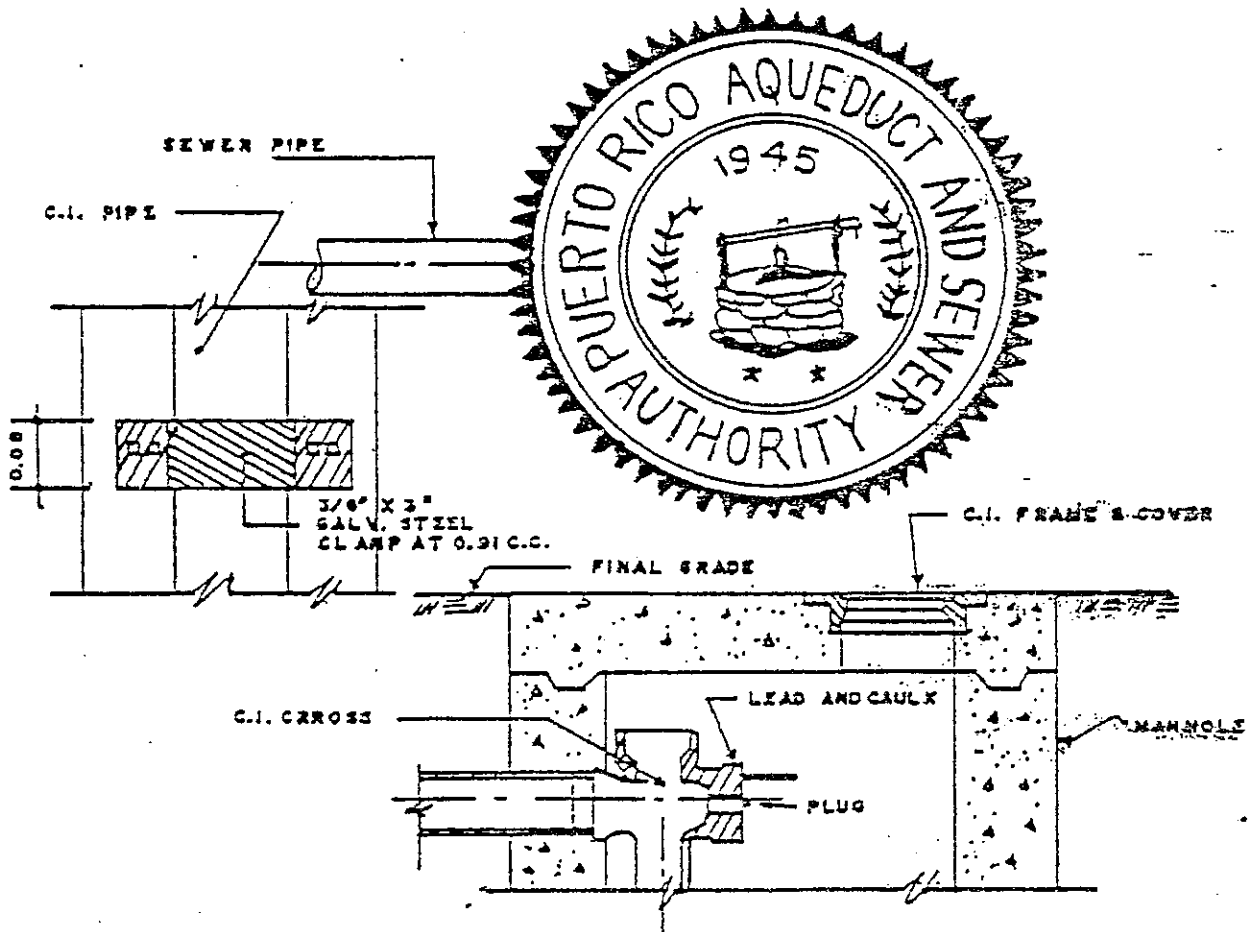


RULES AND REGULATIONS FOR THE DESIGN STANDARDS



PUERTO RICO AQUEDUCT AND SEWER AUTHORITY



F O R E W O R D

The purpose of this Rules of Design Standards is to establish the needed requirements and the proper procedure for the development and approval of design projects for Sanitary Sewer Systems and/or Water Supply Systems. These Standards are not expected to cover each and everyone of the submitted cases, and they may be subjected to particular conditions.



*** I N T R O D U C T I O N ***

The Puerto Rico Aqueduct and Sewer Authority in its desire to offer a better service to its customers and to lessen its operation and maintenance problems, prepared what at the time entitled "House Connection Standards" and considered this as its first attempt to prepare a manual that in the future would be called "Operation Manual and Design Standards". This "House Connection Rules" advised that from time to time, when new ideas, new methods appear, the necessary revisions should be made.

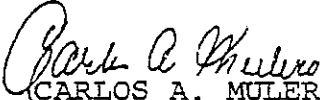
By the year 1957, its name was changed to "Design Standard Manual", and in 1974, the Authority was compelled to revise its standards. Now, the Authority, recognizes that due to the new water quality standards, new programs, raising costs of equipment, chemical products, operation and maintenance programs, must deal with the revision of its design standards aiming at the uniformity of its structures, services, operation and maintenance programs, etc.

In addition the Authority for its revision, held public hearings, consulted customers, updated safety requirements, incorporating them into the "Rules of Design Standards".

Today I am very pleased to submit to you the Rules that will govern the Design of Aqueduct and Sewer Systems in Puerto Rico and that will come into effect today.



To all entities both governmental and private, fellow engineers, businessmen and to all that in one way or another assisted us in preparing this rules of design standards, our gratitude.


CARLOS A. MULERO
EXECUTIVE DIRECTOR

December 19, 1983



RESOLUTION NUMBER 1127

WHEREAS: The Puerto Rico Aqueduct and Sewer Authority was created in order to provide and help provide the inhabitants of Puerto Rico an adequate water and sanitary sewer service and any other service or incidental facilities concerning to the same (22 L.P.R.A., Section 144);

WHEREAS: The Puerto Rico Aqueduct and Sewer Authority is empowered to promulgate rules and regulations concerning the use and conservation of water, the disposal of waste waters, the care, conservation and protection of the facilities used or to be used for the supply, distribution, consumption or use of water and disposal of waste waters in order to comply with the purposes for which the Puerto Rico Aqueduct and Sewer Authority was created (32 L.P.R.A., Section 152);

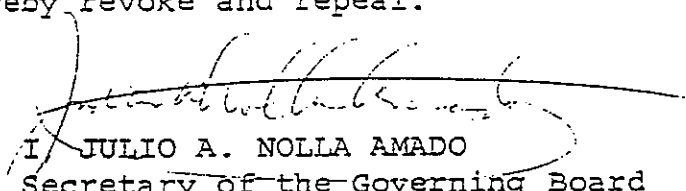
WHEREAS: In the year 1974 the Rules and Regulations for Designing were approved, which actually regulates the designing for Sanitary Sewer Systems and the Water Supply Systems;

WHEREAS: A committee was appointed to perform a revision to such rules and regulations and to adapt them for today's technical and professional needs;

WHEREAS: After having complied with all the law requirements including public hearings and submitted to the Executive Director, Eng. Carlos A. Mulero, who approved the same;



NOW, THEREFORE BE IT RESOLVED: By this Governing Board and in compliance with Law Number 163 of May 3rd., 1949 to RATIFY THE APPROVAL OF THE RULES AND REGULATIONS FOR DESIGNING, which shall be in effect as soon as it is complied by filing the same at the Department of State. The Rules and Regulations for Designing in force are hereby revoke and repeal.


I, JULIO A. NOLLA AMADO
Secretary of the Governing Board
of the Puerto Rico Aqueduct and
Sewer Authority, DO HEREBY CERTIFY,
the above is a true and exact copy
of the Resolution approved by the
Board during their meeting held on
June 26, 1984.





L E G A L B A S I S

These Rules and Regulations issued in compliance with and pursuant to Section 20, of the Aqueduct and Sewer Authority of Puerto Rico, Law Number 40 of May 1, 1945, as amended by Law 163 of May 3, 1949, Section 144, paragraphs (J) and (K) and Section 159, shall have force of Law.



TABLE OF CONTENT

We understand that both the table of content or index constitute an essential part of the norms, but considering of valuable assistance to the fellow designer that they be part of the corresponding chapter, only the chapter's title and number is included in this Table of Content.

Chapter I	REQUIREMENTS FOR THE PRESENTATION OF PROJECT PLANS
Chapter II	GENERAL NORMS FOR THE DESIGN OF AQUEDUCT SYSTEMS
Chapter III	WATER FILTER PLANTS
Chapter III-A	CLEAR WATER PUMPING STATIONS
Chapter IV	GENERAL STANDARDS FOR THE DESIGN OF SANITARY SEWERS
Chapter V	SEWAGE PUMPING STATION
Chapter VI	WASTEWATER TREATMENT PLANT
Chapter VII	GUIDES FOR DESIGN AND REVISION OF ELECTRICAL PLANS
Chapter VIII	SAFETY REGULATIONS
Chapter IX	WATER SUPPLY NORMS FOR APARTEMENTS BUILDINGS AND CONDOMINIUMS
Chapter X	RULES AND REGULATIONS FOR THE SUPPLY OF WATER AND SEWER SERVICE, PUERTO RICO AQUEDUCT AND SEWER AUTHORITY 1976.
Chapter XI	ACT FOR THE CONSERVATION, DEVELOPMENT AND USE OF THE WATER RESOURCES OF P.R. LAW #136, JUNE 3, 1976
Chapter XII	TYPICAL DETAILS



CHAPTER I

REQUIREMENTS FOR THE SUBMITTAL OF PLANS

This chapter comprises the requirements applicable to the submittal of plans, from the Preliminary Consultation to the Final Plans for each type of project, including Trailer Houses.

<u>SECTION</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
1.01	Types of Projects	I-1
1.02	Preliminary Consultation	I-1
1.03	Preliminary Plans	I-1
1.04	Final Plans	I-2
1.05	Trailer Housing	I-5
1.06	Basis of Design	I-7



CHAPTER I

REQUIREMENTS FOR THE PRESENTATION OF PLANS

1.01 Types of Projects

- 1.01.01 Private and public urbanizations, simple lot divisions, urban renewal projects, and any other public housing project where water and/or sewer facilities are provided to be connected to the systems of the Authority or to be transferred to it for its operation.
- 1.01.02 Apartment, condominiums or office buildings with more than three units and trailer houses.
- 1.01.03 Hotels, hospitals, medical centers, industrial buildings, institutional buildings, commercial, educational, recreational, sports centers, gasoline station.
- 1.01.04 Any other project not included in the above clauses, which requires a water connection 4" in diameter or larger.

1.02 Preliminary Consultation

Prior to submitting the preliminary plans, a written consultation is required from the proposer or designer, regarding water and sewer facilities available in the area where the project is to be located, with evidence of the submittal of the project plans to the Planning Board, Permit and Regulations Administration, and/or other agencies (E.Q.B., U.S. Army Corps of Engineers, Department of Natural Resources, Health Department, and Transportation and Public Works Authority). The consultation also shall include a site plan and a general description of the project.

1.03 Preliminary Plans

After obtaining the approval of the permits and requirements aforementioned and submitting evidence of such approvals, the proposer shall submit two (2) advance copies of the proposed project plans, including the information specified in Sections 1.04.01 to 1.04.06 for revision and recommendations by the Authority.

1.04 Final Plans

- 1.04.01 Once the recommendations and approval by the Authority regarding the preliminary plans are obtained and incorporated, the project planner shall submit two (2) copies for revision and final approval, then two (2) copies, (one in Mylar (0.005) for the Authority and one in sepiia to be returned to the project planner, after the approval seal of the Authority is stamped) and six (6) copies of the final plans of the project. Copy of these documents shall be forwarded to the Permits and Regulations Administration.
- 1.04.02 The horizontal projections shall indicate the following; project site, topography, project limits, adjacent property owners, north, scale, elevation contours at intervals no greater than one (1) meter, road and nearest kilometric marker, streets and other nearby accesses, bench marks within the project limits, referred to one of the U.S. Coast and Geodetic survey and clearly identified in the plans. All dimensions and contours, except pipe sizes and fittings, pump suction and discharge, valves and other accessories related with piping will be indicated in the metric system and in parenthesis its equivalent in the English system.
- 1.04.03 Horizontal projections indicating the proposed water distribution system and sewer system. In cases of lot divisions or urbanization; numbered lots must be indicated, as well as existing and proposed roads or access. Also, the various elements and details of the water and sewer systems to be installed in the project.
- 1.04.04 Longitudinal profiles showing the elevations of the roads, streets, as well as the existing and proposed sewers related with the project, survey points, partial distances between manholes, station points, slopes and dimension of the sewers. The manholes shall have the same numbers, invert and top elevations as shown on the site plans. Also all existing sanitary and storm sewers, aqueduct,

gas or any other piping, cable or structure that would cross the water or sewer piping of the proposed project. Aqueduct projects shall include hydraulic profiles of the piping between pumping stations and distribution tank and between tanks and points of maximum or minimum pressure in the distribution system.

In sanitary sewer projects where pumping stations are included, it will be required to show the hydraulic gradient of the system including velocity.

- 1.04.05 Submit detailed plans, including typical details related to the proposed project, according to the norms of the Authority, as well as special works, such as, overflows, crossings of ramparts, streams, tunnels, siphons, house connections, culverts, channels, sewers of non-circular sections etc.
- 1.04.06 In case of works that must be installed in private property, the necessary right of way to be adquired and transferred to the Authority, must be indicated.

The land to be transferred, by the Developer, to the Authority, must be transferred at no cost and with a notarized non-return clause and proof of the Owner's agreement. Right-of-way along the property limits of adjacent lots shall not be permitted and shall be accessible to permit maintenance. For right of way width refer to Section 1.04.15.

- 1.04.07 The plans must include a minimum space of 5" high and 6" long over the title on the lower right hand corner of each sheet for the seal of approval of the Authority. Full name and address of the owner must appear on the first sheet of the plans.
- 1.04.08 Each project plans must have a conventional symbols' legend or code.
- 1.04.09 All plans submitted for approval must be prepared and signed by an engineer duly authorized to practice the profession in Puerto Rico including full name, address, and license number.

- 1.04.10 The minimum scales for the plan shall be 1:1000; for profiles H= 1:1000, V= 1:1000; for street or road transverse sections 1:1000 except typical sections indicating paving details that will be 1:50. For special details an adequate scale shall be used.
- 1.04.11 On projects for every kind of building, a site plan of the project must be submitted indicating its use, number of floors, housing, offices, rooms, beds, students etc. Also, building sections and soil test results must be indicated.
- 1.04.12 Isometric plans or water and plumbing installations of the buildings comprised in the project must be submitted.
- 1.04.13 Plans for urbanizations shall include a scaled sheet showing all structures comprised in both aqueduct or sewer projects.
- 1.04.14 The lots for the location of structures, such as pumping stations and distribution tanks that are part of the project, must be indicated in the plans, including compass bearings and length of property lines, area, name of existing adjacent property owners, topography, existing and proposed ways of communication, nearest kilometric marker, existing and proposed access, etc. The lot shall be large enough to allow easy access to the structures, providing paved concrete walks around them, no less than two (2) meters wide. Every lot for pumping stations shall be concrete paved. Restriction to adjacent properties will be required, such as setback around the structures where no other structure will be built. The setback for sewage pumping stations will be 15 meters. For wastewater treatment plants see Chapter 6 Section 6.02. The access road shall be no less than four (4) meters wide with one (1) meter wide shoulder on each side.
- 1.04.15 The necessary rights-of-way for the installation of water pipes or sewers on private property will be indicated on the plans, having a width as follows:
- a) three (3) meters for water pipes up to or twelve (12) inches diameter.
 - b) four (4) meters for water pipes up to or 18" diameter.

- c) for water pipes twenty (20) inches to sixty six (66) inches in diameter, the width shall be six (6) meters.
- d) three (3) meter wide for sewer pipes up to twenty-four (24) inches diameter,
- e) for sewer with a larger diameter the Authority will determine the width of the right of way, and
- f) four meter wide for common right of ways of up to twelve (12) inches for water pipe and sewers up to twenty-four (24) inches in diameter.

1.04.16 For the project final approval a report must be submitted including the stratigraphical profiles and localization of the soil test and recommendation of the foundation of the structures. Stratigraphical profile of this soil test must be shown in the project plans. The report should be certified by a Soil Engineer. The Authority may require additional tests, such as:

- a) compaction tests to determine settling,
- b) triaxial tests to establish resistance to cutting or digging,
- c) test trench to verify construction methods,
- d) pumping test to determine the coefficient of permeability to use in the design of the drainage system,
- e) seismic refraction test, jointly with the borings, to obtain geological information data.
- f) establish the number, depth and spacing of the borings. In the case of treatment plants, the dimensions and depth of the structure should be considered.

1.05 Trailer Housing

1.05.01 Trailer housing is a recent type of development and sufficient experience is not yet available to establish design standards. Requirements approved by the Authority shall be applied.

- a- Summer trailer housing
- b- Residential trailer housing

1.05.02 Up to this date the only regulation pursuant to Trailer Houses has been established by the Planning Board in its Resolution No. J.P. 229. This Resolution aims to promote projects of this type in an orderly and planned manner for the enjoyment of these facilities under healthfulness, comfortable and safety conditions. Said Resolution entails the following criteria:

Definition of Trailer Houses' Recreational Projects

Will be understood as trailer houses' recreational project, that which comprises a lot with minimum facilities, oriented toward the local tourism, to provide two or more parking spaces for compact housing units, with all or part of the ordinary facilities of a house, permanently assembled over a chassis that can be towed by another vehicle, or can move on its own it does not excludes the combination of trailer houses with cottages and/or tents for short term stays, in trailer houses' projects.

Location

- 1- Projects within or adjacent to an area of environmental, natural and cultural importance will need the endorsement of the Department of Natural Resources.
- 2- The minimum drinking water infrastructure with adequate capacity according to the rules of the Puerto Rico Aqueduct and Sewer Authority must exist. If there are no sanitary facilities, central septic tanks or any other system will be used.
- 3- Its location will be at:
 - a) 30 meters measured from the exterior river bed of every river, channel and brook.
 - b) 200 meters measured from P.R.A.S.A.'s acquisition limit on every reservoir for the supply of drinking water.

- 4- Projects proposed to be on lands adjacent to residential areas, urbanizations, rural communities, etc., must observe a buffer zone planted with trees, free of every activity, of 20 meters.

Special Controls

- 1- The segregation or division into lots or spaces for trailer houses in recreational projects will not be allowed.
- 2- The trailer houses will no be allowed to be used as permanent housing units.

1.05.03 In compliance, with the Planning Board's Resolution No. 229 this Authority states that:

- 1- Only one connection of size corresponding to the number of trailer houses at a rate of 200 gallons per day per trailer house, will be allowed.
- 2- Only one connection to be discharged into a tank or cistern will be allowed and the distribution will be at the owner or administrator's expenses.
- 3- There will be no segregation, nor installation of individual connections.
- 4- The distribution system to be used will be designed by a qualified, licensed engineer and it will have to be approved by the Aqueduct and Sewer Authority.

1.06 Basis of Design

- 1.06.01 The design and construction of this Authority's facilities shall comply with the applicable requirements of "Concrete Sanitary Engineering Structures," reported by ACI Committee 350. Where a conflict exists between the requirements specified by ACI 350 and the requirements specified, shown on the drawings or elsewhere, the more stringent requirement shall apply.

1.06.02 The particular attention of the Designer is directed to the fact that the water and waste-water facilities and all appurtenances shall be designed and constructed to withstand, in addition to normally occurring stresses, the stress resulting from earthquake and hurricane forces.

