8.11.3 Portable Lighting Equipment
8.11.4 Nonsparking Tools
8.11.5 Portable Air Blowers
8.11.6 Safety Belt
8.11.7 Inhalators
8.11.8 Diver's Suit
8.12 EMERGENCY MAINTENANCE
8.13 INSPECTION
8.13.1 Necessity for Inspection
8.13.2 Type of Inspection
8.13.3 Direct Inspection
8.13.4 Indirect Inspection
8.13.5 Planning for Sewer Inspection
8.14 SEWER REHABILITATION
8.14.1 Methods
8.14.2 Sewer Renovation
8.15 SAFETY PRACTICES
8.15.1 Safety Practice Programme
8.15.2 Keeping Records of Injury
8.15.3 Searching out Hazards
8.15.4 Safe Equipment, Working Methods
8.15.4.1 Motivation and Training
8.15.4.2 Changing Working Habits
8.16 RECORDS
8.16.1 Maps and Profiles
8.16.2 Data
9

SEWAGE AND STORM WATER PUMPING STATIONS

9.1 GENERAL CONSIDERATIONS

9.2 LOCATION

9.3 CAPACITY

9.4 TYPES OF PUMPING STATIONS

9.5 STRUCTURE AND LAYOUT OF THE PUMPHOUSE

9.5.1 Provision of Essential Accessories

9.5.2 Provisions for Functional Requirements

9.5.2.1 Ventilation

9.5.2.2 Safety Measures

9.5.2.3 Other Facilities

9.6 DESIGN CONSIDERATIONS FOR THE DRY AND WET WELLS

9.6.1 Dry Well

9.6.2 Wet Well

9.7 PUMPS

9.7.1 Capacity

9.7.2 Size of the Pump

9.7.3 Pump-Types

9.7.4 Centrifugal Pumps

9.7.5 Computation of the Total Head of Pumping

9.7.5.1 System Head

9.7.5.2 Operating Point of a Centrifugal Pump

9.7.5.3 Parallel Operation

9.7.5.4 Stable Characteristics

9.7.5.5 Cavitation

9.7.6 Progressive Cavity, Helical Rotor Pumps

9.7.7 Installation of Pumps

9.7.8 Operation of the Pumps

9.7.9 Maintenance of Pumps
9.7.9.1 Daily Observations
9.7.9.2 Semi-Annual
9.7.9.3 Annual Inspection
9.7.9.4 Facilities for Maintenance and Repairs
9.7.10 Troubleshooting
9.7.10.1 Check Chart for Centrifugal Pump Troubles
9.7.10.2 Check-Chart for Reciprocating Pump Troubles
9.7.10.3 Check-Chart for Rotary Pump Troubles
9.8 Prime Movers
9.8.1 Selection Criteria
9.8.2 Constructional Features of Induction Motors
9.8.3 Method of Starting
9.8.4 Voltage Ratings
9.8.5 Types of Enclosure
9.8.6 Class of Duty
9.8.7 Insulation
9.8.8 Margin in Brake Kilowatts (BkW)
9.9 Electrical Equipment
9.9.1 Switch Gear
9.9.2 Starters
9.9.3 Capacitors
9.9.4 Cables
9.9.5 Controls
9.10 Maintenance and Repairs of Electrical Equipment
9.11.1 Facilities for Maintenance and Repairs
9.11.2 Preventive Maintenance
9.11.2.1 Daily
9.11.2.2 Monthly
9.11.2.3 Quarterly
9.11.2.4 Semi-Annual
9.11.2.5 Annual
9.11.2.6 Bi-Annual
9.12 TROUBLE SHOOTING FOR ELECTRICAL EQUIPMENTS

