

# **NEEDS TO KNOW GUIDE FOR SURFACE WATER SYSTEM OPERATORS**

Presented by  
NORTH CAROLINA WATERWORKS OPERATORS ASSOCIATION  
BOARD OF EXAMINERS

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PART I  
NEED TO KNOW GUIDE - WATER TREATMENT PLANT OPERATION, VOLUME I  
Sections Listed are from 7th Edition

Guide for Water Treatment Plant Operation, Volume I, A Field Study Training Program Prepared by California State University, Sacramento, School of Engineering, Applied Research and Design Center in Cooperation with the National Environmental Training Association.

PART II  
NEED TO KNOW GUIDE - WATER TREATMENT PLANT OPERATION, VOLUME II  
Sections Listed are from 6th Edition

Guide for Water Treatment Plant Operation, Volume II, A Field Study Training Program Prepared by California State University, Sacramento, School of Engineering, Applied Research and Design Center in Cooperation with the National Environmental Training Association.

PART III  
NEED TO KNOW GUIDE - RULES GOVERNING PUBLIC WATER SYSTEMS  
Sections Listed are from July 1, 2019

Guide for "Rules Governing Public Water Systems", Section .0100 through .2100, Title 15A, Subchapter 18C of the North Carolina Administrative Code, Department of Environment, Health and Natural Resources, Division of Environmental Health.

PART IV  
NEED TO KNOW GUIDE - RULES GOVERNING WATER TREATMENT FACILITY OPERATORS  
Sections Listed are from December 1, 2008 Edition

Guide for "Rules Governing Water Treatment Facility Operators", Section .0100 through Section .2105, Title 15A, Subchapter 18D of the North Carolina Administrative Code, Department of Environment, Health and Natural Resources, Division of Environmental Health.

## PART I

## WATER TREATMENT PLANT OPERATION VOLUME I

| SECTION        | TOPIC   | C   | B   | A   |
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| 1              | <b>KEY TERMS: INTRODUCTION TO WATER TREATMENT</b> |     |     |     |
| 1.1            | WATER AS A LIMITED RESOURCE                       | X   | X   | X   |
| 1.2            | WATER TREATMENT                                   | X   | X   | X   |
| 1.3            | THE SAFE DRINKING WATER ACT                       | X   | X   | X   |
| 1.4            | WATER TREATMENT PLANTS                            | X   | X   | X   |
| 1.4.1          | Conventional Surface Water Treatment              | X   | X   | X   |
| 1.4.2          | Additional Treatment                              | X   | X   | X   |
| 1.5            | PLANT OPERATION                                   | X   | X   | X   |
| 1.5.1          | Daily Operating Procedures                        | X   | X   | X   |
| 1.5.1.1        | At the Start of the Shift                         | X   | X   | X   |
| 1.5.1.2        | During the Shift                                  | X   | X   | X   |
| 1.5.1.3        | At the End of the Shift                           | X   | X   | X   |
| 1.5.2          | Regulation of Flows                               | X   | X   | X   |
| 1.5.2.1        | Treatment Process Changes                         | X   | X   | X   |
| 1.5.3          | Chemical Use & Handling                           | X   | X   | X   |
| 1.5.3.1        | Storage & Supply                                  | X   | X   | X   |
| 1.5.3.2        | Safe Handling                                     | X   | X   | X   |
| 1.5.3.3        | First Aid Procedures                              | X   | X   | X   |
| 1.5.4          | Water Quality Monitoring                          | X   | X   | X   |
| 1.5.4.1        | Turbidity Removal                                 | X   | X   | X   |
| 1.5.4.2        | Water Quality Complaints                          | X   | X   | X   |
| 1.5.5          | Sludge Handling & Disposal                        |     | X   | X   |
| 1.5.6          | Process Instrumentation & Controls                |     | X   | X   |
| 1.5.6.1        | Signal Transmission Methods                       |     | X   | X   |
| 1.5.6.2        | Control Methods                                   |     | X   | X   |
| 1.5.6.3        | Computers   |     | X   | X   |
| 1.5.7          | Emergency Conditions & Procedures                 | X   | X   | X   |
| 1.5.7.1        | Treatment Process Failures                        | X   | X   | X   |
| 1.5.7.2        | Process Equipment Failures                        | X   | X   | X   |
| 1.5.7.3        | Power Failures                                    | X   | X   | X   |
| 1.5.7.4        | Fires   | X   | X   | X   |
| 1.5.7.5        | Natural Disasters                                 | X   | X   | X   |
| 1.5.7.6        | Communications                                    | X   | X   | X   |
| 1.5.8          | Operating Records & Reports                       | X   | X   | X   |
| 1.6            | PLANT MAINTENANCE                                 |     |     | X   |
| 1.6.1          | Planning & Scheduling                             |     |     | X   |
| 1.6.2          | Records & Management                              |     |     | X   |
| 1.6.3          | Spare Parts Management                            |     |     | X   |
| 1.6.4          | Cost & Budget Control                             |     |     | X   |
| 1.6.5          | Emergency Repair Procedures                       |     |     | X   |
| 1.6.6          | Training Program                                  | X   | X   | X   |
| 1.6.7          | Security  | X   | X   | X   |
| 1.7            | ENERGY CONSERVATION                               |     | X   | X   |
| 1.7.1          | Power Management                                  |     | X   | X   |
| 1.7.2          | Power Cost Analysis                               |     | X   | X   |
| 1.8            | SUPERVISION & ADMINISTRATION                      | X   | X   | X   |
| 1.9            | PUBLIC RELATIONS                                  | X   | X   | X   |
| 1.10           | SAFETY  | X   | X   | X   |
| 1.11           | WATER TREATMENT PLANT OPERATIONS                  | X   | X   | X   |
| 1.12           | MATH ASSIGNMENT                                   | X   | X   | X   |
| CHAPTER REVIEW | REVIEW ALL QUESTIONS                              | ALL | ALL | ALL |

## PART I

## WATER TREATMENT PLANT OPERATION VOLUME I

| SECTION | TOPIC   | C | B | A |
|---------|---|---|---|---|
| 2       | <b>KEY TERMS: SOURCE WATER, RESERVOIR MANAGEMENT, &amp; INTAKE STRUCTURES</b> |   |   |   |
| 2.1     | SOURCES OF WATER  | X | X | X |
| 2.1.1   | Ocean   | X | X | X |
| 2.1.2   | Surface Water Treatment Rule (SWTR)   | X | X | X |
| 2.1.2.1 | Rivers & Streams  | X | X | X |
| 2.1.2.2 | Lakes & Reservoirs  | X | X | X |
| 2.1.3   | Groundwater   | X | X | X |
| 2.1.3.1 | Wells   | X | X | X |
| 2.1.3.2 | Springs   | X | X | X |
| 2.1.4   | Reclaimed Water   | X | X | X |
| 2.2     | SELECTION OF A WATER SOURCE   | X | X | X |
| 2.2.1   | Water Rights  | X | X | X |
| 2.2.2   | Sanitary Survey   | X | X | X |
| 2.2.3   | Contamination   | X | X | X |
| 2.2.3.1 | Physical Characteristics  | X | X | X |
| 2.2.3.2 | Chemical Characteristics  | X | X | X |
| 2.2.3.3 | Biological Factors  | X | X | X |
| 2.2.3.4 | Radiological Factors  | X | X | X |
| 2.3     | SURFACE RESERVOIRS AS DOMESTIC WATER SUPPLIES                                 | X | X | X |
| 2.3.1   | Factors Affecting Water Quality   | X | X | X |
| 2.3.1.1 | Watershed Conditions  |   | X |   |
| 2.3.1.2 | Thermal Stratification  | X | X | X |
| 2.3.1.3 | Nutrients   | X | X | X |
| 2.3.1.4 | Algal Blooms  | X | X | X |
| 2.3.1.5 | Anaerobic Conditions  | X | X | X |
| 2.4     | RESERVOIR MANAGEMENT PROGRAMS   |   | X | X |
| 2.4.1   | Improvement & Maintenance of Water Quality                                    |   | X | X |
| 2.4.2   | Reduction of Water Treatment Costs  |   | X | X |
| 2.4.3   | Improvement & Maintenance of Fishery, Recreational, & Property Values         |   | X | X |
| 2.4.4   | Removal of Trees & Brush in Areas to Be Flooded                               |   | X | X |
| 2.4.5   | Watershed Management  |   | X | X |
| 2.4.5.1 | Wastewater  |   | X | X |
| 2.4.5.2 | Fertilization   |   | X | X |
| 2.4.5.3 | Industrial Discharges   |   | X | X |
| 2.4.5.4 | Soil Grading & Farming Practices  |   | X | X |
| 2.4.5.5 | Livestock Grazing   |   | X | X |
| 2.4.5.6 | Pesticides & Herbicides   |   | X | X |
| 2.4.5.7 | Wildfires   |   | X | X |
| 2.4.5.8 | Land Use Control  |   | X | X |
| 2.4.5.9 | Highway Stormwater Runoff   |   | X | X |
| 2.4.6   | Algae Control by Chemical Methods   |   | X | X |
| 2.4.6.1 | Chemicals Available   |   | X | X |
| 2.4.6.2 | Methods of Copper Sulfate Applications  |   | X | X |
| 2.4.6.3 | Copper Sulfate Doses  |   | X | X |
| 2.4.6.4 | Monitoring  |   | X | X |
| 2.4.6.5 | Recordkeeping   |   | X | X |
| 2.4.6.6 | Safety  |   | X | X |
| 2.4.7   | Reaeration & Artificial Destratification                                      |   |   | X |
| 2.4.7.1 | Methods of Reaeration   |   |   | X |
| 2.4.7.2 | Destratification  |   |   | X |
| 2.4.7.3 | Hypolimnetic Aeration or Oxygenation  |   |   | X |
| 2.4.8   | Managing Frozen Reservoirs  |   |   | X |
| 2.4.8.1 | Physical Effects of Ice Formation   |   |   | X |

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| 2.4.8.2        | Effects on Raw Water Quality                     |     |     | X   |
| 2.4.8.3        | Recreational Use of Reservoir Ice Surfaces       |     |     | X   |
| 2.4.9          | Dam & Reservoir Management                       |     |     | X   |
| 2.4.9.1        | Dam Inspection & Maintenance                     |     |     | X   |
| 2.4.9.2        | Reservoir Maintenance                            |     |     | X   |
| 2.5            | LABORATORY & MONITORING PROGRAMS                 |     |     | X   |
| 2.5.1          | Procedures                                       |     |     | X   |
| 2.5.2          | Recordkeeping                                    |     |     | X   |
| 2.5.3          | Safety   |     |     | X   |
| 2.6            | INTAKE STRUCTURES                                |     |     | X   |
| 2.6.1          | Types of Intake Structures                       |     |     | X   |
| 2.6.2          | Types of Intake Gates                            |     |     | X   |
| 2.6.3          | Intake Screens & Trash Racks                     |     |     | X   |
| 2.6.4          | Operation & Maintenance Procedures               |     |     | X   |
| 2.6.5          | Records & Management                             |     |     | X   |
| 2.6.6          | Safety   |     |     | X   |
| 2.7            | Math Assignment                                  | X   | X   | X   |
| CHAPTER REVIEW | REVIEW ALL QUESTIONS                             | ALL | ALL | ALL |
| 3              | <b>KEY TERMS: COAGULATION &amp; FLOCCULATION</b> |     |     |     |
| 3.1            | REMOVING PARTICULATES FROM WATER                 | X   | X   | X   |
| 3.2            | COAGULATION                                      | X   | X   | X   |
| 3.2.1          | Coagulants                                       | X   | X   | X   |
| 3.2.2          | Basic Coagulant Chemistry                        | X   | X   | X   |
| 3.2.3          | Effective Mixing                                 | X   | X   | X   |
| 3.3            | FLOCCULATION                                     | X   | X   | X   |
| 3.3.1          | Process Performance                              | X   | X   | X   |
| 3.3.1.1        | Detention Time                                   | X   | X   | X   |
| 3.3.1.2        | Types of Flocculators (Stirrers)                 | X   | X   | X   |
| 3.3.1.3        | Flocculation Basins                              | X   | X   | X   |
| 3.4            | INTERACTION WITH OTHER TREATMENT PROCESSES       | X   | X   | X   |
| 3.5            | PROCESS CONTROL                                  | X   | X   | X   |
| 3.6            | NORMAL OPERASTIONS                               | X   | X   | X   |
| 3.6.1          | Process Actions                                  | X   | X   | X   |
| 3.6.2          | Process Operations                               | X   | X   | X   |
| 3.6.2.1        | Detention Times                                  | X   | X   | X   |
| 3.6.2.2        | The Jar Test                                     | X   | X   | X   |
| 3.6.2.3        | Streaming Current Meters                         | X   | X   | X   |
| 3.6.2.4        | Evaluation of Plant Performance                  | X   | X   | X   |
| 3.6.3          | Chemical Usage for Small Plants                  | X   | X   | X   |
| 3.6.3.1        | Calculating the Amount of Chemical Required      | X   | X   | X   |
| 3.6.3.2        | Chemical Feeding                                 | X   | X   | X   |
| 3.6.3.3        | Preparation of Chemical Solutions                | X   | X   | X   |
| 3.6.4          | Recordkeeping                                    | X   | X   | X   |
| 3.6.5          | Safety   | X   | X   | X   |
| 3.6.6          | Communications                                   | X   | X   | X   |
| 3.7            | ABNORMAL CONDITIONS                              | X   | X   | X   |
| 3.7.1          | Process Actions                                  |     | X   | X   |
| 3.7.2          | Recordkeeping                                    |     | X   | X   |
| 3.7.3          | Communications                                   |     | X   | X   |
| 3.8            | STARTUP & SHUTDOWN PROCEDURES                    |     | X   | X   |
| 3.8.1          | Startup Procedure                                |     | X   | X   |
| 3.8.2          | Shutdown Procedure                               |     | X   | X   |
| 3.8.3          | Recordkeeping                                    | X   | X   | X   |