All designs shall comply with applicable requirements of the Building Regulations of the Puerto Rico Planning Board and of the Uniform Building Code, latest editions.

1.06.03 The designer shall submit the design data and design calculations of the Process, Structural, Electrical, Mechanical, Architectural or any other matter deemed necessary for the revision and approval of plans submitted to this Authority.

CHAPTER II

GENERAL STANDARDS FOR THE DESIGN OF AQUEDUCT SYSTEM

This chapter includes the daily consumption for different uses such as domestic, industrial, commercial, etc., both urban and rural. Norms for buildings requiring tanks and pumping systems to satisfy the minimum water pressure required, factors to be considered in the design for maximum hourly demand and for 25 years future demand. Water sources of supply are regulated for quality and quantity. General conditions are established for the pumping of raw water and clear water in the distribution system, type and capacity of pumps, and general norms for distribution systems.

<u>SECTION</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
2.01	Domestic Consumption	II-1
2.02	Other Uses	II-1
2.03	Additional Requirements	II-2
2.04	General Norms for Rural Aqueduct Design	II-3
2.05	Pumping Stations	II-4
2.06	Reserve-Tanks	II-11
2.07	Distribution Systems	II-12



CHAPTER II

GENERAL STANDARDS FOR DESIGN OF AQUEDUCT SYSTEMS

2.01 Domestic Use

2.01.01 Private housing projects - 1514 liters (400 gallons) per day per housing unit.

2.01.02 Public housing projects, renewal projects and other public-communal projects-1135 liters (300 gallons) per day per housing unit.

2.01.03 Rural housing projects - 946 liters (250 gallons) per day per housing unit.

2.02 Other Uses

2.02.01 Light Industry (Consumption for personal use only). Shall be determined based on 1325 liters (350 gallons) of water daily per 93.0 square meters (1000 square feet) of floor space or 37,850 liters (10,000 gallons) daily per each "cuerda" of land assigned for construction of industrial buildings.

2.02.02 Heavy Industry. (Consumption includes human needs and industrial process). The consumption for human need will be the same as in the preceding clause. The owner or the sponsor of the project shall submit the necessary information on the quantities of water to be used for the industrial process.

2.02.03 Commercial Buildings

The consumption will be determined based on 1135 liters (300 gallons) daily per each 93.0 square meters (1000 square feet) of floor space or 26300 liters (7000 gallons) daily per "cuerda" of land assigned for construction of commercial buildings.

2.02.04 Office Buildings

Will be computed based on 1,135 liters (300 gallons) daily per each 93.0 square meter (1000 square feet) of floor space.

2.02.05. Apartment and Condominium Buildings.
1515 liters (400 gallons) daily per apartment.

2.02.06. Hotels (with all services and facilities) - 2650
liters (700 gallons) per room per day

Deductions for Services or Facilities not provided

Laundry -----378 liters (100 gallons) per
room per day

Beach -----378 liters (100 gallons) per
room per day

Food Service -----378 liters (100 gallons) per
room per day

Swimming pool -----189 liters (50 gallons) per
room per day

2.02.07. Hospitals and Medical Centers.
1325 liters (350 gallons) per bed per day.

2.02.08. Schools.
114 liters (30 gallons) per student per day.

2.03 Additional Requirements

In those cases where water services can not be provided by gravity, to the buildings mentioned on clauses 2.02.04 and 2.02.07, the following additional requirements must be considered:

2.03.01. A tank must be provided for water storage with a minimum capacity equivalent to half the daily average total consumption of the building, plus an adequate reserve, that in no case shall be less than 11,560 liters (300 gallons) to be used in case of fire. The fire protection system should be designed in accordance with the regulations of the Planning Board, the Administration of Permits and Regulations and the Fire Department.

2.03.02. The water service connection must be sized to fill the water storage tank in eight (8) hours.

2.03.03. A pump system must be used, with a capacity equal to the maximum instant consumption of the building, but never less than 11340 liters per second (50 gallons per minute). At least two (2) units shall be provided with capacity to supply maximum instant

consumption each one, which will function alternately or simultaneously if necessary.

In apartment buildings, hospitals, or other institutions that provide emergency services, an emergency power generating plant, will be provided, with capacity to run one of the pumps.

- 2.03.04 The minimum residual pressure, at the top floor level, shall not be less than 1.05 kgs/square cen. (15 lbs/sq. inch.).
- 2.03.05 For apartment buildings and condominiums see Chapter IX.
- 2.04 General Standards for Rural Aqueduct Systems Design Guide.
 - 2.04.01 Average domestic water consumption shall be determined based on 190 liters (50 gallons) per capita. Population shall be computed based on five (5) persons per family or living unit. The average domestic consumption will be estimated based on 190 liters (50 gallons) daily per person, plus 114 liters (30 gallons) per student, if schools exist. If industrial developments, urbanizations, public housing or a possibility of them exist, their consumption must be considered in addition to the rural system consumption and computed according to the norms of the Authority.
 - 2.04.02 The rural aqueducts systems shall be designed with capacity to supply the estimated demand in the next twenty five (25) years, considering a population growth of 25% the actual population, thus the daily future consumption shall be computed by multiplying the actual daily consumption by 1.25. Hourly future maximum demand to be determined by multiplying future demand by 2.25. To calculate the loss due to friction in cast iron pipe use coefficient C-100.
 - 2.04.03 The minimum capacity of the source of supply should be sufficient to provide the demand for the next twenty five (25) years. If not possible the project should include the study of sources to be used in the future.
 - 2.04.04 The water to be used should be chemical and bacteriological satisfactory for human consumption.

When chlorine treatment alone does not guarantee this condition, additional treatment and chemical use should be considered.

- 2.04.05 The dams for rural aqueduct systems, and when so permitted by the supply source, should be small dams, approximately 1.5 meters high to facilitate the water intake and storage for a period of time. The dams shall be constructed of reinforced concrete and preferably on rock ground. At the intake structure, two (2) racks should be installed, one at the intake made of steel rods 1.27 centimeter (1/2 inch) in diameter and spaced 5.08 to 10.2 centimeter (1/2 to 2 inches) and another in the interior made of wire mesh gauge number 10, spaced about one centimeter (3/8 inch). A gate, not less than 41 centimeters (16 inch) diameter, shall be provided for drainage and cleaning.

2.05 Pump Stations

- 2.05.01 When not technically possible or economically feasible to provide a gravity water supply system and/or distribution system, a pumping system as included in clauses 2.05.02 and 2.05.03 will be provided.
- Selected pumps should be of the minimum size necessary to supply the daily future flow operating sixteen (16) hours daily and most convenient with regard to efficiency. Two (2) units of equal capacity should be provided, maintaining one in reserve for emergencies and/or maintenance facilities.
- All pumping stations shall be provided with pressure gauges to measure pump suction and discharge pressure and automatic graphic pressure recorder of seven (7) days duration. They must be protected by a 1.83 m. (6 feet) high galvanized chain link fence with 3 strands of barbed wire on top, along the property line of the lot with a four (4) meters gate. See Fig. No. 1.
- A paved road for access to the pumping stations, not less than four (4) meters wide with one meter shoulders at each side. In case of concrete pavement, construction joints 5.49 meters (18 feet) apart should be provided.

Final grading of the access road will have a minimum elevation of 0.60 meters above maximum flood level. All pumping equipment should at least be duplicated for emergencies, except in particular cases of small projects using a deep well as a supply source. To estimate losses due to friction a coefficient of $C = 100$ must be used.

2.05.02 Distribution Pump Stations

Distribution pumping stations must have concrete houses of adequate size. The possibility of eliminating the pump house should be considered, subject to previous consultation and approval of the Authority. The space inside the house should permit the easy arrangement and installation of the equipment and accessories so that operation and maintenance can be accomplished with comfort. To facilitate the removal of vertical type pumps for replacing or to repair, a one square meter opening should be provided, above each pump, with a watertight lid with hinges and lock. In case of horizontal pumps with motors larger than 15 H.P., an I beam with hoist, must be provided. An automatic starting generator, should be provided for emergencies in case of electric power failure.

2.05.03 Raw Water Pumping Stations

The raw water intake pumping stations shall consist of a catch basin with a minimum capacity equal to eight (8) hours daily average consumption which will be supplied from a river, stream, or a deep well, etc. Means of measuring the flow should be provided. Pumps and electrical controls up to 30 H.P. can be installed outdoors and for those over 40 H.P. a control house should be built. When installed outdoors the control box shall be watertight (NEMA III) and a Diesel driven generator for emergencies shall be provided, with adequate delay relay to operate automatically in case of electric power failure. An automatic transfer switch shall be provided. Generators shall be housed in a concrete structure. The structures and equipment shall be arranged according to typical details of the Authority.

When the water supply is a river, stream, etc., the catch basin shall be design to include bar screens, weir, drains, and intake dam. In this case a filtering plant is required according to requirements of the Authority depending on each particular case. In this type of installation two pumps-well type, will be required, each with a capacity equal to the maximum filtering flow of the plant in 24 hours. See Fig. No. 29 and 29A.

The maximum yield of the well should be 1.67 times greater than the flow to be provided. Concrete housing for the chlorination equipment and electric power generator, shall be provided. The well shall be constructed as follows:

- a. Should be tested for plumbness and alignment. Any deviation or bend which might affect the installation or operation of the pump, should constitute basis for rejection.
- b. The diameter of the final casing shall depend on the flow required, but never less than 10 inches.
- c. The final casing pipe thickness will be determined by the Authority, depending on the diameter and the depth of the well, but shall not be less than 0.23 inches thick.
- d. New smooth type steel pipe shall be used for the casing and not less than 15.3 meters (50 feet) deep and seal with cement mortar to eliminate possible contamination of the water.
- e. The contractor shall submit to the Authority a tabulation of the well, as constructed, indicating the depth of the different formations penetrated, the pipe installed, the grouting depths, water static levels, water veins founded and any other information that might be usefull to the project history.
- f. The contractor shall perform a 48 hours yield test after well construction, supervised by personnel of the Authority. All equipment needed for the test, including the pump, shall be furnished by the contractor.

The owner or the project shall deposit a certified check in the amount of \$3,500.00 to cover the cost of supervision and chemical analysis (mineral and bacteriologic) to be done by the Authority.

The Authority will submit a detailed statement of the expenses incurred in order to adjust the corresponding charges for the test.

2.05.04 Pump Capacity

The pumps shall be designed in the following manner:

- a. Pumps for supply sources for filtration plants equal to maximum daily flow of filtration of the plant in 24 hours. Underground pumps will not be permitted in raw water systems.
- b. Booster pumps - Average daily flow in 16 hours for rural and urban zones:

Rural

Average flow	= Nx5x60 g.p.d.
Daily maximum flow	= Nx5x60 g.p.d.x1.5
Hourly maximum flow	= Nx5x60 g.p.d.x1.5x1.5

Urban

Average flow	= Nx5x80 g.p.d.
Daily maximum flow	= Nx5x80 g.p.d.x1.5
Hourly maximum flow	= Nx5x80 g.p.d.x1.5x1.5

N = Number of housing units

At least two equal pumps with the capacity shown above, must be provided, which will operate alternately, by means of the appropriate electric mechanism.

All mechanical equipment should be the most efficient possible, preferably automatic, and that better serves the special function they are expected to perform.

Pump suctioning directly from the piping will not be permitted unless it is proven that hydraulic conditions will permit it, proved by a 24 hours graphic pressure record.

A suction well must be provided with a minimum water reserve of eight (8) hours, based on the average pump capacity and the connection sized for the capacity of the pit for 24 hours.

2.05.05 Centrifugal Pumps

Every booster pump for water supply purposes must be a centrifugal type pump (horizontal or vertical, simple or multiple stage, turbine well type or with submergible motor), and determined according to the specifications of flow and head on each case.

When pumps of the vertical barrel type are used, they should have the suction and discharge flanges at the same elevation.

In general, these pumps will be bronze fitted, body will be gray iron with a high percentage of steel. The housing impeller wearing and lubrication rings will be of bronze, the shaft shall be of stainless steel (304N) and mounted in adequate ball bearing when required. The pump will be provided with blow off valves, cooling interconnections packing box glands or mechanical seals as required by the Authority.

The horizontal pumps will be driven by electric motors, by means of direct or flexible coupling, mounted on a common base of cast iron or welded steel, subject to the approval of the Authority. When the coupling is flexible, a coupling guard will be provided.

The motor will be horizontal or vertical according to the type and speed of the pumps. They will be induction type, with class B insulation, three phase, 60 cycles and 230 to 460 volts. The Authority has the option, in cases of synchronous motors larger than 150 H.P., to authorize voltage of 4160 volts. The motors and their installation shall meet all the latest requirements of the National Electric Code and the P.R. Electric Power Authority.

When designing the electrical system, consideration should be given to use the most economic power rates.

Pumping equipment electrical control panel shall consist of the following accessories:

- a) Automatic type, general circuit breaker of adequate capacity for the total load to be connected.
- b) Control for each unit with its magnetic starter, according to the capacity of the motor, preceded by the automatic circuit breaker. For motors larger than 40 H.P. the starter will be of the reduced voltage autotransformer type, with overload protection.
- c) Relays for protection against power failure, drop in voltage or phase failure, reversal or unbalance, should be provided connected to the input buss bars of the control panel and electrically protected by a current limiting fuse block at the input of the equipment (C.L.F.). Spare fuses should be provided for emergency use. This device should normally maintain a couple of contacts closed.
- d) An electrical control system by means of an exposed, concealed, pneumatic, radio or electric signal device that would be sensitive to the variations of water level in the tank or system, should be provided, to operate automatically the pumping units, using electrodes at the pump suction sump pit to prevent pumping while dry. In case of booster pumps installed in the pipe line a time retarder switch, shall be provided due to the electrodes short margin of operation.
- e) Every pump shall be provided with an autographic pressure recorder of seven (7) days duration of a well known and accepted make, electrically operated and will be connected to the system by valves, snubbers and flexible coupling at the pump suction and discharge ends.

Each pump shall be provided with adequate gate valves and flexible couplings in the suction and at the discharge of the same. In addition a pressure sustaining and check valve will be installed at the discharge, prior to the gate valve. All this accessories of adequate size in accordance with the pumping capacity and the velocity recommended in the design. All these fittings & connection shall be flanged connections.

All check valves shall be of the silent type, or any other combined type for pumps of large capacity, as determine by the Authority. See Fig. No. 23 and 24.

- f) Other necessary accessories, such as selector switch for manual or automatic operation or for circuit breaker interruptor.

2.05.06 Turbine Type Pumps for Deep Wells

Turbine or centrifugal vertical type pumps for deep wells shall follow the requirements and recommendations of the National Association of Vertical Turbine Pumps Manufactures and the Standards of the Hydraulic Institute with the following conditions:

- a) The motor will be open drip-proof weather protected NEMA I of a hollow shaft for a maximum speed of 1750 r.p.m., 3 phase, 60 cycles 230 to 460 volts and couple directly to the base of the pump discharge.
- b) The discharge columns shall be of oil lubrication type, and no larger than 3.05 meters (10 feet) and of adequate diameter, according to the capacity and conditions of the system. Total length of the column and the diameter of its components shall be indicated in the plans.
- c) The pumping element must be of the multiple type with scroll cases made of cast iron, properly enameled or other equivalent material, bronze closed type impellers, and stainless steel column. Provided with the corresponding suction pipe of adequate size and galvanized conical screen.

In addition, the necessary equipment to determine the pumping level at any desired moment and an automatic switch for low level.

The pump discharge shall be provided with a flexible rubber gasket coupling, check valve, a gate valve, a flow control valve, smooth nosed sampling tap, a pressure releif valve according to the pumping pressure gauge at the discharge end of the pump and an air release valve of adequate capacity before the check

valve or at the base of the pump.

In addition, in the pump discharge line, after the check valve and before the "T" cleanout a turbine or venturi type meter to measure the flow across the pump shall be installed according to manufacturer instructions. See Fig. No. 23.

A chlorination system shall be installed consisting of hyperchlorinator and solution tank for pump capacities up to 350 g.p.m. and a gas chlorinator of adequate capacity for pumping stations with pump capacities greater than 350 g.p.m., with all necessary equipment.

All electrical equipment and material shall conform to the existing norms and regulations of the National Electric Code and to the Puerto Rico Electric Power Authority.

2.06 Reserve Tanks

2.06.01 Capacity

- a) The capacity of the tanks or deposits for reserve for rural systems will be estimated using the following formula:

$$V = N (250) + (250 \times 60 \times 4)$$

where V = Volume or capacity of the tank in gallons.

N = Number of families

- b) For urban systems the capacity will be estimated by the following formula:

$$V = N (400) + (250 \times 60 \times 4)$$

where V = Volume or capacity of the tank in gallons.

N = Number of families

2.06.02 General Tank Requirements

- a) The location of the tank should be such that produces uniform pressures in the distribution system. In case that the topography does not

permit the construction of the tank on the ground, the construction of an elevated tank will be permitted. Where, due to special conditions, the construction of a concrete elevated tank would be too costly, the construction of reserve tank made of steel or other acceptable material will be permitted.

These tanks must be cathodically protected. However, the construction of such tanks will not be permitted at coastal areas, where the same would be exposed to the effects of sodium nitrates. Prefabricated pre-stress concrete tanks will be accepted subject to previous approval of the Authority.

- b) The elevation of the bottom of the tank should be such that maintains, at the highest point of the system, the minimum pressure required as specified in clause 2.06.01.
- c) Emergency overflow piping connected to a natural trench or to a storm sewer, shall be provided. Internal overflow pipe should be of the same or greater diameter as the diameter of the inlet pipe. On the outside of the structure the overflow pipe diameter should be the same used in the hydraulic gradient calculations. Cast iron or ductile cast iron pipe shall be used for exposed pipe lines.
- d) A plot will be provided according to the size of the tank, leaving a 3 meter strip around its perimeter. In urban areas the plots shall be concrete paved with paved access and of an area that will permit the addition of another tank.
- e) The minimum distance from the perimeter of the base of the elevated tank to the nearest structure will be the same as the height at the top of the tank plus 3 meters.
- f) An automatic control to prevent spills and an overflow shall be provided.

2.07 Distribution System

2.07.01 Minimum Pressure Required

The minimum pressure required in the distribution system will be 2.1 kg/sq. cm (30 lbs/sq inch) at the level of the sidewalk curb at the highest point of the system, based on the design maximum hourly consumption.

2.07.02 Capacity of Main Piping

The main piping shall be design to carry from the reserve or storage tanks to the distribution system, a minimum of 2.25 times the average normal consumption plus the reserve for fire or average consumption plus 60,000 GPD (4 hours fire reserve) whichever is greater. The maximum velocity permitted in piping systems flowing by gravity will be 1.22 meters/second (4 feet/second) and in forced mains 2.44 meters/second (8 feet/second).

2.07.03 Pipe Types

Piping for main lines and distribution systems, except in cases approved by the Authority, will be of cast iron or Ductile iron 150 type, with cement lining, P.V.C. or reinforced concrete.

a) Cast Iron and Ductile Iron Pipe

The cast iron pipe, pit cast, size 30" or larger will adjust to specifications ANSI A-21.2 The cast iron pipes centrifugally cast in molds, will meet specifications ANSI A-21.6 (AWWA C-106) or ANSI A-21.8 (AWWA C-108). In addition the ends of the mechanical joints shall conform to specification ANSI A-21.11 (AWWA C-111). Pipes of 2" diameter will adjust to specification CIPRA 8-57.

Ductile iron pipe shall conform to specification A-21-51 (AWWA C-151) and ANSI A-21-51A (AWWA C-151a). Specifications in force, latest revision, shall be applied.