9.12.1 Motor gets overheated

9.12.2 Motor gets overloaded

9.12.3 Starter/Breaker Trips

9.12.4 Vibration in Motor

9.12.5 Cables Get Overheated

10 BASIC DESIGN CONSIDERATIONS

10.1 DEGREE OF TREATMENT

10.2 DESIGN PERIOD

10.3 POPULATION SERVED

10.4 SEWAGE FLOWS

10.4.1 Population Equivalent

10.5 SEWAGE CHARACTERISTICS

10.5.1 Temperature

10.5.2 Hydrogen Ion Concentration

10.5.3 Colour and Odour

10.5.4 Solids

10.5.5 Nitrogen

10.5.6 Phosphorus

10.5.7 Chlorides

10.5.8 Biochemical Oxygen Demand

10.5.9 Chemical Oxygen Demand

10.5.10 Toxic Metals and Compounds

10.6 EFFECT OF INDUSTRIAL WASTES

10.7 DUMPING CHUTES FOR NIGHTSOIL

10.8 EFFLUENT DISPOSAL AND UTILISATION

10.9 UNIT OPERATIONS, PROCESSES AND REACTOR DESIGN PRINCIPLES

10.9.1 Unit Operations and Processes

10.9.2 Reactors

10.9.3 Biological Reactor Design

10.9.4 Design of Process Flow Sheets

10.10 CHOICE OF PROCESSES
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>PRETREATMENT - SCREENING AND GRIT REMOVAL</td>
<td></td>
</tr>
<tr>
<td>11.1</td>
<td>SCREENING</td>
<td>200</td>
</tr>
<tr>
<td>11.1.1</td>
<td>Coarse Screens</td>
<td>200</td>
</tr>
<tr>
<td>11.1.2</td>
<td>Medium Screens</td>
<td>201</td>
</tr>
<tr>
<td>11.1.3</td>
<td>Fine Screens</td>
<td>201</td>
</tr>
<tr>
<td>11.1.4</td>
<td>Comminuting Devices</td>
<td>201</td>
</tr>
<tr>
<td>11.1.5</td>
<td>Location of Screens</td>
<td>201</td>
</tr>
<tr>
<td>11.1.6</td>
<td>Housing of Screens</td>
<td>201</td>
</tr>
<tr>
<td>11.1.7</td>
<td>Hydraulics</td>
<td>201</td>
</tr>
<tr>
<td>11.1.8</td>
<td>Velocity</td>
<td>202</td>
</tr>
<tr>
<td>11.1.9</td>
<td>Head Loss</td>
<td>202</td>
</tr>
<tr>
<td>11.1.10</td>
<td>Quantity of Screenings</td>
<td>203</td>
</tr>
<tr>
<td>11.1.11</td>
<td>Disposal of Screenings</td>
<td>203</td>
</tr>
<tr>
<td>11.2</td>
<td>GRIT REMOVAL</td>
<td>203</td>
</tr>
<tr>
<td>11.2.1</td>
<td>Composition of Grit</td>
<td>203</td>
</tr>
<tr>
<td>11.2.2</td>
<td>Types</td>
<td>204</td>
</tr>
<tr>
<td>11.2.2.1</td>
<td>Mechanically Cleaned Grit Chambers</td>
<td>204</td>
</tr>
<tr>
<td>11.2.2.2</td>
<td>Manually Cleaned Grit Chambers</td>
<td>204</td>
</tr>
<tr>
<td>11.2.3</td>
<td>Aerated Grit Chambers</td>
<td>204</td>
</tr>
<tr>
<td>11.2.4</td>
<td>Design Data</td>
<td>204</td>
</tr>
<tr>
<td>11.2.5</td>
<td>Design of Grit Chambers</td>
<td>205</td>
</tr>
<tr>
<td>11.2.5.1</td>
<td>Settling Velocity</td>
<td>206</td>
</tr>
<tr>
<td>11.2.5.2</td>
<td>Surface Over Flow Rate</td>
<td>208</td>
</tr>
<tr>
<td>11.2.5.3</td>
<td>Detention Period</td>
<td>209</td>
</tr>
<tr>
<td>11.2.5.4</td>
<td>Bottom Scour and Flow Through Velocity</td>
<td>209</td>
</tr>
<tr>
<td>11.2.5.5</td>
<td>Velocity Control Devices</td>
<td>209</td>
</tr>
<tr>
<td>11.2.5.6</td>
<td>Number of Units</td>
<td>213</td>
</tr>
<tr>
<td>11.2.5.7</td>
<td>Dimensions of Each Unit</td>
<td>213</td>
</tr>
<tr>
<td>11.2.6</td>
<td>Loss of Head</td>
<td>213</td>
</tr>
<tr>
<td>11.2.7</td>
<td>Disposal of Grit</td>
<td>213</td>
</tr>
<tr>
<td>12</td>
<td>SEDIMENTATION</td>
<td>214</td>
</tr>
<tr>
<td>12.1</td>
<td>GENERAL</td>
<td>214</td>
</tr>
<tr>
<td>12.2</td>
<td>CHARACTERISTICS OF SETTLEABLE SOLIDS</td>
<td>214</td>
</tr>
</tbody>
</table>
12.3 TYPES OF SETTLING
12.3.1 Discrete Settling
12.3.2 Flocculent Settling
12.3.3 Hindered or Zone Settling
12.3.4 Compression
12.4 DESIGN CONSIDERATIONS
12.4.1 Factors Influencing Design
12.4.2 Design Criteria
12.4.2.1 Overflow Rate or Surface Loading Rate
12.4.2.2 Detention Period
12.4.2.3 Solids Loading Rate
12.4.2.4 Weir Loading
12.4.2.5 Depth
12.4.2.6 Sludge Removal
12.4.2.7 Inlets and Outlets
12.4.2.8 Scum Removal
12.4.2.9 Types and Shapes
12.5 PERFORMANCE
12.6 CHEMICAL-AIDED SEDIMENTATION
12.6.1 Chemicals Used
12.6.1.1 Iron Salts
12.6.1.2 Aluminium Salts
12.6.1.3 Lime and Sodium Carbonate
12.6.2 Unit Operations
12.6.2.1 Mixing
12.6.2.2 Flocculation
12.6.2.3 Sedimentation
13 AEROBIC SUSPENDED GROWTH SYSTEMS
13.1 INTRODUCTION
13.2 ACTIVATED SLUDGE PROCESS VARIABLES
13.2.1 Loading Rate
13.2.2 Mixing Regime
13.2.3 Flow Scheme
13.3 CONVENTIONAL SYSTEM AND MODIFICATIONS