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| 3.8.4          | Safety                                 | X   | X   | X   |
| 3.9            | LABORATORY TESTS                       | X   | X   | X   |
| 3.9.1          | Sampling Procedures                    | X   | X   | X   |
| 3.9.2          | Sample Analysis                        | X   | X   | X   |
| 3.9.3          | Safety                                 | X   | X   | X   |
| 3.9.4          | Recordkeeping                          | X   | X   | X   |
| 3.10           | EQUIPMENT OPERATION & MAINTENANCE      | X   | X   | X   |
| 3.10.1         | Chemical Feeders                       | X   | X   | X   |
| 3.10.2         | Calibration Method                     | X   | X   | X   |
| 3.10.3         | Preventive Maintenance Procedures      | X   | X   | X   |
| 3.10.4         | Safety                                 | X   | X   | X   |
| 3.11           | ENHANCED COAGULATION                   |     | X   | X   |
| 3.11.1         | Chemical Reactions                     |     | X   | X   |
| 3.11.2         | Process Control                        |     | X   | X   |
| 3.12           | BALLASTED FLOCCULATION                 |     | X   | X   |
| 3.12.1         | Process Stages                         |     | X   | X   |
| 3.12.2         | Startup                                |     | X   | X   |
| 3.12.3         | Microsand Management                   |     | X   | X   |
| 3.12.3.1       | Microsand Concentration Monitoring     |     | X   | X   |
| 3.12.3.2       | Microsand Addition                     |     | X   | X   |
| 3.12.4         | Hydrocyclone Performance               |     | X   | X   |
| 3.12.5         | Process Performance Monitoring         |     | X   | X   |
| 3.12.6         | Process Optimization                   |     | X   | X   |
| 3.12.7         | Troubleshooting Procedures             |     | X   | X   |
| 3.12.8         | Intermittent Use                       |     | X   | X   |
| 3.12.8.1       | Short-Term Standby Mode (Wet Storage)  |     | X   | X   |
| 3.12.8.2       | Long Term Shutdown & Freeze Protection |     | X   | X   |
| 3.12.9         | Equipment Maintenance                  |     | X   | X   |
| 3.12.9.1       | Tube Setter Modules                    |     | X   | X   |
| 3.12.9.2       | Mixers                                 |     | X   | X   |
| 3.12.9.3       | Scrapers                               |     | X   | X   |
| 3.12.9.4       | Microsand Recirculation Pumps          |     | X   | X   |
| 3.12.9.5       | Hydrocyclones                          |     | X   | X   |
| 3.13           | MATH ASSIGNMENT                        | X   | X   | X   |
| CHAPTER REVIEW | REVIEW ALL QUESTIONS                   | ALL | ALL | ALL |
| 4              | <b>KEY TERMS: SEDIMENTATION</b>        |     |     |     |
| 4.1            | PRESEDIMENTATION                       | X   | X   | X   |
| 4.2            | PROCESS PERFORMANCE                    | X   | X   | X   |
| 4.2.1          | Nature of Particulate Impurities       | X   | X   | X   |
| 4.2.2          | Water Temperature                      | X   | X   | X   |
| 4.2.3          | Currents                               | X   | X   | X   |
| 4.2.4          | Particle Interactions                  | X   | X   | X   |
| 4.3            | SEDIMENTATION BASINS                   |     | X   | X   |
| 4.3.1          | Basin Types                            |     | X   | X   |
| 4.3.1.1        | Rectangular Basins                     |     | X   | X   |
| 4.3.1.2        | Double-Deck Basins                     |     | X   | X   |
| 4.3.1.3        | Circular & Square Basins               |     | X   | X   |
| 4.3.1.4        | High-Rate Settlers                     |     | X   | X   |
| 4.3.1.5        | Solids-Contact Units                   |     | X   | X   |
| 4.4            | DESIGN & OPERATIONAL GUIDELINES        | X   | X   | X   |
| 4.4.1          | Basin Layout                           | X   | X   | X   |
| 4.4.2          | Detention Time                         | X   | X   | X   |
| 4.4.3          | Surface Loading                        |     | X   | X   |

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| 4.4.4          | Effective Water Depth                      |     | X   | X   |
| 4.4.5          | Mean Flow Velocity                         |     | X   | X   |
| 4.4.6          | Weir Loading Time                          |     | X   | X   |
| 4.5            | SOLIDS-CONTACT CLARIFICATION               |     | X   | X   |
| 4.5.1          | Operational Control                        |     | X   | X   |
| 4.5.2          | Maintenance                                |     | X   | X   |
| 4.5.3          | Calculations                               |     |     | X   |
| 4.6            | SLUDGE HANDLING                            |     | X   | X   |
| 4.6.1          | Sludge Removal Systems                     | X   | X   | X   |
| 4.6.2          | Sludge Removal Frequency                   | X   | X   | X   |
| 4.7            | INTERACTION WITH OTHER TREATMENT PROCESSES | X   | X   | X   |
| 4.8            | NORMAL OPERATIONS                          | X   | X   | X   |
| 4.8.1          | Process Control                            | X   | X   | X   |
| 4.8.2          | Process Actions                            | X   | X   | X   |
| 4.8.3          | Recordkeeping                              |     | X   | X   |
| 4.9            | ABNORMAL OPERATIONS                        | X   | X   | X   |
| 4.9.1          | Process Actions                            | X   | X   | X   |
| 4.10           | STARTUP & SHUTDOWN PROCEDURES              |     | X   | X   |
| 4.10.1         | Startup Procedure                          |     | X   | X   |
| 4.10.2         | Shutdown Procedure                         |     | X   | X   |
| 4.11           | LABORATORY TESTS                           | X   | X   | X   |
| 4.11.1         | Sampling Procedures                        | X   | X   | X   |
| 4.11.2         | Sample Analysis                            | X   | X   | X   |
| 4.12           | EQUIPMENT OPERATION & MAINTENANCE          |     | X   | X   |
| 4.12.1         | Corrosion Control                          |     | X   | X   |
| 4.12.2         | Preventive Maintenance Procedures          |     | X   | X   |
| 4.12.3         | Safety                                     | X   | X   | X   |
| 4.13           | MATH ASSIGNMENT                            | X   | X   | X   |
| CHAPTER REVIEW | REVIEW ALL QUESTIONS                       | ALL | ALL | ALL |
| 5              | <b>KEY TERMS: FILTRATION</b>               |     |     |     |
| 5.1            | FILTRATION MECHANISMS                      | X   | X   | X   |
| 5.2            | TYPES OF FILTERS                           | X   | X   | X   |
| 5.2.1          | Gravity Filtration                         | X   | X   | X   |
| 5.2.2          | Pressure Filtration                        | X   | X   | X   |
| 5.2.4          | Slow Sand Filtration                       |     |     | X   |
| 5.3            | PROCESS PERFORMANCE CONSIDERATIONS         |     | X   | X   |
| 5.3.1          | Filter Media                               |     |     | X   |
| 5.3.2          | Operational Criteria                       |     |     | X   |
| 5.3.2.1        | Filter Layout                              |     | X   | X   |
| 5.3.2.2        | Filter Production & Filtration Rate        |     | X   | X   |
| 5.3.2.3        | Filtration Efficiency                      |     | X   | X   |
| 5.3.3          | Filter Operation                           | X   | X   | X   |
| 5.3.3.1        | Filtration Mode                            | X   | X   | X   |
| 5.3.3.2        | Backwashing                                | X   | X   | X   |
| 5.3.3.3        | Surface Wash                               | X   | X   | X   |
| 5.3.4          | Filter Control Systems                     |     |     | X   |
| 5.4            | ACTIVATED CARBON FILTERS                   |     |     | X   |
| 5.5            | INTERACTION WITH OTHER TREATMENT PROCESSES | X   | X   | X   |
| 5.5.1          | Pretreatment Processes                     |     | X   | X   |
| 5.5.2          | Inline Filtration                          |     | X   | X   |
| 5.5.3          | Conventional Filtration (Treatment)        |     | X   | X   |
| 5.5.4          | Direct Filtration                          |     | X   | X   |
| 5.6            | PROCESS CONTROL                            | X   | X   | X   |

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## WATER TREATMENT PLANT OPERATION VOLUME I

| SECTION        | TOPIC  | C   | B   | A   |
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| 5.7            | OPERATING PROCEDURES ASSOCIATED WITH NORMAL PROCESS CONDITIONS   | X   | X   | X   |
| 5.7.1          | Process Actions  |     | X   | X   |
| 5.7.2          | Mudball Evaluation Procedure                                     |     |     | X   |
| 5.7.3          | Process Calculations   |     | X   | X   |
| 5.7.3.1        | Filter Efficiency  |     | X   | X   |
| 5.7.3.2        | Filtration Rate  |     | X   | X   |
| 5.7.3.3        | Backwash Rate  |     | X   | X   |
| 5.7.4          | Recordkeeping  |     | X   | X   |
| 5.7.5          | Filter Monitoring Instrumentation                                |     | X   | X   |
| 5.8            | OPERATING PROCEDURES ASSOCIATED WITH ABNORMAL PROCESS CONDITIONS |     |     | X   |
| 5.8.1          | Process Actions  |     | X   | X   |
| 5.8.2          | Air Binding  | X   | X   | X   |
| 5.8.3          | Excessive Head Loss  |     | X   | X   |
| 5.9            | STARTUP & SHUTDOWN PROCEDURES                                    | X   | X   | X   |
| 5.9.1          | Implementation of Startup/Shutdown Procedures                    | X   | X   | X   |
| 5.9.1.1        | Filter Checkout Procedures                                       | X   | X   | X   |
| 5.9.1.2        | Backwash Procedures  | X   | X   | X   |
| 5.9.1.3        | Filter Startup Procedures  | X   | X   | X   |
| 5.9.1.4        | Filter Shutdown Procedures                                       | X   | X   | X   |
| 5.10           | PROCESS & SUPPORT EQUIPMENT OPERATION & MAINTENANCE              |     |     | X   |
| 5.10.1         | EQUIPMENT OPERATION & MAINTENANCE                                |     | X   | X   |
| 5.10.2         | Preventive Maintenance Procedures                                |     | X   | X   |
| 5.10.3         | Safety Considerations  | X   | X   | X   |
| 5.11           | DRINKING WATER REGULATIONS                                       |     | X   | X   |
| 5.11.1         | Safe Drinking Water Act (SDWA)                                   | X   | X   | X   |
| 5.11.2         | Surface Water Treatment Rule (SWTR)                              | X   | X   | X   |
| 5.11.3         | Turbidity Requirements   | X   | X   | X   |
| 5.12           | PARTICLE COUNTERS  |     |     | X   |
| 5.12.1         | Particle Counting to Monitor Filter Performance                  |     |     | X   |
| 5.12.1.1       | Filter Ripening  |     |     | X   |
| 5.12.1.2       | Filter Flow Rate   |     |     | X   |
| 5.12.1.3       | Filter Run Time  |     |     | X   |
| 5.12.1.4       | Filter Media Selection   |     |     | X   |
| 5.12.1.5       | Polymer Application  |     |     | X   |
| 5.12.1.6       | Other Uses of Particle Counters                                  |     |     | X   |
| 5.12.2         | How Particle Counters Work                                       |     |     | X   |
| 5.12.3         | Grab vs. In-Process Particle Counters                            |     |     | X   |
| 5.12.3.1       | Grab Samples   | X   | X   | X   |
| 5.12.3.2       | In-Process Measurements  |     | X   | X   |
| 5.12.4         | Particle Counters Compared to Turbidity Meters                   |     | X   | X   |
| 5.12.5         | Operation & Maintenance  |     |     | X   |
| 5.12.5.1       | Sampling   |     | X   | X   |
| 5.12.5.2       | Flow Control   |     |     | X   |
| 5.12.5.3       | Sample Tubing  |     | X   | X   |
| 5.12.5.4       | Bubbles  |     | X   | X   |
| 5.12.5.5       | Initial Startup  | X   | X   | X   |
| 5.12.5.6       | Overconcentration  |     |     | X   |
| 5.12.5.7       | Troubleshooting  |     | X   | X   |
| 5.12.5.8       | Quality Assurance/Quality Control                                |     |     | X   |
| 5.13           | MATH ASSIGNMENT  | X   | X   | X   |
| CHAPTER REVIEW | REVIEW ALL QUESTIONS   | ALL | ALL | ALL |