1. Accessories

Accessories with bell and spigot ends in sizes 4" to 12" shall conform to specification ANSI 21.10 (AWWA C-110) and in sizes larger than 12" to specification AWWA C-100. All 90° curves shall conform to AWWA C-100.

All accessories with mechanical joint ends in sizes 4" to 12" shall conform to specification ANSI 21.10 (AWWA C-110), ANSI A-21.11 (AWWA C-111), CIPRA 2.54, 3.5 and 6.54.

Accessories with flanged ends shall conform to specification ANSI B-16.1, class 125.

2. Connections and Coupling Materials

Pipes and accessories in sizes 6" or larger will have push-on mechanical joints.

In crossings under river bed; permanent structures which obstruct their easy removal and replacement, or in installations on road bridges, the use of mechanical joint pipe and accessories shall be required.

3. Pressure Connections

In pipe and accessories with pressure connections the joints shall conform to specification ANSI A21.11 (AWWA C-111). The gasket and the lubricant for the joints shall conform to specification ANSI A21.11.

4. Mechanical Joints

Dimensional and material requirements for pipe ends, pipe caps, screws, lock nuts, joints shall conform with specification ANSI A21.11 (AWWA C-111).

5. Concrete Pipe

Reinforced concrete pipe shall conform to specification AWWA C-300. Prestressed concrete pipe shall meet requirements of specification

AWWA C-301 of latest revision. Both will be designed for the following minimum conditions.

Pressure Calibration....10.5kg./cm² (150 lbs/sq. inch).
Soil Cover.....1.83 meters (6 feet)
Hydraulic Ram.....40% x Pressure Calibration
Accidental Load.....ASSHO H-20

To all concrete pipe, a bituminous layer shall be applied, to seal the interior surface according to specification ANSI A21.4.

The use of concrete pipe will be subject to the approval of the Authority.

All accessories shall be subject to the same requirements as the concrete pipe and the same type of cement should be used.

All joints and coupling material will be subject to the approval of the Authority.

2.07.04 Piping Installation

In General water piping will be installed in streets and roads, avoiding private areas leading to rights-of-way. Installing them at the most convenient side of the public roads, at a depth of not less than 0.75 meters (measured from ground surface to the upper part of the pipe) and a minimum distance of 1.50 meters to the side-walk curb.

On roads with no sidewalk curb or concrete gutter, the 1.50 meter limit can be reduce to 1.00 meter from the edge of the shoulder, subject to the approval of the Authority.

In all installations where plastic pipe is used a detectable metal or plastic tape shall be placed above all the length of the pipe to permit locating the pipe.

a. Crossings

Water mains crossing sewers, above or under or running at a distance less than 1.52 meters

(5.0 feet) shall be laid above the sewer providing a vertical distance of 0.30 meters (1 foot) between the outside of the water main and the outside of the sewer. When crossing at a distance less than 0.30 meter (one foot), or even greater, a concrete foundation shall be provided to the water main to prevent transmitting its weight to the sewer pipe. See Fig. No 43.

b. Parallel Installations

Water mains shall be laid at least 3.05 meters (10 feet) horizontally from any existing or proposed sewer. The distance shall be measured edge to edge. This distance may be less if the water main is installed 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 0.46 meters (18 inches) above the top of the sewer, subject to the approval of the Authority. See Fig. No. 43. No crossing or contact between a water pipe and a sanitary or storm sewer manhole will be permitted.

2.07.05 Accessories

In the distribution system the following accessories shall be provided:

- a. Valves to isolate the circuits which divide the distribution system. Each circuit shall include four (4) blocks of houses. Valves shall adjust to the specifications of the American Water Works Association (AWWA C-500 71, latest revision) and will be for at least a working pressure of 150 pounds. Valves will open to the left.
- b. Drainage valves will be installed in the lower places of the distribution system. The diameter of the drainage valves and piping shall not be less than 4 inches and sufficient to drain the water that flows to the drainage area in a maximum time of two (2) hours. Drainage sizes shall not be less than one half (1/2) the diameter in piping up to 8" diameter and one third (1/3) in piping up to 24" diameter. In piping of larger than 36" diameter, the size of the drainage shall be one fourth (1/4) the diameter of the pipe.

*Need to incorporate
valve indication
plate system to
avoid lost valves.*

- c. Dead ends in the pipe systems will not be permitted. At the ends, after the last house connection, a tapped plug or cap shall be placed. In cases where probability of future development exist, a valve shall be installed before the plug or cap. See Fig. No. 8 and 9.
- d. Fire hydrants shall be Puerto Rico type according with the design adopted by the Authority. See Fig. No. 20.

Each fire hydrant shall be provided with an auxiliary valve and a four (4) inch diameter pipe connection when the diameter of the piping to be connected is 4"; and 6" diameter connection when the main is 6" or larger in diameter. The fire hydrants will be located preferably close to street intersections at a distance not less than four (4) meters (13 feet) from the corner of the sidewalks and in such a way that will not interfere with the driveways and yards of residences.

Shall be connected to the piping of larger diameter in the vicinity of the hydrant location. In straight lenththes the maximum spacing between hydrants shall be 150 meters. In curved spaces the maximum distance shall be the same, measured on a line parallel to the center line of the street or road. Hydrants shall be located in the planting strip between curb and sidewalk. If no planting strip exists it shall be located at not less than one meter from the property line. See Fig. 20.

2.07.06 House Connections

The water service will be provided by house connections or water taps from the distribution mains according to the following:

- a. Water service connections will be at least 1/2" in diameter, located in the front and at the center of each plot, its end will be at 0.25 meters (10 inches) from the sidewalk finished surface and will consist of a corporation cock, flexible type "K" copper piping, adapter, straight line jokes provided with a stopcock that permits the installation of a lock and cast iron meter box, all in accordance with the specification and requirements of the Authority. (See Fig. No. 11 and 12. Instead of the straight line joke and the cast iron box, a meter jokebox of a model and specifications accepted by the Authority, may be installed.

The box will be installed in the planting strip, 0.15 meters (6 inches) from the exterior edge of the sidewalk (facing the street) and 0.15 meter (6 inches) thick concrete slab as shown of Figure No. 12. Copper piping from the meter box to a length of 0.30 meters (1 foot) inside the property limit, passing under the sidewalk provided with a brass stop valve. The Authority will determine and approve the adequate size of the house connection and the meter according to the water service to be provided on each case.

- b. The following table shows the maximum size house connections allowed in centrifugal cast iron, Class 150. Larger connections than the specified in this, will be done with type F-4339 Double Strap Service Clamp from James B. Clow & Sons, Inc., or approved equal.

Piping Size (inches)	4	6	8	10	12	16	20	24
Water Connection Size (inches)	3/4	1	1	1-1/2	2	2	4	4

In 2" diameter, connections will be done using one strap only.

- c. Water connections to service piping larger than 2" diameter will be made with tapping valve and sleeve of the type approved by the Authority. In out of service piping the water connection will be made with a tee and gate valve of the type and class approved by the Authority.
- d. The installation of 2" or larger water meters will include special fittings such as nipples, valves.

corporation cocks, concrete meter box, cast iron lid to protect meter as indicated in typical detailed figures #13 and 14.

2.07.07 Other Dispositions

In special cases in which the project includes other units not covered by this norms, such as dikes, filtration plants, intake lines, etc., the Authority should be consulted in relation to the norms to be used in the design.

2.07.08 Concrete Painting

The interior walls of the pumping stations will be painted in beige color. The exterior walls will be painted ceiling blue. Special paint for concrete of a quality accepted by the Authority will be used. A primer coat and two coats of paint shall be applied.



CHAPTER III

WATER FILTER PLANTS

In this chapter before covering standards related to the title subject, we had covered other areas included in the design of a water supply system, since they are considered exceedingly necessary as an approach to a Water Filter Plant design such as:

- a) Supply sources
- b) Collection and transportation works

Referring to supply sources we have tried, in the case of surface water, to include; hydrological information, flow, safe yield, description of the watershed, etc., and in the case of underground sources, its advantages, the geological formation through which the source is to be developed, a summary of the exploration, etc., the Engineer would notice that these phases precede the standards for treatment that begins in Section 3.10, page III-27, which, to the best of our knowledge, covers a wide range in the field of surface water treatment, and future designs shall be evaluated by these Design standards.

<u>SECTION</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
3.01	Water Filter Plants	III-1
3.02	Design General Considerations	III-5
3.03	Sources Development	III-9
3.03.02	Surface Water	III-10



<u>SECTION</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
3.04	Ground Water	III-12
3.05	Location	III-14
3.06	Test and Record	III-14
3.07	Well Construction	III-16
3.08	Aquifer Types and Construction Methods Special Condition	III-21
3.09	Well Pumps, Discharge Piping and Appurtenances	III-24
3.10	Treatment	III-27
3.11	Filtration	III-34
3.12	Rapid Rate Pressure Filters	III-41
3.13	Disinfection	III-42
3.14	Aeration	III-44
3.15	Iron and Manganese Control	III-47
3.16	Fluoridation	III-50
3.17	Taste and Odor Control	III-52
3.18	Waste Handling and Disposal	III-53
3.19	Chemicals Application	III-58
3.20	Facilities Design	III-59
3.21	Operator Safety	III-66
3.22	Acids	III-67



CHAPTER III

WATER FILTER PLANTS

3.01 A system for supplying or providing water consist of the following basic parts:

- a- Sources of water supply
- b- Structures for its collection and transportation from the source to the treatment works
- c- Water treatment structures
- d- Distribution system

The water supplied should meet two basic conditions:

- a- Should be free of risks or dangers to the health or life of the consumers.
- b- Should consider all costs and the system should be operated at a reasonable cost.

At times this conditions may be conflicting, but both factors must be taken in consideration. To satisfy the first, the water should be free of pathogenic micro-organisms, substances that are health toxic or noxious, which is an essential and indispensable condition. To fulfil the second, the water characteristics must be such that do not cause any damage to the distribution system, the industries or the domestic economy, and can be obtained without having to incur in an exceptionally expensive treatment process, consuming great quantities of electric power.

3.01.01 General

All permits necessary for the location of the plant should be obtained from all agencies such as the Planning Board, Health Department, the U.S. Army Corps of Engineers, Enviromental Quality Board, Department of Permits and Regulations, Department of Natural Resources and others; before applying for approval to the Aqueduct and Sewer Authority.

Permits for construction, for waste discharge, for crossing of water courses, etc. must be required from the pertinent federal, state, or local agencies.

Preliminary plans and the engineer's report should be submitted for review prior to the preparation of final plans.

No approval for construction can be issued until final, complete, detailed plans and specifications have been submitted to the Authority and found to be satisfactory. The documents submitted for formal approval shall include at least

- a- a summary of the basis of design,
- b- operation requirements, where applicable,
- c- general layout,
- d- detail plans,
- e- specifications,
- f- cost estimates

3.01.02 Sources of Water Supply

The Engineer's report shall describe the proposed source or sources of water supply to be developed, the reasons for their selection, and provide the following information:

A- Surface Water Sources

Including:

- a- hydrological data, stream flow and weather records,
- b- safe yield, including all factors that may affect it,
- c- maximum flood level, together with approval for safety features of the spillway and dam from the appropriate authorities,

- d- description of the watershed, noting any existing or potential sources of contamination which may affect water quality
- e- summarized quality of the raw water with special reference to fluctuations in quality, changing meteorological conditions, etc.

B- Ground Water Sources

Including:

- a- sites considered,
- b- selected site advantages,
- c- elevations with respect to surroundings,
- d- probable character of formations through which the source is to be developed,
- e- geologic conditions affecting the site,
- f- summary of source exploration, test well depth, and methods of construction; placement of liners or screen; test pumping rates and their duration; water levels and specific yield; water quality,
- g- sources of possible contamination such as sewers and sewerage facilities, landfills, waste disposal wells, etc.

3.01.03 Proposed Treatment Processes

Summarize and establish the adequacy of proposed processes and unit parameters for the treatment of the specific water under consideration. 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.

3.01.04 Waste Disposal

Discuss the various wastes from the water treatment plant, their volume, proposed treatment and points of discharge, considering Public Federal, Law 95-217 Rev.

3.01.05 Automation

Provide supporting data justifying automatic equipment, including the servicing and operator training. Manual override must be provided for any automatic controls.

3.01.06 Project Sites

Including:

- a) discussion of the various sites considered and advantages of the recommended ones,
- b) the proximity of residences, industries, and other establishments.
- c) any potential source of pollution that may influence the quality of the supply or interfere with the effective operation of the water works system, such as sewage absorption systems, septic tanks, privies, cesspools, sink holes, sanitary landfills, refuse and garbage dumps, etc.
- d) plant location
 1. the plant should be located as near as possible to present and future developments to be service,
 2. with easy access
 3. plot of sufficient area available for expansion and addition of facilities.

3.01.07 Influent and Effluent Quality

The characteristics of the influent shall determine the modes and degree of treatment to be applied and should be based on the standards for water quality.

3.02 General Design Considerations

3.02.01 General

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

3.02.02 Plant Layout

The design shall consider

- a) functional aspects of the plant layout,
- b) provisions for future plant expansions,
- c) provisions for expansion of the plant waste treatment and disposal facilities,
- d) access roads,
- e) site grading,
- f) site drainage,
- g) walks,
- h) driveways,
- i) chemical delivery

3.02.03 Building Layout

Design shall provide for

- a) adequate ventilation,
- b) adequate lighting
- c) mechanical ventilation, if necessary,
- d) adequate drainage,
- e) dehumidification equipment, if necessary,
- f) accessibility of equipment for operation, serving, and removal,

- g) flexibility of operation,
- h) operator safety,
- i) convenience of operation
- j) chemical storage and feed equipment in a separate room to reduce hazards and dust problems.

3.02.04 Location of Structures

The appropriate regulating authority must be consulted regarding any structure which may impede normal or flood stream flows because of its location.

3.02.05 Electrical Controls

Main switch gear electrical controls shall be located above ground level.

3.02.06 Stand-by Power

Standby power may be required by the Authority so that the plant operations may continue during power outage.

3.02.07 Shop Space and Storage

Adequate facilities for shop space and storage should be include, consistent with the designed facilities.

3.02.08 Laboratory Equipment

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

3.02.09 Testing Equipment

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

3.02.10 Physical Facilities

Adequate ventilation, adequate lighting,

sufficient bench space, storage room, laboratory sink, and auxiliary facilities shall be provided. Air conditioning may be necessary.

3.02.11 Monitoring Equipment

Water treatment plants with a capacity of 1.89 mld (0.5 mgd) or more should be provided with continuous monitoring equipment (including recorders) to monitor water being discharged to the distribution system as follows:

- a) plants treating surface water and plants using lime for softening should have the capability to monitor and record turbidity and free chlorine residual,
- b) plants treating ground water using iron removal and/or ion exchange softening should be capable of monitoring and recording free chlorine residual.

3.02.12 Sample Taps

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

3.02.13 Facility Water Supply

Water supply service line for the facility and the plant finished water sample tap shall be supplied from a source of finished water at a point where all chemicals have been thoroughly mixed.

3.02.14 Wall Sleeves

To facilitate future uses whenever pipes pass through walls of concrete structures, consideration

shall be given to providing extra wall sleeves built into the structure.

3.02.15 Piping Color Code

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

Water Lines

Raw	Olive green
Settled or Clarified	Aqua Blue
Finished or Potable	Dark Blue

Chemical Lines

Alum	Orange
Ammonia	White
Carbon Slurry	Red
Chlorine (Gas or Solution)	Yellow
Fluoride	Light Yellow with Red Band
Lime Slurry	Light Green
Potassium Permanganate	Violet
Sulfur Dioxide	Light Green with Yellow Band

Waste Lines

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

Other

Compressed Air	Dark Green
Gas	Black
Other Lines	Light Gray

In cases where two colors do not have sufficient contrast to easily differentiate between them, a six-inch band of contrasting color should be painted on one of the pipes at approximately 76 cm. (30 inches) intervals.

The name of the gas or liquid should also be painted on the pipe. In some cases it may be advantageous to paint arrows indicating the direction of flow.

3.02.16 Disinfection

All pipes, tanks, wells, and equipment that can convey or store potable water shall be disinfected in accordance with AWWA procedures. The procedure shall be outlined in the plans and specifications, including the disinfectant dosage, contact time, and method of testing the results of the procedure.

3.02.17 Manuals and Parts Lists

A part list and parts order form, and an operation and maintenance manuals shall be supplied to all water works as part of every unit installed in the facility.

3.02.18 Operation Instruction

Provisions shall be made for operator instruction at the start-up of a plant or a pumping station.

3.02.19 Other Considerations

Consideration must be given to the design requirements of other federal state and local agencies for items such as special designs for the handicapped, plumbing and electrical codes, etc.

3.03 Source Development

3.03.01 General

In selecting the source of water to be developed, the designing engineer must prove to the satisfaction of the Authority 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 the authorities with respect to microbiological, physical, chemical and radiological qualities. Each water supply should take its water from the best available source which is economically reasonable and technically possible.

3.03.02 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.

3.03.03 Quantity

The quantity of water at the source shall

- a) be adequate to meet the projected water demand of the service area as determined by calculations based on the extreme drought of record,
- b) provide a reasonable surplus for anticipated growth,
- c) be adequate to compensate for all losses such as silting, evaporation, seepage, etc.

3.03.04 Quality

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

- a) determined possible future uses of impoundments and reservoirs,
- b) determined the degree of control of watershed,
- c) assessing the degree of hazard to the supply by accidental spillage of materials that may be toxic harmful or detrimental to treatment process
- d) obtaining samples over a sufficient period of time to assess the microbiological, physical, chemical and radiological characteristics of the water,
- e) assessing the capability of the proposed treatment process to reduce contaminants to applicable standards.

3.03.05 Structures

1. Design of Intake Structures shall provide for:
 - a) withdrawal of water from more than one level if quality varies with depth,

- b) separate facilities for release of less desirable water held in storage,
- c) inspection manholes every 300 meters for pipe sizes large enough to permit visual inspection,
- d) occasional cleaning of the inlet line,
- e) adequate protection against rupture,
- f) parts located above the bottom of the stream, lake, or impoundment, but at a sufficient depths to be kept submerged at low water levels,
- g) where shore wells are not provided, a diversion device capable of keeping large quantities of fish or debris from entering an intake structure.

2. Shore Wells

Shall:

- a) have motors and electrical controls located above grade, and protected from flooding as required by the Authority,
- 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 application 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,
- g) provide for withstanding surges where necessary.

3. An Upground Reservoir

Is a facility into which water is pumped during periods of good quality and high stream flow for future release to treatment facilities. Upground reservoirs shall be constructed to assure that:

- a) the water quality is protected, by controlling the runoff into the reservoir,
- b) dikes are protected against wind action and erosion and structurally sound,
- c) intake structures and devices meet requirements of Section 3.03.05,
- d) influent flow point is separated from the point of withdrawal,
- e) provide separate pipes for influent to and effluent from the reservoir.

3.04 Ground Water

A ground water source includes all water obtained from dug, drilled, bored wells, and infiltration lines.

3.04.01 Quantity

The total developed ground water source capacity shall equal or exceed the design maximum future day demand with the largest producing well out of service. A minimum of two (2) sources of ground water shall be developed.

3.04.02 Auxiliary Power

- a) When power failure would result in interruption of the minimum essential service sufficient power shall be provided to meet average day demand by means of:
 - 1. connection to at least two independent 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 shall be provided with a by-pass, with valve, around the automatic control.

