinfection equipment manufacturer's should be obtained to provide assistance during installation and start-up of the equipment. Also, the equipment manufacturers should provide training to the plant operators on the operation, maintenance, and safety procedures for the specific equipment installed.

4.4.13 Safety Equipment and Placards

Safety equipment should be provided including leak detection sensors, ambient gas monitors, protective clothing, self-contained breathing apparatus, and ventilation controls to protect the plant staff, visitors, and the public. Placards should be provided to identify hazardous areas that are acceptable to the local fire department and hazardous materials responders.

4.5 SOFTENING

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

4.5.1 Lime or Lime-Soda Ash Process

Design standards for rapid mix, flocculation and sedimentation are in Part 4.1 and 4.2. Additional consideration must be given to the following process elements.

4.5.1.1 Hydraulics

When split treatment is used, the bypass line should be sized to carry total plant flow, and an accurate means of measuring and splitting the flow must be provided.

4.5.1.2 Encrustation

A significant problem in operation and maintenance of lime softening processes is encrustation of calcium carbonate on the process and hydraulic components. Consideration should be taken during design to accommodate additional hydraulic capacity in pipeline and flumes that may be affected.

4.5.1.3 Aeration

Determinations should be made for the carbon dioxide content of the raw water. When concentrations exceed 10 mg/L, the economics of removal by aeration as opposed to removal with lime should be considered if it has been determined that dissolved oxygen in the finished water will not cause corrosion problems in the distribution system. See Part 4.6.

4.5.1.4 Chemical feed point

Lime and recycled sludge should be fed directly into the rapid mix basin.

4.5.1.5 Rapid mix

Rapid mix basins must provide not more than 30 seconds detention time with adequate velocity gradients to keep the lime particles dispersed.

4.5.1.6 Stabilization

Equipment for stabilization of water softened by the lime or lime-soda process is required. See Part 4.9.

4.5.1.7 Sludge Collection

Mechanical sludge removal equipment should be provided in the sedimentation basin. Sludge recycling to the rapid mix should be provided.

4.5.1.8 Sludge Disposal

Provisions must be included for proper disposal of softening sludges. See Part 4.10.

4.5.1.9 Disinfection

The use of excess lime should not be considered an acceptable substitute for disinfection. See Part 4.4.

4.5.1.10 Plant Start-up

The plant processes must be manually started following shut-down.

4.5.2 Cation Exchange Process

Alternative methods of hardness reduction should be investigated when the sodium content and/or dissolved solids concentration are of concern.

4.5.2.1 Pre-treatment Requirements

Iron, manganese, or a combination of the two, should not exceed 0.3 mg/L in the water as applied to the ion exchange resin. Pre-treatment is required when the content of iron, manganese, or a combination of the two, is one milligram per liter or more. See Part 4.7. Waters having 5 units or more turbidity should not be applied directly to the cation exchange softener.

4.5.2.2 Design

The units may be of pressure or gravity type, of either an upflow or downflow design. Automatic regeneration based on volume of water softened should be used unless manual regeneration is justified and is approved by NMED. A manual override should be provided on all automatic controls.

4.5.2.3 Exchange Capacity

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

4.5.2.4 Depth of Resin

The depth of the exchange resin should not be less than three feet.

4.5.2.5 Flow Rates

The rate of softening should not exceed seven gallons per minute per square foot of bed area and the backwash rate should be a minimum of six to eight gallons per minute per square foot of bed area, unless otherwise recommended by the softener equipment and resin supplier/manufacturer. Rate-of-flow controllers or the equivalent must be installed for the above purposes.

4.5.2.6 Freeboard

The freeboard will depend upon the specific gravity of the resin and the direction of water flow. Generally, the washwater collector should be 24 inches above the top of the resin on downflow units.

4.5.2.7 Underdrains

The bottoms, strainer systems and support for the exchange resin should be as recommended by the softening equipment and resin manufacturer and per the requirements outlined in Part 4.3.

4.5.2.8 Brine Distribution

Facilities should be included for even distribution of the brine over the entire surface of both up-flow and down-flow units.

4.5.2.9 Cross-connection Control

Backwash, rinse and air relief discharge pipes should be installed in such a manner as to prevent any possibility of back-siphonage. Use approved backflow prevention devices.

4.5.2.10 Bypass Piping and Equipment

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

4.5.2.11 Additional Limitations

Silica gel resins should not be used for waters having a pH above 8.4 or containing less than six milligrams per liter silica and should not be used when iron is present. When the applied water contains a chlorine residual, the cation exchange resin should be of a type that is not damaged by residual chlorine. Phenolic resin should not be used. Resins and salt used for potable water treatment should conform to the requirements of the United States Federal Drug Administration (FDA) requirements.

4.5.2.12 Sampling Taps

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

4.5.2.13 Brine and Salt Storage Tanks

a. Salt dissolving or brine tanks and wet salt storage tanks must be covered and must be corrosion-resistant.

b. The make-up water inlet must be protected from back-siphonage using an approved backflow preventer. Water for filling the tank should be distributed over the entire surface by pipes above the maximum brine level in the tank. The tanks should be provided with an automatic declining level control system on the make-up water line.

c. Wet salt storage basins should be equipped with manholes or hatchways for access and for direct dumping of salt from truck or railcar. Openings must be provided with raised curbs and watertight covers having overlapping edges similar to those required for finished water reservoirs.

d. Overflows, where provided, must be protected with corrosion resistant screens and must terminate with either a turned downed bend having a proper free fall discharge or a self-closing flap valve.

e. Two wet salt storage tanks or compartments designed to operate independently should be provided.

f. The salt should be supported on graduated layers of gravel placed over a brine collection system.

g. Alternative designs which are conducive to frequent cleaning of the wet salt storage tank may be considered.

4.5.2.14 Salt and Brine Storage Capacity

Total salt storage should have sufficient capacity to store in excess of 30 days of operation.

4.5.2.15 Brine Pumps or Eductors

An eductor(s) may be used to transfer brine from the brine tank to the softeners. If a pump is used, a brine measuring tank or means of metering should be provided to obtain proper dilution.

4.5.2.16 Stabilization

Refer to Part 4.9.

4.5.2.17 Waste Disposal

a. Suitable disposal must be provided for brine waste. See Part 4.10. Where the volume of spent brine must be reduced, consideration may be given to using a part of the spent brine for a subsequent regeneration.

b. Discharging the brine waste to a sanitary sewer should only be considered after approval by the sewer authority.

4.5.2.18 Construction Materials

Pipes and contact materials must be resistant to the aggressiveness of salt. Steel and concrete must be coated with a non-leaching protective coating which is compatible with salt and brine.

4.5.2.19 Housing

Bagged salt and dry bulk salt storage should be enclosed and separated from other operating areas in order to prevent damage to equipment.

4.5.3 Membrane Softening

The removal of calcium and magnesium ions can be done using membrane softening using nano-filtration or reverse osmosis membranes.

4.5.3.1 Pilot Study

In most cases, a pilot study should be performed to demonstrate the membrane softening process and to develop design criteria. NMED should be contacted prior to conducting a pilot study or designing a membrane softening system for producing potable water.

4.5.3.2 Other Information to Be Provided to NMED.

The design engineer should submit to NMED information on the following areas prior to starting a pilot study or design:

a. Pre-treatment. Membrane softening requires pretreatment of the raw water to prevent damage and fouling of the membranes;

b. Post-treatment. The permeate from the membranes will require post-treatment to stabilize the water prior to delivery to the water distribution system. Additionally, disinfection of the permeate is required; and

c. Brine Disposal. Membrane softening will produce concentrated salt brine that will require proper handling and disposal.

4.5.4 Water Quality Test Equipment

Test equipment for alkalinity, total hardness, carbon dioxide content, and pH should be provided to determine treatment effectiveness.

4.6 AERATION

Aeration may be used to help remove offensive tastes and odors due to dissolved gases from decomposing organic matter, or to reduce or remove objectionable amounts of carbon dioxide, hydrogen sulfide, etc., and to introduce oxygen to assist in iron and/or manganese removal. NMED should be contacted prior to the design of systems that will discharge contaminants to the atmosphere. In some instances, it may be necessary to scrub the discharge to remove contaminants to prevent air pollution.

4.6.1 Natural Draft Aeration

The design should provide the following:

a. Perforations in the distribution pan 3/16 to 1/2 inches in diameter, spaced 1 to 3 inches on centers to maintain a six inch water depth;

b. For distribution of water uniformly over the top tray;

c. Discharge through a series of three or more trays with separation of trays not less than 12 inches;

d. Loading at a rate of 1 to 5 gallons per minute for each square foot of total tray area;

e. Trays with slotted, heavy wire (1/2 inch openings) mesh or perforated bottoms;

f. Construction using durable material resistant to aggressiveness of the water and dissolved gases;

g. Protection from loss of spray water by wind carriage by enclosure with louvers sloped to the inside at an angle of approximately 45 degrees; and

h. Protection from insects by 24-mesh screen.

4.6.2 Forced or Induced Draft Aeration Devices

These systems should be designed with the following:

a. Include a blower with a weatherproof motor in a weather tight housing and screened enclosure;

b. Insure adequate counter current of air through the enclosed aerator column;

c. Include a down-turned and 24-mesh screened air outlet and inlet;

d. Be such that air introduced in the column should be as free from noxious fumes, dust, and dirt as possible;

e. Be such that sections of the aerator can be easily reached or removed for maintenance of the interior or installed in a separate aerator room;

f. Provide loading at a rate of 1 to 5 gallons per minute for each square foot of total tray;

g. Insure that the water outlet is adequately sealed to prevent unwarranted loss of air;

h. Discharge through a series of five or more trays with separation of trays not less than six inches;

i. Provide distribution of water uniformly over the top tray; and

j. Be of durable material resistant to the aggressiveness of the water and dissolved gases.

4.6.3 Spray Aeration

Design should provide for the following:

a. A hydraulic head of between 5 - 25 feet;

b. Nozzles, with the size, number, and spacing of the nozzles being dependent on the flow-rate, space, and the amount of head available;

c. Nozzle diameters in the range of 1 to 1.5 inches to minimize clogging; and

d. An enclosed basin to contain the spray. Any openings for ventilation, etc. must be protected with a 24-mesh screen.

4.6.4 Pressure Aeration

Pressure aeration may be used for oxidation purposes only if pilot plant study indicates the method is applicable; it is not acceptable for removal of dissolved gases. Filters following pressure aeration must have adequate exhaust devices for release of air. Pressure aeration devices should be designed for the following:

a. To give thorough mixing of compressed air with water being treated; and

b. To provide screened and filtered air, free of noxious fumes, dust, dirt and other contaminants.

4.6.5 Packed Tower Aeration

Packed tower aeration (PTA) which is also known as air stripping involves passing water down through a column of packing material while blowing air counter- currently up through the packing. Generally, PTA is feasible for compounds with a Henry's Constant greater than 100 (expressed in atm mol/mol) - at 12°C), but not normally feasible for removing compounds with a Henry’s Constant less than 10. For values between 10 and 100, PTA may be feasible but should be extensively evaluated using pilot studies. Values for Henry's Constant should be discussed with NMED prior to final design.

4.6.5.1 Process Design

a. Process design methods for PTA involve the determination of Henry's Constant for the contaminant, the mass transfer coefficient, air pressure drop and stripping factor. The design engineer should provide justification for the design parameters selected (i.e. height and diameter of unit, air to water ratio, packing depth, surface loading rate, etc.). Pilot plant testing should be provided. The pilot test should evaluate a variety of loading rates and air to water ratios at the peak contaminant concentration. Special consideration should be given to removal efficiencies when multiple contaminants occur. Where there is considerable past performance data on the contaminant to be treated and there is a concentration level similar to previous projects, NMED may approve the process design based on use of appropriate calculations without pilot testing. Proposals of this type must be discussed with NMED prior to submission of any design.

b. The tower should be designed to reduce contaminants to below the maximum contaminant level (MCL) and to the lowest practical level.

c. The ratio of the column diameter to packing diameter should be at least 7:1 for the pilot unit and at least 10:1 for the full scale tower. The type and size of the packing used in the full scale unit should be the same as that used in the pilot work.

d. The minimum volumetric air to water ratio at peak water flow should be 25:1. The maximum air to water ratio for which credit will be given is 80:1.

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

f. The effects of temperature should be considered since a drop in water temperature can result in a drop in contaminant removal efficiency.

4.6.5.2 Materials of Construction

a. The tower can be constructed of stainless steel, concrete, aluminum, fiberglass or plastic. Towers constructed of light-weight materials should be provided with adequate support to prevent damage from wind.

b. Packing materials should be resistant to the aggressiveness of the water, dissolved gases and cleaning materials and should be approved for contact with potable water by the National Sanitation Foundation (NSF).

4.6.5.3 Water Flow System

a. Water should be distributed uniformly at the top of the tower using spray nozzles or orifice-type distributor trays that prevent short-circuiting. For multi-point injection, one injection point for every 30 in^2 of tower cross-sectional area is recommended.

b. A mist eliminator should be provided above the water distributor system.

c. A side wiper redistribution ring should be provided at least every 10 feet in order to prevent water channeling along the tower wall and short-circuiting.

d. Sample taps should be provided in the influent and effluent piping.

e. The effluent sump, if provided, should have easy access for cleaning purposes and be equipped with a drain valve. The drain should not be connected directly to any storm or sanitary sewer.

f. A blow-off line should be provided in the effluent piping to allow for discharge of water/chemicals used to clean the tower.

g. The design should prevent freezing of the influent riser and effluent piping when the unit is not operating. If piping is buried, it should be maintained under positive pressure.

h. The water flow to each tower should be metered.

i. An overflow line should be provided which discharges 12 to 14 inches above a splash pad or drainage inlet. Proper drainage should be provided to prevent flooding of the area.

j. Butterfly valves may be used in the water effluent line for better flow control, as well as to minimize air entrainment.

k. Means should be provided to prevent flooding of the air blower.

l. The water influent pipe should be supported separately from the tower's main structural support.

4.6.5.4 Air Flow System

a. The air inlet to the blower and the tower discharge vent should be down-turned and protected with a non-corrodible 24-mesh screen to prevent contamination from extraneous matter. It is recommended that a 4-mesh screen also be installed prior to the 24-mesh screen on the air inlet system.

b. The air inlet should be in a protected location.

c. An air flow meter should be provided on the influent air line or an alternative method to determine the air flow should be provided.

d. A positive air flow sensing device and a pressure gauge must be installed on the air influent line. The positive air flow sensing device must be a part of an automatic control system which should turn off the influent water if positive air flow is not detected. The pressure gauge will serve as an indicator of fouling buildup.

e. A backup motor for the air blower must be readily available.

4.6.5.5 Other features that should be provided include the following:

a. A sufficient number of access ports with a minimum diameter of 24 inches to facilitate inspection, media replacement, media cleaning and maintenance of the interior;

b. A method of cleaning the packing material when iron, manganese, or calcium carbonate fouling occurs;

c. Tower effluent collection and pumping wells constructed to clear-well standards;

d. Provisions for extending the tower height without major reconstruction;

e. An acceptable alternative supply must be available during periods of maintenance and operation interruptions. No bypass should be provided unless specifically approved by NMED;

f. Disinfection application points both ahead of and after the tower to control biological growth;

g. Disinfection and adequate contact time after the water has passed through the tower and prior to the distribution system;

h. Adequate packing support to allow free flow of water and to prevent deformation with deep packing heights;

i. Operation of the blower and disinfectant feeder equipment during power failures;

j. Adequate foundation to support the tower and lateral support to prevent overturning due to wind loading;

k. Fencing and locking gate to prevent vandalism;

l. An access ladder with safety cage for inspection of the aerator including the exhaust port and de-mister; and

m. Electrical interconnection between blower, disinfectant feeder and well pump.