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| 6       | <b>KEY TERMS: DISINFECTION</b>                                    |   |   |   |
| 6.1     | DRINKING WATER SAFETY   | X | X | X |
| 6.1.1   | Safe Drinking Water Laws  | X | X | X |
| 6.2     | FACTORS INFLUENCING DISINFECTION                                  | X | X | X |
| 6.2.1   | pH  | X | X | X |
| 6.2.2   | Temperature   | X | X | X |
| 6.2.3   | Turbidity Requirements  | X | X | X |
| 6.2.3.1 | Organic Matter  | X | X | X |
| 6.2.3.2 | Inorganic Matter  | X | X | X |
| 6.2.4   | Reducing Agents   | X | X | X |
| 6.2.5   | Microorganisms  | X | X | X |
| 6.2.5.1 | Removal Processes   | X | X | X |
| 6.3     | DISINFECTION PROCESS  | X | X | X |
| 6.3.1   | Physical Means of Disinfection                                    | X | X | X |
| 6.3.2   | Chemical Disinfectants (Other than Chlorine)                      | X | X | X |
| 6.3.3   | Chlorine  | X | X | X |
| 6.3.3.1 | Chlorine Disinfection Action                                      | X | X | X |
| 6.3.3.2 | Reaction with Water   | X | X | X |
| 6.3.3.3 | Reaction with Impurities in Water                                 |   | X | X |
| 6.3.4   | Hypochlorite  | X | X | X |
| 6.3.4.1 | Reactions with Water  | X | X | X |
| 6.3.4.2 | Difference Between Chlorine Gas & Hypochlorite Compound Reactions | X | X | X |
| 6.3.4.3 | Onsite Chlorine Generation  |   | X | X |
| 6.3.5   | Chlorine Dioxide  |   | X | X |
| 6.3.5.1 | Reaction in Water   |   | X | X |
| 6.3.5.2 | Reactions with Impurities in Water                                |   | X | X |
| 6.3.6   | Breakpoint Chlorination   |   | X | X |
| 6.3.7   | Chloramination  | X | X | X |
| 6.3.7.1 | Methods of Producing Chloramines                                  | X | X | X |
| 6.3.7.2 | Chlorine-to-Ammonia-Nitrogen Ratios                               | X | X | X |
| 6.3.7.3 | Special Water Users   | X | X | X |
| 6.3.7.4 | Blending Chloraminated Waters                                     | X | X | X |
| 6.3.7.5 | Chloramine Residuals  | X | X | X |
| 6.3.8   | Nitrification   |   | X | X |
| 6.3.8.1 | Nitrification Prevention & Control                                |   | X | X |
| 6.3.9   | Chlorine Residual Testing   | X | X | X |
| 6.3.9.1 | Chlorine Residual Curve   |   | X | X |
| 6.3.9.2 | Critical Factors  |   | X | X |
| 6.3.10  | CT Values   |   | X | X |
| 6.3.11  | Process Calculations  | X | X | X |
| 6.4     | POINTS OF CHLORINE APPLICATION                                    | X | X | X |
| 6.4.1   | Prechlorination   | X | X | X |
| 6.4.2   | Postchlorination  | X | X | X |
| 6.4.3   | Rechlorination  | X | X | X |
| 6.4.4   | Wells   | X | X | X |
| 6.4.5   | Mains   | X | X | X |
| 6.4.6   | Tanks & Reservoirs  | X | X | X |
| 6.5     | OPERATION OF CHLORINATION EQUIPMENT                               | X | X | X |
| 6.5.1   | Hypochlorinators  | X | X | X |
| 6.5.2   | Chlorinators  | X | X | X |
| 6.5.2.1 | Chlorinator Flow Path   |   | X | X |
| 6.5.2.2 | Chlorinator Parts & Their Purpose                                 |   | X | X |
| 6.5.3   | Chlorine Containers   | X | X | X |
| 6.5.3.1 | Plastic   | X | X | X |



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| 6.5.3.2  | Steel Cylinders                              | X | X | X |
| 6.5.3.3  | Ton Tanks                                    | X | X | X |
| 6.5.4    | Protect Yourself from Chlorine               | X | X | X |
| 6.5.5    | Removing Chlorine from Containers            | X | X | X |
| 6.5.5.1  | Connections                                  | X | X | X |
| 6.5.5.2  | Valves                                       | X | X | X |
| 6.5.5.3  | Ton Tanks                                    | X | X | X |
| 6.5.6    | Performance of Chlorination Units            | X | X | X |
| 6.5.6.1  | Hypochlorinators                             |   | X | X |
| 6.5.6.2  | Chlorinators                                 |   | X | X |
| 6.5.7    | Normal & Abnormal Operation                  | X | X | X |
| 6.5.7.1  | Container Storage Area                       | X | X | X |
| 6.5.7.2  | Evaporators                                  | X | X | X |
| 6.5.7.3  | Chlorinators, Including Injectors            | X | X | X |
| 6.5.7.4  | Summary, Dailey Operation                    | X | X | X |
| 6.5.7.5  | Laboratory Tests                             | X | X | X |
| 6.5.8    | Troubleshooting Gas Chlorinator Systems      | X | X | X |
| 6.5.9    | Disinfection Troubleshooting                 | X | X | X |
| 6.5.10   | Chlorination System Failure                  | X | X | X |
| 6.6      | MAINTENANCE                                  | X | X | X |
| 6.6.1    | Chlorine Leaks                               | X | X | X |
| 6.6.2    | Installation                                 | X | X | X |
| 6.7      | CHLORINE DIOXIDE FACILITES                   | X | X | X |
| 6.7.1    | Safe Handling of Chemicals                   | X | X | X |
| 6.7.2    | Operation                                    |   | X | X |
| 6.7.2.1  | Prestart Procedures                          |   | X | X |
| 6.7.2.2  | Startup                                      |   | X | X |
| 6.7.2.3  | Shutdown                                     |   | X | X |
| 6.7.3    | Maintenance                                  |   | X | X |
| 6.7.4    | Troubleshooting                              |   | X | X |
| 6.8      | MEASUREMENT OF CHLORINE RESIDUAL             | X | X | X |
| 6.8.1    | Methods of Measuring Chlorine Residual       | X | X | X |
| 6.8.2    | ORP Probes                                   |   | X | X |
| 6.9      | CHLORINE SAFETY PROGRAM                      | X | X | X |
| 6.9.1    | Chlorine Hazards                             | X | X | X |
| 6.9.2    | Why Chlorine Must Be Handled with Care       | X | X | X |
| 6.9.3    | Protect Yourself from Chlorine               | X | X | X |
| 6.9.4    | Hypochlorite Safety                          | X | X | X |
| 6.9.5    | Chlorine Dioxide Safety                      | X | X | X |
| 6.9.6    | Operator Safety Training                     | X | X | X |
| 6.9.7    | CHEMTREC                                     | X | X | X |
| 6.10     | ULTRAVIOLET (UV) SYSTEMS                     |   |   | X |
| 6.10.1   | UV Lamp Types                                |   |   | X |
| 6.10.2   | UV System Types                              |   |   | X |
| 6.10.3   | Safety                                       |   |   | X |
| 6.10.4   | Operation                                    |   |   | X |
| 6.10.4.1 | UV Light Intensity Effectiveness             |   |   | X |
| 6.10.4.2 | Minimum UV Dose Management                   |   |   | X |
| 6.10.4.3 | Routine Operations Tasks                     |   |   | X |
| 6.10.4.4 | Wiping System                                |   |   | X |
| 6.10.4.5 | Equipment Startup/Shutdown Preliminary Steps |   |   | X |
| 6.10.4.6 | Shutdown Sequence                            |   |   | X |
| 6.10.4.7 | Cleaning the Tank                            |   |   | X |
| 6.10.4.8 | Startup Sequence                             |   |   | X |

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| 6.10.4.10      | Monitoring Influent & Effluent Characteristics |     |     | X   |
| 6.10.5         | Emergency Alarms                               |     |     | X   |
| 6.40.6         | Maintenance                                    |     |     | X   |
| 6.10.6.1       | Quartz Sleeve Cleaning                         |     |     | X   |
| 6.10.6.2       | Lamp Maintenance                               |     |     | X   |
| 6.10.7         | Troubleshooting                                |     |     | X   |
| 6.10.7.1       | System Hydraulics                              |     |     | X   |
| 6.10.7.2       | Biofilms on UV Channel Walls & Equipment       |     |     | X   |
| 6.10.7.3       | Particles Shielding Bacteria                   |     |     | X   |
| 6.11           | OZONE SYSTEMS                                  | X   | X   | X   |
| 6.11.1         | EQUIPMENT                                      | X   | X   | X   |
| 6.11.2         | Gas Preparation                                |     | X   | X   |
| 6.11.3         | Electrical Supply Unit                         |     | X   | X   |
| 6.11.4         | Ozone Generator                                |     | X   | X   |
| 6.11.5         | Ozone Contactor                                |     | X   | X   |
| 6.11.6         | Ozone Residuals                                | X   | X   | X   |
| 6.11.7         | Safety   | X   | X   | X   |
| 6.11.8         | Maintenance                                    |     | X   | X   |
| 6.11.9         | Applications of Ozone                          |     | X   | X   |
| 6.11.10        | Advantages and Limitations of Ozone            | X   | X   | X   |
| 6.12           | MIXED OXIDANTS (MIOX) SYSTEMS                  | X   | X   | X   |
| 6.13           | TYPICAL CHLORINATION MATH PROBLEMS             | X   | X   | X   |
| 6.13.1         | Chlorinators                                   | X   | X   | X   |
| 6.13.2         | Hypochlorinators                               | X   | X   | X   |
| 6.14           | MATH ASSIGNMENT                                | X   | X   | X   |
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| 7              | <b>KEY TERMS: CORROSION CONTROL</b>            |     |     |     |
| 7.1            | ADVERSE EFFECTS OF CORROSION                   | X   | X   | X   |
| 7.2            | CORROSION PROCESS                              | X   | X   | X   |
| 7.2.1          | Electrochemical Corrosion: The Galvanic Cell   |     | X   | X   |
| 7.3            | FACTORS INFLUENCING CORROSION                  |     | X   | X   |
| 7.3.1          | Physical Factors                               |     | X   | X   |
| 7.3.1.1        | System Construction                            |     | X   | X   |
| 7.3.1.2        | System Pressure                                |     | X   | X   |
| 7.3.1.3        | Soil Moisture                                  |     | X   | X   |
| 7.3.1.4        | Stray Electric Current                         |     | X   | X   |
| 7.3.1.5        | Temperature                                    |     | X   | X   |
| 7.3.1.6        | Flow Velocity                                  |     | X   | X   |
| 7.3.2          | Chemical Factors                               |     | X   | X   |
| 7.3.2.1        | Alkalinity                                     |     | X   | X   |
| 7.3.2.2        | pH   |     | X   | X   |
| 7.3.2.3        | Dissolved Oxygen                               |     | X   | X   |
| 7.3.2.4        | Dissolved Solids                               |     | X   | X   |
| 7.3.2.5        | Hardness                                       |     | X   | X   |
| 7.3.2.6        | Chloride & Sulfate                             |     | X   | X   |
| 7.3.2.7        | Phosphate & Silicate                           |     | X   | X   |
| 7.3.2.8        | Trace Materials                                |     | X   | X   |
| 7.3.3          | Biological Factors                             |     | X   | X   |
| 7.3.3.1        | Iron Bacteria                                  |     | X   | X   |
| 7.3.3.2        | Sulfate-Reducing Bacteria                      |     | X   | X   |
| 7.3.4          | Oxygen Concentration Cell                      |     |     | X   |
| 7.4            | HOW TO DETERMINE IF CORROSION PROBLEMS EXIST   | X   | X   | X   |