3.04.03 Microbiological Quality

- a) Disinfection of every new, modified or re-conditioned ground water source;
 - 1. should be provided after completion of work if a period of time, to be determined by the Authority, elapses prior to test pumping or placement of permanent pumping equipment, and
 - 2. shall be provided after placement of permanent pumping equipment.
- b) After disinfection, one or more water samples shall be submitted to a laboratory satisfactory to the Authority for microbiological analysis and results submitted to the Authority before the well is placed into service.

3.04.04 Physical and Chemical Quality

- a) Every new, modified or reconditioned ground water source shall be examined for applicable physical and chemical characteristics by tests of a representative sample in a laboratory approved by the Authority with the results submitted to the Authority.
- b) Samples shall be collected at the conclusion of the test pumping procedure and examined as soon as practical or at the earliest opportunity in the required period of time.
- c) The Authority may require field determination of physical and chemical constituents or special sampling procedure.

3.04.05 Radiological Quality

Every new, modified or recondition ground water source shall be examined for radiological activity

as required by the Authority by tests of a representative sample in an approved laboratory, with results reported to the Authority.

3.05 Location

3.05.01 Well Location

The Authority and other pertinent agencies shall be consulted prior to design and construction regarding a proposed well location since its location may be affected by potential sources of contaminations and other ground water developments.

3.05.02 Continued Protection

Continued protection of the well site from potential sources of contamination shall be provided either through ownership, zoning, easements, leasing, righth-of-way or other means acceptable to the Authority. Fencing of the site will be required by the Authority.

3.06 Testing and Records

3.06.01 Yield and Drawdown Tests

- a) Yield and drawdown tests shall be performed on every production well after construction or subsequent treatment and prior to placement of the permanent pump.
- b) The test methods should be clearly indicated in the specifications.
- c) Shall have a test pump capacity, at maximum anticipated drawdown, at least 1.5 times the quantity anticipated.
- d) Provide for a continuous pumping test for at least 48 hours or until stabilized drawdown has continued for at least six hours when test pumped at 1.5 times the design pumping rate.
- e) Shall provide the following information:
 1. test pump capacity-head characteristics,

- 2- static water level
 - 3- depth of test pump setting, and
 - 4- time of starting and ending each cycle, which consist of a time period where a balance between production and drawdown level is established, which could last for days.
- f) Provide recordings and graphic evaluation at one hour intervals or less, as may be required by the Authority, of the following:
- 1- capacity and pumping rate characteristics,
 - 2- pumping water level,
 - 3- drawdown, and
 - 4- water recovery rate and levels.

3.06.02 Plumbness and Alignment Requirements

- a) Every well shall be tested for plumbness alignment in accordance with the Authority and AWWA standards.
- b) The test method and allowable tolerance shall be clearly stated in the specifications.
- c) The Engineer may accept the well even though it fails to meet the requirements of plumbness and alignment if it does not interfere with the installation or operation of the pump or uniform placement of grout.

3.06.03 Geological Data

- a) Shall be determined from samples collected 1.52 meters (5.0 feet) and at each pronounced change in formation.
- b) Shall be recorded and submitted to the Authority.
- c) Shall be supplemented with information on accurate record of drillhole diameters and

depths, assembled order of size and length of casings and liners, grouting depths, formation penetrated, water levels.

3.07 General Well Construction

3.07.01 Minimum Protected Depths

Drilled wells minimum protected depths shall provide watertight construction to such depth as required by the Authority, to:

- a) exclude contamination
- b) seal off formations that are, or maybe, contaminated or yield undesirable water

3.07.02 Temporary Steel Casing

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

3.07.03 Permanent Steel Casing Pipe

Shall

- a) be new pipe meeting ASTM or API specifications for water construction,
- b) have minimum weights and thickness indicated in Table I,
- 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) have full circumferential welds or threaded coupling joints.

TABLE I

STEEL PIPE*

SIZE	DIAMETER (INCHES)		THICKNESS (INCHES)	WEIGHT PER FOOT (POUNDS)	
	EXTERIOR	INTERIOR		PLAIN ENDS (CALCULATED)	WITH THREADS Y COUPLINGS (NOMINAL)
10 id	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	

* Abstracted from AWWA standard for Deep Wells, AWWA A-100.
id, Interior Diameter
od, Exterior Diameter



3.07.04 Nonferrous Casing Materials

- a) Prior to submission of plans and specifications, approval of the use of any nonferrous material as well casing, shall be subject to special determination by the Authority.
- b) Nonferrous material proposed as well casing must be resistant to the corrosiveness of the water and to the stress to which it will be subjected during installation, grouting and operation.
- c) The material used for packing shall be such that will not impart taste, odor, toxic substance or bacterial contamination to the well water.

3.07.05 Screens

Shall

- a) be constructed of materials resistant to damage by chemical action of ground water or cleaning operations,
- b) have size of openings based on sieve analysis of formation and/or gravel pack materials,
- c) have sufficient diameter to provide adequate specific capacity and aperture for a low entrance velocity. Usually the entrance velocity should not exceed 0.1 feet per second.
- d) shall be installed so the pumping water level remains above the screen under all operating conditions,
- e) be designed and installed, where applicable, to permit removal or replacement without adversely affecting watertight construction of the well.

3.07.06 Grouting Requirements

All permanent well casing, except driven Schedule 40 steel casing with the approval of the Authority, shall be surrounded by a minimum of 1 1/2 inches of grout to the depth required by the Authority. All temporary construction casings should be removed, but shall be withdrawn at least five feet to insure grout contact with the native formation.

a) Neat Cement Grout

1. For 1 1/2 inches openings, cement conforming to ASTM Standard C-150 and water, with not more than six gallons per sack of cement, must be used
2. Fluidity may be increased by using additives, subject to the approval of the Authority.

b) Concrete Grout

1. For openings larger than 1 1/2 inches, equal parts of cement conforming to ATSM Standard C-150, and sand, with not more than six gallons of water per sack of cement, may be used
2. Gravel not larger than one-half inch in size may be added where an annular opening larger than four inches is available.

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 percent swelling bentonite may be used subject to approval by the Authority.

d) Application

1. To permit a minimum of 1 1/2 inches of grout around permanent casings, including couplings, sufficient annular opening should be provided.
2. Prior to grouting 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 10 cm. (four inches), grout shall be applied 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 concrete grout is used and the annular opening is 10 cm. (four inches) or more and less than 30.5 meters (100 feet) in depth, the grout may be placed by gravity through a grout pipe installed at the bottom of the annular opening in one continuous operation until the annular opening is filled.
 5. If the annular opening exceeds 15 cm. (6 inches), less than 30.5 meters (100 feet) in depth, and a clay seal is used, it may be placed by gravity.
 6. The work on the well shall be discontinued once the cement grouting is applied, until the cement or concrete grout has properly set.
- e) The casing must be provided with sufficient guides welded to the casing to permit unobstructed flow and uniform thickness of the grout.

3.07.07 Upper Terminal Well Construction

- a) Ground water sources' permanent casing shall project at least 30 cm. (12 inches) above the pumphouse floor, and at least 46 cm. (18 inches) above final ground surface.
- b) The floor surface shall be at least 15 cm (6 in.) above the final ground elevation where a well house is constructed.
- c) Sites subject to flooding shall be provided with an earth berm surrounding the casing and terminating at an elevation at least 0.60 meters (2 feet) above the highest known flood elevation, or other suitable protection as determined by the Authority.

- d) At sites subject to flooding, the top of the well casing shall terminate at least 1.52 meters (5 feet) above the highest known flood elevation or as required by the Authority.

3.07.08 Development

- a) Every well shall be developed to remove the native silts and clay, drilling mud and/or finer fraction of the gravel pack,
- b) Development should continue until the maximum specific capacity is obtained from the completed well.
- c) The specification shall include provisions for the method, equipment, chemicals, testing for residual chemicals, and disposal of waste and inhibitors, when chemical conditioning is required.
- d) Where blasting procedures may be used, the specifications shall include provisions for blasting and cleaning.

3.07.09 Capping Procedures

- a) The preferred method for capping a well is a threaded cap or a welded metal plate,
- b) To prevent tampering with the well or entrance of foreign materials, the contractor shall provide protection at all times during the progress of the work.

3.07.10 Well Abandonment

- a) Test wells or ground water sources which are not in use shall be sealed by such methods as necessary to restore the controlling geological conditions which existed prior to construction or directed by the Authority.
- b) Wells to be abandoned shall :
 - 1. be sealed to prevent undesirable exchange of water from one aquifer to another,

2. preferably be filled with neat cement grout,
3. have fill materials other than cement grout or concrete, disinfected and free of foreign materials, and
4. when filled with concrete or cement grout, these materials will be applied to the well hole through a pipe, tremie or bailer.
5. The Authority may determined not to seal an abandoned well to use it as an observation point for aquifer fluctuations.

3.08 Aquifer Types and Construction Methods Special Conditions

3.08.01 Sand or Gravel Wells

- a) If above the water bearing formation, clay or hard pan is encounter, the permanent casing and grout shall extend through such materials.
- b) When a sand or gravel aquifer is overlaid only by permeable soils, the permanent casing and grout shall extend to at least 6.10 meters (20 feet) below original or final elevation, whichever is lower.
- c) The temporary outer casing, when used, shall be completely withdrawn as grout is applied.

3.08.02 Gravel Pack Wells

- a) Gravel pack shall be well rounded particles, 95 per cent siliceous material, that are smooth and uniform, free of foreign material, properly sized, washed and disinfected immediately prior to or during placement.
- b) Gravel pack shall be placed in one uniform continuous operation.
- c) When used, gravel refill pipes shall be Schedule 40 steel pipe incorporated within the pump foundation and terminated with screwed or welded caps at least 30 centimeters (12 inches) above the pump house floor level or concreted apron.

- d) A minimum of 1 1/2 inches of grout shall surround the annular opening when gravel refill pipes are located in the grouted annular opening.
- e) Protection from leakage of grout into the gravel pack or screen shall be provided.
- f) Inner and outer permanent casings shall meet requirements of Section 3.07.03.
- g) Minimum casing and grouted depth shall be approved by the Authority.

3.08.03 Radial Water Collector

- a) Locations of all caisson construction joints and porthole assemblies shall be indicated.
- b) The caisson shall be reinforced to withstand the forces to which it will be subjected.
- c) Radial collectors shall be in areas and depths approved by the Authority.
- d) Provisions shall be made to assure that radial collectors are essentially horizontal.
- e) A watertight floor shall cover the top of the caisson.
- f) All openings in the floor shall be curb and protected from entrance of foreign material.
- g) The pump discharge pipe shall not be placed through the caisson walls.

3.08.04 Infiltration Lines

- a) Only where geological conditions preclude the possibility of developing an acceptable drilled well, consideration may be given to infiltration lines.
- b) The area around infiltration lines shall be under the control of the Authority for an acceptable or required distance.
- c) Flow in the lines shall be by gravity to the collecting well.

3.08.05 Dug Wells

- a) Dug wells may be considered only if geological conditions preclude the possibility of developing an acceptable drilled well.
- b) A watertight cover shall be provided.
- c) Protective lining and grouted depth shall be at least a minimum of 3.05 meters (10 feet) below original or final ground elevation, whichever is lower.
- d) Openings shall be curb and protected from entrance of foreign material.
- e) Pump discharge piping shall not be placed through the well casing or wall.

3.08.06 Limestone or Sandstone Wells

- a) The permanent casing shall be firmly seated in increviced or unbroken rock if the depth of the mantle is more than 15.3 meters (50 feet). The Authority shall determined the grouting requirements.
- b) Where the depths of mantle is less than 15.3 meters (50 feet), the casing and grout shall be at least 15.3 meters (50 feet) or as determined by the Authority.

3.08.07 Naturally Flowing Wells

- a) Flow shall be controlled.
- b) Provisions shall be made for permanent casing and grout.
- c) Special protective construction may be required by the Authority if erosion of the confining bed appears likely.

3.09 Well Pumps, Discharge Piping and Appurtenances

3.09.01 Line Shaft Pumps

Wells equipped with line shaft pumps shall:

- 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.

3.09.02 Submersible Pumps

Where a submersible pump is used:

- a) The top of the casing shall be effectively sealed against the entrance of water under all conditions of vibration or movement of conductors or cables,
- b) The electrical cable shall be firmly attached to the riser pipe at 6.10 meter (20 feet) intervals or less.

3.09.03 Discharge Piping

The discharge piping shall:

- a) Be designed so that the friction loss will be as low as possible.
- b) When an above-ground discharge is provided, control valves and appurtenances located above the pump house floor have to be installed.
- c) Be protected against the entrance of contamination
- d) Be equipped with a check valve, a shutoff valve, a pressure gauge, a means of measuring flow, and a smooth rised tap located at a point where positive pressure is maintained.

- e) Where applicable, be equipped with an air release-vacuum relief valve located upstream from the check valve, with exhaust relieve piping ending in a down turned position at least 46 centimeters (18 inches) above the floor and covered with a 24 mesh corrosion resistance screen.
 - f) Provide valve to permit test pumping and control of each well.
 - g) Have all exterior piping, valves and appurtenances protected against physical damage
 - h) Be properly anchored to prevent movement.
 - i) Be protected against surge or water hammer
- 2- Means of pumping to waste shall be provided for the discharge piping, but not directly connected to a sewer.

3.09.04 Pitless Well Units

- a) The Authority must be consulted for approval of specific applications of pitless units.
- b) Pitless units shall:
 - 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 or compatible to the casing
 - 5- Have field connection to the lateral discharge from the pitless unit of thread, flanged or mechanical type.
 - 6- End at least 46 centimeters (18 inches) above final ground elevation or 1.52 meters (5feet) above highest known flood elevation or as the Authority determines.

c) Provisions shall be made in the design for:

- 1- Access to disinfect the well.
- 2- An adequate constructed casing vent meeting the requirements of Section 3.09.05.
- 3- Facilities to measure water levels in the well (See Section 3.09.06)
- 4- Prevent the entrance of contamination by providing a cover at the upper terminal of the well.
- 5- A contamination-proof entrance for the electrical cable
- 6- Up to and including casing diameters of 30 centimeters (12 inches) have an inside diameter as great as that of the well casing, to facilitate work and repair on the well, pump, or well screen.
- 7- At least one check valve within the well casing or in compliance with the requirements of the Authority.

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

3.09.05 Casing Vent

Provisions shall be made for venting the well casing to the atmosphere. The vent shall end in a down-turned position at or above the top of the casing or pitless unit in a minimum 1 1/2 inch diameter opening covered with a 24 mesh, corrosion resistant screen. The pipe connecting the casing to the vent shall be of adequate size to provide rapid venting of the casing.

3.09.06 Water Level Measurements

- a) Provisions shall be made for periodic measurements of water levels in the completed well.
- b) Permanent water level measuring equipment installation shall be made using corrosion resistant materials attached firmly to the drop pipe of pump column and in such a manner as to prevent entrance of foreign materials.

3.09.07 Observation Wells

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

3.10 Treatment

3.10.01 General

The design of treatment process and devices shall depend on evaluation of the nature and quality of the particular water to be treated and the desired quality of the final product.

3.10.02 Clarification

Plants design for processing surface water shall:

- a) For rapid mix, flocculation and sedimentation, a minimum of two units each should be provided.
- b) Permit operation of the units either in series or in parallel.
- c) Be constructed to permit units to be taken out of service without disrupting operation, and with drains and pumps sized to allow dewatering in a reasonable period of time.
- d) When required by the Authority provide multi-stage treatment facilities.

- e) Be able to start manually following shutdown.

3.10.03 Presedimentation

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

- a) Basin Design - Basins for presedimentation should have hopper bottoms or be equipped with continuous mechanical sludge removal apparatus, and provide arrangements for dewatering.
- b) Inlet - In coming water shall be dispersed across the full width of the line of travel as quickly as possible, short-circuiting must be prevented
- c) By-pass - Presedimentation basins bypassing provisions shall be included
- d) Detention Time - The minimum detention period recommended is three (3) hours; greater detention may be required.

3.10.04 Rapid Mix

Shall mean the rapid dispersion, usually by violent agitation, of chemicals throughout the water to be treated.

- a) Equipment - Basins shall be equipped with mechanical mixing devices.
- b) Mixing - The detention period should not be less than twenty (20) seconds.
- c) Location - The rapid mix and flocculation basins shall be located as close together as possible.

3.10.05 Flocculation

Shall mean the agitation of water at low velocities for long periods of time.

- a) Tank Design - Inlet and outlet design shall prevent destruction of floc and short-circuiting. A drain or pumps shall provided to handle dewatering and sludge removal.
- b) Detention - The flow-through velocity shall not be less than 15 centimeters (0.5 ft.) nor greater than 30 centimeters (one ft.) per minute with a detention time for floc formation of at least 30 minutes.
- c) Equipment - Variable speed drives with the peripheral speed of paddles ranging from 15 to 30 centimeters (0.5 to 1.0 ft.) per second, shall be used to drive the agitators.
- d) Piping - Flocculation and sedimentation basins shall be as close together as possible. The velocity of flocculated water through pipes and conduits to settling basins shall not be less than 15 centimeters (0.5 ft) per second nor greater than 30 centimeters (1 ft.) per second. Allowances must be made to minimize turbulence at bends and changes in direction.
- e) Other Types - Baffling may be used to provide for flocculation in small plants, only after consultation with the Authority. The design shall be so that the velocities and flows noted above will be maintained.

3.10.06 Sedimentation

Flocculation shall be followed by sedimentation. For effective clarification, the detention time is dependent on a number of factors related to basin design and the nature of the raw water.

- a) Detention Time - A minimum of four hours of settling time shall be provided for detention time.
- b) Inlet Devices - Inlets shall be design to distribute the water equally and at uniform velocities. Entrance arrangements such as open ports, submerged ports or similar, are required. A baffle should be constructed across

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

- c) Outlet Devices - Outlet devices shall be designed to maintain velocities suitable for settling in the basin and to minimize short-circuiting. In order to provide a volume above the orifices for storage when there are fluctuations in flow, the use of submerged orifices is recommended.
- d) Overflow Rate - The rate of flow over the outlet weir shall not exceed 75,700 liters (20,000 gallons) per day per 30 centimeters (one foot) of weir length. Submerged orifices shall not be lower than 0.91 meters (3 feet) below the flow line with flow rates equivalent to weir loadings, when used as an alternate for overflow weirs.
- e) Velocity - The velocity through settling basins shall not exceed 60 centimeters (2.0 ft.) per minute. The basins must be designed to minimize short-circuiting and baffles must be provided as necessary.
- f) Overflow - The maximum water level desired on top of the filters will be established by installing an overflow weir (or pipe). It shall discharge with a free fall at a location where the discharge will be noted.
- g) Sludge Collection - Mechanical sludge collection equipment should be provided.
- h) Drainage - Means for dewatering the basins must be provided. The slope of the basin bottoms toward the drain shall not be less than 30 centimeters (1 foot) in 3.66 meters (12 feet) where mechanical sludge collection equipment is not required.
- i) Flushing Lines - Flushing lines or hydrants with 2 1/2" diameter nozzles shall be provided and must be equipped with backflow prevention devices acceptable to the Authority.
- j) Access - On the inside walls of basins, permanent ladders or handholds, shall be provided.

Guard rails should be included.

- k) Sludge Disposal - Facilities for disposal of sludge (See Section 3.20) are required by the Authority. Provisions shall be made for the operator to observe or sample sludge being withdrawn from the unit.

3.10.07 Solids Contact Unit

When the water characteristics are not variable and flow rates are uniform, combine softening and clarification units are acceptable. Approval of the Authority shall be obtained before such units are considered as clarifiers without softening. 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 are required for surface water treatment.