4.6.5.6 Environmental Factors

a. The applicant must contact the NMED Air Quality Bureau to determine if permits are required under the Clean Air Act.

b. Noise control facilities should be provided on PTA systems located in residential areas.

4.6.6 Other Methods of Aeration

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

4.6.7 Protection of Aerators

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

4.6.8 Disinfection

Groundwater supplies exposed to the atmosphere by aeration must receive chlorination as the minimum additional treatment. Additionally, NMED must make a determination of whether the treatment configuration is sufficient to re-classify the water source to surface water for purposes of additional required treatment.

4.6.9 Bypass

A bypass should be provided for all aeration units except those installed to comply with maximum contaminant levels.

4.6.10 Corrosion Control

The aggressiveness of the water after aeration should be determined and corrected by additional treatment, if necessary. (See Part 4.9)

4.6.11 Quality Control

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

4.7 IRON AND MANGANESE CONTROL

Iron and manganese control, as used herein, refers solely to treatment processes designed specifically for this purpose. The treatment process used will depend upon the character of the raw water. The selection of the treatment processes must meet specific local conditions as determined by engineering investigations, including chemical analyses of representative samples of water to be treated, and receive the approval of NMED. It may be necessary to operate a pilot plant in order to gather all information pertinent to the design. Consideration should be given to adjusting pH of the raw water to optimize the chemical reaction. Testing equipment and sampling taps should be provided as outlined in Parts 2.11 and 2.10.

4.7.1 Removal by Oxidation, Detention and Filtration

4.7.1.1 Oxidation

a. Oxidation may be by aeration, as indicated in Part 4.6, or by chemical oxidation with chlorine, potassium permanganate, ozone or chlorine dioxide. It may be necessary to adjust the pH of the water prior to oxidation for effective treatment. Also, it may be necessary to use a chemical oxidant in lieu of aeration for effective treatment, especially for oxidation of manganese.

b. Application of too high a dose of a chemical oxidant should be avoided so as not to convert manganese to permanganate resulting in colored (pink) water.

4.7.1.2. Detention

a. Reaction Tank/Basin. For effective oxidation and the formation of a filterable material, especially when treating for manganese, a reaction period following oxidation is generally required. Information on the sizing of the reaction tank should be submitted to NMED for review and approval prior to designing the system. A pilot study may be appropriate for determining the reaction time required. The reaction tank(s) should be baffled to prevent short-circuiting.

b. For effective iron and/or manganese removal, it may be necessary to adjust the pH of the water as well as add an oxidant to convert the iron and manganese into a filterable material. Proper storage, feed, and control systems should be provided for chemical feed.

4.7.1.3 Filtration

Filters should be provided and should conform to Part 4.3.

4.7.2 Removal by the Lime-Soda Softening Process

See Part 4.5.1.

4.7.3 Removal by Manganese Coated Media Filtration

This process consists of a continuous feed of potassium permanganate to the influent of a manganese coated media filter.

a. Provisions should be made to apply the permanganate as far ahead of the filter as practical and to a point immediately before the filter.

b. Other oxidizing agents or processes such as chlorination or aeration may be used prior to the permanganate feed to reduce the cost of the chemical.

c. An anthracite media cap of at least six inches is recommended over manganese coated media.

d. Normal filtration rate is three gallons per minute per square foot.

e. Normal wash rate is 8 to 10 gallons per minute per square foot with manganese greensand and 15 to 20 gallons per minute with manganese coated media.

f. Air washing should be provided. `

g. Sample taps should be provided:

   1. Prior to application of permanganate;

   2. Immediately ahead of filtration;

   3. At the filter effluent; and

   4. At points between the anthracite media and the manganese coated media.

4.7.4 Removal by Ion Exchange

This process of iron and manganese removal should be evaluated by pilot study and based upon the characteristics of the water source. This process is not acceptable where either the raw water or wash water contains dissolved oxygen or other oxidants.

4.7.5 Sequestration by Polyphosphates

This process may be suitable for treating water which has iron concentrations of less than 1.0 mg/L and manganese levels of less than 0.1 mg/L. The total phosphate applied should not exceed 10 milligrams per liter as PO_4. Where phosphate treatment is used, satisfactory chlorine residuals should be maintained in the distribution system. Possible adverse affects on corrosion must be addressed when phosphate addition is proposed for iron and/or manganese sequestering.

a. Feeding equipment should conform to the requirements of Part 5.

b. Stock phosphate solution must be kept covered and disinfected by carrying approximately 10 milligrams per liter free chlorine residual. Phosphate solutions having a pH of 2.0 or less may be exempted from this requirement.

c. Polyphosphates should not be applied ahead of iron and manganese removal treatment. The point of application should be prior to any aeration, oxidation or disinfection if no iron or manganese removal treatment is provided.

4.7.6 Sequestration by Sodium Silicates

Sodium silicate sequestration of iron is appropriate only for groundwater supplies prior to air contact. On-site pilot tests are required to determine the suitability of sodium silicate for the particular water and the minimum feed needed. Rapid oxidation of the metal ions such as by chlorine or chlorine dioxide must accompany or closely precede the sodium silicate addition. Injection of sodium silicate more than 15 seconds after oxidation may cause detectable loss of chemical efficiency. Dilution of feed solutions much below five per cent silica as SiO_2 should also be avoided for the same reason.

a. Sodium silicate addition is applicable to waters containing up to 2 mg/l of iron, manganese or combination thereof.

b. Chlorine residuals should be maintained throughout the distribution system to prevent biological breakdown of the sequestered iron.

c. The amount of silicate added should be limited to 20 mg/l as SiO_2, but the amount of added and naturally occurring silicate should not exceed 60 mg/l as SiO_2.

d. Feeding equipment should conform to the requirements of Part 5.

e. Sodium silicate should not be applied ahead of iron or manganese removal treatment.

4.7.7 Sampling Taps

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

4.7.8 Testing Equipment

a. The equipment should have the capacity to accurately measure the iron content to a minimum of 0.1 mg/L and the manganese content to a minimum of 0.05 mg/L.

b. Where polyphosphate sequestration is practiced, appropriate phosphate testing equipment should be provided.

4.8 FLUORIDATION

Sodium fluoride, sodium silicofluoride and fluorosilicic acid should conform to the applicable AWWA standards. Other fluoride compounds which may be available must be approved by NMED.

4.8.1 Fluoride Control Ranges

Any public water system that fluoridates its water supply must maintain fluoride levels within the control range that has been established for its climate. The established fluoride control ranges vary according to average air temperatures. This variation is based on the concept that people in cooler climates typically drink less water per day than people in warmer climates. Therefore, in cooler areas, a higher fluoride level is required to provide the same dental health benefits. The table below shows the optimal fluoride levels (in parts per million) and the fluoride control ranges for different average daily air temperatures. The optimal fluoride level identifies the target fluoride level for each temperature range. However, it is important to note, that any fluoride level within a public water system's prescribed control range should provide dental health benefits.

Fluoride Control Ranges

Average Daily Air Temperature (F°)	Optimal Fluoride Level (ppm)	Control Range (ppm)
50.0 to 53.7	1.2	1.1 to 1.7
53.8 to 58.3	1.1	1.0 to 1.6
58.4 to 63.8	1.0	0.9 to 1.5
63.9 to 70.6	0.9	0.8 to 1.4
70.7 to 79.2	0.8	0.7 to 1.3
79.3 to 90.5	0.7	0.6 to 1.2

4.8.2 NMED Approval

Public water systems must obtain approval from NMED prior to fluoridating their drinking water supplies. Public water systems must also monitor the fluoride levels in their drinking water on a daily basis to ensure that fluoride levels remain within the prescribed control range.

4.8.3 Fluoride Compound Storage

Fluoride chemicals should be isolated from other chemicals to prevent contamination. Compounds should be stored in covered or unopened shipping containers and should be stored inside a building. Unsealed storage units for fluosilicic acid should be vented to the atmosphere at a point outside any building. Bags, fiber drums and steel drums should be stored on pallets. Forced air ventilation of rooms used for storing and feeding fluoride is required.

4.8.4 Chemical Feed Equipment and Methods

In addition to the requirements in Part 5, fluoride feed equipment should meet the following requirements:

a. The feed system should ensure accurate dosing of fluoride under all water flow rates and conditions. The fluoride concentration in the water should be nearly constant, within ± 10 percent of the dose set point;

b. Scales, loss-of-weight recorders or liquid level indicators, as appropriate, accurate to within five percent of the average daily change in reading should be provided for chemical feeds;

c. Feeders should be accurate to within ± two percent of their maximum capacity and within ± five percent of any desired feed rate;

d. Fluoride compound should not be added before lime-soda softening or ion exchange softening;

e. The point of application of fluorosilicic acid, if into a horizontal pipe, should be in the lower half of the pipe;

f. A fluoride solution should be applied by a positive displacement pump having a stroke rate not less than 30 strokes per minute;

g. A spring opposed diaphragm type anti-siphon device should be provided for all fluoride feed lines and dilution water lines;

h. A device to measure the flow of water to be treated;

i. The dilution water pipe should terminate at least two pipe diameters above the solution tank;

j. Water used for sodium fluoride dissolution should be softened if hardness exceeds 75 mg/l as calcium carbonate;

k. Fluoride solutions should be injected at a point of continuous positive pressure or a suitable air gap provided;

l. The electrical outlet used for the fluoride feed pump should have a nonstandard receptacle and should be interconnected with the well or service pump; and

m. Saturators should be of the up-flow type and be provided with a meter and backflow protection on the makeup water line.

4.8.5 Secondary Controls

Secondary control systems for fluoride chemical feed devices should be provided as a means of reducing the possibility for overfeed; these may include flow or pressure switches or other devices.

4.8.6 Protective Equipment

Personal protective equipment as outlined in Part 5.3 should be provided for operators handling fluoride compounds. Deluge showers and eye wash devices should be provided at all fluosilicic acid installations.

4.8.7 Dust Control

a. Provision must be made for the transfer of dry fluoride compounds from shipping containers to storage bins or hoppers in such a way as to minimize the quantity of fluoride dust which may enter the room in which the equipment is installed. The enclosure should be provided with an exhaust fan and dust filter which place the hopper under a negative pressure. Air exhausted from fluoride handling equipment should discharge through a dust filter to the outside atmosphere of the building.

b. Provision should be made for disposing of empty bags, drums or barrels in a manner which will minimize exposure to fluoride dusts. A floor drain should be provided to facilitate the hosing of floors.

4.8.8 Testing equipment

Equipment should be provided for measuring the quantity of fluoride in the water. Such equipment will be subject to the approval of NMED.

4.9 CORROSION CONTROL AND STABILIZATION

Water that is unstable due either to natural causes or to subsequent treatment should be stabilized. The expected treated water quality should be evaluated to determine what, if any, treatment is necessary. Controlling corrosion is important to protect infrastructure as well as for compliance with drinking water regulations, such as the Lead and Copper Rule.

4.9.1 Corrosion Control

a. General. Corrosion control is a complex subject that requires the input of a qualified design engineer. The recommendations set forth in this subsection should be considered minimum requirements. A design engineer should evaluate the specific situation of the water system and determine if additional measures are necessary to adequately control corrosion.

b. Treated Water pH. The pH of the water entering a water distribution system should be maintained in a range that does not promote corrosion or excessive deposit of calcium carbonate or other mineral layers. In most instances, a minimum pH of 8.0 should be maintained.

c. Calcium Carbonate Precipitation Potential (CCPP). The CCPP is a corrosion control index that predicts a water's tendency to deposit a layer of calcium carbonate on the surface of water distribution system pipes. It is recommended that a CCPP of between 4 and 10 mg/L be maintained in the water entering a water distribution system. To achieve a CCPP in this range may require the pH and possibly the alkalinity of the water to be adjusted through the addition of treatment chemicals.

d. Phosphate Addition. For some systems, the addition of a phosphate based corrosion inhibitor may be appropriate. A report from the design engineer should be submitted to NMED for review and approval prior to designing such a system.

4.9.2 Stabilization Following Lime Softening

a. Following lime addition, with or without soda ash addition, for softening, the water will be encrustive and will require stabilization. Stabilization will reduce the water's tendency to deposit (precipitate) calcium carbonate and other minerals on downstream filter media and other surfaces.

b. Carbon Dioxide Addition

1. Re-Carbonation Basin General Design Criteria:

(a) Minimum Detention Time ≥ 20 minutes;

(b) Diffuser Submergence ≥ 8 feet and/or as recommended by design engineer and equipment manufacturer; and

(c) Minimum Mixing Compartment Detention Time ≥ 3 minutes

2. Plants generating carbon dioxide from combustion should have open top re-carbonation tanks in order to dissipate carbon monoxide gas.

3. Where liquid carbon dioxide is used, adequate precautions must be taken to prevent carbon dioxide from entering the plant from the re-carbonation process.

4. Provisions should be made for draining the re-carbonation basin and removing sludge.

c. Acid Addition

1. Feed equipment should conform to Part 5.

2. Adequate precautions should be taken for operator safety, such as not adding water to the concentrated acid. See Part 5.3.

d. Phosphates

1. The feeding of phosphates may be applicable for sequestering calcium in lime-softened water, for corrosion control, and in conjunction with alkali feed following ion exchange softening.

2. The design engineer should submit a report to NMED for review and approval detailing the proposed use of phosphates in such applications prior to designing the system.

3. Feed equipment should conform to Part 5.

4. Stock phosphate solution must be kept covered and disinfected by carrying approximately 10 milligrams per liter free chlorine residual. Phosphate solutions having a pH of 2.0 or less may be exempt from this requirement by NMED.

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

4.10 WASTE HANDLING AND DISPOSAL

a. Provisions must be made for proper disposal of water treatment plant waste such as sanitary, laboratory, clarification sludge, softening sludge, iron sludge, filter backwash water, and brines. All waste discharges should be governed by local, state (i.e., NMED) and federal requirements.

b. The recommendations outlined herein should be considered as general minimum requirements as there may be more stringent specific requirements.

c. The design engineer and Owner of the water system should contact NMED and local authorities to determine specific requirements and file applications for necessary permits prior to completing the planning, design, and construction of any facilities.

d. In locating waste disposal facilities, due consideration should be given to preventing potential contamination of the water supply.

e. Alternative methods of water treatment and chemical use should be considered as a means of reducing waste volumes and the associated handling and disposal problems.

f. Whenever applicable, reference should be made to the U.S. EPA Technology Transfer Handbook, Management of Water Treatment Plant Residuals, April 1996, EPA/625/R-95/008.

4.10.1 Sanitary Waste

The sanitary waste from water treatment plants, pumping stations, and other waterworks installations must receive treatment. Waste from these facilities must be discharged directly to a sanitary sewer system, when available and feasible, or to an adequate on-site waste treatment facility permitted by local authorities and NMED.

4.10.2 Alum, Ferric, and Other Coagulant Sludge

a. A waste discharge permit will be required.

b. The solids from clarification and filtration processes may be disposed of using lagoons or mechanical dewatering systems. For small systems, disposing of the solids into a sanitary sewer may be a suitable alternative, depending on the approval of the local authorities.

c. Discharge of alum, ferric, and other coagulant solids into surface water or aquifers is not permitted.

d. For mechanical dewatering, a pilot study should be done prior to design.

e. Lagoons

1. A minimum of three separate lagoons should be provided; preferably four.

2. Lagoons should be sized based on the coagulant dose and raw water turbidity ranges. (Refer to Kawamura, Integrated Design of Water Treatment Facilities, 1991 for lagoon sizing information.)