13.3.1 Conventional System

13.3.2 Completely Mixed

13.3.3 Extended Aeration

13.4 DESIGN CONSIDERATION

13.4.1 Aeration Tank

13.4.2 Oxygen Requirements

13.4.3 Aeration Facilities

13.4.3.1 Diffused Air Aeration

13.4.3.2 Surface Aerator

13.4.3.3 Mixing Requirements

13.4.4 Measuring Devices

13.4.5 Secondary Settling

13.4.6 Sludge Recycle

13.4.7 Excess Sludge Wasting

13.4.8 Nitrification

13.4.9 Operation

13.5 AERATED LAGOONS

13.6 DESIGN VARIABLES

13.6.1 Mixing Conditions

13.6.2 Substrate Removal Rates

13.6.3 Power Level

13.6.4 Effluent Characteristics

13.6.5 Sludge Accumulation

13.7 CONCLUSION
14 AEROBIC ATTACHED GROWTH SYSTEMS

14.1 GENERAL CONSIDERATIONS

14.2 TRICKLING FILTERS

14.2.1 Process Description

14.2.2 Types of Filters

14.2.3 Process Design

14.2.3.1 Rankin's Equation

14.2.3.2 National Research Council (Canada) Equation

14.2.3.3 Eckenfelder Equation

14.2.3.4 Applicability of the Different Equations

14.2.4 Constructional Features

14.2.4.1 Shape of Filter

14.2.4.2 Provision for Filter Flooding

14.2.4.3 Filter Walls

14.2.4.4 Filter Floor

14.2.4.5 Under-Drainage System

14.2.4.6 Main Collecting Channel

14.2.4.7 Ventilation

14.2.4.8 Filter Media

14.2.4.9 Plastic Media

14.2.4.10 Filter Dosing

14.2.4.11 Flow Distribution

14.2.5 Multiple Units

14.2.6 Plant Hydraulics

14.2.7 Pumping Arrangements

14.2.8 Operational Problems
14.3  ROTATING BIOLOGICAL CONTACOR

14.3.1  Process Description

14.3.2  Constructional Features

14.3.3  Design and Operational Parameters

15  STABILIZATION PONDS

15.1  CLASSIFICATION

15.1.1  Aerobic

15.1.2  Anaerobic

15.1.3  Facultative

16  MECHANISM OF PURIFICATION

16.2  MECHANISM OF PURIFICATION

15.2.1  Aerobic and Anaerobic Reactions

15.2.2  Diurnal Variations

15.2.3  Odour Control

15.2.4  Algae

15.3  DESIGN CONSIDERATIONS

15.3.1  Areal Organic Loading

15.3.2  Detention Time and Hydraulic Flow Regimes

15.3.3  Depth

15.3.4  Sludge Accumulation

15.3.5  Bacterial Reduction

16  CONSTRUCTION DETAILS

16.4  CONSTRUCTION DETAILS

15.4.1  Site Selection

15.4.2  Pretreatment

15.4.3  Construction in Stages

15.4.4  Multiple Units

15.4.5  Pond Shape
15.4.6 Embankment
15.4.7 Pond Bottom
15.4.8 Pond Inlets
15.4.9 Pond Outlets
15.4.10 Pond Interconnections
15.4.11 Other Aspects
15.5 OPERATION AND MAINTENANCE
15.6 PERFORMANCE
15.7 APPLICATIONS
16 ANAEROBIC TREATMENT OF WASTEWATERS
16.1 INTRODUCTION
16.2 HIGH RATE ANAEROBIC SYSTEMS
16.2.1 Anaerobic Contact Process
16.2.2 Anaerobic Filter
16.2.3 Anaerobic Fixed Films Reactor