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| 7.4.1          | Examine Materials Removed from Distribution System | X   | X   | X   |
| 7.4.2          | Flow Tests   |     |     | X   |
| 7.4.3          | Chemical Tests on Water                            |     |     | X   |
| 7.4.3.1        | Dissolved Oxygen                                   |     | X   | X   |
| 7.4.3.2        | Toxic Heavy Metals                                 |     | X   | X   |
| 7.4.3.3        | Calcium Carbonate Saturation                       |     | X   | X   |
| 7.4.4          | Complaints   | X   | X   | X   |
| 7.5            | METHODS OF CONTROLLING CORROSION                   |     | X   | X   |
| 7.5.1          | Selection of Corrosion Control Chemicals           |     | X   | X   |
| 7.5.2          | Determination of Chemical Dose                     |     | X   | X   |
| 7.5.3          | Determination of Chemical Feeder Setting           |     | X   | X   |
| 7.5.4          | Zinc, Silica, and Phosphate Compounds              |     | X   | X   |
| 7.5.5          | Cathodic Protection                                |     | X   | X   |
| 7.5.5.1        | How the Protection System Works                    |     |     | X   |
| 7.5.5.2        | Equipment  |     | X   | X   |
| 7.5.5.3        | Protection of Flocculators, Clarifiers, & Filters  |     |     | X   |
| 7.5.5.4        | Maintenance  |     | X   | X   |
| 7.5.6          | Removal of Oxygen                                  |     |     | X   |
| 7.5.7          | External Corrosion                                 |     |     | X   |
| 7.5.7.1        | Soil Corrosion                                     |     |     | X   |
| 7.5.7.2        | Corrosion of Steel Embedded in Concrete            |     |     | X   |
| 7.5.7.3        | Stray Electric Currents                            |     | X   | X   |
| 7.6            | TROUBLESHOOTING                                    |     | X   | X   |
| 7.6.1          | Internal Pipe Corrosion                            |     |     | X   |
| 7.6.2          | External Pipe Corrosion                            |     |     | X   |
| 7.7            | THE LEAD & COPPER RULE                             |     | X   | X   |
| 7.7.1          | Health Concerns                                    | X   | X   | X   |
| 7.7.2          | Regulations  |     | X   | X   |
| 7.7.3          | Monitoring Requirements                            |     | X   | X   |
| 7.7.3.1        | Monitoring Frequency                               |     | X   | X   |
| 7.7.3.2        | Sampling Procedures                                |     | X   | X   |
| 7.7.3.3        | Maximum Contaminant Level Goals (MCLGs)            |     | X   | X   |
| 7.7.3.4        | Other Water Quality Monitoring                     |     | X   | X   |
| 7.7.3.5        | Analytical Methods & Certification Requirements    |     |     | X   |
| 7.7.4          | Treatment Requirements                             |     |     | X   |
| 7.7.4.1        | Corrosion Treatment Studies                        |     |     | X   |
| 7.7.4.2        | Source Water Treatment                             |     |     | X   |
| 7.7.4.3        | Lead Service Line Replacement                      |     |     | X   |
| 7.7.4.4        | Treatment for Control of Lead & Copper             |     |     | X   |
| 7.7.5          | Public Education & Reporting Requirements          |     |     | X   |
| 7.7.5.1        | Public Education                                   |     |     | X   |
| 7.7.5.2        | Reporting & Recordkeeping Requirements             |     |     | X   |
| 7.8            | MATH ASSIGNMENT                                    | X   | X   | X   |
| CHAPTER REVIEW | REVIEW ALL QUESTIONS                               | ALL | ALL | ALL |
| 8              | <b>KEY TERMS: TASTE AND ODOR</b>                   |     |     |     |
| 8.1            | EFFECTS OF TASTE & ODOR PROBLEMS                   | X   | X   | X   |
| 8.2            | CAUSES OF TASTES & ODORS                           | X   | X   | X   |
| 8.2.1          | Common Taste & Odor Compounds                      | X   | X   | X   |
| 8.2.2          | Natural Causes                                     |     | X   | X   |
| 8.2.2.1        | Biological Growth in Source Waters                 |     | X   | X   |
| 8.2.2.2        | Environmental Conditions                           |     | X   | X   |
| 8.2.3          | Human Causes                                       | X   | X   | X   |
| 8.2.3.1        | Municipal Wastewaters                              |     | X   | X   |

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| 8.2.3.2        | Industrial Wastes                                  |     | X   | X   |
| 8.2.3.3        | Chemical Spills                                    |     | X   | X   |
| 8.2.3.4        | Urban Runoff                                       |     | X   | X   |
| 8.2.3.5        | Agricultural Wastes                                |     | X   | X   |
| 8.2.3.6        | Treatment Plant & Distribution System Conditions   |     | X   | X   |
| 8.2.3.7        | Household Plumbing                                 |     | X   | X   |
| 8.3            | LOCATING TASTE & ODOR SOURCES                      | X   | X   | X   |
| 8.3.1          | Raw Water Sources                                  | X   | X   | X   |
| 8.3.2          | Treatment Plant                                    |     | X   | X   |
| 8.3.3          | Distribution System                                | X   | X   | X   |
| 8.4            | TASTE & ODOR PREVENTION & MONITORING               | X   | X   | X   |
| 8.4.1          | Raw Water Management                               |     | X   | X   |
| 8.4.2          | Plant Maintenance                                  |     | X   | X   |
| 8.4.3          | Distribution System Maintenance                    |     | X   | X   |
| 8.5            | TASTE & ODOR TREATMENT                             | X   | X   | X   |
| 8.5.1          | Improved Coagulation/Flocculation/Sedimentation    |     | X   | X   |
| 8.5.2          | Aeration Processes & Systems                       | X   | X   | X   |
| 8.5.2.1        | Air Blowers  |     | X   | X   |
| 8.5.2.2        | Cascades & Spray Aerators                          |     | X   | X   |
| 8.5.2.3        | Air Stripping                                      |     | X   | X   |
| 8.5.3          | Oxidative Processes                                | X   | X   | X   |
| 8.5.3.1        | Chlorine   | X   | X   | X   |
| 8.5.3.2        | Potassium Permanganate                             | X   | X   | X   |
| 8.5.3.3        | Ozone  | X   | X   | X   |
| 8.5.3.4        | Chlorine Dioxide                                   | X   | X   | X   |
| 8.5.4          | Adsorption Processes                               | X   | X   | X   |
| 8.5.4.1        | Powdered Activated Carbon                          |     | X   | X   |
| 8.5.4.2        | Granular Activated Carbon                          |     | X   | X   |
| 8.6            | IDENTIFYING TASTE & ODOR PROBLEMS                  | X   | X   | X   |
| 8.7            | DEVELOPING A TASTE & ODOR CONTROL STRATEGY         |     | X   | X   |
| 8.8            | MATH ASSIGNMENT                                    | X   | X   | X   |
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| 9              | <b>KEY TERMS: LABORATORY PROCEDURES</b>            |     |     |     |
| 9.1            | BASIC LABORATORY CONCEPTS, EQUIPMENT, & TECHNIQUES | X   | X   | X   |
| 9.1.2          | Chemical Names & Formulas                          | X   | X   | X   |
| 9.2            | LABORATORY EQUIPMENT & TECHNIQUES                  | X   | X   | X   |
| 9.2.1          | Water Laboratory Equipment                         | X   | X   | X   |
| 9.2.2          | Using Laboratory Glassware                         | X   | X   | X   |
| 9.2.2.1        | Reading Volumes                                    | X   | X   | X   |
| 9.2.2.2        | Using Pipets                                       | X   | X   | X   |
| 9.2.3          | Chemical Solutions                                 | X   | X   | X   |
| 9.2.3.1        | Mass Concentration                                 |     | X   | X   |
| 9.2.3.2        | Molar Concentration                                |     | X   | X   |
| 9.2.3.3        | Normality  |     | X   | X   |
| 9.2.4          | Data Recording & Recordkeeping                     | X   | X   | X   |
| 9.2.5          | Laboratory Quality Control                         | X   | X   | X   |
| 9.3            | LABORATORY SAFETY                                  | X   | X   | X   |
| 9.3.1          | Laboratory Hazards                                 | X   | X   | X   |
| 9.3.2          | Personal Safety & Hygiene                          | X   | X   | X   |
| 9.3.3          | Preventing Laboratory Accidents                    | X   | X   | X   |
| 9.3.3.1        | Chemical Storage                                   | X   | X   | X   |
| 9.3.3.2        | Moving Chemicals                                   | X   | X   | X   |
| 9.3.3.3        | Proper Laboratory Techniques                       | X   | X   | X   |

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| 9.3.3.4        | Accident Prevention   | X   | X   | X   |
| 9.4            | WATER QUALITY TESTS   | X   | X   | X   |
| 9.4.1          | Instrument-Based Tests                                      | X   | X   | X   |
| 9.4.1.1        | Temperature   | X   | X   | X   |
| 9.4.1.2        | pH  | X   | X   | X   |
| 9.4.1.3        | Turbidity   | X   | X   | X   |
| 9.4.2          | Titration-Based Tests                                       | X   | X   | X   |
| 9.4.2.1        | General Titration Procedure                                 | X   | X   | X   |
| 9.4.2.2        | Alkalinity  | X   | X   | X   |
| 9.4.2.3        | Hardness  | X   | X   | X   |
| 9.4.2.4        | Chlorine Residual Curve                                     | X   | X   | X   |
| 9.4.3          | Tests for Plant Processes                                   | X   | X   | X   |
| 9.4.3.1        | Jar Test for Coagulation/Flocculation                       | X   | X   | X   |
| 9.4.3.2        | Chlorine Demand   | X   | X   | X   |
| 9.4.4          | Biological Tests  | X   | X   | X   |
| 9.4.4.1        | Test Methods Overview                                       | X   | X   | X   |
| 9.4.4.2        | What is Tested  | X   | X   | X   |
| 9.4.4.3        | General Materials Required for Microbiological Testing      | X   | X   | X   |
| 9.4.4.4        | Procedures for Testing Total Coliform Bacteria              | X   | X   | X   |
| 9.4.4.5        | Additional Test Methods                                     | X   | X   | X   |
| 9.5            | SAMPLING  | X   | X   | X   |
| 9.5.1          | Representative Sampling                                     | X   | X   | X   |
| 9.5.1.1        | Source Water Sampling                                       | X   | X   | X   |
| 9.5.1.2        | In-Plant Sampling   | X   | X   | X   |
| 9.5.1.3        | Distribution System Sampling                                |     | X   | X   |
| 9.5.2          | Types of Samples  | X   | X   | X   |
| 9.5.2.1        | Grab Samples  | X   | X   | X   |
| 9.5.2.2        | Composite Samples   | X   | X   | X   |
| 9.5.3          | Sampling Devices  | X   | X   | X   |
| 9.5.4          | Sampling Techniques   | X   | X   | X   |
| 9.5.4.1        | Surface Sampling  | X   | X   | X   |
| 9.5.4.2        | Depth Sampling  | X   | X   | X   |
| 9.5.4.3        | Water Tap Sampling  | X   | X   | X   |
| 9.5.4.4        | First-Draw Sampling   | X   | X   | X   |
| 9.5.5          | Sampling Containers & Preservation of Samples               | X   | X   | X   |
| 9.5.5.1        | Chain-of-Custody Samples                                    | X   | X   | X   |
| 9.5.6          | Reporting   | X   | X   | X   |
| 9.6            | MATH ASSIGNMENT   | X   | X   | X   |
| CHAPTER REVIEW | REVIEW ALL QUESTIONS  | ALL | ALL | ALL |
|                | <b>APPENDIX A: INTRODUCTION TO BASIC MATH FOR OPERATORS</b> |     |     |     |
|                | INTRODUCTION  | X   | X   | X   |
|                | BASIC CONCEPTS (SECTIONS A.1 - A.4)                         | X   | X   | X   |
| A.1            | NUMBERS & OPERATIONS  | X   | X   | X   |
| A.1.1          | Addition  | X   | X   | X   |
| A.1.2          | Subtraction   | X   | X   | X   |
| A.1.3          | Multiplication  | X   | X   | X   |
| A.1.4          | Division  | X   | X   | X   |
| A.2            | ORDER OF OPERATIONS   | X   | X   | X   |
| A.2.1          | More on Exponents   |     | X   | X   |
| A.3            | BASIC ALGEBRA (SOLVING EQUATIONS)                           | X   | X   | X   |
| A.4            | PERCENTAGES   | X   | X   | X   |
|                | INTERMEDIATE CONCEPTS (SECTIONS A.5 - A.6)                  | X   | X   | X   |
| A.5            | UNITS   | X   | X   | X   |

## PART I

## WATER TREATMENT PLANT OPERATION VOLUME I

| SECTION | TOPIC  | C | B | A |
|---------|--|---|---|---|
| A.5.1   | Distance of Length   | X | X | X |
| A.5.2   | Area   | X | X | X |
| A.5.2.1 | Surface Area of a Rectangle  | X | X | X |
| A.5.2.2 | Surface Area of a Triangle   |   | X | X |
| A.5.2.3 | Surface Area of a Trapezoid  |   | X | X |
| A.5.2.4 | Surface Area of a Circle   | X | X | X |
| A.5.2.5 | Surface Area of a Cylinder   | X | X | X |
| A.5.2.6 | Surface Area of a Cone   |   | X | X |
| A.5.2.7 | Surface Area of a Sphere   |   | X | X |
| A.5.3   | Volume   | X | X | X |
| A.5.3.1 | Cube   |   | X | X |
| A.5.3.2 | Rectangular Prism  |   | X | X |
| A.5.3.3 | Triangular Prism   |   | X | X |
| A.5.3.4 | Cylinder   | X | X | X |
| A.5.3.5 | Cone   |   | X | X |
| A.5.3.6 | Sphere   |   | X | X |
| A.5.4   | Mass & Weight  | X | X | X |
| A.5.5   | Density Specific Weight, and Specific Gravity                      | X | X | X |
| A.5.6   | Concentration  | X | X | X |
| A.5.7   | Velocity & Flow Rate   |   | X | X |
| A.5.8   | Force & Pressure   |   | X | X |
| A.5.9   | Work, Head, & Power  |   | X | X |
|         | ADVANCED CONCEPTS (SECTIONS A.7 - A.8)                             | X | X | X |
| A.7     | PUMPS  | X | X | X |
| A.7.1   | Pressure   | X | X | X |
| A.7.2   | Work   | X | X | X |
| A.7.3   | Power  | X | X | X |
| A.7.4   | Horsepower   | X | X | X |
| A.7.5   | Head   | X | X | X |
| A.7.6   | Pump Characteristics   | X | X | X |
| A.7.7   | Evaluation of Pump Performance                                     | X | X | X |
| A.7.7.1 | Capacity   | X | X | X |
| A.7.7.2 | Efficiency   | X | X | X |
| A.7.8   | Pump Speed-Performance Relationships                               | X | X | X |
| A.7.9   | Friction or Energy Losses  | X | X | X |
| A.8     | ANALYSIS & PRESENTATION OF DATA                                    | X | X | X |
| A.8.1   | Causes of Variations in Results                                    | X | X | X |
| A.8.1.1 | Water or Material Being Examined                                   | X | X | X |
| A.8.1.2 | Sampling   | X | X | X |
| A.8.1.3 | Testing  | X | X | X |
| A.8.2   | Controlling Variation  | X | X | X |
| A.8.2.1 | Reading Charts   | X | X | X |
| A.8.3   | Describing Data or Results   | X | X | X |
| A.8.3.1 | Graphs & Charts  | X | X | X |
| A.8.3.2 | Numerical Representation of Data                                   | X | X | X |
| A.8.4   | Moving Averages  | X | X | X |
| A.8.5   | More Applications of Graphs  | X | X | X |
| A.8.5.1 | Volume of Sludge in a Digester                                     | X | X | X |
| A.8.5.2 | Tracking BOD Loading   | X | X | X |
| A.8.6   | Regression Analysis (Prediction Equations, Trends, & Correlations) | X | X | X |
| A.8.6.1 | Correlations   | X | X | X |
| A.9     | TYPICAL WATER TREATMENT PLANT PROBLEMS (ENGLISH)                   | X | X | X |
| A.9.1   | Plant Operation  | X | X | X |
| A.9.2   | Flows  | X | X | X |