- a) Equipment Installation - At the time of installation and initial operation, supervision by a representative of the manufacturer shall be provided including instruction to the personnel assigned by the Authority.
- b) Operating Equipment - The following shall be provided for plant operation:
 - 1. 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.
- c) Chemical Feed - Chemical shall be applied at such points and by such means as to insure satisfactory mixing of the chemicals with the water.
- d) Mixing - The Authority may require a rapid mix device or chamber ahead of the solids contact units to assure proper mixing of the chemicals applied.

Mixing devices employed shall be so constructed as to:

1. provided good mixing of the raw water with previously formed sludge particles, and.
2. prevent deposition of solids in the mixing zone.

e) Flocculation - Flocculation equipment shall:

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

f) Sludge Concentrators - In order to obtain a concentrated sludge with the minimum of waste of water, the equipment should provide either internal or external concentrators

g) Sludge Removal - The sludge removal design shall make provisions for

1. sludge pipes to be not less than six (6) inches in diameter and so arranged as to facilitate cleaning,
2. the entrance to sludge withdrawal piping shall prevent clogging,
3. for accessibility, valves shall be located outside the tank,
4. the operator to be able to observe and sample sludge being withdrawn from the unit.

h) Cross-Connections-

1. The Authority will determined the places where the blow-off outlets and drains must terminate and discharge.
2. For potable water lines used to backflush sludge lines, cross-connection control must be included.

i) Detention Period - The raw water characteristics and other local conditions that affect the operation of the unit, should be the basis to establish the detention time. Based on design flow rates, the detention time should be:

- 1- four hours for suspended solids contact clarifiers and softeners treating surface water, and
- 2- one hour for the suspended solids contact softeners treating only groundwater.

The Authority may alter the detention time requirements.

j) 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.

k) Water Losses - The design should take into consideration that

- 1- units shall be provided with suitable controls for sludge withdrawal,
- 2- total water losses shall not exceed five per cent for clarifiers and three per cent for softners,
- 3- solid concentration of sludge bled to waste should be three per cent, by weight, for clarifiers and five per cent, by weight for softners.

l) Weirs or Orifices - 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 ten feet horizontally to the collection trough.

- 1- Weirs shall be adjustable, and at least equivalent in length to the tank perimeter
- 2- Weir loading shall not exceed 38 liters per minute per 30 centimeters (10 gal./min./foot) of weir length for units used for clarifiers and 76 liters per minute per 30 centimeters (20 gal./min./foot) of weir length for units used as softeners.
- 3- Where orifices are used, the loading per foot of launder should be equivalent to weir loadings.

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

- m) Upflow Rates - Unless supporting data is submitted to the Authority to justify rates exceeding the following, rates shall not exceed
 - 1- 3.8 liters per minute per 929 sq. centimeter (1 gal./min./sq. ft.) of area at the sludge separation line, for units used as clarifiers
 - 2- 6.62 liters per minute per 929 sq. centimeter (1.75 gal./min./ sq. ft.) of area at the slurry separation line, for units used as softeners.
- n) Tube Settlers - Even though recognized as an alternate method of clarification, sufficient experience is not yet available to establish design standards. Therefore, proposals for tube settler clarification must include pilot plant and/or full scale demonstration satisfactory to the Authority prior to the preparation of final plans and specifications for approval.

3.11 Filtration

Upon the discretion of the Authority, the acceptable filters shall include the following types:

- a) rapid rate gravity filters, and
- b) rapid rate pressure filters.

Water quality data representing a reasonable period of time to characterize the variations in water quality must support the application of any one type. The Authority may require experimental treatment studies to demonstrate the applicability of the method of filtration proposed.

3.11.01 Rapid Rate Gravity Filters

- a) Pretreatment - When using rapid rate gravity filters, pretreatment is required

- b) Number - At least two units must be provided. If only two units are provided, each shall be capable of meeting the plant design capacity (normally the projected maximum daily demand) at the approved filtration rate. When more than two filter units are provided, the filters shall be capable of meeting the plant design capacity at the approved filtration rate with one filter removed from service.
- c) Rate of Filtration - Such factors as raw water quality, degree of pretreatment provided, filter media, water quality control parameters, and other factors as required by the Authority, must be considered when determining the rate of filtration. In any case, the filter rate should be proposed and justified by the designing engineer to the satisfaction of the Authority, prior to the preparations of final plans and specifications.
- d) Structural Details and Hydraulics

The filter structure shall be so designed as to provide for:

- 1- vertical walls within the filter,
- 2- no protrusion of the filter walls into the filter media,
- 3- head room to permit normal inspection and operation,
- 4- minimum depth of filter box of 2.59 meters (8.5 feet), except in special cases, which requires the approval of the Authority,
- 5- minimum water depth over the surface of the filter media of 91 centimeters (3 feet),
- 6- trapped effluent to prevent backflow of air to the bottom of the filters,
- 7- prevention of floor drainage to the filter

- with a minimum 4 inch curb around the filters,
8. maximum velocity of treated water in pipes and conduits to filters of 60 centimeters (2 feet) per second,
 9. cleanouts and straight alignment for influent pipes and conduits where solids loading is heavy or following line-soda softening.
 10. washwater drain capacity to carry maximum flow, and
 11. walkways around filters to be not less than 76 centimeters (30 inches) wide.

e) Washwater Troughs

Washwater troughs shall be designed to provide

1. the bottom elevation above the maximum level of expanded media during washing and a 5 centimeters (2 inches) freeboard at the maximum rate of wash,
2. the top edge to be level, and
3. spacing so that each trough serves the same number of square centimeters of filter area and maximum horizontal travel of suspended particles to reach the trough not to exceed 91 centimeters (3 feet).

f) Filtering Media

1. The media shall be clean silica sand or other natural or synthetic media approved by the Authority, having the following characteristics:
 - a- a total depth of not less than 61 centimeters (24 inches) and generally not more than 76 centimeters (30 inches)
 - b- an effective size range of the smallest material no grater than 0.45mm. to 0.55mm.

- c) an uniformity coefficient of the smallest material not greater than 1.65,
- d) 12 inch minimum of media with an effective size range no greater than 0.45 mm to 0.55 mm and specific gravity greater than other filtering materials within the filter,
- e) types of filter media:
 - 1. Anthracite - Clean crushed anthracite or a combination of anthracite and other media may be considered on the basis of experimental data specific to the project and shall have:
 - a- effective size of 0.45 mm - 1.2 mm depending on the intended use (anthracite used alone must meet the specifications of Section 3.11.01, Subsection f)
 - b- uniformity coefficient of not greater than 1.85 (not greater than 1.65 if use alone)
 - 2. Sand shall have:
 - a- effective size of 0.45mm to 0.55 mm.,
 - b- uniformity coefficient of not greater than 1.65
 - 3. Granular activated carbon - Use of granular activated carbon media may be considered only with the approval of the Authority, and must meet the basic specifications for filter material as given in Section 3.11.01, Subsection f) and
 - a- provision shall be made for a free chlorine residual in the water following the filters and before distribution,
 - b- means for periodic treatment of filter material for control of bacterial and other growths must be provided.
 - 4. Other media - Bases on experimental data and operating experience, other media

will be considered.

5. Torpedo - An 8 centimeter (3 inch) layer of torpedo sand should be used as a supporting media for filter sand, and should have
 - a- effective size of 0.8 mm to 2mm, and
 - b- uniformity coefficient not greater than 1.7
6. Gravel - When gravel is used as supporting media, shall consist of hard, rounded particles and not include flat or elongated particles. The coarsest gravel shall be 6 centimeters (2 1/2 inches) in size when the gravel rests directly on the strainer system, and must extend above the top of the perforated laterals. Four layers of gravel at least shall be provided when used with perforated laterals, in accordance with the following size and depth distribution:

<u>Size*</u>	<u>Depth*</u>
2 1/2 to 1 1/2	5 to 8
1 1/2 to 3/4	3 to 5
3/4 to 1/2	3 to 5
1/2 to 3/16	2 to 3
3/16 to 3/32	2 to 3

*Size and depth in inches

The reduction of gravel depths may be considered upon approval of the Authority.

3.11.02 Filter Bottoms and Strainer Systems

Deviations from these standards may be acceptable for high rate filters. Porous plate bottoms shall not be used where iron or manganese may clog them or with waters softened by lime. Manifold-type collection systems shall be of such design as to

- a) minimize loss of head in the manifold and laterals.
- b) assure even distribution of washwater and even rate of filtration over the entire area of the filter,

- c) provide the ratio of the area of the final openings of the strainer systems to the area of the filter at about 0.003,
- d) provide the total cross-sectional area of the laterals at about twice the total area of the final openings,
- e) provide the cross-sectional area of the manifold at 1 1/2 to 2 times the total area of the laterals,

3.11.03 Surface Wash or Subsurface Wash

Facilities for surface or subsurface wash are required except for filters used exclusively for iron or manganese removal.

It may be accomplished by a system of fixed nozzels or a revolving-type apparatus. All devices shall be designed with.

- a) water pressures of at least 3.2 kgs/sq./cm. (45 psi) must be provided,
- b) properly installed vacuum breaker or other approved device to prevent back siphonage if connected to the treated water system,
- c) rate of flow of 2 gal./min./square foot of filter area with fixed nozzles or 0.5 gal./min./square foot with revolving arms.

3.11.04 Appurtenances

For every filter, the following shall be provided:

- 1- facilities for influent and effluent sampling,
- 2- an indicating loss of head gauge with 24 hours recorder,
- 3- a rate-of-flow meter with recorder for 24 hours,
- 4- a continuous or rotating cycle turbidity

recording device for surface water treatment plants,

5. manholes providing access to the filter interior at several locations for sampling or pressure sensing.
6. a 1 to 1-1/2 inch pressure hose and storage rack at the operating floor for washing filter walls.
7. provisions for draining the filter with appropriate measures for backflow prevention. (See Section 3.18)

3.11.05 Backwash

Provisions shall be made for washing filters as follows:

- a) a minimum of 57 liters (15 gallons) per minute per 929 square centimeter (square foot), consistent with water temperature and specific gravity of the filter media. A rate of 76 liters per minute per 929 sq. cem. (20 gallons per minute per square foot) or a rate necessary to provide for a 50 per cent expansion of the filter bed is recommended. For full depth anthracite or granular activated carbon filters, a reduced rate of 38 liters per minute per 929 sq. centimeters (10 gallons per minute per square foot) may be acceptable,
- b) filtered water provided at the required rate by washwater tanks, washwater pump, from the high service main, or a combination of these,
- c) duplicate washwater pumps unless other means of obtaining washwater is available,
- d) not less than 15 minutes wash of one filter at the design rate of wash,
- e) a washwater regulator or valve on the main washwater line to obtain the desired rate of filter wash with the washwater valves on the individual filters open wide,

f) on the main washwater line, a rate-of-flow indicator, preferably with an indicator, located so that it can be easily read by the operator during the washing process,

g) design to prevent rapid changes in backwash water flow.

3.11.06 Miscellaneous

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

3.12 Rapid Rate Pressure Filters

For iron or manganese removal the use of rapid rate pressure filters may be considered. Pressure filters shall not be used in the filtration of polluted waters or following lime-soda softening.

3.12.01 General

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

3.12.02 Rate of Filtration

The rate shall not exceed 11.4 liters per minute per 929 sq. cm. (3 gals./min/sq. ft.) of filter area.

3.12.03 Details of Design

The design of the filters shall provide for:

- a) on the inlet and outlet pipes of each filter, a loss of head gauge,
- b) an easily readable meter or flow indicator on each battery of filters. A flow indicator is recommended for each filter,
- c) an arrangement of piping as simple as possible to accomplish filtration and backwashing of

each filter individually,

- d) the height of the side wall shall be determined according to the type of filter and filter media used,
- e) the underdrain system to efficiently collect the filtered water and to uniformly distribute the backwash water at a rate not less than 57 liters per minute per 929 square centimeters (15 gal./min./sq,ft) of filter area.
- f) backwash flow indicators and controls that are easily readable while operating the control valves,
- g) on the highest point of each filter, an air release valve,
- h) an accessible manhole to facilitate inspections and repairs,
- i) means to observe the wastewater during backwashing,
- j) construction to prevent cross-connection.

3.13 Disinfection

The preferred disinfecting agent is chlorine. Chlorination may be accomplished by means of liquid chlorine, calcium or sodium hypochlorites or chlorine dioxide. Providing reliable application equipment is available and testing procedures for a residual are recognized in "Standards Methods for the Examination of Water and Wasterwater" latest edition, consideration may be given to other disinfecting agents. Disinfection is required at all surface water supplies and at any ground water supplies which are of questionable sanitary quality or where any other treatment is provided. Continous disinfection is recommended for all water supplies..

3.13.01 Chorination Equipment

- a) Type- Solution-feed-gas-type chlorinators or hypochlorite feeders of the positive displacement type must be provided. (See Section 3.21).

- b) Capacity - The capacity of the chlorinator shall be such that a free chlorine residual of at least 2 milligrams per liter can be attained in the water after contact time of at least 30 minutes when maximum flow rates coincide with anticipated maximum chlorine demands. The equipment shall be of such design that it will operate accurately over the desired feeding range.
- c) Standby Equipment - Where chlorination is required for protection of the supply, standby equipment of sufficient capacity shall be available to replace the largest unit during shut-down.
- d) Automatic Proportioning - Where the rate of flow or chlorine demand is not reasonably constant, automatic proportioning chlorinators will be required.

3.13.02 Contact Time and Point of Application

Due consideration shall be given to the contact time of the chlorine in water with relation to pH, ammonia, taste-producing substances, temperature, bacterial quality, and other pertinent factors. Chlorine should be applied at a point which will provide the maximum contact time. At plants treating surface water, provisions should be made for applying chlorine to the raw water, filtered water, and water entering the distribution system. At plants treating ground water, provisions should be made for applying chlorine to at least the detention basin inlet and water entering the distribution system. Free residual chlorination is the preferred practice; 30 minutes contact time for ground water and two hours for surface water must be provided. In package plants the chlorine may be apply before or after the filter or at both points preferably before the filter. The amount of chlorine that should be apply varies with the degree of contamination.

3.13.03 Residual Chlorine

In a potable water distribution system, the residual chlorine should be according to the design and the requirements of the Authority.

3.13.04 Testing Equipment

Chlorine residual test equipment recognized in the latest edition of "Standard Methods for the Examination of Water and Wastewater" shall be provided. All plants with a capacity of 2 mgd or more should be equipped with recording chlorine analyzers monitoring water entering the distribution system. (See Section 3.02.11).

3.13.05 Chlorinator Piping

The chlorinator water supply piping should be designed to prevent contamination of the treated water supplied to the system. At all facilities treating surface waters, pre-and post-chlorination systems must be independent to prevent possible siphoning of partially treated water into the clear well.

3.13.06 Housing

Adequate housing must be provided for the chlorination equipment and for storing the chlorine. (See Section 3.21 and Chapter VIII).

3.13.07 Other Disinfecting Agents

Although disinfecting agents other than chlorine are available, each has usually demonstrated shortcomings when applied to a public water supply. Proposals for use of other than chlorine, disinfecting agent must be approved by the Authority prior to preparation of the final plans and specifications.

3.14 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 sulphide, etc., and to introduce oxygen to assist in iron and/or manganese removal.

3.14.01 Natural Draft Aeration

Design shall provide:

- a) perforations in the distribution pan 0.48 to 1.3 centimeters (3/16 to 1/2 inch) in diameter, spaced 2.54 to 7.62 centimeters (1 to 3 inches) on centers to maintain a 15 centimeter (6 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 30 centimeters (12 inches),
- d) a rate of loading of 3.8 to 18.9 liters (1 to 5 gals.) per minute for each 927 square centimeter (square foot) of total tray area
- e) trays with slotted, heavy wire (1.3 centimeters (1/2 inch) openings) mesh or perforated bottoms,
- f) construction of durable material resistant to aggressiveness of the water and dissolved gases,
- g) protection from loss of spray water by wind carriage by means of enclosure with louvers sloped to the inside at an angle of approximately 45 degrees,
- h) for a 24-mesh screen protection from insects.

3.14.02 Forced or Induce Draft Aeration

Devices shall be design to:

- a) include a blower with a weather proof motor in a tight housing and screened enclosure,

- b) insure adequate counter current of air through the enclosed aerator column,
- c) exhaust air directly to the outside atmosphere,
- d) include a down-turned and 24-mesh screened air inlet and outlet,
- e) be such that air introduced in the column shall be as free from harmful fumes, dust, and dirt as possible,
- f) 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,
- g) provide loading at a rate of 3.8 to 18.9 liters (1 to 5 gals.) per minute for each 929 square centimeter (square foot) of total tray area.
- h) insure that the water outlet is adequately sealed to prevent unwarranted loss of air,
- i) discharge through a series of five or more trays with separation of trays of not less than 15 centimeters (6 inches),
- j) provide distribution of water uniformly over the top tray,
- k) be of durable material resistant to the aggressiveness of the water and dissolved gases.

3.14.03 Pressure Aeration

Only if pilot plant study indicates the method is applicable, may pressure aeration be used for oxidation purposes. Filters following pressure aeration must have adequate exhaust devices for release of air. Pressure aeration devices shall be design to:

- a) give thorough mixing of compressed air with water being treated,

- b) provide screened and filtered air, free of obnoxious fumes, dust, dirt and other contaminants.

3.14.04 Other Methods of Aeration

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

3.14.05 Protection of Aerators

All aerators except those discharging to lime softening or clarification plants shall be protected from birds and insects.

3.14.06 Disinfectation

Ground water supplies exposed to the atmosphere by aeration must receive chlorination as the minimum additional treatment.

3.14.07 By-pass

All aeration units shall be provided with a by-pass.

3.15 Iron and Manganese Control

As used herein, iron and manganese control, refers solely to treatment processes designed specifically for this purpose. The character of the raw water will determined the treatment processes to be used. The selection of one or more treatment process must meet specific local conditions as determined by engineering investigations, including chemical analysis of representative samples of water to be treated, and receive approval of the Authority. 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.

3.15.01 Removal by Oxidation, Detention and Filtration

a) Oxidation

May be by aeration, as indicated in Section 3.14, or by chemical oxidation with chlorine or potassium permanganate.

b) Detention

1- Reaction - A minimum detention time of 20 minutes shall be provided following aeration in order to insure that the oxidation reactions are as complete as possible. The minimum detention shall be omitted only where a pilot plant study indicates no need for detention. The detention basin shall be designed as a holding tank with no provisions for sludge collection but with sufficient baffling to prevent short circuits.

2- Sedimentation - Basins for Sedimentation, shall be provided when treating with high iron and/or manganese content, or where chemical coagulation is used to reduce the load of the filters.

3- Filtration - Filters shall be provided and shall conform to Section 3.08

3.15.02 Removal by Lime-Soda Softening Process

See Section 3.10.02

3.15.03 Removal by Manganese Greensand Filtration

This process, consisting of a continuous feed of potassium permanganate to the influent of a manganese greensand filter, is more applicable to the removal of manganese than to the removal of iron.

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 before the permanganate feed to reduce the cost of the chemical.
- c) Anthracite media cap of at least six inches shall be provided over manganese greensand.
- d) Normal filtration rate is 11.3 liters per minute per 929 square centimeters (3 gallons per minute per square foot)
- e) Normal wash rate is 30.3 to 37.8 liters per minute per 929 square centimeters (8 to 10 gallons per minute per square foot).
- f) Air washing should be provided.
- g) Sample taps shall be provided
 - 1- before the application of permanganate,
 - 2- immediately ahead of filtration,
 - 3- at a point between the anthracite media and the manganese greensand,
 - 4- halfway down the manganese greensand,
 - 5- at the filter effluent.