16.2.4 Fluidized and Expanded Bed Reactor
16.2.5 Upflow Anaerobic Sludge Blanket Reactor
16.3 DESIGN AND OPERATIONAL CONSIDERATIONS
16.3.1 Organic Load and Sludge Retention Time
16.3.2 Hydraulic Load
16.3.3 Effect of Temperature
16.3.4 Excess Sludge Production and Nutrient Requirement
16.3.5 Toxicity
16.3.6 Recirculation
16.3.7 Gas Yield and Utilization
16.4 PRETREATMENT
16.5 EFFLUENT QUALITY AND POST TREATMENT
<table>
<thead>
<tr>
<th>17</th>
<th>SLUDGE THICKENING, DEWATERING, DIGESTION AND DISPOSAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.1</td>
<td>INTRODUCTION</td>
</tr>
<tr>
<td>17.2</td>
<td>SLUDGE THICKENING</td>
</tr>
<tr>
<td>17.2.1</td>
<td>Gravity Thickening</td>
</tr>
<tr>
<td>17.2.2</td>
<td>Air Floatation</td>
</tr>
<tr>
<td>17.2.3</td>
<td>Centrifugation</td>
</tr>
<tr>
<td>17.3</td>
<td>SLUDGE DEWATERING</td>
</tr>
<tr>
<td>17.3.1</td>
<td>Sludge Drying Beds</td>
</tr>
<tr>
<td>17.3.1.1</td>
<td>Design Criteria</td>
</tr>
<tr>
<td>17.3.2</td>
<td>Mechanical Methods</td>
</tr>
<tr>
<td>17.3.2.1</td>
<td>Sludge Conditioning</td>
</tr>
<tr>
<td>17.3.2.2</td>
<td>Equipments</td>
</tr>
<tr>
<td>17.3.3</td>
<td>Heat Drying</td>
</tr>
<tr>
<td>17.3.4</td>
<td>Incineration</td>
</tr>
<tr>
<td>17.4</td>
<td>SLUDGE DIGESTION</td>
</tr>
<tr>
<td>17.4.1</td>
<td>Anaerobic Digestion</td>
</tr>
<tr>
<td>17.4.1.1</td>
<td>Microbiology of the Process</td>
</tr>
<tr>
<td>17.4.1.2</td>
<td>Types</td>
</tr>
<tr>
<td>17.4.1.3</td>
<td>Digester Capacity</td>
</tr>
<tr>
<td>17.4.1.4</td>
<td>Sizing of Low Rate Digesters</td>
</tr>
<tr>
<td>17.4.1.5</td>
<td>Sizing of High Rate Digesters</td>
</tr>
<tr>
<td>17.4.1.6</td>
<td>Digester Elements</td>
</tr>
<tr>
<td>17.4.1.7</td>
<td>Performance of Digesters</td>
</tr>
<tr>
<td>17.4.2</td>
<td>Aerobic Digestion</td>
</tr>
<tr>
<td>17.4.3</td>
<td>Merits and demerits of anaerobic digestion</td>
</tr>
<tr>
<td>17.5</td>
<td>SLUDGE DISPOSAL</td>
</tr>
<tr>
<td>17.5.1</td>
<td>Sludge as Fertilizer</td>
</tr>
<tr>
<td>17.5.2</td>
<td>Sludge Lagooning</td>
</tr>
<tr>
<td>17.5.3</td>
<td>Land Fill</td>
</tr>
<tr>
<td>17.5.4</td>
<td>Disposal in Water or Sea</td>
</tr>
</tbody>
</table>
18 SLUDGE PUMPING
  18.1 GENERAL CONSIDERATIONS
  18.2 SLUDGE-PUMPING
  18.3 SLUDGE PUMPS
  18.3.1 Centrifugal Pumps
  18.3.2 Air-Lift Pumps
  18.3.3 Screw Pumps
  18.3.4 Reciprocating Plunger or Diaphragm Pumps
  18.4 OPERATIONAL PROBLEMS
  18.5 REQUIREMENT OF STANDBY UNITS
  18.6 SLUDGE CONVEYING PIPING
  18.7 PUMP APPURTEANCES