3. Lagoons should normally be concrete-lined. If the lagoons are to be left un-lined, the design engineer should submit a report to NMED demonstrating that groundwater contamination will not occur.

4. Other considerations to be addressed are the following:

(a) Lagoons should be in a location free from flooding;

(b) Dikes, deflecting gutters or other means of diverting storm water from entering the lagoons should be constructed;

(c) The minimum usable depth should be four feet;

(d) Adequate freeboard of at least two feet should be provided;

(e) An adjustable decanting system (e.g., stop logs) should be provided;

(f) Inlet design should prevent erosion of each lagoon;

(g) Valves or gates should be provided to allow isolation of each lagoon; and

(h) Adequate safety provisions (fencing, etc).

4.10.3 Filter Waste Washwater

a. For surface water treatment plants and plants treated groundwater under the direct influence of surface water, the filter waste washwater system should comply with the Filter Backwash Recycling Rule (FBRR). Adherence to and any deviation from this rule should be discussed with and approved by NMED prior to finalizing the design of new and upgraded water treatment facilities.

b. When a water treatment system recycles filter backwash water and other waste streams, it introduces contaminants back into the main treatment processes. This practice increases the risk of microbial pathogens passing through to the treated water system. The purpose of the FBRR is to reduce the risk from microbial contaminants, such as *Cryptosporidium*. The FBRR addresses waste washwater generated by filter backwashing as well as recycle streams of liquids from dewatering processes (e.g., solids lagoons and mechanical dewatering systems) and sludge thickener supernatant. These different flow streams tend to have much higher concentrations of *Cryptosporidium* and other pathogens than the raw water, so pose a particular risk of contamination.

c. The best practice for handling recycle flows is to equalize the flow and then treat the flow to remove solids, including microbial pathogens, prior to returning the flow to the main plant processes.

d. All conventional filtration plants (i.e., plants that include a clarification process ahead of filtration) should include a filter backwash waste washwater recovery equalization basin (WWR Equalization Basin), if the waste washwater will be recycled. The purpose of the WWR Equalization Basin is to collect the relatively large surge of waste washwater generated during a filter backwash and allow this flow to be recycled at a rate that is less than 10 percent of the main plant flow rate, and thereby, not overburden or create a hydraulic surge to the main plant processes. The WWR Equalization Basin should be sized so as to accept at least the volume of waste washwater generated by two filter backwashes.

e. Direct filtration plants should include a WWR Equalization Basin as described in Paragraph “d” above, and also must include a treatment process to remove solids from the waste washwater prior to recycling back to the main treatment processes. The treatment process should be designed to remove at least 90 percent of the suspended solids as measured by turbidity or particle counts from the recycle stream.

f. Plants employing lime softening, ballasted flocculation-clarification, suspended media contact clarifiers, two-stage filters, dissolved air flotation, or other unit processes that generate solids streams that may contain concentrations of *Cryptosporidium* oocysts, *Giardia* cysts, or other microbial pathogens greater than the raw water, must also comply with the requirements of the FBRR. Waste flows from these unit processes should be equalized (less than 10 percent of main plant flow rate) prior to recycling.

g. Other specific design recommendations are as follows:

1. The recycle flow should be introduced at or upstream of the main plant flash mix and primary coagulant addition point, so that the recycle flow is fully mixed with the coagulant(s) and main plant flow;

2. A flow meter should be provided to continuously measure the rate of the recycled flow;

3. The coagulant feed system should adjust the feed rate to account for the changes in flow associated with recycle flow. For example, the signals from the main plant raw water flow meter and the recycle flow meter should be combined to determine the coagulant feed dose; and

4. The design should include the ability to monitor the turbidity of the recycle stream prior to introduction into the main plant flow.

4.10.4 Brine Waste

a. Ion exchange, demineralization, or other plants which produce a brine (concentrated mineral or salt solution) will require a permit for disposal. Brine solutions should not be discharged to surface waters or drinking water aquifers. Potential options of disposal include to a sanitary sewer system, to a deep saline aquifer, or to lined drying beds for evaporation. Any disposal option should be approved by NMED, local, and potentially federal authorities.

b. When discharging to a sanitary sewer, a holding tank may be required to prevent the overloading of the sewer and/or interference with the waste treatment processes, subject to approval of the local authority.

4.10.5 Lime Softening Sludge

Sludge from plants using lime to soften water varies in quantity and in chemical characteristics depending on the softening process and the chemical characteristics of the water being softened. Recent studies show that the quantity of sludge produced can be much larger than indicated by stoichiometric calculations. Methods of treatment and disposal are as follows:

a. Lagoons

1. Temporary lagoons which must be cleaned periodically should be designed on the basis of 0.7 acres per million gallons per day per 100 mg/L of hardness removed based on a usable lagoon depth of five feet. This should provide about

2 ½ years storage. At least two but preferably more lagoons should be provided to give flexibility in operation. An acceptable means of final sludge disposal must be provided. Provisions must be made for convenient cleaning.

2. Permanent lagoons should have a volume of at least four times that for temporary lagoons.

3. The design of both temporary lagoons and permanent lagoons should provide for:

   (a) Location free from flooding;

   (b) When necessary, dikes, deflecting gutters or other means of diverting surface water so that it does not flow into the lagoons;

   (c) A minimum usable depth of five feet;

   (d) Adequate freeboard of at least two feet;

   (e) Adjustable decanting device;

   (f) Effluent sampling point;

   (g) Adequate safety provisions; and

   (h) Parallel operation.

b. The application of liquid lime sludge to farm land should be considered as a method of ultimate disposal. Prior to land application, a chemical analysis of the sludge, including calcium and heavy metals, should be conducted. Approval from NMED and, possibly other authorities, must be obtained. When this method is selected, the following provisions should be made:

1. Transport of sludge by vehicle or pipeline should incorporate a plan or design which prevents spillage or leakage during transport;

2. Interim storage areas at the application site should be kept to a minimum and facilities should be provided to prevent wash-off of sludge or flooding;

3. Sludge should not be applied at times when wash-off of sludge from the land could be expected;

4. Sludge should not be applied to sloping land where wash-off could be expected unless provisions are made, for suitable land, to immediately incorporate the sludge into the soil;

5. Trace metals loading should be limited to prevent significant increases in trace metals in the food chain, phytotoxicity or water pollution; and

6. Each area of land to receive lime sludge should be considered individually and a determination made as to the amount of sludge needed to raise soil pH to the optimum for the crop to be grown.

c. Discharge of lime sludge to sanitary sewers should be avoided since it may cause both liquid volume and sludge volume problems at the sewage treatment plant. This method should be used only when the sewerage system has the capability to adequately handle the lime sludge and is approved by the local authority.

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

e. Disposal at a landfill can be done as either a solid or liquid if the landfill can accept such waste, depending on individual state requirements, and approval of the landfill operator.

f. Mechanical dewatering of sludge may be considered. Pilot studies on a particular plant waste are recommended.

g. Calcination of sludge may be considered. Pilot studies on a particular plant waste are recommended.

h. Lime sludge drying beds with underdrain collection systems are not recommended due to the likelihood of clogging.

4.10.6 Iron and Manganese Solids Waste

Waste filter wash water from iron and manganese removal plants can be disposed of as follows:

4.10.6.1 Lagoons

Lagoons should have the following features:

a. Be designed with volume 10 times the total quantity of wash water discharged during any 24-hour period;

b. A minimum usable depth of three feet;

c. Length four times width, and the width at least three times the depth, as measured at the operating water level;

d. Outlet to be at the end opposite the inlet;

e. A weir overflow device at the outlet end with weir length equal to or greater than depth; and

f. Velocity to be dissipated at the inlet end.

4.10.6.2 Discharge to Community Sanitary Sewer

"Red water" can be discharged to a community sewer. However, approval of this method will depend on obtaining approval from the owner of the sewerage system as well as from the NMED before final designs are made. A holding tank to equalize the flow will likely be required to prevent overloading the sewers.

PART 5

CHEMICAL STORAGE AND FEED

5.0 GENERAL

No chemicals should be applied to treat drinking waters unless specifically permitted by NMED.

5.0.1 Plans and Specifications

Plans and specifications should be submitted for review and approval, as provided for in Parts 1 and 2, and should include the following:

a. Descriptions of feed equipment, including maximum and minimum feed ranges;

b. Location of feeders, piping layout and points of application;

c. Storage and handling facilities;

d. Specifications for chemicals to be used;

e. Operating and control procedures including proposed application rates; and

f. Descriptions of testing equipment and procedures.

5.0.2 Chemical Application

Chemicals should be applied to the water at such points and by such means as to

a. Assure maximum efficiency of treatment;

b. Assure maximum safety to consumer;

c. Provide maximum safety to operators;

d. Assure satisfactory mixing of the chemicals with the water;

e. Provide maximum flexibility of operation through various points of application, when appropriate; and

f. Prevent backflow or back-siphonage between multiple points of feed through common manifolds.

5.0.3 General Equipment Design

General equipment design should be such that:

a. Feeders should be able to supply, at all times, the necessary amounts of chemicals at an accurate rate, throughout the range of feed;

b. Chemical-contact materials and surfaces are resistant to the aggressiveness of the chemical solution;

c. Corrosive chemicals are introduced in such a manner as to minimize potential for corrosion;

d. Chemicals that are incompatible are not stored or handled together;

e. All chemicals are conducted from the feeder to the point of application in separate conduits;

f. Chemical feeders are as near as practical to the feed point;

g. Chemical feeders and pumps should operate at no lower than 20 percent of the feed range unless two fully independent adjustment mechanisms, such as pump pulse rate and stroke length, are fitted then the pump should operate at no lower than 10 percent of the rated maximum; and

h. Chemical feeders should be equipped with pulsation dampeners to provide more even application of the chemicals.

5.1 FACILITY DESIGN

5.1.1 Number of Feeders

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

1. A minimum of two feeders should be provided;
2. The standby unit or a combination of units of sufficient capacity should be available to replace the largest unit during shut-downs; and
3. Where a booster pump is required, duplicate equipment should be provided and, when necessary, standby power.

b. A separate feeder should be used for each chemical applied.

c. Spare parts should be available for all feeders to replace parts that are subject to wear and damage.

5.1.2 Control

a. Feeders should be automatically controlled, with automatic controls being designed so as to allow override by manual controls.

b. Chemical feeders should be electrically interconnected with the well or service pump and should be provided a nonstandard electrical receptacle.

c. Chemical feed rates should be proportional to flow.

d. A means to accurately measure water flow must be provided in order to determine chemical feed rates.

e. Provisions should be made for measuring the quantities of chemicals used, including calibration columns for liquid chemical feeders.

f. It is recommended that chemical feeders be equipped with flow meters or switches on the discharge piping from the pumps and set to alarm on low or zero flow.

g. Where addition of a chemical is required to comply with a treatment technique or maximum contaminant level (such as a primary coagulant or disinfectant for surface water systems) all chemical feeders are required to be equipped with flow meters or switches on the discharge piping from the pumps and set to alarm on low or zero flow.

h. Weighing scales should be:

1. Provided for weighing cylinders at all plants utilizing chlorine gas;
2. Provided for fluoride solution feed and other chemicals delivered and stored in drums or tote bins;
3. Provided for volumetric dry chemical feeders; and
4. Capable of providing reasonable precision in relation to average daily dose.

i. Where conditions warrant, for example with rapidly fluctuating intake turbidity, coagulant and coagulant aid addition may be adjusted according to turbidity, current velocity or other sensed parameter.

j. For all chemicals, equipment and materials should be provided to measure the quantity (concentration) of the chemical that has been added to the water at a point after complete mixing has occurred. For example, to measure fluoride concentration in the treated water entering the water distribution system, an ion specific probe should be used that can accurately measure dissolved fluoride in water to within ±0.05 mg/L. Such equipment should be approved by NMED prior to purchase and use.

5.1.3 Dry Chemical Feeders

Dry chemical feeders should:

a. Measure chemicals volumetrically or gravimetrically;

b. Provide adequate solution water and agitation of the chemical in the solution mixing chamber;

c. Provide a holding tank for polymers, where needed; and

d. Completely enclose chemicals to prevent emission of dust to the operation room.

5.1.4 Positive Displacement Solution Pumps

a. Positive displacement type solution feed pumps should be used to feed liquid chemicals, but should not be used to feed chemical slurries. Pumps must be capable of operating at the required maximum rate against the maximum head conditions found at the point of injection.

b. For slurries (e.g., powdered activated carbon), peristaltic or hose pumps are recommended.

c. Liquid chemical feeders should be such that chemical solutions cannot be siphoned into the water supply, by:

1. Assuring discharge at a point of positive pressure; or

2. Providing vacuum relief; or
3. Providing a suitable air gap; or
4. Providing other suitable means or combinations as necessary.

5.1.5 Cross-Connection Control

Cross-connection control must be provided to assure that:

a. The service (utility) water lines discharging to solution tanks should be properly protected from backflow;

b. Liquid chemical solutions cannot be siphoned through solution feeders into the water supply as required in Part 5.1.4.c; and

c. No direct connection exists between any sanitary sewer and a drain or overflow from the feeder, solution chamber or tank.

5.1.6 Chemical Feed Equipment Location

Chemical feed equipment should be:

a. Readily accessible for servicing, repair, and observation of operation;

b. Located in a separate room when required to reduce hazards and dust problems;

c. Conveniently located near points of application to minimize length of feed lines; and

d. Located in close proximity of the chemical storage tanks so as to minimize the length of pump suction lines.

5.1.7 Utility Water Supplies

The water supply for use with the chemical systems should have the following provisions:

a. Be separated from the potable water supply using an approved backflow device;

b. Include individual check valves and isolation valves at each application point so as to avoid any backflow;

c. Ample in quantity and adequate in pressure;

d. Provided with means for measurement when preparing specific solution concentrations by dilution;

e. Properly treated for hardness, when necessary, for instance when used for carrier water or dilution water for high pH chemical solutions;

f. Obtained from a location sufficiently downstream of any chemical feed point to assure adequate mixing; and

g. Color coded and labeled so as to identify it as “utility water” and distinguish it from “potable water”.

5.1.8 Storage of Chemicals

a. Space should be provided for:

1. At least 30 days of chemical supply;
2. Convenient and efficient handling of chemicals;
3. Dry storage conditions; and
4. A minimum storage volume of 1½ truck loads where purchase is by truck load lots.

b. Storage tanks and pipelines for liquid chemicals should be specified for use with individual chemicals and not used for different chemicals.

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

d. Liquid chemical storage tanks must have:

1. A liquid level indicator; and
2. An overflow and a receiving basin capable of receiving accidental spills or overflows without uncontrolled discharge.

e. Double containment should be provided for storing chemicals.

f. Incompatible chemicals, such as acids and bases, should be stored separately.

g. The requirements of the state and locally adopted fire codes should be fully addressed when designing and constructing chemical storage facilities.