## PART I

WATER TREATMENT PLANT OPERATION VOLUME I

| <b>SECTION</b> | <b>TOPIC</b>                             | <b>C</b> | <b>B</b> | <b>A</b> |
|----------------|--|----------|----------|----------|
| A.9.3          | Chemical Doses                           | X        | X        | X        |
| A.9.4          | Reservoir Management & Intake Structures | X        | X        | X        |
| A.9.5          | Coagulation & Flocculation               | X        | X        | X        |
| A.9.6          | SEDIMENTATION BASINS                     | X        | X        | X        |
| A.9.7          | FILTRATION MECHANISMS                    | X        | X        | X        |
| A.9.8          | Disinfection                             | X        | X        | X        |
| A.9.9          | Corrosion Control                        | X        | X        | X        |
| A.9.10         | Laboratory Procedures                    | X        | X        | X        |

## PART II

## WATER TREATMENT PLANT OPERATION VOLUME II

| SECTION | TOPIC  | C | B | A |
|---------|--|---|---|---|
| 12.     | <b>WORDS: IRON AND MANGANESE CONTROL</b>         | X | X | X |
| 12.0    | NEED TO CONTROL IRON AND MANGANESE               | X | X | X |
| 12.10   | Occurrence Of Iron And Manganese                 | X | X | X |
| 12.11   | Collection Of Iron And Manganese Samples         | X | X | X |
| 12.12   | Analysis For Iron And Manganese                  |   | X | X |
| 12.20   | Alternate Source                                 | X | X | X |
| 12.21   | Phosphate Treatment                              | X | X | X |
| 12.22   | Removal By Ion Exchange                          |   | X | X |
| 12.23   | Oxidation By Aeration                            |   | X | X |
| 12.24   | Oxidation With Chlorine                          |   | X | X |
| 12.25   | Oxidation With Permanganate                      |   | X | X |
| 12.26   | Operation Of Filters                             |   | X | X |
| 12.27   | Proprietary Process                              |   |   | X |
| 12.28   | Monitoring Of Treated Water                      | X | X | X |
| 12.29   | Summary  |   |   | X |
| 12.3    | OPERATION OF AN IRON AND MANGANESE REMOVAL PLANT |   | X | X |
| 12.30   | Description Of Equipment And Process             |   | X | X |
| 12.31   | Regeneration Of Manganese Greensand              |   | X | X |
| 12.32   | Troubleshooting                                  |   | X | X |
| 12.4    | MAINTENANCE OF A CHEMICAL FEEDER                 |   | X | X |
| 12.5    | TROUBLESHOOTING RED WATER PROBLEMS               | X | X | X |
| 13.     | <b>WORDS: FLUORIDATION</b>                       | X | X | X |
| 13.0    | IMPORTANCE OF FLUORIDATION                       | X | X | X |
| 13.1    | FLUORIDATION PROGRAMS                            |   | X | X |
| 13.2    | COMPOUNDS USED TO FURNISH FLUORIDE ION           | X | X | X |
| 13.3    | FLUORIDATION SYSTEMS                             |   | X | X |
| 13.30   | Chemical Feeders                                 |   | X | X |
| 13.31   | Saturators                                       |   | X | X |
| 13.32   | Downflow Saturators                              |   |   | X |
| 13.33   | Upflow Saturators                                |   |   | X |
| 13.34   | Large Hydrofluosilicic Acid Systems              |   | X | X |
| 13.4    | FINAL CHECK-UP OF EQUIPMENT                      |   | X | X |
| 13.40   | Avoid Overfeeding                                | X | X | X |
| 13.41   | Review Of Designs And Specifications             |   | X | X |
| 13.5    | CHEMICAL FEEDER START-UP                         |   | X | X |
| 13.6    | CHEMICAL FEEDER OPERATION                        |   | X | X |
| 13.60   | Fine Tuning                                      |   | X | X |
| 13.61   | Preparation Of Fluoride Solution                 |   | X | X |
| 13.62   | Fluoridation Log Sheets                          |   | X | X |
| 13.620  | Hydrofluosilicic Acid                            |   | X | X |
| 13.621  | Sodium Silicofluoride                            |   | X | X |
| 13.63   | Equipment Check Procedures                       |   | X | X |
| 13.7    | PREVENTION OF OVERFEEDING                        | X | X | X |
| 13.8    | UNDERFEEDING                                     | X | X | X |
| 13.9    | SHUTTING DOWN CHEMICAL SYSTEMS                   | X | X | X |
| 13.10   | MAINTENANCE                                      | X | X | X |
| 13.11   | SAFETY IN HANDLING FLUORIDE COMPOUNDS            | X | X | X |
| 13.110  | Avoid Overexposure                               | X | X | X |
| 13.111  | Symptoms Of Fluoride Poisoning                   | X | X | X |
| 13.112  | Basic First Aid                                  | X | X | X |
| 13.113  | Protecting Yourself And Your Family              | X | X | X |
| 13.114  | Training   | X | X | X |
| 13.12   | CALCULATING FLUORIDE DOSAGES                     |   | X | X |



## PART II

## WATER TREATMENT PLANT OPERATION VOLUME II

| SECTION | TOPIC   | C | B | A |
|---------|---|---|---|---|
| 15.     | <b>WORDS: SPECIALIZED TREATMENT PROCESSES</b>                 | X | X | X |
| 15.0    | THE TRIHALOMETHANES (THM) PROBLEM                             |   | X | X |
| 15.1    | FEASIBILITY ANALYSIS PROCESS                                  |   | X | X |
| 15.2    | PROBLEM DEFINITION  |   |   | X |
| 15.20   | Sampling  |   |   | X |
| 15.21   | THM Calculations  |   | X | X |
| 15.22   | Chemistry of THM Formation                                    |   |   | X |
| 15.3    | CONTROL STRATEGIES  |   |   | X |
| 15.4    | EXISTING TREATMENT PROCESSES                                  |   |   | X |
| 15.5    | TREATMENT PROCESS RESEARCH STUDY RESULTS                      |   |   | X |
| 15.50   | Consider Options  |   |   | X |
| 15.51   | Remove THM's After They Are Formed                            |   |   | X |
| 15.52   | Remove THM Precursors   |   |   | X |
| 15.53   | Alternative Disinfectants                                     |   |   | X |
| 15.6    | SELECTION AND IMPLEMENTATION OF A COST-EFFECTIVE ALTERNATIVES |   |   | X |
| 15.7    | REGULATORY UPDATE   |   | X | X |
| 15.8    | SUMMARY AND CONCLUSIONS                                       |   |   | X |
| 15.100  | Why Are We Concerned About Arsenic?                           | X | X | X |
| 15.101  | What Are the Sources of Arsenic?                              | X | X | X |
| 15.102  | Chemistry of Arsenic  |   | X | X |
| 15.110  | New Source Alternative to Treatment                           |   | X | X |
| 15.111  | Summary of Arsenic Treatment Options                          | X | X | X |
| 15.112  | Engineered Blending   |   | X | X |
| 15.113  | Ion Exchange (IX)   |   | X | X |
| 15.114  | Active Alumina (AA)   |   |   | X |
| 15.115  | Oxidation-Filtration & Iron Based Adsorption                  |   |   | X |
| 15.116  | Point of Use (POU) & Point of Entry (POE) Devices             |   | X | X |
| 15.117  | Proprietary Media   |   | X | X |
| 15.12   | TYPICAL ARSENIC TREATMENT PLANT                               | X | X | X |
| 15.120  | Plant Start-Up & Shutdown                                     |   | X | X |
| 15.121  | Operation   |   | X | X |
| 15.122  | Maintenance   |   | X | X |
| 15.123  | Troubleshooting   |   |   | X |
| 15.124  | Safety & Security Issues                                      | X | X | X |
| 15.125  | Review of Plans & Specifications                              |   |   | X |
| 15.13   | WASTEWATER AND RESIDUALS                                      |   | X | X |
| 15.140  | MONITORING - Analysis of Arsenic                              | X | X | X |
| 15.141  | Types of Arsenic Sampling/Monitoring                          |   | X | X |
| 15.142  | Monitoring for Compliance                                     |   | X | X |
| 15.143  | Monitoring for Process Control                                |   | X | X |
| 15.15   | RECORDKEEPING AND REPORTING                                   |   | X | X |
| 15.150  | Records   | X | X | X |
| 15.151  | Reporting   |   | X | X |
| 17.     | <b>WORDS: HANDLING AND DISPOSAL OF PROCESS WASTES</b>         |   | X | X |
| 17.0    | NEED FOR HANDLING AND DISPOSAL OF PROCESS WASTES              |   | X | X |
| 17.1    | SOURCES OF TREATMENT PROCESS WASTES                           |   |   | X |
| 17.2    | PROCESS SLUDGE VOLUMES  |   |   | X |
| 17.3    | METHODS OF HANDLING AND DISPOSING OF PROCESS WASTES           |   |   | X |
| 17.4    | DRAINING AND CLEANING TANKS                                   |   |   | X |
| 17.5    | BACKWASH RECOVERY PONDS (SOLAR LAGOONS)                       |   |   | X |
| 17.6    | SLUDGE DEWATERING PROCESSES                                   |   |   | X |
| 17.60   | Solar Drying Lagoons  |   |   | X |
| 17.61   | Sand Drying Beds  |   |   | X |
| 17.62   | Belt Filter Presses   |   |   | X |

## PART II

## WATER TREATMENT PLANT OPERATION VOLUME II

| SECTION | TOPIC   | C | B | A |
|---------|---|---|---|---|
| 17.63   | Centrifuges   |   |   | X |
| 17.64   | Filter Presses  |   |   | X |
| 17.65   | Vacuum Filters  |   |   | X |
| 17.7    | DISCHARGE INTO COLLECTION SYSTEMS (SEWERS)            |   |   | X |
| 17.8    | DISPOSAL OF SLUDGE                                    |   |   | X |
| 17.9    | EQUIPMENT   |   |   | X |
| 17.90   | Vacuum Trucks   |   |   | X |
| 17.91   | Sludge Pumps  |   |   | X |
| 17.10   | PLANT DRAINAGE WATERS                                 |   |   | X |
| 17.11   | MONITORING AND REPORTING                              |   |   | X |
| 18.     | <b>WORDS: MAINTENANCE</b>                             | X | X | X |
| 18.0    | TREATMENT PLANT MAINTENANCE - GENERAL PROGRAM         | X | X | X |
| 18.00   | Preventive Maintenance Records                        | X |   | X |
| 18.01   | Library of Manufacturers' Operation and Parts Manuals | X |   | X |
| 18.02   | Emergencies   |   |   | X |
| 18.03   | Lockout/Tagout Procedures                             | X | X | X |
| 18.10   | Beware of Electricity                                 | X |   | X |
| 18.100  | Recognize Your Limitations                            | X | X | X |
| 18.11   | Understanding Electricity                             | X | X | X |
| 18.110  | Volts   | X | X | X |
| 18.111  | Direct Current (D.C.)                                 | X | X | X |
| 18.112  | Alternating Current (A.C.)                            | X | X | X |
| 18.113  | Amps  | X | X | X |
| 18.114  | Watts   | X | X | X |
| 18.115  | Power Requirements                                    | X | X | X |
| 18.116  | Conductors and Insulators                             |   | X | X |
| 18.12   | Tools, Meters and Testers                             |   | X | X |
| 18.120  | Voltage Testing                                       |   | X | X |
| 18.121  | Ammeter   |   | X | X |
| 18.122  | Megger  |   | X | X |
| 18.123  | Ohmmeters   |   | X | X |
| 18.13   | Switch Gear   |   | X | X |
| 18.130  | Equipment Protective Devices                          | X | X | X |
| 18.131  | Fuses   | X | X | X |
| 18.132  | Circuit Breakers                                      | X | X | X |
| 18.133  | Overload Relays                                       | X | X | X |
| 18.134  | Motor Starters  |   | X | X |
| 18.140  | Electric Motors - Classifications                     |   | X | X |
| 18.1410 | Troubleshooting - Step-By-Step Procedures             |   | X | X |
| 18.1411 | Troubleshooting Guide for Electric Motors             | X | X | X |
| 18.1412 | Troubleshooting Guide for Magnetic Starters           | X | X | X |
| 18.1413 | Trouble/Remedy Procedures for Induction Motors        | X | X | X |
| 18.142  | Record Keeping  |   | X | X |
| 18.150  | Auxiliary Electric Power - Safety First               | X | X | X |
| 18.151  | Standby Power Generation                              | X |   | X |
| 18.152  | Emergency Lighting                                    | X | X | X |
| 18.153  | Batteries   | X | X | X |
| 18.160  | High Voltage - Transmission                           |   |   | X |
| 18.161  | Switch Gear   |   |   | X |
| 18.162  | Power Distribution Transformers                       |   |   | X |
| 18.17   | Electrical Safety Checklist                           | X | X | X |
| 18.2    | MECHANICAL EQUIPMENT                                  | X | X | X |
| 18.20   | Repair Shop   | X | X | X |
| 18.21   | Pumps   | X | X | X |