    18.7.1 Air Chamber
    18.7.2 Revolution Counter
    18.7.3 Gland Seals
    18.7.4 Valves
    18.7.5 Gauges
    18.7.6 Sampling Devices
    18.7.7 Washouts and Drains
    18.7.8 Time clocks
    18.7.9 Measuring Devices
  18.8 PUMP DRIVE EQUIPMENT
19 TERTIARY TREATMENT OF SEWAGE FOR REUSE
  19.1 GENERAL
  19.2 BASIC APPROACH
  19.3 TERTIARY TREATMENT METHODS
  19.4 DESIGN CRITERIA
19.6  REUSE FOR AGRICULTURAL PURPOSES  316
19.7  REUSE BY GROUND WATER RECHARGE  316
20  EFFLUENT DISPOSAL AND UTILISATION  318
20.1  GENERAL  318
20.2  DISPOSAL INTO WATER BODIES  318
20.2.1  Disposal into River  318
20.2.2  Disposal into Estuaries  318
20.2.3  Disposal into Ocean  318
20.2.4  Basic Information  319
20.3  RECLAMATION OF TREATED EFFLUENT  319
20.4  PISCICULTURE  320
20.5  ARTIFICIAL RECHARGE OF AQUIFERS  320
20.6  DISPOSAL ON LAND  320
20.6.1  Sewage Farming  320
20.7  WATER QUALITY CONSIDERATIONS FOR IRRIGATION WATERS  320
20.7.1  Osmotic Effects  321
20.7.2  Toxic Effects  322
20.7.3  Impairment of Soil Quality  324
20.7.3.1  Sodium Hazard  324
20.7.3.2  Organic Solids  325
20.7.4  Other Considerations  325
20.8  DESIGN AND MANAGEMENT OF SEWAGE FARMS  328
20.8.1  Management of Water in Sewage Farming  328
20.8.1.1  Hydraulic Loading  327
20.8.1.2  Organic Loading  328
20.8.1.3  Irrigation Interval  328
20.8.2 Management of Soil 328
20.8.3 Utilisation of Plant Nutrients 329
20.8.4 Land requirements 329
20.9 ALTERNATIVE ARRANGEMENTS DURING NON-IRRIGATING PERIODS 330
20.10 PROTECTION AGAINST HEALTH HAZARDS 330
20.11 STANDARDS 331
21 ON-SITE SANITATION 333
21.1 BACKGROUND 333
21.2 SEPTIC TANK 333
21.2.1 Design 333
21.2.2 Construction Details 335
21.2.3 Sludge Withdrawal and Disposal 335
21.2.4 Secondary Treatment and Disposal of Effluent 337
21.2.4.1 Soak Pits 337
21.2.4.2 Dispersion Trenches 338
21.2.4.3 Up-Flow Anaerobic Filter 338
21.3 POUR FLUSH WATER SEAL LATRINES 338
21.3.1 Design and Materials 339
21.3.1.1 Squatting Pan, Trap, Footrests and Connecting Drain 339
21.3.1.2 Super Structure 339
21.3.1.3 Leach Pits 341
21.3.2 Construction of Pour Flush Latrine 343
21.3.2.1 Squatting Pan and Trap 343
21.3.2.2 Foot-Rests 343
21.3.2.3 Pit Lining 343
21.3.2.4 Pit Bottom 343
21.3.2.5 Pit Cover 343
21.3.2.6 Leach Pit Connection 343
21.3.3 Pollution Safeguards 349
21.3.3.1 Safe Distance From Drinking Water Sources 350
21.3.3.2 Safe Distance From Water Supply Mains 350
21.3.3.3 Location of Pits 350
21.3.3.4 Sub-Soil Conditions 351
21.4 AN OVERVIEW OF OTHER ALTERNATIVE ON-SITE SANITATION METHODS