5.1.9 Chemical Solution Storage Tanks

a. A means which is consistent with the nature of the chemical solution should be provided in a solution tank to maintain a uniform strength of solution.

b. Continuous agitation should be provided to maintain slurries in suspension.

c. Two solution tanks of adequate volume may be required for a chemical to assure continuity of supply while servicing a solution tank.

d. Means should be provided to measure the liquid level in the tank.

e. Chemical solutions should be kept covered. Large tanks with access openings should have such openings curbed and fitted with overhanging covers.

f. Subsurface locations for solution tanks should:

1. Be free from sources of possible contamination, and
2. Assure positive drainage for groundwaters, accumulated water, chemical spills and overflows.

g. Overflow pipes should:

1. Be turned downward, with the end screened;

2. Be sized to maintain atmospheric pressure in the tank during the maximum tank fill rate;
3. Have a free fall discharge; and
4. Be located where noticeable.

h. Tanks should be vented to outside atmosphere, sized to maintain atmospheric pressure in the tank during maximum filling flow rate, and have the end screened.

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

j. Each tank should be provided with a valved drain, protected against backflow in accordance with Parts 5.1.5 and 5.1.6.

k. Solution tanks should be located and protective curbing provided so that chemicals from equipment failure, spillage or accidental drainage will not enter the water in conduits, treatment or storage basins.

5.1.10 Day Tanks

a. Day tanks may be used where bulk storage of liquid chemical is provided.

b. Day tanks should meet all the requirements of Part 5.1.9.

c. Day tanks should hold no more than a 30-hour supply.

d. Day tanks should be scale-mounted, or have a calibrated gauge painted or mounted on the side if liquid level can be observed in a gauge tube or through translucent sidewalls of the tank. For opaque tanks, a gauge rod extending above a reference point at the top of the tank, attached to a float may be used. The ratio of the area of the tank to its height must be such that unit readings are meaningful in relation to the total amount of chemical fed during a day.

e. Hand pumps may be provided for transfer from a carboy or drum. Where motor-driven transfer pumps are provided, a liquid level limit switch and an over-flow from the day tank, must be provided.

f. A means which is consistent with the nature of the chemical solution should be provided to maintain uniform strength of solution in a day tank. Continuous agitation should be provided to maintain chemical slurries in suspension.

g. Tanks and tank refilling line entry points should be clearly labeled with the name of the chemical contained.

5.1.11 Chemical Suction and Feed Lines

a. Chemical suction lines between the storage tanks and the chemical feeders and feed lines to the point of application should be designed and constructed with the following provisions:

   1. Have the minimum length practical;

2. Be of materials that are durable, corrosion-resistant, and suitable for the specific chemical being conveyed;
3. Be easily accessible throughout the entire length;
4. Be protected against freezing;
5. Be readily cleanable;
6. Be double-contained, when the chemical poses a health and safety concern;
7. Have thermal expansion of the piping considered in its layout, with the consideration of including expansion loops;
8. Have a minimum number of high points where air or other gases can be trapped and interrupt chemical flow; and
9. Be color coded and labeled (Refer to Part 2.15).

b. When polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), or other plastic piping with solvent welded joints is used, the most appropriate solvent cement for the pipe material and chemical service should be used.

c. Double-contained lines should be provided with inspection/drain ports periodically along the line and at all local low spots.

d. Pipes used to convey chemicals with the tendency to off-gas, such as sodium hypochlorite, should have vents with valves at high spots to safely release any accumulated gas pockets.

e. It is recommended that spare chemical feed lines be provided in case of problems with an initial line and to allow the future conveyance of an additional treatment chemical to a point of application.

5.1.12 Chemical Handling

a. Carts, elevators, fork lifts, pallet lifts, and other appropriate means should be provided for lifting chemical containers to minimize excessive lifting by operators.

b. Provisions should be made for disposing of empty bags, drums or barrels by an approved procedure that should minimize exposure to dusts.

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

1. Vacuum pneumatic equipment or closed conveyor systems;
2. Facilities for emptying shipping containers in special enclosures; or
3. Exhaust fans and dust filters that put the hoppers or bins under negative pressure.

d. Provision should be made for measuring quantities of chemicals used to prepare feed solutions.

5.1.13 Chemical Storage and Feed Equipment Housing

a. Chemical tanks and feeders should be properly housed to protect them from the weather and unauthorized persons.

b. Floor surfaces should be smooth and impervious, slip-proof and well drained with a ¼-inch per foot minimum slope.

c. Rooms should be well lit for operations and maintenance staff.

d. Continuous ventilation should be provided to prevent the accumulation of fumes.

e. Rooms should be conditioned to facilitate operations and maintenance staff.

f. Energy conservation requirements should be addressed.

g. Fire prevention, detection, alarm, and suppression code requirements should be addressed.

h. Prevention, control, and mitigation of dangerous conditions related to the storage, dispensing, use, and handling of hazardous materials and information needed by emergency response personnel should be in accordance with state and locally adopted codes such as Article 80 of the Uniform Fire Code. The design engineer should contact state and local authorities for specific requirements.

i. Vents from feeders, storage facilities and equipment exhaust should discharge to the outside atmosphere above grade and remote from air intakes.

j. Eye wash and deluge showers should be provided at convenient locations, including, but not limited to, the following:

   1. At bulk chemical fill stations;

   2. Within each separate chemical storage and feeder containment area; and

   3. At all points of application.

k. Eye wash and deluge showers should be designed to be non-freezing and to provide water at a temperature near room temperature (i.e., approximately 75 degrees Fahrenheit, F). A water holding tank that will allow water to come to room temperature should be installed in the water line feeding the deluge shower and eye-washing device. Other methods of water tempering will be considered on an individual basis. Eye wash and deluge showers should be in compliance with the latest applicable American National Standards Institute (ANSI) and Occupational Safety and Health Administration (OSHA) standards.

5.2 TREATMENT CHEMICAL QUALITY ASSURANCE

5.2.1 Shipping Containers

Chemical shipping containers should be fully labeled to include the following:

a. The chemical name, purity, and concentration; and

b. The chemical supplier name and address.

5.2.2 Specifications

Chemicals should meet ANSI/AWWA quality standards and ANSI/NSF Standard 60 for chemicals used to treat drinking water.

5.2.3 Assay

a. The chemical supplier should provide the plant staff with a written assay of chemicals being delivered.

b. The plant staff may collect a sample of the chemicals being delivered for verification testing.

5.3 GENERAL OPERATOR SAFETY PROVISIONS

5.3.1 Operator Training

The operations and maintenance staff at the treatment facility should be provided with training on the specific treatment chemicals being used. This training should be provided by qualified, experienced individuals for the specific chemicals being used. Training should include the requirements for the safe handling, storage, and feeding of the different chemicals, including instructions on the proper clothing, eye protection, and respiratory protection for handling and working around each of the chemicals being used.

5.3.2 Ventilation

As discussed in Part 5.1.13, proper ventilation of chemical storage and feed areas is required to prevent the accumulation of chemical fumes that could pose a health threat to the operations and maintenance staffs.

5.3.3 Respiratory Protection Equipment

Respiratory protection equipment, meeting the requirements of the National Institute for Occupational Safety and Health (NIOSH) should be available where treatment chemicals are handled and stored, and should be stored at a convenient heated location outside the room of concern. The respiratory equipment should be suitable for the specific chemicals being used. Multiple sets of equipment should be provided and there must be equipment sized to fit the different operations and maintenance personnel.

5.3.4 Eye Protection Equipment and Protective Clothing

a. Eye protection equipment and protective clothing should be issued to plant operations and maintenance staff suitable for handling and work around the different chemicals being used. At least one pair of rubber gloves, a dust respirator of a type certified by NIOSH for toxic dusts, an apron or other protective clothing and goggles or face mask should be provided for each operator and maintenance staff member. Equipment should be available in multiple sizes so as to properly fit the different personnel. Equipment must be in compliance with the latest applicable ANSI standards.

b. Other protective equipment should be provided, as necessary.

5.4 SPECIFIC CHEMICALS

5.4.1 Chlorine Gas and Solution Feed

a. Chlorine is an extremely hazardous substance. Therefore, the design of systems for handling, storing, and feeding chlorine requires special care.

b. Employers owning or operating a facility in which there are 100 pounds or more of chlorine must comply with the Environmental Protection Agency's emergency planning requirements as listed in 40 CFR Part 355.30.

c. All chlorination equipment should be of the best construction with components designed for long and continuous operation in a corrosive (moist chlorine) atmosphere. All equipment and components of the chlorination system should be from a single manufacturer and as recommended by the Chlorine Institute, Inc.

d. Chlorine gas feed and storage should be enclosed and separated from other operating areas. The chlorine room should be:

1. Provided with a shatter resistant inspection window installed in an interior wall;

2. Constructed in such a manner that all openings between the chlorine room and the remainder of the plant are sealed;

3. Provided with doors equipped with panic hardware, assuring ready means of exit and opening outward only to the building exterior;

4. Provided with a bottle of concentrated ammonium hydroxide (56 percent ammonia solution) for chlorine leak detection;

5. Where ton containers are used, provided with a leak repair kit approved by the Chlorine Institute; and

6. The room layout should minimize the distance between the chlorine cylinder connections to the feed piping and the exits, so as to facilitate operator egress in case of an emergency (e.g., chlorine gas leak). There should be no obstacles in the operator's path of escape.

e. Full and empty cylinders of chlorine gas should be:

   1. Isolated from operating areas;

   2. Restrained in position to prevent upset;

   3. Stored in rooms separate from ammonia and all other chemical storage; and

   4. Stored in areas not in direct sunlight or exposed to excessive heat.

e. Where chlorine gas is used, the room should be constructed to provide the following:

   1. Each room should have a ventilating fan with a capacity which provides one complete air change per minute when the room is occupied;

   2. The ventilating fan should take suction near the floor as far as practical from the door and air inlet, with the point of discharge so located as not to contaminate air inlet to any rooms or structures;

   3. Air inlets should be through louvers near the ceiling;

   4. Louvers for chlorine room air intake and exhaust should facilitate airtight closure using weighted and motorized louvers and dampers;

   5. Separate switches for the fan and lights should be located outside of the chlorine room and at the inspection window. Outside switches should be protected from vandalism. A signal light indicating fan operation should be provided at each entrance when the fan can be controlled from more than one point;

   6. Vents from feeders and storage should discharge to the outside atmosphere, above grade;

   7. The room location should be on the prevailing downwind side of the building away from entrances, windows, louvers, walkways, etc.; and

   8. The chlorinator and chlorine storage rooms should not have floor drains. The floor of the chlorine storage room should be sloped to the center of the room to collect spilled liquid chlorine.

f. Chlorinator rooms should be heated to 60°F, and be protected from excessive heat. Cylinders and gas lines should be protected from temperatures above that of the feed equipment.

f. The chlorination system should include automatic switchover vacuum regulator units and pressure check/relief valves. The automatic switchover vacuum regulator units should be provided on the manifold of each of the two sets of chlorine cylinders. The automatic switchover vacuum regulator units should convert chlorine gas to a less than atmospheric pressure state for use by the chlorinators. When the on-line chlorine supply becomes exhausted, the automatic valves will switch positions and the standby supply will be placed on-line. The system should allow manual gas shutoff and contain integral drip leg heaters, liquid chlorine drip legs, and gas traps and filters.

h. The chlorination system should include pressure check/relief valves located immediately downstream of the automatic switchover vacuum regulator units. In the event of a malfunction of the automatic switchover vacuum regulator check units, the pressure check/relief valve should vent chlorine via a vent pipe to a safe location outside the building.

i. Pressurized chlorine feed lines should not carry chlorine gas beyond the chlorinator room. Chlorine gas should be drawn by a vacuum created by the chlorine injector (eductor) at the point of application.

j. If the water supply to the injector(s) should fail, or if the vacuum should fail to be maintained in the chlorine gas line, for any reason whatsoever, a chlorine vacuum regulator check unit should close automatically.

k. Provisions should be made for limiting the vacuum with the chlorine feeder in order to prevent back siphoning of water into the metering equipment.

l. A chlorine gas leak detection system should be provided for both the chlorine cylinder storage room and chlorinator room. The detectors should contain electro-chemical sensing cells requiring minimum maintenance and should be sensitive to the presence of chlorine gas only. The sensing cells should be connected to a set of local horns and beacons that will be activated when one (1) part per million (ppm) of chlorine gas is detected in the room air. If chlorine gas is detected in the room air at three (3) ppm or higher, the signal from the sensing cell should automatically start the chlorine scrubbing system and should close all the motor-operated louvers and dampers on the room ventilation system.

m. A chlorine gas scrubbing system should be provided to chemically neutralize chlorine gas due to a leak or spill. Such equipment should be designed as part of the chlorine gas storage and feed areas to automatically engage in the event of any measured chlorine release. The equipment should be sized to treat the entire contents of the largest storage container on site. The scrubbing system should be designed and constructed to meet or surpass the requirements of Article 80 of the Uniform Fire Code.

n. Two complete sets of self-contained breathing apparatus should be provided, National Institute for Occupational Safety and Health/Mine Safety and Health Administration (NIOSH/MSHA) certified, with a 30-minute compressed air supply, pressure-demand regulator, low-pressure audible alarm, and fully encapsulated protective suit, complying with all the requirements of NIOSH and ANSI/NFPA, and a suit integrity check kit. This equipment should be stored at a convenient heated location, but not inside any room where chlorine is used or stored. The equipment should be compatible with or exactly the same as units used by the fire department responsible for the plant.

5.4.2 Ozone Generation and Feed

Like chlorine, ozone is an extremely hazardous substance. Unlike chlorine, ozone must be generated on-site at the time of use, rather than delivered and stored as a pressurized liquid. The design of systems for generating and feeding ozone requires special care.

a. All ozone generation and feed equipment should be of the best construction with components designed for long and continuous operation. All equipment and components of the ozonation system should be from a single manufacturer, the Ozone System Supplier (OSS).

b. The ozone generation equipment should be enclosed and separated from other operating areas. The Ozone Generation Room should have the following items:

   1. The room should be provided with a shatter resistant inspection window installed in an interior wall;

   2. It should be constructed in such a manner that all openings between the Ozone Generation Room and the remainder of the plant are sealed;

   3. It should be provided with doors equipped with panic hardware, assuring ready means of exit and opening outward;

   4. The room should have a ventilating fan with a capacity which provides one complete air change per minute when the room is occupied;

   5. The ventilating fan should take suction near the floor as far as practical from the door and air inlet, with the point of discharge so located as not to contaminate air inlet to any rooms or structures;

   6. Air inlets should be through louvers near the ceiling;

   7. Separate switches for the fan and lights should be located outside of the room and at the inspection window. Outside switches should be protected from vandalism. A signal light indicating fan operation should be provided at each entrance when the fan can be controlled from more than one point;

   8. The room should be conditioned to protect it from freezing and to provide adequate cooling of the equipment during summertime;

   9. Both ambient oxygen and ozone gas concentration monitors should be installed in the Ozone Generator Room. Alarm signals from the monitors should be sent to local audible alarms and beacons to alert the operations and maintenance staff of a possible oxygen or ozone leak. The ozone alarm should be activated when an ozone concentration of 0.1 ppm is detected in the room air. The ozone generation system will be automatically shut-down if a concentration of 0.3 ppm or higher is detected. The oxygen alarm should be activated if the oxygen level in the room reaches 22 percent and will shut-down the ozonation system and closes the oxygen supply valve, if the level reaches or exceeds 23 percent; and

   10. The high voltage and current requirements for generating ozone require special design, operation, and maintenance procedures.

c. If the ozone contact basins include a gallery and/or off-gas destruction equipment room, these rooms should also be equipped with ambient oxygen and ozone gas monitoring systems, as described in Part 5.4.2.b.9. This requirement also applies to any other enclosed areas where oxygen and/or ozone could accumulate.

d. The discharge of the ozone contact basin off-gas destruct units will have a high concentration of oxygen. This discharge needs to be directed away from any areas that could accumulate oxygen and result in dangerous levels of oxygen representing a combustion or health hazard.

e. Two complete sets of self-contained breathing apparatus should be provided that are National Institute for Occupational Safety and Health/Mine Safety and Health Administration (NIOSH/MSHA) certified, with a 30-minute compressed air supply, pressure-demand regulator, low-pressure audible alarm, and fully encapsulated protective suit, complying with all the requirements of NIOSH and ANSI/NFPA, and a suit integrity check kit. This equipment should be stored at a convenient heated location, but not inside any room where ozone is generated or used. The equipment should be compatible with or exactly the same as units used by the fire department responsible for the plant.

f. Ozone is a corrosive substance. Therefore, suitable materials must be used in the design and construction of ozone generation and ozone feed systems. The most suitable material for ozone service is Type 316 stainless steel.

g. Special care must be taken to clean all piping used for conveying ozone and oxygen. All organic materials must be cleaned from the internal surfaces of the pipe and associated valves and instruments to prevent combustion. Cleaning of oxygen and ozone service pipe requires specialized procedures best done by an experienced, trained specialist.

h. The OSS should provide the plant operations and maintenance staffs with the specialized training necessary for the safe operation and maintenance of the ozonation system.