3.15.04 Removal by Ion Exchange

This process of iron and manganese removal should not be used for water containing more than 0.3 milligrams per liter of iron, manganese or combination thereof. This process is not acceptable where either the raw water or wash water contains dissolved oxygen.

3.15.05 Sequestration by Polyphosphates

This process shall not be used when iron, manganese or combination thereof exceeds 1.0 milligrams per liter. The total phosphate applied shall not exceed 10 milligrams per liter as PO₄.

Where phosphate treatment is used, satisfactory chlorine residuals shall be maintained in the distribution system.

- a) Feeding equipment shall conform to the requirements of Section 3.20
- b) Stock phosphate solution must be kept covered and disinfected by carrying approximately 10 milligrams per liter free chlorine residual.
- c) Polyphosphates shall not be applied ahead of iron and manganese removal treatment. The point of application shall be prior to any aeration, oxidation or disinfection if no iron or manganese removal is provided.
- d) Phosphate chemicals must be food grade.

3.15.06 Sampling Equipment

For control purposes, smooth-nosed sampling taps shall be provided.

3.15.07 Testing Equipment

All plants shall be provided with testing equipment.

- a) The equipment should be capable of accurately measure the iron content to a minimum of 0.1 milligram per liter and the manganese content to a minimum of 0.05 milligram per liter.
- b) Appropriate phosphate test equipment shall be provided where polyphosphate sequestration is provided.

3.16 Fluorination

Commercial sodium fluoride, sodium silicofluoride and hydrofluosilicic acid shall conform to the applicable AWWA standards. Other fluoride compounds which may be available must be approved by the Authority. Fluoride application proposed method must be approved prior to preparation of final plans and specifications.

3.16.01 Fluoride Compound Storage

Covered or unopened containers shall be used to store fluoride compounds and should be stored inside a building.

Unsealed storage units for hydrofluosilicic acid should be vented to the atmosphere at a point outside any building.

3.16.02 Chemical Feed Equipment and Methods

In addition to the requirements in Section 3.20, fluoride feed equipment shall meet the following requirements:

- a) scales or loss-of-weight recorders shall be provided for dry chemicals feeds,
- b) feeders shall be accurate to within five percent of any desired feed rate,
- c) to avoid precipitation of fluoride, the fluoride compound should not be added before lime-soda softening and shall not be added before ion exchange softening.
- d) the point of application of hydrofluosilicic acid, if into a horizontal pipe, shall be in the lower half of the pipe,
- e) a positive displacement pump, having a stroke rate of not less than 20 strokes per minute, shall be used to applied a fluoride solution,
- f) adequate anti-siphon devices shall be provided for all fluoride feed lines.

3.16.03 Protective Equipment

At least one pair of rubber gloves, a respirator of a type certified by the Occupational Safety and Health Administration for toxic dusts or acid (as necessary), an apron or other protective clothing and goggles or face mask shall be provided for each operator.

3.16.04 Dust Control

For the transfer of dry fluoride compounds from shipping containers to the 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, provision must be made. The enclosure shall be provided with an exhaust fan and dust filter which place the hopper under a negative pressure. Air exhausted from fluoride handling equipment shall discharge through a dust filter to the outside atmosphere of the building.

Provisions shall 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.

3.16.05 Testing Equipment

Equipment shall be provided, subject to the approval of the Authority, for measuring the quantity of fluoride in the water.

3.17 Taste and Odor Control

At all surface water treatment plants, provision shall be made for the addition of taste and odor control chemicals. Such chemicals shall be added sufficiently ahead of other treatment processes to assure adequate contact time for an effective and economical use of chemicals.

3.17.01 Flexibility

So that the operator will have flexibility of operation, equipment that makes several of the control processes available, should be provided at plants treating water that is known to have taste and odor problems.

3.17.02 Chlorination

For the removal of some objectionable odors, chlorination can be used, provided adequate contact time is allowed to complete the chemical reactions involved.

3.17.03 Powdered Activated Carbon

a) Powdered activated carbon may be added prior to coagulation to provide maximum contact time.

Facilities to allow the addition at several points is preferred. Activated carbon should not be applied near the point of chlorine application.

- b) The carbon can be added as pre-mixed slurry or by means of a dry-feed machine as long as the carbon is properly wetted
- c) Agitation is necessary to keep the carbon from depositing in the slurry storage tank
- d) Adequate dust control shall be provided
- e) The required rate of feed of carbon in a water treatment plant depends upon the tastes and/or odors involved, but provisions should be made for adding from 0.1 milligrams per liter to at least 40 milligrams per liter.

3.17.04 Granular Activated Carbon Absortion Units

See Section 3.11.01 (f)

3.17.05 Copper Sulfate and other Copper Compounds

Continuous or periodic treatment of water with copper compounds to kill algae or other growths shall be controlled to prevent copper in excess of 1.0 milligrams per liter as copper in the plant effluent or distribution system.

3.17.06 Aeration

See Section 3.14

3.17.07 Other Methods

Only after consultations with and approval by the Authority should the decision be made to use other methods of taste and odor control.

3.18 Waste Handling and Disposal

Provisions shall be made for proper disposal of water treatment plant waste such as sanitary, laboratory, clarification sludge, softening sludge, iron sludge, filter back-wash water and brines.

All wastes discharges shall be governed by the pertinent regulatory agencies. The requirements outlined herein must be considered minimum requirements as water pollution control authorities may have more restrictive requirements. When selecting waste disposal facilities, due consideration shall be given to preventing contamination of the water supply.

Alternative methods of water treatment and chemical use should be considered as a means of reducing waste handling and disposal problems.

3.18.01 Sanitary Waste

The sanitary waste from water treatment plants, pumping stations, etc., must receive treatment. Waste from these facilities must be discharged directly to a sanitary sewer system, if feasible, or to any adequate waste treatment facility.

3.18.02 Brine Waste

By controlled discharge to a stream, if adequate dilution flow is available, the waste from ion exchange plants, demineralization plants, etc. may be disposed of. Stream requirements of the regulatory agency will control the rate of discharge. A holding tank of sufficient size to allow the brine to be discharge over a period of 24 hours, should be provided, except when discharging to large waterways. When discharging directly to a sanitary sewer, a holding tank may be required to prevent the overloading of the sewer and/or interference with waste treatment process.

The effects of brine discharge to sewage lagoons may depend on the rate of evaporation from the lagoons.

3.18.03 Alum Sludge

The use of lagoons as a mean to handle the alum sludge should be considered. Lagoon size can be calculated using total chemicals used plus a factor for turbidity. Mechanical concentration may be considered. A pilot plant study is required before

the design of a mechanical dewatering installation. Alum sludge may be discharge to a sanitary sewer, however, approval of this method should be obtained from the Authority before final designs are made. Acid treatment of sludge for alum recovery may be a possible alternative.

Lagoons should be designed to produce an effluent satisfactory to the regulatory agencies and should provide for:

- a) free from flooding location
- b) if necessary, dikes, deflecting gutters or other means of diverting surface water so that it does not flow into the lagoon,
- c) a minimum usable depth of 1.52 meters (five feet),
- d) adequate freeboard, 30 cms. (12 inches),
- e) adjustable decanting device,
- f) effluent sampling point, and
- g) adequate safety provisions.

3.18.04 "Red Water" Waste

Plants for removal of iron and manganese can dispose of the filter wash water waste as follows:

a) Sand filters

The following features should be included for sand filters:

1. Regardless of the volume of water to be handled, the total filter area should be no less than 9.29 square meters (100 sq. ft.) Two or more cells are required unless the filter is small enough to be cleaned and return to service in one day:
2. Unless the production filters are washed on a rotating schedule and the flow through the production filters is regulated by true rate of flow controllers, the "red water" filters

shall have sufficient capacity to contain, above the level of the sand, the entire volume of wash water produced by washing all of the production filters in the plant. To properly dispose of the wash water involved, sufficient volume must be provided;

3. Sufficient filter surface area should be provided so that, during any one filtration cycle, no more than 0.60 meters (2feet) of backwash water will accumulate over the sand surface;
4. The filter shall not be subject to flooding by surface runoff or flood waters. Finished grade elevation shall be such as to facilitate maintenance, cleaning and removal of sand as required;
5. The filter media should consist of a minimum of 30 centimeters (12 inches) of sand, 7.6 to 10 centimeters (3 to 4 inches) of supporting small gravel or torpedo sand, and 23 centimeters (9 inches) of gravel in graded layers. All sand and gravel should be washed to remove fines;
6. The effective size of the filter sand should be 0.3 to 0.5 mm and an uniformity coefficient not to exceed 3.5. The use of larger sized sands shall be justified by the designing engineer to the satisfaction of the Authority;
7. An adequate underdrain collection system to permit satisfactory discharge of filtrate, should be provided in the filter;
8. Provision shall be made for the sampling of the filter effluent.
9. Overflow devices from "red water" filters shall not be permitted.
10. "Red Water" filters shall comply with the requirements for common walls which pertain

to the possibility of contamination of finished water when finished water and raw water are stored or conveyed in adjacent compartments. The Authority must be consulted for approval of any arrangement when separate structures are not contemplated.

b) Lagoons

Lagoons shall have the following features:

- 1- the design volume shall be ten (10) times the total quantity of wash water discharged during any 24 hour period,
- 2- a minimum usable depth of 0.91 meters (3feet),
- 3- length four times width, and the width at least three times the depth, as measured at the operating water level,
- 4- outlet located at the end opposite the inlet,
- 5- a weir overflow device at the outlet end with weir length equal to or greater than depth,
- 6- dissipate the velocity at the inlet end.

c) Discharge to Sanitary Sewer

Red water can be discharge to the community sanitary sewer. However, approval of this method must be obtained from the Authority. To prevent overloading the sewers, provision for a holding tank is recommended.

3.18.05 Waste Filter Wash Water

Waste filter wash water from surface water treatment or lime softening plants should have the suspended solids reduced to a level acceptable to the Authority and regulatory agencies before being discharge.

Constructing a holding tank and returning this water to the inlet end of the plant should be contemplated. This tank should be of such a size that it will contain the anticipated volume of waste wash water produced by the plant when operating at design capacity. Plants having two filters should have a holding tank that will contain the total waste wash water from both filters calculated by using a 15 minutes wash at 75.7 liters per minute per 929 square centimeters (20 gallons per minute per square foot). In plants with more filters, the size of the tank will depend on the anticipated hours of operation. A waste filter wash water rate of return of less than 10% of the raw water entering the plant is recommended.

3.19 Chemicals Application

To treat drinking waters, no chemicals shall be applied unless specifically permitted by the Authority.

3.19.01 Plans and Specifications

Plans and specifications shall be submitted for review and approval of the Authority, as provided in Chapter I, and should include

- a) descriptions of feed equipment, including minimum and maximum feed limits,
- b) location of feeders, piping layout and points of application,
- c) facilities for storage and handling,
- d) specifications for chemicals to be used,
- e) operating and control procedures including proposed application rates, and
- f) descriptions of testing equipment and procedures.

3.19.02 Chemical Application

Chemicals shall 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 maximum mixing of the chemicals with the water,
- e) provide maximum flexibility of operation through several points of application, when appropriate, and
- f) prevent backflow and back-siphonage between multiple points of feed through common manifolds.

3.19.03 General Equipment Design

Design of general equipment shall be such that:

- a) at all times, the feeders shall be able to supply, at an accurate rate, the necessary amounts of chemicals throughout the range of feed,
- b) surfaces and chemical-contact materials are resistant to the aggressiveness of the chemical solution,
- c) introduce corrosive chemicals in such a manner as to minimize potential for corrosion, and
- d) chemicals that are incompatible are not feed, stored or handled together.

3.20 Facilities Design

3.20.01 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 shall be provided, and

- 2- to replace the largest unit during shut-downs, a standby unit or a combination of units of sufficient capacity should be available;
 - 3- where a booster pump is required, duplicate equipment should be provided and, when necessary, standby power,
- b) For each chemical applied a separate feeder shall be used
 - c) To replace parts which are subject to wear and damage, spare parts shall be available for all feeders

3.20.02 Control

- a) Manually or automatically controlled feeders may be used, with automatic controls being designed so as to allow override by manual controls.
- b) Chemical feed rates shall be proportional to flow.
- c) In order to determine chemical feed rates, means to measure water flow must be provided.
- d) Provisions shall be made for measuring the quantities of chemical used.
- e) Weighing scales
 - 1- shall be provided to weigh cylinders, at all plants utilizing chlorine gas,
 - 2- may be required for fluoride solution feed,
 - 3- shall be provided for volumetric dry chemical feeders, and
 - 4- should be accurate to measure increments of 0.5 per cent of the load. Means to verify the accuracy of the scales shall be provided.

3.20.03 Dry Chemical Feeders

Dry chemical feeders shall

- a) measure chemicals volumetrically or gravimetrically,
- b) provide adequate solution water and agitation of the chemical in the solution pot,
- c) provide gravity or pumped feed from solution pots, and
- d) completely enclosed chemicals to prevent emission of dust to the operating room.

3.20.04 Positive Displacement Solution Pumps

To feed liquid chemicals, positive displacement type solution feed pumps should be used, but shall not be used to feed chemical slurries.

3.20.05 Liquid Chemical Feeders-Siphon Control

Liquid chemical feeders shall be such that the chemical solutions cannot be siphoned into the water supply by

- a) assuring discharge at a point of positive pressure, or
- b) providing vacuum relief, or
- c) providing an air gap.

3.20.06 Cross-Connection Control

Provide cross-connection control to assure that

- a) the service water lines discharging to solution tanks shall be properly protected from backflow as required by the Authority,
- b) liquid chemicals solutions cannot be siphoned through solution feeders into the water supply as required in Section 3.20.05.

- c) no direct connection exists between any sewer and a drain or overflow from the feeder, solution chamber or tank by providing that all drains terminate at least 15 centimeters (6 inches) or two (2) pipe diameters, whichever, is greater, above the over flow rim of a receiving sump, conduit or waste receptacle

3.20.07 Chemical Feed Equipment Location

Chemical feed equipment shall

- a) be located in a separate room to reduce hazards and dust problems,
- b) be conveniently located near points of application to minimize the length of feed lines, and
- c) be readily accesible for servicing, repair, and observation of operation.

3.20.08 Service Water Supply

Service water supply shall be

- a) adequate in pressure and ample in supply
- b) provided with means for measurement when preparing specific solution concentrations by dilution,
- c) when necessary, properly treated for hardness, and
- d) properly protected against backflow

3.20.09 Storage of Chemicals

a) Space should be provided for:

1- a chemicals supply for at least 30 days,

2- convenient and efficient handling of chemicals,

3- dry storage conditions, and

4- a minimum storage area of 13.94 square meters (150 square feet).

- b) Liquid chemicals storage tanks and pipe lines shall be specific to the chemicals and not for alternates.
- c) Chemicals shall be stored in covered or unopened shipping containers, unless transferred into an approved storage unit.
- d) Liquid chemical storage tanks must
 - 1- have a liquid level indicator, and
 - 2- be provided with an overflow and a receiving basin or drain capable of receiving accidental spills or overflows.
- e) Handling
 - 1- provide carts, elevators and other appropriate means for lifting chemical containers to minimize excessive lifting by operators,
 - 2- made provisions for disposing of empty bags, drums or barrels by an approved procedure which will minimize exposure to dusts.
 - 3- made provisions for the proper transfer from shipping containers to storage bins or hoppers of dry chemicals in such a way as to minimize the quantity of dust which may enter the room in which the equipment is installed. Control should be provided by use of,
 - a- vacuum pneumatic equipment or closed conveyor systems,
 - b- facilities for emptying shipping containers in special enclosures, and/or
 - c- dust filters and exhaust fans which put the hoppers or bins under negative pressure
 - d- provision shall be made for measuring quantities of chemicals used to prepare feed solutions.

3.20.10 Solution Tanks

- a) A means which is consistent with the chemical solution shall be provided in a solution tank to maintain an uniform strength of solution. To maintain slurries in suspension, continuous agitation shall be provided.
- b) To assure continuity of supply in servicing a solution tank, two solution tanks of adequate volume may be required for a chemical.
- c) Means shall be provided to measure the solution level in the tank.
- d) Chemical solutions shall be kept covered. Large tanks with access openings shall have such openings curbed and fitted with tight overhanging covers.
- e) Subsurface locations for solution tanks shall
 - 1- be free from sources of possible contamination and
 - 2- assure positive drainage for ground waters, accumulated water, chemical spills and overflows.
- f) Overflow pipes, when provided should
 - 1- be turned downward, with the end screened,
 - 2- have a freefall discharge, and
 - 3- be located where noticeable.
- g) Acid storage tanks must be vented to the outside atmosphere, but not through vents in common with solution tanks.
- h) Each tank shall be provided with a valved drain, protected against backflow in accordance with Sections 3.20.05 and 3.20.06
- i) Solution tanks shall be located, and protective curbings provided, so that chemicals from

equipment failure, spillage or accidental drainage shall not enter the water in conduits, treatment or storage basins.

3.20.11 Day Tanks

- a) Where bulk storage of liquid chemical is provided, day tanks shall be provided.
- b) Day tanks shall meet all the requirements of Section 3.20.10
- c) No more than a 30 hour supply should be held by day tanks
- d) Day tanks shall be mounted on scales, 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. In 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. A tip rack may be used to permit withdrawal into a bucket from a spigot. Where motor-driven transfer pumps are provided, a liquid level limit switch and an over-flow from the day tank, which will drain by gravity back into the bulk storage tank, must be provided.
- f) To maintain uniform strength of solution in a day tank, a means which is consistent with the nature of the chemical solution shall be provided. Chemical slurries may be maintained in suspension by providing continuous agitation.
- g) Tanks shall be properly labeled to designate the chemical contained.

3.20.12 Feed Lines

Chemical solution feed lines should be

- a) as short as possible in length of run, and
 - 1- of durable, corrosion resistant material,
 - 2- easily accessible throughout the entire length,
 - 3- readily cleanable and maintainable
- b) should slope upward from the chemical source to the feeder when conveying gases,
- c) shall be designed consistent with scale-forming or solids depositing properties of the water, chemical, solution or mixture conveyed,
- d) should be color coded.

3.20.13 Housing

- a) Floor surfaces shall be smooth and impervious, slip-proof and well drain with 2.5 per cent minimum slope.
- b) Storage facilities, equipment exhaust and vents from feeders shall discharge to the outside atmosphere above grade and far from air intakes.

3.21 Operator Safety (See Chapter VIII)

3.21.01 Ventilation

Special provisions shall be made for ventilation of chlorine feed and storage rooms.

3.21.02 Respiratory Protection Equipment

Where chlorine gas is handled, respiratory protection equipment that meets the requirements of OSHA (Occupational Safety and Health Administration) shall be available and shall be stored at a convenient location, but not inside any room

where chlorine is used or stored, The units shall use compressed air, have at least a 30 minutes capacity, and be compatible with or exactly the same as units used by the Fire Department.

3.21.03 Chlorine Leak Detention

An automatic alarm equipment that detects chlorine gas leakage shall be provided. A bottle of ammonium hydroxide, 56 per cent ammonia solution, shall be available for chlorine leak detentions where ton containers are used, a leak repair kit approved by the Chlorine Institute shall be provided.

3.22 Specific Chemicals

3.22.01 Chlorine Gas

- a) Chlorine gas feed and storage shall be enclosed and separated from other operating areas. The chlorine room shall be
 - 1- provided with an acrylic panel 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, and
 - 3- provided with doors equipped with emergency hardware assuring ready means of exit and opening only to the building exterior.
- b) 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 storage, and
 - 4- stored in areas not in direct sunlight or exposed to excessive heat.