21.4.1 Bucket/Dry Latrine

21.4.2 Trench Latrine (Shallow Type)

21.4.3 Bore Hole latrine

21.4.4 Dug well Latrine

21.4.5 Aqua Pricky

21.4.6 Ventilated Improved Pit Latrine (VIP Latrine)

21.5 NIGHT SOIL DIGESTERS

21.5.1 Design Criteria

21.6 MINI PACKAGE TREATMENT PLANTS

22 CORROSION PREVENTION AND CONTROL

22.1 GENERAL

22.2 CORROSION OF SEWERS

22.2.1 Corrosion due to Biological Reactions

22.2.2 Factors Influencing Sulphide Generation

22.2.2.1 Temperature

22.2.2.2 Strength of Sewage

22.2.2.3 Velocity of Flow

22.2.2.4 Age of Sewage

22.2.2.5 Hydrogen Ion Concentration

22.2.2.6 Sulphate Concentration

22.2.2.7 Ventilation

22.2.3 Sulphide Control Procedures

22.2.3.1 Design of sewers

22.2.3.2 Control of Sewage Character

22.2.3.3 Cleaning of Sewers

22.2.3.4 Chlorination

22.2.4 Materials of Construction

22.2.5 Sewer-Protection

22.2.5.1 Liners

22.2.5.2 Protective Coatings

22.2.5.3 Cathodic Protections

22.2.5.4 Protection by Sacrificial Anode
22.3 CORROSION OF TREATMENT SYSTEMS
22.3.1 Neutralisation Tanks 363
22.3.2 Sedimentation Tanks 363
22.3.3 Sludge Digestion 363
22.3.4 Activated Sludge 364
22.3.5 Trickling Filters 364
22.3.6 Sewage and waste water pumps 364
22.3.7 Preventive Maintenance 366
22.3.8 Piping Requirements in Treatment Plants 366
22.3.9 Modification of Materials 366