5.4.3 Liquid Oxygen for Ozone Generation

Most modern ozone generation systems use oxygen as the feed gas. In most applications, the oxygen is supplied to the plant site as pressurized liquid oxygen (LOX).

a. Both LOX and gaseous oxygen (GOX) will greatly increase the likelihood of combustion (fire) of organic and other materials. LOX storage tanks and piping must be located away from organic materials, including asphalt roadways. Concrete pads should be provided at LOX off-loading areas and for tanks and equipment pads. Ventilation and ambient oxygen monitoring systems must be used to prevent an alarm of high oxygen levels. (Refer to Paragraph 5.4.2.b.9.)

b. Liquid oxygen has a high thermal coefficient of expansion and dangerously high pressures may build up with only a small increase in temperature. Pressure relief valves should be provided at strategic locations to prevent rupture of the equipment and piping. The piping design should prevent trapping liquid oxygen at locations where pressure relief valves do not exist. For instance, do not place isolation valves at the opposite end of a pipe run that does not include a pressure relief valve on the pipe run.

c. Materials suitable for oxygen piping include stainless steel, copper, and bronze.

d. Special care must be taken to clean all piping used for conveying LOX and GOX. All organic materials must be cleaned from the internal surfaces of the pipe and associated valves and instruments to prevent combustion. Cleaning of oxygen service pipe requires specialized procedures best done by an experienced, trained specialist.

e. Refer to appropriate publications and other references available from the Compressed Gas Association (CGA).

f. LOX Storage Tank Requirements

1. Liquid oxygen is a cryogenic fluid stored at relatively high pressures. Storing LOX requires specialized tanks and piping. The full written requirements of the LOX supplier should be followed in the design of the LOX storage facility.

2. The tank should be fitted with temperature and pressure monitoring systems. Also, the tank should be fitted with pressure relief valve(s) to prevent over pressurization.

3. The tank should be insulated.

4. LOX tanks should be securely mounted to a concrete pad. No organic material should be located within the potential spill area of the LOX tank.

5. A concrete pad should be provided for the LOX unloading truck and trailer to sit during unloading operations. Care must be taken to avoid any possibility of LOX spilling on asphalt-based pavement.

5.4.4 General Acids and Caustics

a. Acids and caustics should be kept in closed corrosion-resistant shipping containers or storage units.

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

5.4.5 Ferric Chloride

Ferric chloride is sometimes used as a primary coagulant at surface water treatment plants. It may also be used as part of an arsenic removal process.

a. Ferric chloride is very corrosive to most metals. Titanium is usually the metal of choice for handling ferric chloride.

b. Refer to the requirements under Part 5.4.4, Acids and Caustics and other requirements herein.

5.4.6 Fluoride

Fluoride is fed to drinking water to promote dental health. Fluoride is typically fed in liquid form as hydro-fluosilicic (fluosilicic) acid (H_2SiF_6), which is a corrosive, fuming acid. Other forms of fluoride include sodium fluoride and sodium silicofluoride. As discussed in Part 4, fluoride must be dosed within a tight range; therefore, very good control over chemical feed rates and water flow rates is important. There have been a significant number of cases across the country of overfeeding fluoride due to improper design and/or operation of fluoridation systems. Overfeeding of fluoride has resulted in human illnesses and, in at least one case, death. NMED should be consulted prior to starting the design and construction of fluoride handling, storage, and feed facilities.

a. The requirements for proper and safe storage, handling, and feed of acidic treatment chemicals should be addressed when using fluoride.

b. The fluoride compound fed should meet the applicable AWWA standard and ANSI/NSF Standard 60.

c. Fluoride chemicals should be stored away from other chemicals to prevent contamination and reactions. Compounds should be stored in covered or unopened shipping containers and inside a building. Unsealed storage units, feed tanks, or bulk tanks for fluosilicic acid must be vented to the outside atmosphere at a point above grade and away from air intakes and normally occupied areas. Bags, fiber drums, and steel drums should be stored on pallets to prevent floor moisture from contaminating the chemicals. Bulk or feed tank containers should be of suitable strength and of materials compatible (i.e., non-corrosive) with the chemical.

d. Fluoride feed equipment should include a day tank capable of holding no more than enough fluoride solution to meet maximum day demands. This is to assist in preventing large overdosing incidents.

e. Scales or other loss-of-weight recorders, or liquid level indicators, as appropriate, accurate to within five (5) percent of the average daily change in reading, should be provided for fluoride solution tanks. Spill containment should be provided for day tanks.

f. Positive displacement pumps should be used as the standard method for feeding fluoride solutions. Rotodip type feeders should be avoided.

g. For greatest accuracy, feed pumps should be sized to operate near the mid-point of their range (30 to 70% of capacity). Feed pumps should be accurate to within five (5) percent of any desired feed rate.

h. Backpressure valves should be included on the discharge of each feed pump to maintain a near constant backpressure on the pump discharge.

i. Redundant diaphragm-type anti-siphon devices must be installed in the fluoride feed line. The anti-siphon devices should have diaphragms that are spring-loaded in the closed position. These devices should be located at the fluoride injection point and at the metering pump head on the discharge side. The anti-siphon device on the head of the metering pump should be selected so that it will provide the necessary backpressure required by the manufacturer of the metering pump. Often these devices are integral with the pump and are part of a multi-purpose valve package, including a backpressure valve, pressure relief valve, anti-siphon valve, and feed valve.

j. Vacuum testing of all anti-siphon devices and multi-purpose valve should be performed at least twice per year or more frequently if based on the valve or chemical feed system manufacturer's recommendations. All anti-siphon devices and multi-purpose valves should be dismantled and visually inspected frequently by qualified individuals, or at least once per year.

k. The fluoride solution feed pump should be located on a shelf or pedestal not more than four (4) feet higher than the lowest normal level of the liquid in the day tank. A flooded suction is not recommended in water fluoridation. The suction line should be as short as practical and as straight as possible. There should be a foot valve and strainer at the bottom of the suction line, and if necessary, a weight to hold it down. The weight should not be of lead or any other material that can corrode in the fluoride solution.

l. The priming switch on the feed pump should be spring-loaded to prevent the pump from being started erroneously with the switch in the priming position.

m. Isolation valves on the fluoride feed line should be provided at both the fluoride feeders and injection point. The isolation valve at the feeders should be closed by the plant operators when the plant is shut-down.

n. A flow meter with a totalizing feature on the pump discharge line is recommended for further confirmation of fluoride feed rate.

o. The fluoride feed point should be located where all of the treated water passes. Fluoride should not be injected at locations where substantial losses of fluoride can occur (e.g., ahead of coagulation, lime softening, or ion exchange processes). Whenever possible, fluoride should be fed upstream of the treated water storage tanks, so that in the event of an overfeed, the concentration peak will be dampened. In a treatment plant, the most suitable location may be the filter effluent line prior to a clearwell.

p. The point of application of fluoride, if into a horizontal pipe, should be in the lower one-third of the pipe, ideally 45 degrees from the bottom of the pipe, and the end of the injection diffuser should extend into the water pipe at least one-third of the water pipe's diameter. This configuration will allow better mixing of the fluoride solution with the water. The diffuser should not enter at the top of the water pipe because of potential air binding problems and to avoid the likelihood of the acid fluoride solution pooling at the bottom of the pipe, resulting in corrosion.

q. For well supplies, the point of fluoride application should be downstream of the well discharge check valve. This will ensure that there is positive pressure on the fluoride injection diffuser. For treatment plants, a location of consistent positive backpressure should also be selected.

r. An in-line mixer or a small mixing tank should be installed in the finished water line from the water plant or well, if the first water service connection is less than 50 pipe diameters downstream of the injection point.

s. Water used for sodium fluoride dissolution should be softened to less than 75 mg/L as $CaCO_3$.

t. The fluoride feed system must be designed and constructed so that it can never operate unless water is being produced (i.e., plant in-service or well(s) on). Furthermore, there should be redundant electrical activation of the fluoride feed to ensure that water is being produced prior to feeding fluoride. For instance, the fluoride feed pumps could be wired in-series with the well pump(s) or high-service pump(s). A second flow based-device, such as a flow meter or flow switch could also be wired in-series with the fluoride feeder to provide the required redundant activation signal.

u. If the fluoride feeder is not hardwired, the electrical outlet used for powering the feeder must be a non-standard receptacle to prevent the possibility of the fluoride feed pump being plugged into a continuously powered (hot) electrical outlet. The fluoride feeder may also be hard wired directly into the appropriate circuit so that the electrical source changes could only be made by deliberate action.

v. Provisions must be made for the transfer of dry fluoride compounds, if used, from shipping containers to storage bins or hoppers in such a manner as to minimize the quantity of dust. The enclosure should be provided with an exhaust fan and dust filter which places the hopper under a negative pressure. Air exhausted from fluoride handling equipment should discharge through a dust filter to the outside atmosphere of the building at a safe location. Only granular sodium fluoride should be used in saturators, because powdered sodium fluoride tends to cause clogging in the saturator. A sediment filter (20 mesh) should be installed in the water make-up line going to the sodium fluoride saturator.

5.4.7 Sodium Hydroxide (Caustic Soda)

Sodium hydroxide, also referred to as caustic soda, is often fed at water treatment plants to elevate the pH of the water. Caustic soda is a dangerous chemical that can cause serious injury if it comes in contact with eyes, skin, or other body surfaces. Proper safety equipment, protective eye wear, and clothing must be available and worn when working near this chemical. Refer to Part 5.3 herein.

a. Caustic soda is typically delivered, stored, and fed as a concentrated liquid. Caustic soda may be delivered to a site as 50 percent strength and then diluted in the on-site storage tanks to a lower concentration (typically 20 to 25%). Dilution is typically done to avoid freezing (crystallization) of the caustic soda solution.

b. Concentrated caustic soda can freeze at relatively high temperatures. For instance, 50 percent caustic soda should freeze (i.e., crystallize) at a temperature of 53^{o}F.

c. Caustic soda can be stored in steel storage tanks. Fiberglass reinforced plastic (FRP) tanks are also sometimes used. However, care must be taken in using FRP, because caustic soda is often delivered to the site at elevated temperatures. Also, heat is generated during the dilution process by the addition of water. Therefore, the tank and associated piping must be suitable for handling concentrated caustic soda at elevated temperatures. Unique FRP compositions are needed for caustic soda service. Un-reinforced plastic tanks (e.g., high density polyethylene, HDPE) are not recommended for caustic soda service.

d. For applications where the caustic soda will be diluted in the on-site storage tanks, a minimum of two tanks should be used. This will allow one tank to be used while giving time for the newly diluted tank to cool down prior to placing it in-service. Preferably, the dilution water will be softened prior to use to avoid precipitation of calcium carbonate and other scales in the tank.

e. Due to the potential for caustic soda to be at elevated temperatures, the tank fill piping and associated valves, fittings, instruments, etc. should be of a suitable alloy of steel (e.g., Type 304 or 316 stainless steel).

f. The recirculation pump and associated piping, valves, instruments, fittings, etc. used for dilution should all be of a suitable alloy of steel (e.g., Type 304 or 316 stainless steel).

g. If the bulk storage tanks are to be fitted with a site gauge for indicating the level of caustic soda, it is recommended that a gauge of the magnetic type be used, that is suitably constructed and armored to prevent accidental breakage and spilling of caustic soda.

h. The suction and feed piping between the tank and feed pumps and between the feed pumps and point(s) of application must be designed and constructed to be compatible with concentrated caustic soda and the potential for the solution to be at elevated temperatures.

i. Like all hazardous chemicals, double-contained piping must be used for caustic soda. It is preferable to not run this chemical overhead in occupied spaces, so as to limit the possibility of eye or other injury from a leaking (dripping) pipe.

j. If dry sodium hydroxide granules are used for preparing caustic soda solutions on-site, then special safety precautions need to be considered, including the handling of very high temperatures created when the granules are mixed with water. As with any hazardous chemical system, the services of a qualified and experienced design engineer should be employed in the planning and design. Information on the design of such systems should be submitted to NMED for review and approval prior to beginning construction.

5.4.8 Ammonia

Ammonia may be fed to chlorinated water to form chloramines as a residual disinfectant. Ammonia is often delivered, stored, and fed as a concentrated water-based solution (aqueous ammonia or aqua ammonia). Ammonia is also available as anhydrous ammonia that is delivered and stored as a pressurized liquid. Ammonia is also available in dry granules.

This section only addresses aqueous ammonia systems, which are the most commonly used for drinking water treatment. Specific requirements for either anhydrous or granular ammonia systems should be evaluated on a case-by-case basis, with supporting information from a qualified, experienced design engineer. Anhydrous ammonia is an especially dangerous form of ammonia requiring special care in the design, construction, and operation of facilities for safe handling, storage, and feeding.

a. Aqueous ammonia is often delivered to a plant site as either a 24 or 29 percent strength solution. The higher concentration strength solution is more prone to off-gassing, which can especially be a problem during hot weather. Sometimes, plants use 24 percent strength during the summer months and use the higher strength solution during the remainder of the year.

b. Due to its propensity to off-gas, aqueous ammonia systems must be designed to allow venting of piping at high points to avoid vapor lock and disruption of dosing.

c. Aqueous ammonia solutions are at elevated pH and therefore, can result in scaling at the point(s) of application if the water being treated has relatively high levels of hardness (i.e., calcium and magnesium). This is also an important consideration if the aqueous ammonia is to be diluted with water. The water must be softened prior to mixing with the aqueous ammonia.

d. As with all treatment chemicals, proper materials must be used to store, pump, and convey aqueous ammonia solutions.

e. To prevent nuisance releases of ammonia into the air, a vapor capture tank of water can be used to submerge the end of the vent and overflow pipes from the tank.

f. Concentrated solutions of ammonia should not be mixed with concentrated solutions of chlorine or hypochlorite. Such actions could result in explosive conditions and the creation of undesirable reaction products. Ammonia should be fed to water streams in which the chlorine compound has already been fully mixed. Therefore, the ammonia feed should be well downstream of the chlorine feed point with adequate mixing of the chlorine into the water prior to introducing the ammonia solution.

g. Ammonia must be stored in a separate containment room from hypochlorites and, of course, chlorine gas (chlorine gas must be kept separate from all other chemicals).

5.4.9 Sodium Chlorite for Chlorine Dioxide Generation

Proposals for the storage and use of sodium chlorite must be approved by NMED prior to the preparation of final plans and specifications. Provisions should be made for proper storage and handling of sodium chlorite to eliminate any danger of fire or explosion associated with its powerful oxidizing nature.