## PART II

## WATER TREATMENT PLANT OPERATION VOLUME II

| SECTION    | TOPIC                                 | C | B | A |
|------------|---------------------------------------|---|---|---|
| 18.210     | Centrifugal Pumps                     | X | X | X |
| 18.211     | Let's Build a Pump                    | X | X | X |
| 18.212     | Vertical Centrifugal Pumps            | X | X | X |
| 18.213     | Horizontal Centrifugal Pumps          | X | X | X |
| 18.214     | Reciprocating or Piston Pumps         | X | X | X |
| 18.215     | Progressive Cavity (Screw-Flow) Pumps | X | X | X |
| 18.216     | Chemical Metering Pumps               | X | X | X |
| 18.220     | Purpose of Lubrication                | X | X | X |
| 18.221     | Properties of Lubrication             | X | X | X |
| 18.222     | Lubrication Schedule                  | X | X | X |
| 18.223     | Precautions                           | X | X | X |
| 18.224     | Pump Lubrication                      | X | X | X |
| 18.225     | Equipment Lubrication                 | X | X | X |
| 18.230     | Pump Maintenance - Section Format     | X | X | X |
| 18.231     | Preventative Maintenance              | X | X | X |
| 18.231 #1  | Pumps, General                        | X | X | X |
| 18.231 #2  | Reciprocating Pumps, General          | X | X | X |
| 18.231 #3  | Propeller Pumps, General              | X | X | X |
| 18.231 #4  | Progressive Cavity Pumps, General     | X | X | X |
| 18.231 #5  | Pump Controls                         | X | X | X |
| 18.231 #6  | Electric Motors                       | X | X | X |
| 18.231 #7  | Belt Drives                           | X | X | X |
| 18.231 #8  | Chain Drives                          | X | X | X |
| 18.231 #9  | Variable Speed Belt Drives            | X | X | X |
| 18.231 #10 | Couplings                             | X | X | X |
| 18.231 #11 | Shear Pins                            | X | X | X |
| 18.240     | Starting a New Pump                   | X | X | X |
| 18.241     | Pump Shutdown                         | X | X | X |
| 18.242     | Pump-Driving Equipment                | X | X | X |
| 18.243     | Electrical Controls                   | X | X | X |
| 18.244     | Operating Troubles                    | X | X | X |
| 18.245     | Starting and Stopping Pumps           | X | X | X |
| 18.2450    | Centrifugal Pumps                     | X | X | X |
| 18.2451    | Positive Displacement Pumps           | X | X | X |
| 18.25      | Compressors                           | X | X | X |
| 18.26      | Valves                                | X | X | X |
| 18.260     | Uses of Valves                        | X | X | X |
| 18.261     | Gate Valves                           | X | X | X |
| 18.262     | Maintenance of Gate Valves            | X | X | X |
| 18.262 #12 | Gate Valves                           | X | X | X |
| 18.263     | Globe Valves                          |   | X | X |
| 18.264     | Eccentric Valves                      |   | X | X |
| 18.265     | Butterfly Valves                      |   | X | X |
| 18.266     | Check Valves                          | X | X | X |
| 18.267     | Maintenance of Check Valves           | X | X | X |
| 18.267 #13 | Check Valves                          | X | X | X |
| 18.268     | Automatic Valves                      |   | X | X |
| 18.30      | Gasoline Engines                      | X | X | X |
| 18.300     | Need to Maintain Gasoline Engines     | X | X | X |
| 18.301     | Maintenance                           | X | X | X |
| 18.302     | Starting Problems                     |   | X | X |
| 18.303     | Running Problems                      |   | X | X |
| 18.304     | How to Start a Gasoline Engine        |   | X | X |
| 18.3040    | Small Engines                         |   | X | X |

## PART II

## WATER TREATMENT PLANT OPERATION VOLUME II

| SECTION | TOPIC  | C | B | A |
|---------|--|---|---|---|
| 18.3041 | Large Engines  |   | X | X |
| 18.31   | Diesel Engines   |   | X | X |
| 18.310  | How Diesel Engines Work                                  | X | X | X |
| 18.311  | Operation  |   | X | X |
| 18.312  | Fuel System  |   | X | X |
| 18.313  | Water-Cooled Diesel Engines                              |   | X | X |
| 18.314  | Air-Cooled Diesel Engines                                |   | X | X |
| 18.315  | How to Start Diesel Engines                              |   | X | X |
| 18.316  | Maintenance and Troubleshooting                          |   | X | X |
| 18.32   | Cooling Systems  |   | X | X |
| 18.330  | Fuel Storage - Code Requirements                         | X | X | X |
| 18.331  | Diesel   | X | X | X |
| 18.332  | Gasoline   | X | X | X |
| 18.333  | Liquid Petroleum Gas (LPG)                               |   | X | X |
| 18.334  | Natural Gas  |   | X | X |
| 18.34   | Standby Engines  | X | X | X |
| 18.40   | Chemical Storage   | X | X | X |
| 18.41   | Drainage from Chemical Storage and Feeders               | X | X | X |
| 18.42   | Use of Feeder Manufacturer's Manual                      | X | X | X |
| 18.43   | Solid Feeders  | X | X | X |
| 18.44   | Liquid Feeders   | X | X | X |
| 18.45   | Gas Feeders  |   | X | X |
| 18.46   | Calibration of Chemical Feeders                          |   | X | X |
| 18.460  | Large-Volume Metering Pumps                              |   | X | X |
| 18.461  | Small-Volume Metering Pumps                              |   | X | X |
| 18.462  | Dry Chemical Systems                                     |   |   | X |
| 18.47   | Chlorinators   | X | X | X |
| 18.5    | TANKS AND RESERVOIRS                                     |   |   | X |
| 18.50   | Scheduling Inspections                                   | X | X | X |
| 18.51   | Steel Tanks  |   |   | X |
| 18.52   | Cathodic Protection                                      |   |   | X |
| 18.53   | Concrete Tanks   |   |   | X |
| 18.6    | BUILDING MAINTENANCE                                     | X | X | X |
| 19.     | <b>WORDS: INSTRUMENTATION</b>                            | X | X | X |
| 19.00   | Importance & Nature of Instrumentation & Control Systems |   | X | X |
| 19.01   | Importance to the Water Treatment Operator               |   | X | X |
| 19.02   | Nature of the Measurement Process                        |   | X | X |
| 19.03   | Explanation of Control Systems                           |   | X | X |
| 19.030  | Modulating Control Systems                               |   | X | X |
| 19.031  | Motor Control Stations                                   |   | X | X |
| 19.10   | General Precautions                                      |   | X | X |
| 19.11   | Electrical Hazards                                       |   | X | X |
| 19.12   | Mechanical & Pneumatic Hazards                           |   | X | X |
| 19.13   | Confined Spaces  |   | X | X |
| 19.14   | Oxygen Deficiency or Enrichment                          |   | X | X |
| 19.15   | Explosive Gas Mixtures                                   |   | X | X |
| 19.16   | Falls & Associated Hazards                               |   | X | X |
| 19.20   | General Principles of Sensors                            |   | X | X |
| 19.21   | Pressure Measurements                                    |   | X | X |
| 19.22   | Level Measurements                                       |   | X | X |
| 19.23   | Flow (Rate of Flow and Total Flow)                       |   | X | X |
| 19.24   | Chemical Feed Rate                                       |   | X | X |
| 19.25   | Process Instrumentation                                  |   | X | X |
| 19.26   | Signal Transmitters/Transducers                          |   | X | X |

## PART II

## WATER TREATMENT PLANT OPERATION VOLUME II

| SECTION | TOPIC                                     | C | B | A |
|---------|---|---|---|---|
| 19.30   | Primary Elements                          |   | X | X |
| 19.31   | Panel Instruments                         |   | X | X |
| 19.310  | Indicators                                |   | X | X |
| 19.311  | Recorders                                 |   | X | X |
| 19.312  | Totalizers                                |   | X | X |
| 19.313  | Alarms                                    |   | X | X |
| 19.32   | Automatic Controller                      |   |   | X |
| 19.33   | Pump Controllers                          |   |   | X |
| 19.34   | Air Supply Systems                        |   |   | X |
| 19.35   | Laboratory Instruments                    |   |   | X |
| 19.36   | Test and Calibration Equipment            |   |   | X |
| 19.370  | Computer Control Systems                  |   | X | X |
| 19.371  | Typical Computer Control System Functions |   | X | X |
| 19.40   | Proper Care of Instruments                |   | X | X |
| 19.41   | Indications of Proper Function            |   | X | X |
| 19.42   | Start-up/Shutdown Considerations          |   | X | X |
| 19.43   | Preventative Maintenance                  |   | X | X |
| 19.44   | Operational Checks                        |   | X | X |
| 19.45   | Preventive Maintenance                    |   | X | X |
| 20.     | <b>WORDS: SAFETY</b>                      | X | X | X |
| 20.00   | What is Safety?                           | X | X | X |
| 20.01   | Causes of Accidents                       | X | X | X |
| 20.02   | Steps to Avoid Accidents                  | X | X | X |
| 20.10   | Safe Handling of Chemicals                | X | X | X |
| 20.11   | Acids                                     | X | X | X |
| 20.110  | Acetic Acid (Glacial)                     | X | X | X |
| 20.111  | Hydrofluorosilicic Acid                   | X | X | X |
| 20.112  | Hydrogen Fluoride                         | X | X | X |
| 20.113  | Hydrochloric Acid                         | X | X | X |
| 20.114  | Nitric Acid                               | X | X | X |
| 20.115  | Sulfuric Acid                             | X | X | X |
| 20.12   | Bases                                     | X | X | X |
| 20.120  | Ammonia                                   | X | X | X |
| 20.121  | Calcium Hydroxide                         | X | X | X |
| 20.122  | Sodium Hydroxide                          | X | X | X |
| 20.123  | Sodium Silicate                           | X | X | X |
| 20.124  | Hypochlorite                              | X | X | X |
| 20.125  | Sodium Carbonate                          | X | X | X |
| 20.13   | Gases                                     | X | X | X |
| 20.130  | Chlorine                                  | X | X | X |
| 20.131  | Carbon Dioxide                            |   |   | X |
| 20.132  | Sulfur Dioxide                            |   |   | X |
| 20.14   | Salts                                     | X | X | X |
| 20.140  | Aluminum Sulfate (Alum)                   | X | X | X |
| 20.141  | Ferric Chloride                           | X | X | X |
| 20.142  | Ferric Sulfate                            | X | X | X |
| 20.143  | Ferrous Sulfate                           | X | X | X |
| 20.144  | Sodium Aluminate                          | X | X | X |
| 20.145  | Fluoride Compounds                        | X | X | X |
| 20.15   | Powders                                   | X | X | X |
| 20.150  | Potassium Permanganate                    | X | X | X |
| 20.151  | Powdered Activated Carbon                 | X | X | X |
| 20.152  | Other Powders                             | X | X | X |
| 20.16   | Labeling of Chemical Containers           | X | X | X |

## PART II

## WATER TREATMENT PLANT OPERATION VOLUME II

| SECTION | TOPIC                                       | C | B | A |
|---------|---|---|---|---|
| 20.17   | Chemical Storage Drains                     | X | X | X |
| 20.20   | Fire Prevention                             | X | X | X |
| 20.21   | Classification of Fires and Extinguishers   | X | X | X |
| 20.22   | Fire Extinguisher Operation and Maintenance | X | X | X |
| 20.23   | Fire Hoses                                  | X | X | X |
| 20.24   | Storage of Flammables                       | X | X | X |
| 20.25   | Exits                                       | X | X | X |
| 20.30   | Maintenance Hazards                         | X | X | X |
| 20.31   | Cleaning                                    | X | X | X |
| 20.32   | Painting                                    | X | X | X |
| 20.33   | Cranes                                      | X | X | X |
| 20.34   | Confined Spaces                             | X | X | X |
| 20.35   | Manholes                                    | X | X | X |
| 20.36   | Power Tools                                 | X | X | X |
| 20.37   | Welding                                     | X | X | X |
| 20.38   | Safety Valves                               | X | X | X |
| 20.40   | Types of Vehicles                           | X | X | X |
| 20.41   | Maintenance                                 | X | X | X |
| 20.42   | Seat Belts                                  | X | X | X |
| 20.43   | Accident Prevention                         | X | X | X |
| 20.44   | Forklifts                                   | X | X | X |
| 20.50   | Electrical Safety                           | X | X | X |
| 20.51   | Current - Voltage                           | X | X | X |
| 20.52   | Transformers                                | X | X | X |
| 20.53   | Electric Starters                           | X | X | X |
| 20.54   | Electric Motors                             | X | X | X |
| 20.55   | Instrumentation                             | X | X | X |
| 20.56   | Control Panels                              | X | X | X |
| 20.57   | Lockout/Tagout Procedure                    | X | X | X |
| 20.60   | Laboratory Hazards                          |   | X | X |
| 20.61   | Glassware                                   |   | X | X |
| 20.62   | Chemicals                                   |   | X | X |
| 20.63   | Biological Considerations                   |   | X | X |
| 20.64   | Radioactivity                               |   | X | X |
| 20.65   | Laboratory Equipment                        |   | X | X |
| 20.650  | Hot Plates                                  |   | X | X |
| 20.651  | Water Stills                                |   | X | X |
| 20.652  | Sterilizers                                 |   | X | X |
| 20.653  | Pipet Washers                               |   | X | X |
| 20.70   | Operator Safety                             | X | X | X |
| 20.71   | Respiratory Protection                      | X | X | X |
| 20.72   | Safety Equipment                            | X | X | X |
| 20.73   | Eye Protection                              | X | X | X |
| 20.74   | Foot Protection                             | X | X | X |
| 20.75   | Hand Protection                             | X | X | X |
| 20.76   | Head Protection                             | X | X | X |
| 20.77   | Water Safety                                | X | X | X |
| 20.8    | PREPARATION FOR EMERGENCIES                 | X | X | X |
| 21.     | <b>ADVANCED LABORATORY PROCEDURES</b>       |   |   |   |
| 21.0    | USE OF A SPECTROPHOTOMETER                  | X | X | X |
| 21. #1  | Algae Counts                                |   | X | X |
| 21. #2  | Calcium                                     |   | X | X |
| 21. #3  | Chloride                                    |   | X | X |
| 21. #4  | Color                                       | X | X | X |