23 TREATMENT PLANT OPERATION AND MAINTENANCE
23.1 INTRODUCTION 367
23.2 TREATMENT UNITS
23.2.1 Screens 368
23.2.2 Grit Chamber 369
23.2.3 Sedimentation Tanks 369
23.2.3.1 Sludge 369
23.2.3.2 Bulking and Rising of Sludge 369
23.2.3.3 Skimmings 370
23.2.3.4 Structures and Mechanical Equipments 370
23.2.3.5 Records 370
23.2.4 Aeration Tanks 370
23.2.4.1 Sewage Flow 371
23.2.4.2 Air Supply 371
23.2.4.3 Mixed Liquor Suspended Solids 371
23.2.4.4 Return Sludge 371
23.2.4.5 Foaming 371
23.2.4.6 Microscopic Examination 372
23.2.4.7 Records 372
23.2.5 Trickling Filters 372
23.2.5.1 Distributors 372
23.2.5.2 Ponding 372
23.2.5.3 Underdrains 373
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.2.5.4</td>
<td>Odour</td>
<td>373</td>
</tr>
<tr>
<td>22.2.5.5</td>
<td>Filter Flies</td>
<td>373</td>
</tr>
<tr>
<td>22.2.5.6</td>
<td>Records</td>
<td>373</td>
</tr>
<tr>
<td>23.2.6</td>
<td>Sludge Digestion Tanks</td>
<td>373</td>
</tr>
<tr>
<td>23.2.6.1</td>
<td>Digester Operation</td>
<td>373</td>
</tr>
<tr>
<td>23.2.6.2</td>
<td>Records</td>
<td>374</td>
</tr>
<tr>
<td>23.2.7</td>
<td>Sludge Drying Beds</td>
<td>374</td>
</tr>
<tr>
<td>23.2.8</td>
<td>Stabilization Ponds</td>
<td>375</td>
</tr>
<tr>
<td>23.2.8.1</td>
<td>Operation and Maintenance of Facultative Pond</td>
<td>375</td>
</tr>
<tr>
<td>23.2.8.2</td>
<td>Records</td>
<td>376</td>
</tr>
<tr>
<td>23.3</td>
<td>BUILDING AND EQUIPMENT</td>
<td>376</td>
</tr>
<tr>
<td>23.3.1</td>
<td>Building and other Structures</td>
<td>376</td>
</tr>
<tr>
<td>23.3.2</td>
<td>Equipments</td>
<td>376</td>
</tr>
<tr>
<td>23.4</td>
<td>SAFETY IN THE PLANT</td>
<td>377</td>
</tr>
<tr>
<td>23.5</td>
<td>TRAINING OF PERSONNEL</td>
<td>377</td>
</tr>
<tr>
<td>23.6</td>
<td>RECORDING AND REPORTING</td>
<td>378</td>
</tr>
<tr>
<td>23.7</td>
<td>CHECK LIST</td>
<td>379</td>
</tr>
<tr>
<td>24</td>
<td>PLANT CONTROL LABORATORY</td>
<td>380</td>
</tr>
<tr>
<td>24.1</td>
<td>GENERAL</td>
<td>380</td>
</tr>
<tr>
<td>24.2</td>
<td>PLANNING OF LABORATORY FACILITIES</td>
<td>380</td>
</tr>
<tr>
<td>24.2.1</td>
<td>Physical Facilities</td>
<td>380</td>
</tr>
<tr>
<td>24.2.1.1</td>
<td>Size of The Laboratory</td>
<td>380</td>
</tr>
<tr>
<td>24.2.1.2</td>
<td>Location</td>
<td>380</td>
</tr>
<tr>
<td>24.2.1.3</td>
<td>Floor space</td>
<td>380</td>
</tr>
<tr>
<td>24.2.1.4</td>
<td>Walls</td>
<td>382</td>
</tr>
<tr>
<td>24.2.1.5</td>
<td>Lighting</td>
<td>382</td>
</tr>
<tr>
<td>24.2.1.6</td>
<td>Power Supply</td>
<td>382</td>
</tr>
<tr>
<td>24.2.1.7</td>
<td>Floor</td>
<td>382</td>
</tr>
<tr>
<td>24.2.1.8</td>
<td>Work Tables and Benches</td>
<td>382</td>
</tr>
<tr>
<td>24.2.1.9</td>
<td>Reagent Cabinets and Cupboards</td>
<td>382</td>
</tr>
<tr>
<td>24.2.1.10</td>
<td>Sinks</td>
<td>382</td>
</tr>
<tr>
<td>24.2.1.11</td>
<td>Fume Hoods and Chambers</td>
<td>383</td>
</tr>
<tr>
<td>24.2.1.12</td>
<td>Gas Supply</td>
<td>383</td>
</tr>
<tr>
<td>24.2.1.13</td>
<td>Space for Analytical Balance</td>
<td>383</td>
</tr>
</tbody>
</table>
24.2.1.14 Constant Temperature Room
24.2.1.15 Sample Preparation Room
24.2.1.16 Media Preparation and Sterilization Rooms
24.2.1.17 Space for Records
24.2.1.18 Wash and Toilet Facilities