The storage and handling requirements outlined in this section should be considered minimum. Additional requirements will apply. The design engineer and reviewer are directed to reference: The Chlorine Dioxide Handbook, published by the American Water Works Association for additional design and safety requirements for chlorine dioxide systems. Sodium dioxide generation equipment manufacturers should also be consulted.

a. Storage

1. Chlorite (sodium chlorite) should be stored by itself in a separate room and preferably should be stored in an outside building detached from the water treatment facility. It must be stored away from organic materials because many materials will catch fire and burn violently when in contact with chlorite.
2. The storage structures should be constructed of noncombustible materials.
3. If the storage structure must be located in an area where a fire may occur, water must be available to keep the sodium chlorite area cool enough to prevent heat induced explosive decomposition of the chlorite.

b. Handling

1. Care should be taken to prevent spillage.
2. An emergency plan of operation should be available for the clean up of any spillage.
3. Storage drums must be thoroughly flushed prior to recycling or disposal.

c. Feeders

1. Positive displacement feeders should be provided.
2. Tubing for conveying sodium chlorite or chlorine dioxide solutions should be Type 1 PVC, polyethylene, or materials recommended by the manufacturer.
3. Chemical feeders may be installed in chlorine rooms if sufficient space is provided or facilities meeting the requirements of Part 5.4.1 are provided.
4. Feed lines should be installed in a manner to prevent formation of gas pockets and should terminate at a point of positive pressure.
5. Check valves should be provided to prevent the backflow of chlorine into the sodium chlorite line.

PART 6

PUMPING FACILITIES

6.0 GENERAL

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

6.1 LOCATION

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

6.1.1 Site Protection

The station should be:

a. Elevated to a minimum of three feet above the 100-year flood elevation, or three feet above the highest recorded flood elevation, whichever is higher, or protected to such elevations;

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

c. Graded around the station so as to lead surface drainage away from the station;

d. Protected to prevent vandalism and entrance by animals or unauthorized persons; and

e. Fenced and locked to prevent unauthorized persons from entering.

6.2 PUMPING STATIONS

Both raw and finished water pumping stations should:

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

b. Be of durable construction, fire and weather resistant and with outward-opening doors;

c. Have floor elevation of at least six inches above finished grade;

d. Have underground structure waterproofed;

e. Have all floors drained in such a manner that the quality of the potable water will not be endangered. All floors should slope at least ¼-inch per foot to a suitable drain; and

f. Provide a suitable outlet for drainage from pump glands without discharging onto the floor.

6.2.1 Pump Suction Wetwells

Suction wetwells should:

a. Be watertight;

b. Have floors sloped to permit removal of water and entrained solids;

c. Be covered or otherwise protected against contamination;

d. Have two pumping compartments or other means to allow the suction well to be taken out of service for inspection maintenance or repair;

e. Have below grade exterior surfaces coated in a waterproofing material; and

f. Be designed in accordance with Hydraulic Institute standards unless otherwise recommended in writing by the pump manufacturer.

6.2.2 Equipment Servicing

Pump stations should be provided with:

a. Crane-ways, hoist beams, eyebolts, or other adequate facilities for servicing or removal of pumps, motors or other heavy equipment;

b. Openings in floors, roofs or wherever else needed for removal of heavy or bulky equipment as well as the pump and motor from the building;

c. A convenient tool board, or other facilities as needed, for proper maintenance of the equipment; and

d. At least 3-1/2 ft clearance between obstacles to permit wheeled hand truck movement on the pumping station floor.

6.2.3 Stairways and Ladders

a. Should be provided between all floors, and in pits or compartments which must be entered;

b. Should have handrails on both sides, and treads of non-slip material; and

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

6.2.4 Heating and Cooling

a. Provisions should be made for adequate heating and cooling for:

   1. The comfort of the operations and maintenance staffs; and

   2. The safe and efficient operation of the equipment.

b. In pump houses not continuously occupied by personnel, only enough heat or cooling need be provided to prevent freezing or overheating of equipment or treatment process. Auxiliary heating and cooling should be provided during maintenance operations, as appropriate.

6.2.5 Ventilation

a. Ventilation should conform to existing local and/or state codes.

b. Adequate ventilation should be provided for all pumping stations.

c. Forced ventilation of at least six changes of air per hour should be provided for:

   1. All confined rooms, compartments, pits and other enclosures below ground floor; and

   2. Any area where unsafe atmosphere may develop or where excessive heat may be built up.

6.2.6 Dehumidification

In areas where excess moisture could cause hazards to safety or damage to equipment, means for dehumidification should be provided.

6.2.7 Lighting

a. Pump stations should be adequately lighted throughout.

b. All electrical work should conform to the requirements of the National Electrical Code or to relevant state and/or local codes.

6.2.8 Sanitary and Other Conveniences

a. All pumping stations that are manned for extended periods should be provided with potable water, lavatory and toilet facilities.

b. Plumbing must be so installed as to prevent contamination of a public water supply.

c. Wastes should be discharged in accordance with Part 4.10.

6.3 PUMPS

6.3.1 Booster Pumps

a. At least two pumping units should be provided. With any pump out of service, the remaining pump or pumps should be capable of providing the maximum day pumping demand of the system.

b. The pumping units should:

   1. Have ample capacity to supply the peak demand against the required distribution system pressure without dangerous overloading;

   2. Be driven by prime movers able to meet the maximum horsepower condition of the pumps;

   3. Be provided with readily available spare parts and tools; and

   4. Be served by control equipment that has proper heater and overload protection for air temperature encountered.

c. Booster pumps should be located or controlled so that:

   1. They will not produce negative pressure in their suction lines;
   2. The intake pressure should be at least 1.35 times that required by the recommended Net Positive Suction Head (NPSH) when the pump is in normal operation;
   3. Automatic cutoff or low pressure controller should maintain at least 20 psi (70 kPa) in the suction line under all operating conditions;
   4. Automatic or remote control devices should have an adequate range between the low pressure start and high pressure cutoff which will prevent excessive cycling; and
   5. A bypass is available.

6.3.2 Metering

a. All booster pumping stations should contain a flow meter.

b. The station should have indicating, totalizing, and recording metering of the total water pumped.

6.3.3 Inline Booster Pumps

In addition to the other requirements of this section, inline booster pumps should be accessible for servicing and repairs.

6.3.4 Individual Home Booster Pumps

Individual home booster pumps should not be allowed for any individual service from the public water supply main without prior approval from NMED.

6.3.5 Suction Lift

a. Suction lift should be avoided, if possible; and

b. If suction lift is necessary, provision should be made for priming the pumps.

6.4 AUTOMATIC AND REMOTE CONTROLLED STATIONS

a. All automatic stations should be provided with an automatic signaling apparatus that will report when the station is out of service.

b. All remote controlled stations should be electrically operated and controlled and should have signaling apparatus of proven performance.

c. Installation of electrical equipment should conform with the applicable state and local electrical codes and the National Electrical Code.

6.5 APPURTENANCES

6.5.1 Valves

a. Pumps should be adequately valved to permit satisfactory operation, maintenance and repair of the equipment.

b. If foot valves are necessary, they should have a net valve area of at least 2.5 times the area of the suction pipe and should be screened.

c. Each pump should have a positive-acting check valve on the discharge side between the pump and the shut-off valve.

6.5.2 Piping

a. In general, piping should:

1. Be designed so that the friction losses will be minimized;
2. Not be subject to contamination;
3. Have watertight joints; and
4. Be such that each pump has an individual suction line or that the lines should be so manifolded that they will ensure similar hydraulic and operating conditions.

b. Piping should be protected against surge or water hammer and provided with suitable restraints where necessary. Check valves and flow control valves are recommended for this purpose. The pressure rating of the valves should be selected with a pressure rating to accommodate the maximum predicted surge pressures in the piping system.

c. A surge control study may be appropriate, especially for large pumping stations (100 gpm or larger). Refer to Pumping Station Design by Sanks et al. for criteria indicating the need for conducting a transient analysis.

d. The suction piping should be arranged to avoid high points where air or gas may collect. Reducers, where they are required should be eccentric.

e. The discharge piping should be arranged to avoid high points. Air relief valves should be provided at high points. The pipe from the air relief valves should be drained to atmosphere.

f. Pipe supports should be provided to keep weight off the pump. All discharge piping should be rigidly piped to prevent movement.

g. Suction couplings should be provided on the pump to permit removal and replacement of the pump. The coupling is best located on the suction side due to less frequent pressure variations in the suction line.

h. The discharge isolation valve should be located downstream from the check valve. The operators should be able to isolate the check valve from the rest of the system.

i. The guidelines of allowable fluid velocities in the suction and discharge piping should be as follows when all the pumps are operating:

1. Less than 6 ft/sec for suction piping;
2. Less than 10 ft/sec for discharge piping;
3. In multi-pump suction manifolds, the velocity in the manifold pipe should be less than 3 ft/sec; and
4. The design engineer needs to fully evaluate the suction and discharge hydraulics of each pumping station installation to ensure that the pumps will operate correctly, efficiently, and without cavitation.

6.5.3 Gauges

Each pump should have:

a. A standard pressure gauge on its discharge line;

b. A compound pressure gauge on its suction line;

c. Recording gauges in the larger stations, with possible connection to the water system SCADA system; and

d. A means for measuring the discharge flow rate.

6.5.4 Water Seals

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

a. Be provided with either an approved reduced pressure principle backflow preventer or a break tank open to atmospheric pressure; and

b. Where a break tank is provided, have an air gap of at least six inches or two pipe diameters, whichever is greater, between the feeder line and the flood rim of the tank.

6.5.5 Controls

a. Pumps, their prime movers and accessories, should be controlled in such a manner that they will operate at rated capacity without dangerous overload.

b. Where two or more pumps are installed, provision should be made for alternation.

c. Provision should be made to prevent energizing the motor in the event of a backspin cycle.

d. Electrical controls should be located above grade, and should be protected from weather.

e. Equipment should be provided or other arrangements made to prevent surge pressures from activating controls which switch on pumps or activate other equipment outside the normal design cycle of operation.

6.5.6 Standby Power

a. To ensure continuous service when the primary power has been interrupted, a power supply should be provided from at least two independent sources or a standby or an auxiliary source should be provided.

b. If standby power is provided by onsite generators or engines, the fuel storage and fuel line must be designed to protect the water supply from contamination. Natural gas or bottled gas is the preferred fuel. (See Part 2.7.)

6.5.7 Water Pre-lubrication

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

6.5.8 Tools and Spare Parts

A complete tool set, accessories, and spare parts should be provided as required for pump maintenance.

6.5.9 Fencing and Security

a. Security fencing should be provided around pumping facilities to prevent trespassing and vandalism.

b. All gates should be equipped with locks.

c. Provisions should be made for securing all electrical controls and switches from unauthorized persons.

d. Consider installation of security cameras at remote pumping stations or stations more likely to experience vandalism.

6.5.10 Operation and Maintenance Manual

An operation and maintenance manual specifically written for the subject pump station should be provided upon completion. This manual may be included with the operation and maintenance manual provided for the overall water system.

PART 7

FINISHED WATER STORAGE

7.0 GENERAL

The materials and designs used for finished water storage structures should provide stability and durability as well as protect the quality of the stored water. Steel structures should follow the current AWWA standards concerning steel tanks, standpipes, reservoirs, and elevated tanks wherever they are applicable. Other materials of construction are acceptable when properly designed to meet the requirements of Part 7.

7.0.1 Storage Capacity

a. Storage facilities should have sufficient capacity, as determined from engineering studies, to meet all the different demands for potable water, which normally include the following:

   1. Operational/Equalizing Storage. A volume of water to allow for meeting peak hour demands, while allowing treatment plants, wells, and booster pumping stations to operate at a relatively steady rate and without frequent cycling on and off. This volume is system and pressure zone specific and is determined by the peak demand characteristics of the different user groups in these systems and zones.

   2. Fire Water Storage. A volume of water reserved to fight potential fires. This storage volume depends on the size of the city and the types of structures (e.g., houses, commercial, industrial buildings) served by the water system. Fire flow requirements are generally established by the applicable regulations (Insurance Services Office, Uniform Fire Code, National Fire Protection Act) and/or the state and local fire marshals should be satisfied where fire protection is provided.

   3. Emergency Storage. A volume of water reserved for other unusual emergencies, such a primary electrical power outages. This storage volume is dependent on the anticipated vulnerability of treated water source supply outages.

b. The minimum storage capacity (or equivalent capacity) for systems requires a system and pressure zone specific assessment. Whenever possible, storage capacity requirement assessments should be based on actual water use records and other system specific information.

c. The treated water storage capacity requirement of a system may be reduced when the source and treatment facilities have sufficient capacity with permanent standby power generators to supplement peak demands of the system.

d. Excessive storage capacity should be avoided where water quality deterioration may occur.

7.0.2 Location of Ground-Level and Buried Reservoirs

a. The bottom of reservoirs and standpipes should be placed at the normal ground surface and should be above maximum flood level and outside of the 100-year floodplain, as defined by the Federal Emergency Management Agency (FEMA).

b. When the bottom must be below normal ground surface, it should be placed above the groundwater table and outside of the 100-year floodplain, as described above. Buried reservoirs should be constructed of reinforced concrete and include waterstop and other design features to make them completely water-tight and prevent contamination from above the reservoir top, as described herein. Steel reservoirs should not be buried.

c. The reservoir should be located outside areas subject to significant seismic activity.

d. The reservoir should be located in an area free from all overhead obstructions and power lines.

e. Sewers, drains, standing water, and similar sources of possible contamination must be kept at least 50 feet from the reservoir. In cases where a sewer must pass closer than 50 feet from a treated water reservoir, pressure pipe, pressure tested in place to 50 psi (340 kPa) without leakage, may be used for gravity sewers at distances greater than 20 feet and less than 50 feet. In no case, should a sewer be closer than 20 feet from a treated water reservoir.

f. The elevation of the operable storage volume of the reservoir should be located to provide adequate pressure to the distribution system, as identified in Part 8.2.2.

7.0.3 Location of Elevated Reservoirs and Standpipes

The applicable design standards of Part 7.0.2 should be followed for elevated reservoirs.

a. The elevation of the operable storage volume of the reservoir should be located to provide adequate pressure to the distribution system, as identified in Part 8.2.2.

b. Structural support should be adequate to compensate for the impact of wind shear, snow load, and seismic forces as required by applicable design standards.

7.0.4 Foundation

The foundation should be constructed to provide a stable bearing for the reservoir under full capacity conditions.

a. A geotechnical report should include the following information:

1. Level of groundwater;
2. Active, passive, and at-rest soil pressures;
3. Allowable bearing pressures;
4. Minimum depth of foundations;
5. Over-excavation and backfill recommendations;

6. Corrosivity readings;

7. Estimates of settling;

8. Recommendations for appropriate foundation systems; and

9. Site-specific seismic information.

b. The foundation should be constructed on suitable material, such as clean crushed rock, that will allow water drainage and prevent pooling of water around the foundation.

7.0.5 Protection from Contamination

a. All finished water storage structures should have suitable watertight floor slabs, walls, and roofs.

b. Tanks should be constructed with features to exclude birds, animals, insects, and excessive dust.

c. All finished water storage structures should be designed to prevent the entry of light into the reservoir during normal operating conditions.