- c) Where chlorine gas is used, the room shall be constructed to provide the following;
- 1- a ventilating fan with a capacity which provides one complete air change per minute when the room is occupied for each room,
 - 2- the ventilating fan shall 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 inlets to any rooms or structures,
 - 3- air inlets should be through louvers near the ceiling,
 - 4- fans and light switches shall be outside the room, at the entrance, when the fan can be controlled from more than one point, a signal light indicating fan operation should be provided at each entrance,
 - 5- vents from feeders and storage shall discharge to the outside atmosphere, above grade.
- d) Chlorine feed lines shall not carry chlorine gas beyond the chlorinator room.

3.22.02 Acids

- a) Acids shall be kept in closed acid-resistant shipping containers or storage units.
- b) Acids should be pumped in undiluted form from original containers through suitable hose to the point of treatment or to a covered day tank, but should not be handled in open vessels.

CHAPTER III-A

CLEAR WATER PUMPING STATIONS

This chapter is a complement of the preceding Chapter III, it is separated considering that it can form a unit by itself. However, these norms are not limited to consider only the types of pumps, but factors which may influence or affect these norms are considered throughout the entire length of this work, its location, units, elevation, ventilation, maintenance, and the pumps in themselves.

<u>SECTION</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
3.A	Clear Water Pumping Stations	III-A-1
3A.01	Location	III-A-1
3A.02	Pumping Stations	III-A-1
3A.03	Pumps	III-A-3
3A.04	Booster Pumps	III-A-4
3A.05	Automatic and Remote Controlled Stations	III-A-4
3A.06	Appurtenances	III-A-4



CHAPTER III-A

CLEAR WATER PUMPING STATIONS

3A.0 General

Pumping facilities shall be design to maintain the sanitary quality of pumped water. Sub-surface pits or pump rooms and inaccessible installations should be avoided. No pumping station shall be subject to flooding.

3A.01 Location

Located so 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.

3A.01.01 Site Protection

The station shall be

- a- placed elevated to a minimum of 30 cm. (1foot) above the highest recorded flood elevation, or protected to such elevation,
- b- readily accessible at all times, the station is in service,
- c- graded around the station so as to lead surface drainage away from the station,
- d- protected to prevent vandalism and entrance by unauthorized persons or animals.

3A.02 Pumping Stations

Pumping stations for both raw or clear water shall

- a- provide the necessary 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 15 cm. (6 inches) above finished grade
- d- have underground structure water proofed,
- e- provide all floors with drains so that the quality of the potable water will not be endangered.
- f- have a suitable outlet for drainage from pump glands without discharging into the floor.

3A.02.01 Suction Well

The pump suction wells or chambers shall

- a- be watertight,
- b- have floors sloped to permit removal of water and entrained solids,
- c- be covered or protected against contamination.

3A.02.02 Equipment Maintenance

Pump stations shall be provided with

- a- eyebolts, hoist beams, crane-ways, or other adequate facilities for servicing or removal of pumps, motors or other equipment,
- b- openings in floors, roofs or wherever else needed for removal of heavy or bulky equipment,
- c- a convenient tool board, or other facilities as needed, for proper maintenance of the equipment.

3A.02.03 Stairways and Ladders

Pumping stations shall be provided with stairways or ladders

- a- between all floors, and in pits or compartments which must be entered,
- b- with handrails and treads of non-slip material. See Chapter VIII.

3A.02.04 Ventilation

Adequate ventilation shall be provided for all pumping stations in accordance with the requirements of OSHA and EPA. Forced ventilation of at least six changes of air per hour shall be provided for

- a- all underground rooms, pits and other structures
- b- any area where unsafe atmosphere may developed.

3A.02.05 Dehumidification

Means for dehumidification should be provided in areas where excess moisture could cause hazards to safety or damage to equipment.

3A.02.06 Lighting

Pump stations should be adequately lighted throughout. All electrical work shall conform to the norms and requirements in effect of the National Electric Code and the P.R. Electric Energy Authority.

3A.02.07 Sanitary Facilities

All pumping stations should be provided with potable water, lavatory and toilet facilities, except in the case of small automatic stations or where such facilities are otherwise available. Plumbing must be so installed as to prevent contamination of a potable water system supply. Wastes shall be discharge in accordance with Section 3.18.

3A.03 Pumps

At least two pumping units shall be provided. With any pump out of service, the remaining pump or pumps shall be able of providing the maximum daily pumping demand of the system. The pumping units shall:

- a- have ample capacity to supply the peak demand without dangerous overloading,

b- be driven by primer mover able to operate against the maximum probable head

c- have spare parts and tools readily available for maintenance and repairs.

3A.03.01 Suction Lift

If possible, suction lift should be avoided or be within the allowable limits, preferably less than 4.6 meters (15 ft.).

3A.04 Booster Pumps (See Fig. No. 23 and 24)

Booster pumps may be of the vertical barrel type or horizontal submersible type. Shall be located or controlled so that:

a- they will not produce negative pressure in their suction,

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

3A.04.01 In Line Booster Pump

In addition to all mentioned conditions the inline booster pumps shall be accessible for maintenance and repair.

3A.05 Automatic and Remote Controlled Stations

All automatic stations should be provided with automatic signaling apparatus which will report when the station is out of service. All remote controlled stations shall be electrically operated and controlled and shall have signalling devices of proven performance. The electrical equipment shall be installed in accordance with the applicable requirements of the National Electric Code and the Electric Energy Authority.

3A.06 Appurtenances

3A.06.01 Valves

To permit satisfactory operation, maintenance and repair of the equipment, all pumps shall be adequately valved.

If foot valves are necessary, they shall have a net valve area of at least 2 1/2 times the area of the suction pipe and they shall be screened.

A positive-acting check valve shall be installed on the discharge end, between the pump and the shut-off valve.

3A.06.02 Piping

In general piping shall

- a) be design so that the friction losses will be minimized,
- b) not be subject to contamination,
- c) provided with watertight joints,
- d) be protected against surge or water hammer,
- e) be such that each pump has an individual suction line or that the lines shall be so manifolded that they will insure symilar hydraulics and operating conditions.

3A.06.03 Gauges and Meters

Each pump shall have

- a) a standard pressure gauge on its discharge line,
- b) a compound gauge on its suction line,
- c) recording gauges in the large stations,
- d) means for measuring the discharge.

The station should have indicating, totalizing, and recording metering of the total water pumped.

3A.06.04. Water Seals

Water of a lesser sanitary quality than that of the water being pump, shall not be used to supply the water seals.

3A.06.05 Controls

Pumps, their prime movers and accessories, shall be controlled in such a manner that they will operate at rated capacity without dangerous overload. Provision shall be made for alternation, where more than one pump are installed. Energizing the motor, in the event of a backspin cycle, shall be prevented. Electrical controls shall be located above grade.

3A.06.06 Electric Power

If cessation of minimum essential service would result due to power failure, provisions shall be made to supply power from at least two independent sources or a stand-by or an auxiliary source.

3A.06.07 Water Pre-Lubrication

When automatic pre-lubrication of pump bearings is necessary and an auxiliary power supply is provided, the pre-lubrication line shall be provided with a valved by-pass around the automatic control so that the bearings can, if necessary, be lubricated manually before the pump is started.

CHAPTER IV

GENERAL STANDARDS FOR THE DESIGN OF SANITARY SEWERS

4.01 The sanitary sewer systems will be designed for the disposal of domestic sewage and industrial wastes. Combined systems (sanitary and storm sewer) will not be approved.

4.02 Contributions

4.02.01. Domestic

- 1) Private Housing Projects : 1325 liters (350 gallons) per day per housing unit.
- 2) Public Housing Projects : 1136 liters (300 gallons) per day per housing unit
- Renewal Projects and : other Public Communal Projects ----- :

4.02.02. Industrial ----- : 22,710 liters (6000 gallons) per day per "cuerda"

4.02.03. Comercial ----- : 15140 liters (4000 gallons) per day per "cuerda"

4.02.04. Hotels ----- 1987 liters (525 gallons) per day
Hotels with all services and facilities----- : per room

Deductions for facilities or services not rendered. :

Laundry----- : 416 liters (110 gallons) per day per room

Beach----- : 284 liters (75 gallons) per day per room

Food Service----- : 284 liters (75 gallons) per day per room

- Swimming Pool-----: 151 liters (40 gallons)
per day per room.
- 4.02.05 Hospitals-----: 1136 liters (300 gallons)
per day per bed.
- 4.02.06 Medical Centers-----: 1136 liters (300 gallons)
per day per bed.
- 4.02.07 Apartment Buildings and
Condominiums-----: 1325 liters (350 gallons)
per day per housing unit.
- 4.02.08 Office Buildings-----: 1136 liters (300 gallons)
per day per 92.9 square
meters (1000 ft²) of
floor space.
- 4.02.09 Schools-----: 76 liters (20 gallons)
per student
- 4.02.10 Infiltration-----: 290 liters (75 gallons)
per day per housing unit
or 37,850 liters (10,000
gallons) per day per mile
per inch-diameter of
piping, whichever is
more restrictive. However,
for the initial inspection,
not more than 280 liters
per day per kilometer
of pipe per centimeter
of diameter (300 gals.
per day per mile of pipe
per inch of diameter)
for concrete pipe. For
other types of pipe the
Authority will determine
the maximum permitted.

4.03 The capacity of lateral ramifications and subcollectors will be designed according to the following formula:

Design flow : $2(1.75 \text{ Average Daily Domestic Flow} + \text{Infiltration} + \text{Industrial})$.

4.04 The capacity of the collectors: $1.33(1.5 \text{ Average Daily Domestic Flow} + \text{Infiltration} + \text{Industrial})$.

4.05 For hydraulic estimates, Ganguillet's or Manning formulas will be used, with the following coefficient of rugosity:

Concrete pipe-----0.013
 Vitrified clay pipe-----0.013
 Plastic pipe-----0.011

4.06 The minimum velocity for a flow equal to (1.75 average daily flow +Infiltration) in sewers should be 61 cm./sec. (2 feet/sec.). The maximum velocity for a flow equal to (1.75 average daily flow +Infiltration) in sewers will be 3.05 meters/sec. (10 feet/sec.). The velocity can be increase to 4.57 meter/sec. (15 ft./sec.) when cast iron or vitrified clay pipe is used, but only when average flow depth is not less than 5.1 cm. (2 inches) and transitions will be design for each case, where slopes change abruptly.

The following table indicates the maximum number of housing units permitted for piping of 8", 12", 15" diameter:

N= .015		
D	Slope	Units
8"	0.003	---
10"	0.002	330
12"	0.0015	523
14"	0.00115	739

N= .011		
D	Slope	Units
8"	0.002	418
10"	0.0015	375
12"	0.0012	625
14"	0.00115	---

- 4.07 The maximum slopes will be those corresponding to the maximum velocities and will never exceed 10% for concrete piping and 15% for cast iron, ductile iron pipe, vitrified clay, and plastic material.

The minimum slopes with a coefficient of rugosity of 0.013 will be the followings:

Cast Iron - Vitrified Clay

Diameter: 4" : 6" : 8" : 10" : 12" : 14" : 15" : 16" : 18"

Slope : .01: .005: .003: .002: .0015: .0012: .001: .00095:

20" : 21" : 24" : 27" : 30" : 33" : 36" :

.00065: .0006: .0005: .00045: .0004: .00035: .0003

4.08 Depths

5.08.01 In critical cases with sewer lines without water connections, in which it is necessary to place the crown or upper part of the piping, not less than 0.61 meters (2 feet) below ground surface, cast iron pipe for 150 pounds pressure, must be used, with concrete protection according to Fig. No. 35 on natural soil foundation of adequate firmness. The Authority may consider alternate propositions.

4.09 The installation of sanitary sewer systems that crosses a storm sewer will not be permitted when interfering with the water flow. In cases where the sewer is installed on bridge crossings, sewers, or other similar structures, such sewer should be of ductile iron piping, bell and spigot for 150 pound minimum pressure. The pipe should be made according to specifications ASA-A21.6 or A21.8 latest revision.

4.10 When sewer piping and water mains cross each other or when laid at a horizontal distance of less than 1.52 meters (5 ft.) from each other, the water main should be installed at a higher



Minimum Trench Width

Diameter*	Plastic Pipe		Vitrified Clay Pipe		Reinforced Concrete Pipe	
	Meter	Inch	Meter	Inch	Meter	Inch
8	0.61	24	0.51	20	0.47	19
10	0.66	26	0.58	23	0.55	22
12	0.76	30	0.66	26	0.63	25
15			0.76	30	0.76	30
18			0.89	35	0.89	35
21			0.99	39	0.99	39
24			1.09	43	1.12	44
27			1.19	47	1.24	49
30			1.32	52	1.37	54
33			1.42	56	—	—
36			1.52	60	1.63	64
42					1.85	73
48					2.11	83
54					2.34	92
60					2.59	102
66					2.77	109
72					2.97	117
78					3.15	124
84					3.35	132
90					3.53	139
96					3.75	147
102					3.91	154
108						

*Diameter in inches.

The minimum trench widths tabulated above do not include fractions of inches as calculated by the foregoing formula.

4.13 Minimum Diameter

No gravity sewer conveying raw sewage shall be less than 8 inches in diameter.

4.14 Minimum Size for House Connection

The minimum size of the house connection shall be four (4) inches in diameter. In case concrete pipe is used, it shall be type 5.

4.15 Manholes

4.15.01 Manholes shall be installed at the start of each line, at all changes in pipe material, grade, size, alignment, at all intersections with other sewers. They should have a minimum depth of one meter over the top crown of the pipe, except on initial ramifications which will not be extended, that will be of 0.90 meter depth.

4.15.02 The distance between manholes will not be more than 85 meters for pipe 18" or less in diameter, nor larger than 100 meters for pipes 20" to 36" in diameter, nor larger than 150 meters for pipe over 36" in diameter. In some cases, previous approval by the Authority, these distances could be 10% greater, as when a manhole is on a green zone, and not on a sidewalk, street or road.

4.15.03 The manholes must be constructed of concrete and must be built according to the design shown on the typical plans adopted by the Authority (Fig. No. 37 to 41D). The concrete must be class B with a compressive strength of 2500 pounds per square inch, at 28 days after casting and should be built according to the specifications adopted by the Authority. The walls shall have a minimum thickness of 0.20 meters (8 inches). The foundation shall consist of a 0.20 meter thick slab for the bottom, cast monolithically with the walls to prevent infiltration. On this slab the transition channel must be built shaped as an "U" with semicircular bottom and sides high enough to prevent the spilling of water in the bottom by elevating them to the crest or upper part of the pipes. The floor shall have a slope to the channels of 15%.

The installation of prefabricated manholes will be permitted by previous consultation and approval by the Authority and built as indicated in section 4.17.

- 4.15.04. Manholes on sewers up to 15" diameter will have an interior diameter of 1.20 meters, of 16" to 27" diameters of 1.50 meters and in sewers of 30" diameter or larger, will be square or of irregular shape with the same interior width as the diameter of the piping plus 1.00 meter and the walls will be made of concrete.
Square manholes should have a circular hoop of 1.20 meters interior diameter, when the depth of the manhole is greater than 2 meters over the crown of the piping. For details of manholes for sewers of 30" diameter or larger, the Authority must be consulted.
- 4.15.05. The transition channel shall not be horizontal. It should have at least the slope of the piping.
- 4.15.06. When the manhole is located out of roads or streets, the top must be 30 cm(12 inches) above natural ground elevation, except in cases where for ornamental or other reasons, its height could be reduced to a minimum of two inches if previously approved by the Authority.
- 4.15.07. The manholes frame and cover will be made of cast iron with only one hole for ventilation. It will be adapted to the typical detail illustrated on Fig. No.36 and specifications of the Authority. The covers will be adjusted to the frames to prevent noise and movement when light or heavy vehicles pass over it.
- 4.15.08. The Authority will not permit the construction of manholes in private land or lots. When there is no alternative, the manhole cover shall be bolted and sealed.

4.16 Drop Manholes

- 4.16.01. Drop manholes will be built when the use of standard manholes is precluded due to the difference in elevations between the inlet and outlet pipes of the manhole.

4.16.02 The piping will discharge to the crown of the pipe, with a drop pipe which will be connected to the manhole with a "Y" according to detail drawing (Fig. No. 40).

When the difference in level between the bottom of the manhole and the invert of the inlet piping is greater than 1.0 meter and when the sewer is larger than 12 inches in diameter, the drop pipe will be installed in a vertical position as detail drawing (Fig. No. 41). In special cases of connections to existing excessive deep manholes, the drop pipe connection inside the manhole may be permitted as indicated in Fig. No. 39.

4.17 Prefabricated Inspection Manholes

4.17.01 The Authority may authorize the use of prefabricated concrete manholes in lieu of those cast on site provided the contractor shall be responsible for verifying and measuring their elevation in accordance with the plans and/or ground final grade and that he will make all the necessary adjustments call for during or as a result of the project construction.

4.17.02 Every prefabricated manhole shall comply with the following additional conditions and/or requirements and will be accepted whe.. after its installation the hydrostatic and/or infiltration and/or exfiltration tests are performed as required, and the results are accepted by the Authority.

a) The construction of the sections and/or pre-fabricated manholes shall comply strictly with requirements of specifications ASTM C-478 (last revision) as modified, amended and/or supplemented by the following:

1- All welding shall comply with the welding code of the "American AWS D-1.1 and AWS D12.1"

2- All joints shall be provided with a prefabricated seal made of plastic or synthetic material resistant to chemical action and deterioration, which guarantee the hydraulic seal of the joint and comply with the

requirements of federal specification ss-s-210A (1).
Sealing Compounds, Preformed Plastic for Expansion
Joints and Pipe joints.

3. The specimens for the absorption test shall not be less than a core from a prefabricated section for each 20 or fraction of prefabricated sections cast daily.
4. The specimens for the compression test shall be not less than a set of three cylinders or cores representative of 20 or fraction of prefabricated sections casted each day. The specimens shall be cured in the same manner as the sections and tested 28 days after casting.
5. The inspector shall require that the manufacturer test the design and construction of the joints by hydrostatic means and performs infiltration and exfiltration tests as frequently as is deemed necessary to guarantee that the joint complies with the specification, but never to exceed six months intervals.
6. The ladder rungs shall be as approved by the Authority and according to OSHA requirements and set in place when casting the sections or by mechanical installation which guarantee each and all of the established requirements.
7. Sections may be repaired, if necessary, using pre-mixed material, manufactured for that purpose.
8. The manufacturer may mark or destroy rejected sections. The mark shall be "REJECTED BY AAA" in letters not less than 8" high at four longitudinal areas and spaced the same as the exterior perimeter, with bright red waterproof paint. Otherwise the exterior of the section will be totally painted.
9. Any section may be rejected if it fails to comply with the specifications and/or modifications previously described, or for the following:
 - a- Fractures and/or cracks that crosses the wall of the section
 - b- Defects that indicate imperfect proportioning and mixing or casting of the concrete.