## PART II

## WATER TREATMENT PLANT OPERATION VOLUME II

| SECTION | TOPIC  | C | B | A |
|---------|--|---|---|---|
| 21. #5  | Dissolved Oxygen                                       | X | X | X |
| 21. #6  | Fluoride   |   | X | X |
| 21. #7  | Iron (Total)   | X | X | X |
| 21. #8  | Manganese  | X | X | X |
| 21. #9  | Marble Test (Calcium Carbonate Saturation Test)        |   |   | X |
| 21. #10 | Metals   |   | X | X |
| 21. #11 | Nitrate  |   |   | X |
| 21. #12 | pH   | X | X | X |
| 21. #13 | Specific Conductance (Conductivity)                    | X | X | X |
| 21. #14 | Sulfate  |   |   | X |
| 21. #15 | Taste and Odor   | X | X | X |
| 21. #16 | Trihalomethanes  | X | X | X |
| 21. #17 | Total Dissolved Solids                                 |   | X | X |
| 22.     | <b>WORDS: DRINKING WATER REGULATIONS</b>               |   | X | X |
| 22.0    | HISTORY OF DRINKING WATER LAWS AND STANDARDS           |   | X | X |
| 22.1    | HOW EPA DEVELOPS DRINKING WATER STANDARDS              |   | X | X |
| 22.10   | Types of Contaminants                                  |   | X | X |
| 22.11   | Identifying Contaminants To Be Regulated               |   | X | X |
| 22.12   | Unregulated Contaminants                               |   | X | X |
| 22.13   | Newer & Proposed Regulations                           |   | X | X |
| 22.130  | Arsenic Rule   | X | X | X |
| 22.131  | Lead & Copper Rule                                     | X | X | X |
| 22.132  | Total Coliform Rule (TCR)                              | X | X | X |
| 22.133  | Surface Water Treatment Rules                          | X | X | X |
| 22.134  | Filter Backwash Recycling Rule (FBRR)                  | X | X | X |
| 22.135  | Disinfectants & Disinfection By-Products               | X | X | X |
| 22.136  | Ground Water Rule (GWR)                                |   | X | X |
| 22.137  | Radionuclides Rule                                     |   | X | X |
| 22.138  | Regulation of Microbial Contaminants in Drinking Water |   | X | X |
| 22.139  | Standardized Monitoring Framework (SMF)                |   | X | X |
| 22.139  | Consumer Confidence Report (CCR) Rule                  |   | X | X |
| 22.14   | Setting Standards                                      |   | X | X |
| 22.15   | Types of Water Systems                                 |   | X | X |
| 22.2    | PRIMARY DRINKING WATER STANDARDS                       |   | X | X |
| 22.20   | Inorganic Chemical Standards                           |   | X | X |
| 22.200  | Antimony   |   | X | X |
| 22.201  | Arsenic  |   | X | X |
| 22.202  | Asbestos   |   | X | X |
| 22.203  | Barium   |   | X | X |
| 22.204  | Beryllium  |   | X | X |
| 22.205  | Bromate  |   | X | X |
| 22.206  | Cadmium  |   | X | X |
| 22.207  | Chlorite   |   | X | X |
| 22.208  | Chromium   |   | X | X |
| 22.209  | Copper   |   | X | X |
| 22.2010 | Cyanide  |   | X | X |
| 22.2011 | Fluoride   |   | X | X |
| 22.2012 | Lead and Copper  |   | X | X |
| 22.2013 | Mercury  |   | X | X |
| 22.2014 | Nitrate  |   | X | X |
| 22.2015 | Nitrite  |   | X | X |
| 22.2016 | Selenium   |   | X | X |
| 22.2017 | Thallium   |   | X | X |
| 22.21   | Organic Chemical Standards                             |   | X | X |

## PART II

## WATER TREATMENT PLANT OPERATION VOLUME II

| SECTION | TOPIC  | C | B | A |
|---------|--|---|---|---|
| 22.210  | Trichloroethylene  |   | X | X |
| 22.211  | 1,1-Dichloroethylene   |   | X | X |
| 22.212  | Vinyl Chloride   |   | X | X |
| 22.213  | 1,1,1-Trichloroethane  |   | X | X |
| 22.214  | 1,2-Dichloroethane   |   | X | X |
| 22.215  | Carbon Tetrachloride   |   | X | X |
| 22.216  | Benzene  |   | X | X |
| 22.217  | Para-Dichlorobenzene (p-Dichlorobenzene)                     |   | X | X |
| 22.22   | Microbial Standards  |   | X | X |
| 22.220  | Total Coliform Rule  |   | X | X |
| 22.221  | 2012 Revised Total Coliform Rule (RTCR)                      |   | X | X |
| 22.2200 | Sanitary Survey  |   | X | X |
| 22.2201 | Sampling Plan  |   | X | X |
| 22.2202 | Laboratory Procedures  |   | X | X |
| 22.2203 | Monitoring Frequency   |   | X | X |
| 22.2204 | Determining Compliance                                       |   | X | X |
| 22.2205 | Reporting and Notification Requirements                      |   | X | X |
| 22.221  | Surface Water Treatment Rule                                 |   | X | X |
| 22.2210 | Criteria for Avoiding Filtration                             |   | X | X |
| 22.2211 | Requirements for Filtered Water Systems                      |   | X | X |
| 22.2212 | Chlorine Residual Substitutions                              |   | X | X |
| 22.2213 | Turbidity Requirements                                       |   | X | X |
| 22.2214 | Monitoring Requirements                                      |   | X | X |
| 22.2215 | CT Values  |   | X | X |
| 22.2216 | Interim Enhanced Surface Water Treatment Rule (IESWTR)       |   | X | X |
| 22.2217 | Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) |   | X | X |
| 22.2218 | Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) |   | X | X |
| 22.23   | Disinfectants and Disinfection By-Products (D/DBPs)          |   | X | X |
| 22.24   | Radiological Standards                                       |   | X | X |
| 22.30   | Enforcement of Regulations                                   |   | X | X |
| 22.31   | Secondary Maximum Contaminant Levels                         |   | X | X |
| 22.32   | Monitoring   |   | X | X |
| 22.33   | Secondary Contaminants                                       |   | X | X |
| 22.330  | Aluminum   |   | X | X |
| 22.331  | Chloride   |   | X | X |
| 22.332  | Color  |   | X | X |
| 22.333  | Copper   |   | X | X |
| 22.334  | Corrosivity  |   | X | X |
| 22.335  | Fluoride   |   | X | X |
| 22.336  | Foaming Agents   |   | X | X |
| 22.337  | Iron and Manganese   |   | X | X |
| 22.338  | Iron   |   | X | X |
| 22.339  | Manganese  |   | X | X |
| 22.3310 | Odor   |   | X | X |
| 22.3311 | pH   |   | X | X |
| 22.3312 | Silver   |   | X | X |
| 22.3313 | Sulfate  |   | X | X |
| 22.3314 | Total Dissolved Solids (TDS)                                 |   | X | X |
| 22.3315 | Zinc   |   | X | X |
| 22.4    | SAMPLING PROCEDURES  |   | X | X |
| 22.40   | Safe Drinking Water Regulations                              |   | X | X |
| 22.41   | Overview of Sampling   |   | X | X |
| 22.42   | General Guidelines for Water Sampling                        |   | X | X |
| 22.43   | Selecting Sampling Locations                                 |   | X | X |



## PART II

## WATER TREATMENT PLANT OPERATION VOLUME II

| SECTION | TOPIC   | C | B | A |
|---------|---|---|---|---|
| 22.44   | Use of Dedicated Sampling Stations                |   | X | X |
| 22.45   | Sampling Points                                   |   | X | X |
| 22.46   | Sampling Point Selection                          |   | X | X |
| 22.47   | Sampling Schedule                                 |   |   |   |
| 22.48   | Sampling Routine                                  |   | X | X |
| 22.49   | Sample Collection                                 |   | X | X |
| 22.410  | Frequency of Sampling                             |   | X | X |
| 22.411  | Chain-of-Custody Procedures                       |   | X | X |
| 22.5    | REPORTING PROCEDURES                              |   | X | X |
| 22.6    | NOTIFICATION REQUIREMENTS                         |   | X | X |
| 22.7    | RECORDKEEPING                                     |   | X | X |
| 22.8    | CONSUMER CONFIDENCE REPORT (CCRs)                 |   | X | X |
| 23      | <b>WORDS: ADMINISTRATION</b>                      |   | X | X |
| 23.0    | NEED FOR UTILITY MANAGEMENT                       |   |   | X |
| 23.1    | FUNCTIONS OF A MANAGER                            |   |   | X |
| 23.2    | PLANNING  |   |   | X |
| 23.3    | ORGANIZING  |   |   | X |
| 23.40   | STAFFING - The Utility Manager's Responsibilities |   |   | X |
| 23.41   | How Many Employees Are Needed                     |   |   | X |
| 23.42   | Qualifications Profile                            |   |   | X |
| 23.430  | Advertising the Position                          |   |   | X |
| 23.431  | Paper Screening                                   |   |   | X |
| 23.432  | Interviewing Applicants                           |   |   | X |
| 23.433  | Selecting the Most Qualified Candidate            |   |   | X |
| 23.44   | New Employee Orientation                          |   |   | X |
| 23.450  | Probationary Period                               |   |   | X |
| 23.451  | Compensation                                      |   |   | X |
| 23.452  | Training and Certification                        |   |   | X |
| 23.453  | Performance Evaluation                            |   |   | X |
| 23.454  | Dealing with Disciplinary Problems                |   |   | X |
| 23.455  | Example Policy: Harassment                        |   |   | X |
| 23.456  | Labor Laws Governing Employer/Employee Relations  |   |   | X |
| 23.457  | Personnel Records                                 |   |   | X |
| 23.50   | Oral Communication                                |   |   | X |
| 23.51   | Written Communication                             |   |   | X |
| 23.6    | CONDUCTING MEETINGS                               |   |   | X |
| 23.70   | Establish Objectives                              |   |   | X |
| 23.71   | Utility Operations                                |   |   | X |
| 23.72   | The Mass Media                                    |   |   | X |
| 23.73   | Being Interviewed                                 |   |   | X |
| 23.74   | Public Speaking                                   |   |   | X |
| 23.75   | Telephone Contacts                                |   |   | X |
| 23.76   | Consumer Inquiries                                |   |   | X |
| 23.77   | Plant Tours                                       |   |   | X |
| 23.8    | FINANCIAL MANAGEMENT                              |   |   | X |
| 23.80   | Financial Stability                               |   |   | X |
| 23.81   | Budgeting   |   |   | X |
| 23.82   | Equipment Repair/Replacement Funds                |   |   | X |
| 23.83   | Water Rates                                       |   |   | X |
| 23.84   | Capital Improvements and Funding in the Future    |   |   | X |
| 23.85   | Financial Assistance                              |   |   | X |
| 23.90   | The Manager's Responsibilities                    |   |   | X |
| 23.91   | Purpose of O & M Programs                         |   |   | X |
| 23.92   | Types of Maintenance                              |   |   | X |