7.0.6 Security

a. Fencing, locks on access manholes, secured access to external ladders, and other necessary precautions should be provided to prevent trespassing, vandalism, and sabotage.

b. Security cameras should be considered for tank surveillance, especially at un-staffed and remote tank sites.

c. The New Mexico Office of Homeland Security can assist with further security measures, see Part 2.1.

7.0.7 Drains

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

b. The design should allow complete draining of the storage facility for cleaning or maintenance without causing loss of pressure in the distribution system.

c. Drains should drain to daylight, if possible.

d. Drain surface outlets should be designed to prevent soil erosion downstream of the discharge and prevent occupation by rodents and other animals.

7.0.8 Inlet/Outlet and Baffle Walls

a. Inlet and outlet piping should be designed to facilitate turn over of water in the reservoir. Outlets should include a silt stop (See Part 7.0.16).

b. Internal baffles may be installed to promote circulation as well as distribution headers and other devices.

7.0.9 Overflow

All water storage structures should be provided with an overflow which is brought down to an elevation between 12 and 24 inches above the ground surface, and discharges over a drainage inlet structure or a splash plate which directs flow away from the foundation.

a. No overflow may be connected directly to a sewer or a storm drain.

b. All overflow pipes should be located so that any discharge is visible.

c. When an internal overflow pipe is used on elevated tanks, it should be located in the access tube. For vertical drops on other types of storage facilities, the overflow pipe should be located on the outside of the structure.

d. The overflow of a ground-level structure should open horizontally or downward and be screened with a non-corrodible screen installed within the pipe at a location least susceptible to damage by vandalism or be fitted with an acceptable flap valve.

e. The overflow of a ground-level structure should be high enough above the normal or graded ground surface to prevent the entry of surface water.

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

7.0.10 Access

Finished water storage structures should be designed with reasonably convenient access to the interior for cleaning and maintenance. At least two (2) manholes should be provided above the waterline at each water compartment where space permits.

a. The access should be framed (curbed) at least six inches above the surface of the roof at the opening. On buried structures, manholes should be elevated 24 to 36 inches above the top or covering sod to prevent drainage entering the manhole.

b. The access should be fitted with a solid tightly–fitting cover which overlaps the framed opening and extends down around the frame at least two inches.

c. The access should be hinged at one side, and should have a locking device.

d. All access points should be a minimum of 24-inches in the least dimension.

7.0.11 Vents

Finished water storage structures should be vented. Overflows should not be considered as vents. Open construction between the sidewall and roof is not permissible.

a. Vents should prevent the entrance of surface water and rainwater.

b. Vents should exclude birds and animals.

c. Vents should exclude insects and dust, as much as this function can be made compatible with effective venting.

d. Vents should be designed to prevent freezing of water on the screen.

e. Vents should be screened with non-corrodible screen and wire mesh. Mesh screens should be designed to fail in order to protect the tank from collapsing in the event a vacuum should occur.

 1. For elevated tanks and standpipes, four-mesh non-corrodible screen may be used.

 2. On ground-level and buried structures:

  (a) Vents should terminate in an inverted U construction with the opening 24 to 36 inches above the roof or sod, and should be covered with twenty-four mesh non-corrodible screen installed within the pipe at a location least susceptible to vandalism; and

  (b) Alternatively, a manufactured mushroom-type vent may be used.

f. Vents should be sized to allow unrestricted flow of air into the reservoir. Vents must be capable of allowing at least one air volume equivalent to the maximum potential flow of water out of the reservoir.

g. Measures should be taken to safeguard vents from vandalism, such as protecting with a sounding fence.

7.0.12 Roof and Sidewalls

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

a. Any pipes running through the roof or sidewall of a finished water storage structure must be welded, or properly gasketed in metal tanks and protected from freezing. In concrete tanks, these pipes should be connected to standard wall castings (thimbles) which were poured in place during the casting of the concrete. These wall castings should have integral three-inch tall seepage rings embedded in the concrete.

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

c. Valves and controls should be located outside the storage structure so that the valve stems and similar projections will not pass through the roof or top of the reservoir, and will not be subject to contamination by surface water.

d. The roof of concrete reservoirs with earthen cover should be sloped to facilitate drainage. Consideration should be given to installation of an impermeable membrane roof covering, with drain board and/or drain rock on top.

e. The exterior sidewalls of buried tanks should be covered with drain board or drain rock extending to the bottom of the tank to prevent stormwater from accumulating along the side of the tank.

f. At the upper perimeter of buried tanks, a two-foot layer of relatively impermeable soil (e.g., clay) should be placed. This ring should be constructed to convey surface water away from the exterior edge of the tank walls and minimize direct drainage down the sides of the tank.

g. If necessary to prevent the buildup of water at the foundation of the tank, a set of perforated drain pipes should be placed at the foundation. Water collected in these ring drains should be conveyed to daylight or to a drainage sump with automatic pumps to lift the water to a suitable discharge point away from the tank.

7.0.13 Drainage of Roof

a. The roof of the storage structure should be well drained with a minimum two-percent slope.

b. Downspout pipes should not enter or pass through the reservoir.

c. Parapets, or similar construction which would tend to hold water and snow on the roof, will not be approved unless adequate waterproofing and drainage are provided.

d. As mentioned in 7.0.12.d, for completely buried tanks, an impermeable membrane should be considered to assist in preventing contamination from above the tank top. Specific concerns that should be addressed include the presence of landscaping above the tank that may require the periodic use of chemical fertilizers, pesticides, and herbicides.

7.0.14 Safety

The safety of employees must be considered in the design of the water storage structure. As a minimum, such matters should conform to pertinent laws and regulations of the area where the reservoir is constructed.

a. Ladders, ladder guards, balcony railings, and safely located entrance hatches should be provided where applicable.

b. Ladders, ladder guards, and balcony railings should be designed to meet OSHA standards.

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

d. Railings or hand holds should be provided on elevated tanks where persons must transfer from the access tube to the water compartment.

e. Appropriate safety devices should be installed to comply with confined space entry requirements.

7.0.15 Freezing

a. Reservoirs built in locations subject to freezing should be designed to meet applicable requirements pertaining to minimum depth of foundations.

b. Reservoirs that are constructed with slabs on grade should be evaluated for the potential of frost heave.

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

d. Excessive storage capacity should be avoided where ice build up within the reservoir can occur.

e. Consideration can be given to insulation of exposed pipes and valves, if necessary.

7.0.16 Silt Stop

a. The discharge pipes from all reservoirs should be located in a manner that will prevent the flow of sediment from the reservoir into the distribution system.

b. Removable silt stops should be provided.

7.0.17 Grading

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

7.0.18 Painting and/or Cathodic Protection

Proper protection should be given to all metal surfaces, both internal and external, by paints or other protective coatings, by cathodic protective devices, or by both.

a. Internal paint systems should be consistent with AWWA standards, should be ANSI/NSF Standard 61 certified for potable water, and be acceptable to NMED.

b. Exterior and interior coating systems for welded steel tanks and recoating of assembled bolted steel tanks should be as specified in ANSI/AWWA Standard D102. Factory applied coating systems for bolted steel tanks should be in accordance with ANSI/AWWA Standard D103.

c. Interior paint must be properly applied and cured. After curing, the coating should not transfer any substance to the water which will be toxic or cause tastes or odors. Prior to placing in service, an analysis for volatile organic compounds is advisable to establish that the coating is properly cured.

d. Acceptable ambient conditions expected during coating application must be taken into consideration during design prior to selection of the coating systems.

e. Cathodic protection should be designed and installed by competent technical personnel.

f. Cathodic protection devices should be regularly inspected and maintained for satisfactory performance.

7.0.19 Level Controls

a. Any water storage facility should be equipped with a means to allow the determination of the water level within the reservoir without an internal inspection.

b. Any water storage facility should be equipped with a control system to allow detection of unacceptable low or high water levels, and/or control of the water level within the reservoir.

c. The minimum low water level should be 3 feet in ground-level storage tanks. The minimum low water level in standpipes should be based on system pressure requirements.

d. High water levels should be set at least 2 feet below the overflow level.

7.0.20 Disinfection

New reservoirs and reservoirs that have been emptied for service or repair should be disinfected to protect against any contamination introduced by workmen or materials during the course of construction or maintenance.

a. Finished water storage structures should be disinfected in accordance with current AWWA Standard C652 prior to being put into or returned to service.

b. Two or more successive sets of samples, taken at 24-hour intervals, should indicate microbiologically satisfactory water before the facility is placed into operation.

c. Disposal of heavily chlorinated water from the tank disinfection process should be in accordance with the requirements of NMED.

d. The disinfection procedure (AWWA C652 chlorination method 3, Part 4.3) which allows use of the chlorinated water held in the storage tank for disinfection purposes is not recommended. When that procedure is used, it is recommended that the initial heavily chlorinated water be properly disposed in order to prevent release of water which may contain various chlorinated organic compounds into the distribution system.

7.0.21 Provisions for Sampling

Appropriate sampling tap(s) should be provided to facilitate collection of water samples for both bacteriologic and chemical analyses.

7.1 DISTRIBUTION STORAGE

The applicable design standards of Part 7.0 should be followed for distribution system storage.

7.1.1 Pressures

a. The maximum variation between high and low levels in storage structures providing pressure to a distribution system should not exceed 30 feet. Larger variations can be tolerated if other system features, such as pressure reducing valves are used to minimize pressure fluctuations to customers.

b. The minimum working pressure in the distribution system should be at least 35 psi (240 kPa) and the normal working pressure should be approximately 60 to 80 psi (410 - 550 kPa).

c. When static pressures exceed 80 psi (550 kPa), pressure reducing devices should be provided on mains in the distribution system.

d. If the reservoir is providing fire protection, the minimum working pressure at the furthest fire hydrant flowing at the required fire fighting flow rate should be 20 psi, assuming average day demands by the system. In most systems, a hydraulic computer model of the water distribution system should be created for evaluating system pressures under different conditions and to verify that adequate fire fighting capacity is available at each and every fire hydrant.

e. Typical ranges of fire flow requirements are as follows:

   1. Single Family Residential: 500 to 1,500 gpm for at least 2 hours.

   2. Apartments/Condominiums: 2,500 gpm for at least 4 hours.

   3. Commercial: 4,000 gpm for at least 4 hours.

   These are typical fire flow values for illustration purposes only. The actual requirements for a specific system and pressure zone should be determined based upon local fire flow requirements. Note: Industrial facilities can require much higher flows and durations than those indicated above.

f. Fire flow is the flow rate of a water supply, measured at 20 psi (137.9 kPa) residual pressure, which is available for fire fighting.

g. EPANET 2.0 is a free hydraulic computer model available on the USEPA's website that can be used to model distribution system hydraulics. It can be accessed at http://www.epa.gov/nrmrl/wswrd/epanet.html.

7.1.2 Location

Storage structures which are tied to the pressure of the distribution system should be located at an elevation equivalent to other existing storage structures or equipped with altitude valves or other controls to properly regulate the level of water within the reservoir.

7.1.3 Drainage

a. Storage structures which provide pressure directly to the distribution system should be designed so they can be isolated from the distribution system and drained for cleaning or maintenance without necessitating loss of pressure in the distribution system.

b. The drain should discharge to the ground surface with no direct connection to a sewer or storm drain.

7.1.4 Level Controls

a. Adequate controls should be provided to maintain levels in distribution system storage structures.

b. Altitude valves or equivalent controls may be desirable to prevent overflowing of a second and subsequent storage structures that may be hydraulically connected to the system.

7.1.5 Water Quality Considerations

Good circulation of water through reservoirs can assist in the control of tastes and odors, maintenance of residual disinfectant, and control of slime growth.

a. Water circulation through reservoirs should be promoted by the use of baffles, or by placing inlets and outlets on opposite sides of the reservoir, with inlets near the top and outlets near the bottom.

b. All pipes except the overflow should have valves.

c. The minimum reservoir water depth should be about 12 feet.

7.2 PLANT STORAGE

Water storage may be provided at water treatment plants for in-plant uses or to reduce the total amount of distribution system storage required for flow equalization from the treatment plant. The applicable design standards of Part 7.0 should be followed for plant storage.

7.2.1 Washwater Supply Tanks

a. Washwater supply tanks should be sized, in conjunction with available pump units and finished water storage, to provide the backwash water required by Part 4.3.1.11.

b. The minimum capacity in storage required for the washwater tanks is the quantity of water required to backwash a filter for the design backwash flowrate and duration. Consideration must be given to the backwashing of several filters in rapid succession.

7.2.2 Clearwell

Clearwell storage should be sized, in conjunction with distribution system storage, to relieve the filters from having to follow fluctuations in water use.

a. When finished water storage is used to provide contact time for chlorine (See Part 4.4.5) special attention must be given to size and baffling. (See Part 7.2.2.b below.)

b. To ensure adequate chlorine contact time, sizing of the clearwell should include extra volume to accommodate depletion of storage during the nighttime for intermittently operated filtration plants with automatic high service pumping from the clearwell during non-treatment hours.

c. An overflow and vent should be provided.

d. Ideally, a minimum of two clearwell compartments should be provided.

e. For conventional treatment plants, the capacity of the clearwell must be sufficient to provide filter backwash water for the plant and equalizing storage for the plant's high-service pumping station. In most cases, a clearwell capacity equal to 10 percent of the maximum treatment plant design capacity is adequate. However, the sizing of the clearwell should be calculated for specific design conditions.

7.2.3 Adjacent Compartments

Finished water must not be stored or conveyed in a compartment adjacent to unsafe water when the two compartments are separated by a single wall.

7.2.4 Basins and Pump Wetwells

Receiving basins and pump wetwells for finished water should be designed as finished water storage structures.

7.3 HYDROPNEUMATIC TANKS

Hydropneumatic (pressure) tanks, when provided as the only storage facility, are acceptable only in very small water systems. When serving more than 150 living units, ground or elevated storage designed in accordance with Part 7.0.1 should be provided. Pressure tank storage is not to be considered for fire protection purposes.

a. Pressure tanks should meet ASME code requirements or an equivalent requirement of state and local laws and regulations for the construction and installation of unfired pressure vessels.

b. Interior coatings or diaphragms used in pressure tanks that will come into contact with the drinking water should comply with ANSI/NSF Standard 61.

c. The applicable design standards of Part 7.0 should be followed for hydropneumatic tanks.

7.3.1 Location

a. The tank should be located above normal ground surface and normally be housed.

b. In areas where freezing occurs, the tank should be completely housed.

7.3.2 Sizing

a. The capacity of the wells and pumps in a hydropneumatic system should be at least ten times the average daily consumption rate.

b. The system should be designed to provide a minimum of 35 psi pressure at all points in the distribution system during peak instantaneous flow conditions.

c. The gross volume of the hydropneumatic tank, in gallons, should be at least ten times, preferably thirty times, the capacity of the largest pump, rated in gallons per minute. For example, a 250 gpm pump should have a minimum of 2,500 gallon pressure tank.

d. A minimum of two wells or two pumps should be provided.

e. The live water volume of the tank should be sized so that the tank cycles at a maximum frequency of one cycle every two minutes during peak instantaneous flow conditions.

f. Sizing of hydropneumatic storage tanks must consider the need for chlorine detention time, as applicable, independent of the requirements in Part 7.2.2.a.

7.3.3 Pumping

The hydropneumatic system should be equipped with a minimum of two transfer pumps, each capable of meeting the pressure and volume demands during peak instantaneous flow conditions.

7.3.4 Piping

The tank should have bypass piping or devices, such as variable flow devices, or a duplicate unit to permit operation of the system while the tank or the tank accessories are being repaired or painted.

7.3.5 Appurtenances

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

b. Where practical, the access manhole should be 24 inches in diameter.