- c. Superficial defects indicative of empty or shallow spots, porous texture and others.
 - d. Damaged and/or rejected joints, that might prevent perfect joints that may cause infiltrations.
 - e. Any continuous crack that measures on the surface more than 0.25 mm (0.01 inch) wide and/or in excess of 305mm (12 inches) long.
 - f. Any group of non continuous cracks 0.25mm (0.01 inch) wide or more and that their added length exceed 610mm (24 inches).
10. Every Manufacturer should own an up-dated Quality Control Manual that includes every thing concerning the prefabricated section, which shall be accessible at all times to the Authority inspectors.
11. Minimum interior diameter shall be 1.22 meters (48 inches), the wall and bottom minimum thickness shall be 15 cm. (6 inches) and the top slab shall not be less than 20cm. (8 inches) thick. The least possible number of joints shall be provided.
12. The orifices for connecting the pipes to the sections, shall be provided by the manufacturer and made at the plant when casting. The maximum diameter of the orifice shall not exceed the required pipe exterior diameter plus 15cm. (6 inches). No orifice shall be permitted in the base section and in case of making orifices for interconnections (drops, interceptors, etc.) at the project site, the joints shall be designed according to manufacturer's recommendations and which guarantee a positive seal and watertight, using a mortar, premixed and manufactured for this purpose and applied on both the interior and exterior.
13. Prefabricated manholes shall be installed on firm ground providing a 95% compaction and subject to the approval of the Authority.
14. Prefabricated base sections may be supplied with precast invert channels or the invert may be cast in the field using concrete Class B of 2500 lbs. minimum compressive strength and cement mortar.

15. All prefabricated manhole shall be subject to filtration tests, which shall be done by sealing the inlet and the outlet and filling the manhole with water. After a period of no less than an hour, the original water level shall be restored and the loss in an hour in the manhole calculated and expressed in gallons. A loss not exceeding, 0.68 gal./day/ft/ft. is acceptable.
16. Manholes exceeding a depth of 6.10 meters (20 feet) shall be provided with safety devices according to OSHA such as Safety Cages, Intermediate Platform, and/or Saf-T-Climbs Fall Prevention Systems.
17. Prefabricated manholes shall be designed to prevent floating and capable of resisting seismic force according to P.R. Commonwealth Building Regulations, vehicles live loads (including braking), and other loads, lateral pressures, and ground subsurface water level.
18. Prefabricated manholes installed in crosscountry shall have a top elevation of 30 cm. (12 inches) higher than ground elevation. In every case where part of the top section is above ground, adequate joint shall be provided to resist impact.

4.17.03 The Authority may require the use of paints and/or coatings on those prefabricated manholes, which due to the design, will be subject to the action of hydrogen sulphide and/or subject to high turbulence, such as drop manholes, and, as so, shall be shown in the drawings and specifications.

It shall also be required for exterior surfaces of prefabricated manholes which shall be affected by ground conditions such as excessive alkalinity, sulphate action and others.

1- Paintings

Prefabricated manhole surfaces, exterior, interior or both, shall be painted as indicated on the plans and specifications or as required by the specific conditions of the project and in a manner approved by the Authority, which shall consist basically of a Coal Tar Epoxy corrosion resistance coating with a final 20 thousandths of an inch dry

thickness and shall comply with the following:

- a- Paint shall be applied in strict accordance with the technical specifications prepared and recommended by the manufacturer.
- b- Paint shall be applied on all surfaces including any joint which meets any surface to be painted.
- c- The method of application shall consist basically of the following
 - 1- Surface preparation
 - 2- Primer application if required
 - 3- Apply two or more coats of Coal Tar Epoxy to obtain a minimum dry thickness of 20 thousandths of an inch. Deficiencies in thickness shall be corrected by the application of additional coat or coats.
 - 4- Allow the coating to dry before placing in service the prefabricated manhole.
- d- Instruments for measuring the moisture content of the concrete, before applying the paint, shall be provided if required by the manufacturer or if a maximum moisture content is specified.
- e- The paint application shall be inspected by electrical means to detect any imperfections or defects, the paint coat thickness shall be checked in accordance with specifications and the paint adhesion to concrete shall be verified.
- f- The installation may be defective or rejectable if the inspection detects any openings, blisters, sags, wrinkles, inclusions, and/or any other damage or defects in the painting.
- g- Every joint and concrete cast in site shall be painted or sealed with material provided or recommended by the manufacturer.

2. Prefabricated Lining

All exterior, interior or both surfaces as indicated on the plans and specifications or as required by the specific conditions of the project shall receive a prefabricated lining approved by the Authority, which shall consist basically of a plastic or synthetic material resistant to chemical action durable, and not less than 65 thousandth of an inch thick and designed so as to provide an integral bond with the concrete at the time of casting.

- a- The lining shall be applied in strict accordance with the manufacturer specification and written recommendation.
- b- Prefabricated joints shall be provided according to manufacturer specifications.
- c- Every joint or concrete cast in place shall receive the treatment recommended by the manufacturer or shall be provided with the painting system described in part 1 of this section.
- d- Any lining showing wear or abrasion, cracks or any other damage or defects shall be rejected. It may be repaired if accomplished in strict accordance with manufacturer's instructions.

4.18 Inverted Siphons

- 4.18.01 Inverted siphons are generally constructed to clear or overcome obstacles that might be met in the piping alignment, such as rivers, creeks, ground depressions, crossing underground structures.
- 4.18.02 The inverted siphons shall be design by the Hazen-Williams formula with coefficient of C-100.
- 4.18.03 It is advisable to use several barrels, arranged in parallel alignment, so that each one is used according to the flow, maintaining adequate velocity.
- 4.18.04 Inverted siphons shall be constructed of cast iron pipe; protected by concrete encasement.

(See Fig. No. 40). Minimum pipe diameter permitted shall be 8 inches. When crossing rivers or creeks, the minimum difference in elevation between the top of the sewer line and the water bed shall be 1.83 meters (6 feet).

4.19 House Connections

- 4.19.01 For every house or building sewer service a house connection shall be provided. (See Fig. No. 33)
- 4.19.02 House connections shall be made, by installing a "Y" fitting in the sewer as indicated in detail drawing adopted by the Authority. (See Fig. No. 31 to 33). The house connection will extend from the "Y" piece to the property line front of the lot.
- 4.19.03 The size of the house connection for housing units up to five (5) families groups shall be 4 inches in diameters. For buildings with a larger number of living units or other type of buildings shall be made according to tables for discharge and pipe sizes for drainage enclosed in regulations of the Planning Board and the Regulation and Permits Agency.
- 4.19.04 The piping and joints for house connections shall be made of cast iron, concrete or PVC (SDR-35) and according to specifications ASTM standards latest revisions.
- 4.19.05 Joints for cast iron pipe will be made with rubber gaskets according to prevailing regulations.
- 4.19.06 A cleanout manhole will be provided at the end of the piping inside of the lot as close to the property line as possible, according to the Authority's requirements. See standard detail Fig. No. 33 and 34
- 4.19.07 House connections to sanitary mains that are 3.05 meters (10 feet) under ground level will not be permitted. An auxiliary parallel line will be installed to connect the house connections and the existing line will remain as a main sanitary line.

4.20 Other Dispositions

- 4.20.01 The discharge of piping into another of smaller diameter will not be permitted regardless of its capacity.
- 4.20.02 The connections of the lateral sewers and subcollectors to the main line, will be made so that the invert of the lateral sewers be at the level of the top interior part of the subcollectors.
- 4.20.03 The sewers will connect to other lateral or subcollector so that the invert of the lateral will be level with the axis of the lateral or subcollector.
- 4.20.04 In installations under the water table level, vitrified clay, cast iron, or ductile iron pipe with rubber gasket joints or concrete pipe with rubber gasket and steel joints, or plastic pipe shall be used.
- 4.20.05 In installations crossing rivers or creeks the minimum protection between the exterior pipe top and river bed shall be 1.83 meters (6 feet). Concrete pipe shall meet the requirements of specifications ASTM C-14, C-76 and AWWA C-301 and C-302 latest revision.



CHAPTER V

SEWAGE PUMPING STATIONS

This norm is not limited to just the unfortunate and great problem that faces the Engineers today like "How to select and apply the best pump for known conditions" but also contains norms regarding pumps housing, equipment, sanitary and safety conditions. It also includes the right of the Authority to accept any equipment.

<u>SECTION</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
5.01	Pump Houses	V-1
5.02	Sewage Pumping Stations	V-1
5.03	Instructions and Equipment	V-6
5.04	Force Mains	V-6



CHAPTER V

SEWAGE PUMPING STATION

5.01 Pump Houses

Pump houses shall be built of reinforced concrete, of adequate size to accommodate the equipment to be installed. For all types of pumping stations a plan shall be submitted for approval of the Authority.

5.02 Sewage Pumping Stations

Pumping stations that do not discharge into sewage treatment plants, shall be provided with at least three (3) units of the same capacity. Each shall be capable of handling flows of 2.5 times the expected average daily flow. A system which will alternate the operation of each pump shall be provided. The speed of the pump will not exceed 1750 R.P.M. Pumps of the submersible type will be acceptable. See Section 5.02.25 for requirements.

5.02.01 The pumping station shall be provided with the following:

1- A screened chamber, with clear openings not exceeding 3.81 cm. (1 1/2 inches).

2- Electric comminutor or mechanical screen with grinder, including bypass with bar screen.

5.02.02 The effective capacity of the suction pot should be 4 minutes minimum at maximum flow, and not greater than 15 minutes at average flow. (See Fig. 52)

5.02.03 An electric power generator activated by an automatic start Diesel engine, will be provided for the pumping stations. Generating unit size shall be adequate to provide power to operate the comminutor, pumps motor starting currents, controls, at maximum flow, and for lighting, ventilation and other auxiliary equipment necessary for safety and

proper operation of the station.

A Deisel storage tank (See Fig. 3) shall be installed with a capacity of no less than 379 liters (100 gallons), enough to keep the equipment operating 24 consecutive hours with the necessary equipment to measure the fuel in the tank. The construction of the tank shall be in accordance with all Safety Standards in effect. It shall be installed at the adequate level to prevent dumping the fuel by gravity into the generator.

- 5.02.04 Adequate ventilation shall be provided to all pumping stations suction pits and basements by mechanical ventilators made of aluminum. Ventilation may be either continuous or intermittent. Ventilation in the suction pits, if continuous, shall provide at least 12 complete air changes per hour, or if intermittent, at least 30 complete air changes per hour. Mechanical ventilators provided in the basement of the pumping stations, if operated continuously, shall provide at least 6 complete air changes per hour, and if intermittent, at least 30 complete air changes. Ventilator motors shall be located in such place as to not be in the air path.
- 5.02.05 The sequence of the pump's operation will be controlled by an automatic system using water level sensors, of the air bubbler type, or sealed electrodes. Also adequate equipment for level measuring shall be installed.
- 5.02.06 Spiral stairways with rails or hand rails may be used for access to the basements. They will not be over 4.57 meters (15 feet) high. The design shall be in accordance with the model adopted by the Authority. (See Fig. No. 46). Pitched ladders may be used with no height limit.
- 5.02.07 To facilitate the removing of pumps, adjustable connections shall be provided at the suction and discharge ends of the pumps.

- 5.02.08 Wall sleeves shall be provided when piping crosses the wall of a tank or suction pit to prevent leaks.
- 5.02.09 One or more intermediate platforms shall be provided for inspection and maintenance of the pumps' flexible shaft.
- 5.02.10 Copper piping shall be installed to drain stuffing box drippings, discharging directly to the sump pit.
- 5.02.11 Sufficient lighting shall be provided equivalent to forty (40) footcandles at a 1.50 meters (5 ft.) level from both floors.
These lights shall be controlled by switches located on the interior housing wall, close to the entrance door; and duplex receptacles, one on the top floor and another on the lower floor. All electrical installations will be to a main panel and in accordance with electric codes in effect.
- 5.02.12 When pumping pipes discharge into a sewer manhole it should not be less than 1.20 meters deep and have the connection as parallel as possible to the direction of the flow.
- 5.02.13 Pumping stations shall be located at a distance not less than 15 meters from the nearest existing or projected structure. The pumping station lot shall be paved.
- 5.02.14 A 3/4 inch diameter water connection with meter box shall be provided, followed by a reduced pressure type back flow preventer of equal diameter as indicated in the project plans. There shall be no physical connection between any potable water supply and a sewage pumping station which under any conditions might cause contamination of the potable water supply.
- 5.02.15 Pumping stations with a capacity of 1 MGD, or more, a restroom shall be provided, with toilet, lavatory, and shower.
- 5.02.16 A Motor Control Center shall be provided for pumping stations with motors larger than 40 H.P., with main switch, amperimeter, voltmeter,

non-reverse phase relay, pump alternator for the main pumps, as well as for seal pumps, individual switches with magnetic starters for the pumps and switches for the lighting and ventilation systems. At sewage treatment plants where there is a pumping station, said center shall be provided.

- 5.02.17 All electric installations shall be made with adequate size conduits and shall be shown on the final drawings. Every electric installation work shall comply with the National Electrical Code requirements and the regulations of the Puerto Rico Electric Power Authority, latest revision. The electric plans shall be submitted by the designer to the Electric Power Authority for approval before submitting them for the consideration of the Aqueduct and Sewer Authority.
- 5.02.18 Lighting circuits shall be color coded to facilitate its identification and maintenance.
- 5.02.19 In pumping stations of 2,270 liters (600 gallons), or more, per minute, Duplex clean water pump system for stuffing box seals, shall be provided, with a water tank with a capacity of not less than 190 liters (50 gallons), with an automatic float valve to maintain the water level in the tank. Said pumps will operate one at a time, with solenoid valves in the main units, which shall be activated by the control system according to the demand. For pumps of less than 2270 liters (600 gallons) per minute, an Automatic Oiler Grease Sealer shall be provided operated by water pressure from the pump or any other source, with its own solenoid valve for automatic operation or a mechanical automatic oil or grease sealer. The Authority shall determine the type of seal to be used in each case. An overflow valve shall be provided to recirculate the excess water pumped to the seals.

- 5.02.20 An electric control system shall be provided for low water level in the seal pump's tank to prevent them from operating when the tank is dry. Also, a relief valve shall be installed in the main discharge. The solenoid valve shall be installed on the upper floor or on other accessible location. A mercury switch shall be installed to assure the proper water flow and pressure to provide lubrication and cooling of the seal prior to starting the pumps.
- 5.02.21 In order to meet E.P.A. requirements, an automatic system shall be installed to convey signals to the nearest control center that is manned 24 hours. The alarm shall be activated in cases of power failure, pump failure, unauthorized entry or any cause of pump station malfunction.
- 5.02.22 The minimum size of solids shall be 6.4 centimeters (2 1/2 inches). In pumping stations that do not discharge into a sewage treatment plant, comminators will not be required when the pumps are able to pass solids over 10 cm. (4 inches).
- 5.02.23 In cases where the sewage treatment plants require a bar rack or comminutor, recess impeller may be used, as long as their horse power does not exceed 50 per cent of that needed for an open impeller. In all cases, pump curves shall be required including NPSH.
- 5.02.24 The velocity in the suction piping will not exceed 1.5 meters (5 feet) per second.
- 5.02.25 Submersible Pumps
1. Pumps shall be capable of passing spheres of at least 7.6 cm. (3 inches) in diameter and their minimum efficiency shall not be less than 50%
 2. Pump removal - Submersible pumps shall be readily removable and replaceable without dewatering the wet well, disconnecting any piping in the wet well or stopping the operation of other units.

3. Operation - Submersible pumps should be capable of operating without being completely submerged, with no damage or reduction in service capacity, otherwise mechanisms shall be provided to assure pumps submersion.
4. Controls - The motor control center shall be located outside the wet well and be protected from wet well atmosphere, humidity and vandalism and meeting requirements of the National Electrical Code and the Electric Energy Authority.
5. Valves - Valves required for the control of the discharge line shall be located in a separate pit, installed horizontally and well protected from weather and vandalism.
6. Electric Equipment - Installation of a lightning arrester is required to provide protection to the equipment.

5.02.26 The Authority reserves the right to accept or reject any equipment which do not conforms to these Norms.

5.03 Instructions and Equipment

Sewage pumping stations and their operators should be supplied with a complete set of operational instructions, including emergency procedures, maintenance schedules, special tools, and such spare parts as may be necessary.

5.04 Force Mains

At design average flow a velocity of at least 0.61 meters (2 feet) per second shall be maintained. An automatic air relief valve shall be installed at high points in the force main to prevent air locking. Force mains should enter the gravity sewer system at a point not more than 60 cm. (2 feet) above the flow line of the receiving manhole.

The force main and accessories, including thrust blocks shall be designed to withstand normal pressure and pressure surges (water hammer). Friction losses through force mains shall be based on the Hazen and Williams formula, using a value of "C" of 100 for iron or steel pipe and "C" of 120 for P.V.C. pipe.

Sanitary sewer force mains and water mains shall be installed maintaining a horizontal separation between them of at least 3 meters (10 feet) and a vertical separation of not less than 46 cm. (18 inches) between the outside of the force main and the outside of the water line. (See Fig. No. 43).



CHAPTER VI

WASTEWATER TREATMENT PLANT

The Sanitary Engineering field is going through a period of dynamic development. Old ideas are being re-evaluated and new concepts are being formulated. To take active part in the development of this field, the Engineer must understand thoroughly its fundamentals. Therefore the purpose of these norms is to delineate the principal involved in the treatment of wastewater and guide the designer with them.

<u>SECTION</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
6.01	Regulating Agencies Permits	VI-1
6.02	Plant Location	VI-1
6.03	Quality of Effluent	VI-1
6.04	Design	VI-2
6.05	Emergency Operation	VI-5
6.06	Treatment Plant Details	VI-5
6.07	Plant Outfall	VI-7
6.08	Essential Facilities	VI-8
6.09	Sanitary Facilities	VI-9
6.10	Laboratory	VI-9
6.11	Flow Measurement	VI-9
6.12	Floor Slope	VI-9
6.13	Stairs	VI-9



<u>SECTION</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
6.14	Screening, Grit Removal, and Settling	VI-10
6.15	Disposal of Screenings	VI-11
6.16	Channels	VI-12
6.17	Auxiliary Screens	VI-12
6.18	Fine Screens	VI-12
6.19	Grit Removal Facilities	VI-12
6.20	Flocculation	VI-14
6.21	Settling Tanks	VI-15
6.22	Flow Equalization	VI-18
6.23	Sludge Handling and Disposal	VI-18
6.24	Sludge Dewatering	VI-25
6.25	Sludge Final Disposal	VI-27
6.26	Biological Treatment	VI-27
6.27	Disinfection	VI-38
6.28	Equipment	VI-41
6.29	General Consideration	VI-42
6.30	Site Improvements	VI-42
6.31	Water Service	VI-42
6.32	Landscaping	VI-42
6.33	Fences	VI-42
6.34	Painting	VI-43



<u>SECTION</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
6.35	Lighting	VI-43
6.36	Plant Pumping Stations	VI-43
6.37	Discharge by Gravity	VI-43
6.38	Control Houses	VI-43
6.39	Sludge Conveying Pipes	VI-43
6.40	Windows	VI-43
6.41	Sludge Drying Beds Location	VI-43
6.42	Sludge Drying Beds Construction	VI-44
6.43	Project Changes	VI-44
6.44	Equipment Labeling	VI-44
6.45	Tools and Literature	VI-44
6.46	Hydraulic Profile	VI-44
6.47	Influent Measuring	VI-44
6.48	Oil Drainage	VI-44
6.49	Incinerator	VI-44
6.50	Supernatant Recirculation	VI-44
6.51	Flood Level	VI-44
6.52	Storage Area	VI-44
6.53	Gas Burner	VI-44
6.54	Control Valve	VI-45
6.55	Extension Valve	VI-45



<u>SECTION</u>	<u>DESCRIPTION</u>	<u>PAGE</u>
6.56	Bar Screen	VI-45
6.57	Weather Proof Control	VI-45
6.58	Manual Pump Operation	VI-45
6.59	Plastic Material for Overflow	VI-45
6.60	Laboratory	VI-45