24.2.2 Equipment and Chemicals
24.2.2.1 Equipment Required
24.2.2.2 Storage

24.3 SAMPLING OF SEWAGE AND WASTEWATER
24.3.1 Methods of Sampling
24.3.1.1 Grab Samples
24.3.1.2 Composite or Integrated Samples
24.3.2 Sample Volumes
24.3.3 Selection of Sampling Points

24.4 TESTS PERFORMED IN THE LABORATORY
24.4.1 Raw Sewage
24.4.2 Primary Sedimentation Tanks
24.4.3 Trickling Filters
24.4.4 Activated Sludge Aeration Tanks
24.4.5 Secondary Settling Tanks
24.4.6 Septic Tanks and Clarigesters
24.4.7 Sludge Digester
24.4.8 Stabilization Ponds
24.4.9 Digester Gas
24.4.10 Residual Chlorine
24.4.11 Special Tests
24.5 DISPOSAL OF LABORATORY WASTES

24.5.1 Solid Waste

24.5.2 Liquid Wastes

24.5.3 Radioactive Wastes

24.6 ANALYSIS OF DATA

24.7 COMPUTERISATION OF LABORATORY DATA

24.8 PERSONNEL

25 FLOW MEASUREMENT

25.1 INTRODUCTION

25.2 METHODS OF FLOW MEASUREMENTS

25.2.1 Direct Discharge Methods

25.2.1.1 Notches and Weirs

25.2.1.2 Flumes (Free Flowing)

25.2.1.3 Venturi Meters

25.2.1.4 Drops (Fig.25.9)

25.2.1.5 California Pipe (Fig.25.10)

25.2.1.6 Flow Nozzles (Fig.25.11)

25.2.1.7 Orifice Plate (Fig.25.12)

25.2.1.8 Magnetic Flow Meters

25.2.1.9 Ultrasonic Flowmeters

25.2.1.10 Volumetric Measurement

25.2.1.11 Dilution Method

25.2.1.12 Constant Rate Injection Method

25.2.2 Velocity-Area Methods

25.2.2.1 Current Meters

25.2.2.2 Float Measurements

25.2.2.3 Pitot Tubes

25.2.2.4 Chemical and Radioactive Tracers

25.2.2.5 Dye Tracers

25.2.2.6 Conclusion