7.3.6 Air Volume

a. Air delivered by compressors to the pressure tank should be adequately filtered, oil free, and be of adequate volume.

b. Any intake should be screened and draw clean air from a point at least 10 feet above the ground or other source of possible contamination, unless the air is filtered by an approved apparatus.

7.3.7 Water Seal

For air pressure tanks without an internal diaphragm the volume of water remaining in an air pressure tank at the lower pressure setting should be sufficient to provide an adequate water seal at the outlet to prevent the leakage of air.

PART 8

DISTRIBUTION SYSTEMS

8.0 MANAGEMENT

Potable water providers should consider development of distribution system management practices in accordance with AWWA Standard G 200-04. These practices should include written documentation and policies with specific objectives, training, and records management.

8.1 MATERIALS

8.1.1 Standards, Materials Selection

Pipe, fittings, valves and fire hydrants should conform to the latest standards issued by AWWA and/or NSF, if such standards exist, and be acceptable to NMED. In the absence of such standards, materials meeting applicable Product Standards and acceptable to NMED may be selected. Special attention should be given to selecting pipe materials which should protect against both internal and external pipe corrosion.

8.1.2 Permeation of System by Organic Compounds

Where distribution systems are installed in areas of groundwater contaminated by organic compounds:

a. Pipe and joint materials which are not subject to permeation of the organic compounds should be used.

b. Non-permeable materials should be used for all portions of the system including water main, service connections and hydrant leads.

c. Bedding and trench backfill material should be of clean, uncontaminated imported materials.

8.1.3 Used Materials

Water mains which have been used previously for conveying potable water may not be reused, unless first approved by NMED.

8.1.4 Joints

Packing and jointing materials used in the joints of pipe should meet the standards of the AWWA and NMED. Pipe having mechanical joints or slip-on joints with rubber gaskets is preferred. Lead-tip gaskets should not be used. Repairs to lead-joint pipe should be made using alternative methods.

8.1.5 Pressure Class of Pipe and Fittings

a. The selected pipe should be capable of handling the external loading from backfill and surface live loads (e.g., H20 truck loading), and should be capable of withstanding internal working water pressure of a minimum of 150 psig plus a water hammer surge pressure of at least 100 psig.

b. Installation of water mains deeper than 10 feet or in hazardous areas may also require pressure class pipe and fittings in excess of the minimum.

8.2 WATER MAIN DESIGN

8.2.1 Location of Water Mains

a. Generally, all water mains should be installed in dedicated public streets or in other public access ways. A minimum right-of-way of 30 to 50 feet is recommended to ensure adequate access for normal and routine maintenance, as well as emergency repair procedures.

b. In the event that a pipeline must be installed across private property, then agreements must be developed to ensure no permanent structures are constructed within the permanent easements.

c. All pipeline installations should give consideration of future construction and the need for repair and maintenance.

8.2.2 Water Pressure

a. All water mains should be sized after a hydraulic analysis based on flow demands and pressure requirements.

b. As a general rule, the normal working pressure in the distribution system should be approximately 60 to 80 psig and not less than 35 psig.

c. The system should be designed to maintain a minimum pressure of 20 psig at ground level at all service connections and fire hydrants under all conditions of flow, including the following conditions:

   1. User Maximum Hour Demand, and

   2. User Average Day Demand plus the Design Fire Flow Demand.

d. All future planned changes in distribution systems should be designed to maintain the operating pressure at all service connections and fire hydrants per Parts 8.2.2.b and c.

e. Water mains should be designed to have at least five (5) psig of pressure throughout any buried length of the main. This requirement should not apply to short lengths of water main near reservoir inlets and outlets provided the following:

   1. The water main is on premises owned, leased, or otherwise controlled by the drinking water supplier; or

   2. The prior review and written approval of NMED is obtained.

8.2.3 Diameter

The minimum size of water main for providing fire protection and serving fire hydrants is six (6) inch diameter. Larger size mains are required if necessary to allow the withdrawal of the required fire flow while maintaining the minimum residual pressure specified in Part 8.2.2.

8.2.4 Fire Protection

When fire protection is to be provided, system design should be such that fire flows and facilities are in accordance with the requirements of the state Insurance Services Office and the local fire fighting authority.

8.2.5 Small Mains for Domestic Service

The minimum size of water main in the distribution system where fire protection is not to be provided should be four (4) inch in diameter. Any departure from minimum requirements should be justified by hydraulic analysis and future water use, and be considered and approved by NMED.

8.2.6 Hydrants

Water mains not designed to carry fire-flows should not have fire hydrants connected to them.

8.2.7 Dead Ends

a. In order to provide increased reliability of service and reduce head loss, dead ends should be minimized by making appropriate tie-ins whenever practical.

b. Where dead-end mains occur, they should be provided with a fire hydrant if flow and pressure are sufficient, or with an approved flushing hydrant or blow-off for flushing purposes. Flushing devices should be sized to provide flows which give a velocity of at least 3.0 feet per second in the water main being flushed. No flushing device should be directly connected to any sewer.

8.2.8 Water Velocity

Water mains should be designed to provide an average velocity not more than five (5) feet per second (fps) under the Maximum Day Demand flow.

8.3 VALVES

Sufficient valves should be provided on water mains so that inconvenience and sanitary hazards are minimized during repairs. Valves should be located at not more than 500 foot intervals in commercial districts and at not more than one block or 800 foot intervals in other districts. Where systems serve widely scattered customers and where future development is not expected, the valve spacing should not exceed one mile.

8.4 HYDRANTS

8.4.1 Location and Spacing

Hydrants should be provided at each street intersection and at intermediate points between intersections as recommended by the state Insurance Services Office and local fire fighting authorities. Generally, hydrant spacing may range from 350 to 600 feet depending on the area being served.

8.4.2 Valves and Nozzles

The local fire fighting authority should be contacted to determine the proper fire hydrant type, size, number of connections, connection sizes, and threading on fire hydrant nozzles.

8.4.3 Hydrant Leads

The hydrant lead should be a minimum of six inches in diameter, unless otherwise required by the local fire fighting authority. Auxiliary valves should be installed in all hydrant leads of the size and type required by the local fire fighting authority.

8.4.4 Drainage

Where hydrant drains are not plugged, a gravel pocket or dry well should be provided. Hydrant drains should not be connected to or located within 10 feet of sanitary sewers or storm drains.

8.5 AIR RELIEF VALVES; VALVE, METER AND BLOW-OFF CHAMBERS

8.5.1 Air Relief Valves

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

8.5.2 Air Relief Valve Piping

The open end of an air relief pipe from automatic valves should be extended to at least one foot above grade and be provided with a screened, downward-facing elbow. The pipe from a manually operated valve should be extended to the top of the pit.

8.5.3 Vault Drainage

Vaults, pits or manholes containing valves, blow-offs, meters, or other such appurtenances to a distribution system, should not be connected directly to any storm drain or sanitary sewer, nor should blow-offs or air relief valves be connected directly to any sewer. Such vaults or pits should be drained to the surface of the ground where they are not subject to flooding by surface water, or to absorption pits (gravel pockets) underground.

8.6 INSTALLATION OF MAINS

8.6.1 Standards

Specifications should incorporate the provisions of the AWWA standards and/or manufacturer's recommended installation procedures.

8.6.2 Bedding

A continuous and uniform bedding should be provided in the trench for all buried pipe. Backfill material should be tamped in layers around the pipe and to a sufficient height above the pipe to adequately support and protect the pipe. Large stones that could damage the pipe found in the trench should be removed for a depth of at least six inches below the bottom of the pipe.

8.6.3 Cover Over Pipe

All water mains should be covered with sufficient earth or other insulation to prevent freezing. A minimum cover of three feet should be used unless a deeper cover is required to protect the pipe. The top of all water mains should be at least six inches below the maximum recorded depth of frost penetration in the area of installation.

8.6.4 Thrust Blocking and Pipe Restraints

All tees, bends, plugs and hydrants should be provided with concrete reaction thrust blocking, tie rods or joints designed to prevent movement. Buried tie rods should be of stainless steel. Refer to applicable AWWA Manual of Design (e.g., M11: Steel Pipe Design and Installation) for thrust block design guidelines.

8.6.5 Pressure and Leakage Testing

All types of installed pipe should be pressure tested and leakage tested in accordance with the latest edition of AWWA Standard C600. Specifications should include provisions for contractor submittal of a test plan, including test equipment, for engineer review and approval.

8.6.6 Disinfection

All new, cleaned or repaired water mains should be disinfected in accordance with AWWA Standard C651. The specifications should include detailed procedures for the adequate flushing, disinfection, and microbiological testing of all water mains. In an emergency or unusual situation, disinfection procedure should be discussed with NMED.

8.6.7 External Corrosion

a. Provide for a system of records by which the nature and frequency of corrosion problems are recorded. On a plat map of the distribution system, show the location of each problem so that follow-up investigations and improvements can be made when a cluster of problems is identified.

b. If needed, perform a survey to determine the existence of facilities or installations that provide the potential for stray, direct electric currents. Also, determine whether problems are caused by the users of water pipes as grounds for the electrical system.

c. In previously unexplored areas where aggressive soil conditions are suspect, or in areas where there are known aggressive soil conditions, perform analyses to determine the actual aggressiveness of the soil.

d. If soils are found to be aggressive, take necessary action to protect the water main, such as by encasement of the water main in polyethylene, provision of cathodic protection, or using corrosion resistant water main materials.

8.7 SEPARATION OF WATER MAINS, SANITARY SEWERS AND STORM SEWERS

8.7.1 General

The following factors should be considered in providing adequate separation:

a. Materials and type of joints for water and sewer pipes;

b. Soil conditions;

c. Service and branch connections into the water main and sewer line, compensating variations in the horizontal and vertical separations; and

d. Space for repair and alterations of water and sewer pipes, off-setting of pipes around manholes.

8.7.2 Parallel Installation

Water mains should be laid at least ten feet horizontally from any existing or proposed gravity sewer/septic tank absorption field trench. The distance should be measured edge to edge. In cases where it is not practical to maintain a ten-foot separation, NMED may allow deviation on a case-by-case basis, if supported by data from the design engineer. Such deviation may allow installation of the water main closer to a sewer, provided that the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer.

8.7.3 Sewer Crossings

a. Water mains crossing sewers should be laid to provide a minimum vertical distance of 18 inches between the bottom of the water main and the top of the sewer.

b. At crossings, one full length of water pipe should be located so both joints are as far from the sewer as possible.

c. In the case that the water main must pass below the sewer pipe, then a minimum of 18 inches of vertical separation should be provided and the sewer line should be constructed of pressure pipe with joints equivalent to water main pipe and pressure tested to 50 psi with zero leakage. The pressure type sewer pipe must extend at least ten feet past both sides of the water main.

d. Special structural support for the water and sewer pipes may be required, so as to prevent any joint deflections from settlement that could result in eventual leaks.

8.7.4 Exception

NMED must specifically approve any variance from the requirements of Parts 8.7.2 and 8.7.3 when it is impossible to obtain the specified separation distances. Where gravity sewers are being installed and Part 8.6.2 and 8.6.3 cannot be met, the sewer materials should be waterworks grade 150 psi (1.0 Mpa) pressure rated pipe or equivalent and should be pressure tested to ensure zero leakage.

8.7.5 Force Mains

There should be at least a ten-foot horizontal separation between water mains and sanitary sewer force mains. There should be an 18-inch vertical separation at crossings as required in Part 8.7.3.

8.7.6 Sewer Manholes

No water pipe should pass through or come in contact with any part of a sewer manhole.

8.7.7 Separation of Water Mains from Other Sources of Contamination

Design engineers should exercise caution when locating water mains at or near certain sites such as sewage treatment plants or industrial complexes. On-site waste disposal facility including absorption field must be located and avoided. The engineer must contact NMED to establish specific design requirements for locating water mains near any source of contamination.

8.8 SURFACE WATER CROSSINGS

Surface water crossings, whether over or under water, present special problems. NMED should be consulted before final plans are prepared.

8.8.1 Above-Water Crossings

The pipe should be adequately supported and anchored, protected from damage and freezing, and accessible for repair or replacement.

8.8.2 Underwater Crossings

A minimum cover of three feet should be provided over the pipe. When crossing water courses which are greater than 15 feet in width, the following should be provided:

a. The pipe should be of special construction, having flexible, restrained or welded watertight joints;

b. Valves should be provided at both ends of water crossings so that the section can be isolated for testing or repair; the valves should be easily accessible, and not subject to flooding; and the valve closest to the supply source should be in a manhole;

c. Permanent taps should be made on each side of the valve within the manhole to allow insertion of a small meter to determine leakage and for sampling purposes; and

d. Concrete encasement of the pipe is highly recommended for such crossings.

8.9 CROSS-CONNECTIONS, INTERCONNECTIONS, AND BACKFLOW PREVENTION

8.9.1 Cross-Connections

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

8.9.2 Cooling Water

Neither steam condensate, cooling water from engine jackets, nor water used in conjunction with heat exchange devices should be returned to the potable water supply.

8.9.3 Interconnections

The approval of NMED should be obtained for interconnections between potable water supplies.

8.9.4 Approved Backflow Prevention Devices

a. An approved backflow prevention device should be installed at all connections that pose a potential contamination of the drinking water distribution system. The recommendations contained in AWWA M14: Recommended Practice for Backflow Prevention and Cross-Connection Control should be followed.

b. Approved backflow prevention devices should be in conformance with the latest versions of ANSI/AWWA C510: Double Check Valve Backflow Prevention Assembly or C511: Reduced-Pressure Principle Backflow Prevention Assembly.

c. The backflow prevention units should be installed downstream of the water meter.

d. The backflow prevention units should be placed inside a protective enclosure or cage to prevent vandalism.

e. The backflow prevention units should be heat traced and insulated or otherwise protected from freezing.

f. After installation, the backflow prevention units should be tested and approved as functioning properly by an approved AWWA certified inspector within five (5) days of installation. Results of the tests should be submitted to the drinking water supplier and kept on file.

8.10 WATER SERVICES AND PLUMBING

8.10.1 Water Service Connection Pipe

Service connection pipe and fittings should be designed for cold water working pressures of not less than 150 psig. Copper tubing should be commercial designation

Type K or L. Residential service lines should have a minimum inside diameter of 1(one) inch.

8.10.2 Meters

Each service connection should be individually metered. Residential meters should have a minimum inside diameter of 5/8 inches.

8.10.3 Plumbing

Water services and plumbing should conform to relevant local and/or state plumbing codes, or to the applicable National Plumbing Code. Solders and flux containing more than 0.2% lead and pipe and pipe fittings containing more than 8% lead should not be used.

8.10.4 Booster Pumps

Individual booster pumps should not be allowed for any individual service from the public water supply mains without prior NMED approval.

8.11 AS-BUILT RECORD DRAWINGS

The water system should maintain up-to-date drawings showing the location, size, materials of construction, and construction details of the water distribution system piping, valves, and other appurtenances.

8.12 WATER LOADING STATIONS

Water loading stations present special problems because the fill line may be used for filling both potable water vessels and other tanks or contaminated vessels. To prevent contamination of both the public supply and potable water vessels being filled, the following principles should be met in the design of water loading stations:

a. There should be no backflow to the public water supply;

b. The piping arrangement should prevent contaminant being transferred from a hauling vessel to others subsequently using the station;

c. Hoses should not be contaminated by contact with the ground; and

d. Figure 8-1 shows acceptable water loading station devices.

FIGURE 8-1

Acceptable Water Loading Station Devices

(See Part 8.11)