## PART II

## WATER TREATMENT PLANT OPERATION VOLUME II

| SECTION | TOPIC  | C | B | A |
|---------|--|---|---|---|
| 23.93   | Benefits of Managing Maintenance   |   |   | X |
| 23.94   | Computer Control Systems   |   |   | X |
| 23.940  | Description of SCADA Systems   |   |   | X |
| 23.941  | Typical Water Treatment and Distribution SCADA Systems                         |   |   | X |
| 23.95   | Cross Connection Control Program   |   |   | X |
| 23.950  | Importance of Cross Connection Control   |   | X | X |
| 23.951  | Program Responsibilities   |   |   | X |
| 23.952  | Water Supplier Program   |   |   | X |
| 23.953  | Types of Backflow Prevention Devices   |   |   | X |
| 23.954  | Devices Required for Various Types of Situations                               |   |   | X |
| 23.96   | Geographic Information System (GIS)  |   |   | X |
| 23.100  | Planning for Emergency Response  |   |   | X |
| 23.101  | Homeland Defense   |   |   | X |
| 23.1020 | Handling the Threat of Contaminated Water Supplies - Importance                |   |   | X |
| 23.1021 | Toxicity   |   |   | X |
| 23.1022 | Emergency Contaminant Limits   |   |   | X |
| 23.1023 | Protective Measures  |   |   | X |
| 23.1024 | Emergency Countermeasures  |   |   | X |
| 23.1025 | In Case of Contamination   |   |   | X |
| 23.1026 | Cryptosporidium  |   |   | X |
| 23.1100 | Everyone is Responsible for Safety   |   | X | X |
| 23.1101 | Regulatory Agencies  |   | X | X |
| 23.1102 | Managers   |   |   | X |
| 23.1103 | Supervisors  |   |   | X |
| 23.1104 | Operators  |   |   | X |
| 23.111  | First Aid  |   | X | X |
| 23.112  | Hazard Communication Program and Worker Right-To-Know (RTK) Laws               |   |   | X |
| 23.113  | Confined Spaces Entry Procedures   |   |   | X |
| 23.114  | Reporting  |   |   | X |
| 23.115  | Training   |   |   | X |
| 23.116  | Measuring  |   |   | X |
| 23.117  | Human Factors  |   |   | X |
| 23.120  | Purpose of Records   |   | X | X |
| 23.121  | Types of Records   |   | X | X |
| 23.122  | Types of Plant Operations Data   |   |   | X |
| 23.123  | Maintenance Records  |   | X | X |
| 23.124  | Procurement Records  |   |   | X |
| 23.125  | Inventory Records  |   |   | X |
| 23.126  | Equipment Records  |   | X | X |
| 23.127  | Computer Record Keeping Systems  |   |   | X |
| 23.128  | Disposition of Plant Records   |   |   | X |
| 23.130  | Need for Conservation  | X | X | X |
| 23.131  | What Is Water Conservation?  | X | X | X |
| 23.132  | Elements of Water Conservation Program   |   | X | X |
| 23.1320 | Residential Water Surveys  |   | X | X |
| 23.1321 | Residential Plumbing Retrofits   |   | X | X |
| 23.1322 | System Water Audits, Leak Detection, and Repair                                |   | X | X |
| 23.1323 | Meeting with Commodity Rates   |   |   | X |
| 23.1324 | Large Landscape Conservation Programs  |   |   | X |
| 23.1325 | High-Efficiency Clothes Washers  |   |   | X |
| 23.1326 | Public Information Programs  |   |   | X |
| 23.1327 | School Education Programs  |   |   | X |
| 23.1328 | Conservation Programs for Commercial, Industrial & Institutional (CII) Sectors |   |   | X |

## PART II

## WATER TREATMENT PLANT OPERATION VOLUME II

| SECTION  | TOPIC   | C | B | A |
|----------|---|---|---|---|
| 23.1329  | Wholesale Agency Assistance Programs                          |   |   | X |
| 23.13210 | Conservation Pricing  |   |   | X |
| 23.13211 | Conservation Coordinator                                      |   |   | X |
| 23.13212 | Water Waste Prohibition                                       |   |   | X |
| 23.13213 | Residential ULFT Replacement Programs                         |   |   | X |
| 23.13214 | Potential Best Management Practices                           |   |   | X |
| 23.133   | EPA's WaterSense: Efficiency Made Easy                        |   |   | X |
| <b>A</b> | <b>HOW TO SOLVE WATER TREATMENT PLANT ARITHMETIC PROBLEMS</b> |   |   |   |
| A.1      | BASIC CONVERSION FACTORS (ENGLISH SYSTEM)                     |   | X | X |
| A.2      | BASIC FORMULAS  |   | X | X |
| A.30     | Iron and Manganese Control - Examples 1 - 4                   |   | X | X |
| A.31     | Fluoridation - Examples 5 - 10                                |   | X | X |
| A.33     | Specialized Treatment Process - Example 24                    |   | X | X |
| A.34     | Membrane Treatment Process - Examples 27-29                   |   |   | X |
| A.35     | Maintenance - Examples 30 - 33                                |   | X | X |
| A.36     | Advanced Laboratory Procedures - Example 34                   |   | X | X |
| A.37     | Regulations - Example 38                                      |   | X | X |
| A.38     | Administration, Safety - Examples 39 - 40                     |   | X | X |
| A.4      | BASIC CONVERSION FACTORS (METRIC SYSTEM)                      |   | X | X |

## PART III

RULES GOVERNING PUBLIC WATER SYSTEMS

| SECTION | TOPIC   | C | B | A |
|---------|---|---|---|---|
| .0102   | DEFINITIONS   | X | X | X |
| .0201   | SURFACE WATER SUPPLIES FOR PUBLIC WATER SYSTEMS                 | X | X | X |
| .0202   | SURFACE SUPPLIES FROM CLASSIFIED WATERSHEDS                     |   | X | X |
| .0301   | APPLICABILITY: PRIOR NOTICE                                     | X | X | X |
| .0303   | SUBMISSIONS REQUIRED BY ENGINEER AND APPLICANT                  | X | X | X |
| .0304   | APPLICATION FOR APPROVAL: BY WHOM MADE                          | X | X | X |
| .0305   | APPROVALS NECESSARY BEFORE CONTRACTING OR CONSTRUCTION          | X | X | X |
| .0306   | CHANGES IN ENGINEERING PLANS OR SPECIFICATIONS AFTER APPROVAL   | X | X | X |
| .0307   | ENGINEER'S REPORT, WATER SYSTEM MANAGEMENT PLAN AND OTHER PLANS |   |   | X |
| .0308   | ENGINEERING PLANS AND SPECIFICATIONS                            |   |   | X |
| .0309   | FINAL APPROVAL  |   |   | X |
| .0403   | SURFACE WATER FACILITIES  |   |   | X |
| .0404   | WATER TREATMENT FACILITIES                                      | X | X | X |
| .0405   | STORAGE OF FINISHED WATER                                       | X | X | X |
| .0406   | DISTRIBUTION SYSTEMS  | X | X | X |
| .0407   | ELECTRICAL SYSTEMS  | X | X | X |
| .0408   | LEAD FREE CONSTRUCTION  | X | X | X |
| .0409   | SERVICE CONNECTIONS   | X | X | X |
| .0501   | PURPOSE   |   |   | X |
| .0502   | DESIGN CRITERIA   |   |   | X |
| .0601   | IMPOUNDMENTS: PRE-SETTLING RESERVOIRS                           |   |   | X |
| .0602   | RAW WATER INTAKES   |   |   | X |
| .0603   | INTAKE CONDUITS   |   |   | X |
| .0604   | PUMPS: POWER FACILITIES   |   |   | X |
| .0701   | FLASH OR RAPID MIXING FACILITY                                  |   |   | X |
| .0702   | AIR MIXING  |   |   | X |
| .0703   | MECHANICAL FLOCCULATION   |   |   | X |
| .0704   | BAFFLED MIXING AND FLOCCULATION BASINS                          |   |   | X |
| .0705   | CONDUITS: PIPES AND FLUMES: GATES AND VALVES                    |   |   | X |
| .0706   | SEDIMENTATION BASINS  |   |   | X |
| .0707   | SOLIDS CONTACT OR UP-FLOW UNITS                                 |   |   | X |
| .0708   | GRAVITY FILTERS   |   |   | X |
| .0709   | PREVENTION OF BACKFLOW AND BACK-SIPHONAGE                       |   | X | X |
| .0710   | OTHER WATER TREATMENT PLANTS                                    |   |   | X |
| .0711   | ALTERNATIVE FILTRATION TREATMENT TECHNOLOGIES                   |   |   | X |
| .0712   | DIRECT FILTRATION   |   |   | X |
| .0713   | PRESSURE FILTERS  |   |   | X |
| .0714   | PILOT PLAN STUDIES  |   |   | X |
| .0715   | OTHER DESIGN STANDARDS  |   |   | X |
| .0805   | CAPACITIES: ELEVATED STORAGE                                    |   |   | X |
| .0901   | SIZE OF WATER MAINS   | X | X | X |
| .0902   | NUMBER OF RESIDENCES ON A WATER MAIN                            | X | X | X |
| .0903   | DEAD END WATER MAINS  | X | X | X |
| .0904   | PIPE LAYING   | X | X | X |
| .0905   | TESTING NEW WATER MAINS   | X | X | X |
| .0906   | RELATION OF WATER MAINS TO NON-POTABLE WATER LINES              | X | X | X |
| .0907   | VALVES  |   | X | X |
| .1001   | DISINFECTION OF NEW SYSTEM                                      | X | X | X |
| .1003   | DISINFECTION OF STORAGE TANKS & DISTRIBUTION SYSTEMS            | X | X | X |
| .1201   | RECREATIONAL ACTIVITIES   |   |   | X |
| .1202   | PROTECTION OF WATER QUALITY                                     |   |   | X |
| .1203   | MAINTENANCE OF PARKS  |   |   | X |
| .1204   | FISHING   |   |   | X |

## PART III

## RULES GOVERNING PUBLIC WATER SYSTEMS

| SECTION | TOPIC  | C | B | A |
|---------|--|---|---|---|
| .1207   | ANIMALS IN RESERVOIR   |   |   | X |
| .1208   | CONTROLLING THE DRAINAGE OF WASTES                           |   |   | X |
| .1209   | UNTREATED DOMESTIC SEWAGE OR INDUSTRIAL WASTES               |   |   | X |
| .1210   | SEWAGE DISPOSAL  |   |   | X |
| .1211   | GROUND ABSORPTION SEWAGE COLLECTION: TREATMENT/DISP SYSTEMS  |   |   | X |
| .1212   | BURIAL OF CARCASSES  |   |   | X |
| .1213   | BURIAL GROUND  |   |   | X |
| .1214   | DISPOSAL OF ANY SUBSTANCE                                    |   |   | X |
| .1301   | OPERATION OF PUBLIC WATER SUPPLY - GENERAL REQUIREMENTS      | X | X | X |
| .1302   | TEST, FORMS & REPORTING                                      | X | X | X |
| .1303   | FACILITY OVERSIGHT   | X | X | X |
| .1304   | WATER SYSTEM OPERATION AND MAINTENANCE                       |   |   | X |
| .1401   | POLICY- FLUORIDATION   |   | X | X |
| .1402   | FORMAL APPLICATION   |   | X | X |
| .1404   | FEEDING EQUIPMENT  |   | X | X |
| .1405   | PROTECTION OF OPERATORS                                      | X | X | X |
| .1406   | CONTROL OF FLUORIDE PROCESS                                  |   | X | X |
| .1407   | APPROVAL MAY BE RESCINDED                                    |   | X | X |
| .1502   | MONITORING OF CONSECUTIVE PUBLIC WATER SYSTEMS               |   | X | X |
| .1505   | TURBIDITY SAMPLING AND ANALYSIS                              | X | X | X |
| .1506   | MAXIMUM CONTAMINANT LEVELS FOR TURBIDITY                     | X | X | X |
| .1507   | CORROSION CONTROL AND LEAD AND COPPER MONITORING             | X | X | X |
| .1508   | INORGANIC CHEMICAL SAMPLING AND ANALYSIS                     | X | X | X |
| .1509   | SPECIAL MONITORING FOR SODIUM                                |   | X | X |
| .1510   | MAXIMUM CONTAMINANT LEVEL FOR INORGANIC CHEMICALS            | X | X | X |
| .1511   | CONCENTRATION OF IRON  | X | X | X |
| .1512   | CONCENTRATION OF MANGANESE                                   | X | X | X |
| .1513   | TOTAL TRIHALOMETHANES SAMPLING AND ANALYSIS: 10,000 OR MORE  |   | X | X |
| .1514   | TREATMENT TECHNIQUES FOR TOTAL TRIHALOMETHANES               |   | X | X |
| .1515   | ORGANIC CHEMICALS OTHER THAN TTHM, SAMPLING AND ANALYSIS     | X | X | X |
| .1516   | SPECIAL MONITORING OF UNREGULATED CONTAMINANTS               | X | X | X |
| .1517   | MAXIMUM CONTAMINANT LEVEL FOR ORGANIC CHEMICALS              |   | X | X |
| .1518   | MAXIMUM CONTAMINANT LEVEL FOR ORGANIC CONTAMINANTS           | X | X | X |
| .1519   | MONITORING FREQUENCY FOR RADIOACTIVITY                       | X | X | X |
| .1520   | MAXIMUM CONTAMINANT LEVELS FOR RADIUM                        | X | X | X |
| .1521   | MAXIMUM CONTAMINANT LEVEL GOALS FOR RADIONUCLIDES            |   |   | X |
| .1522   | ANALYTICAL METHODS FOR RADIOACTIVITY                         |   |   | X |
| .1523   | PUBLIC NOTICE  | X | X | X |
|         | Subpart Q - Public Notification of Drinking Water Violations | X | X | X |
| .1524   | REPORTING FOR UNREGULATED CONTAMINANT MONITORING RESULTS     | X | X | X |
| .1525   | REPORTING REQUIREMENTS                                       | X | X | X |
| .1526   | RECORD MAINTENANCE   | X | X | X |
| .1527   | CERTIFIED LABORATORIES                                       |   |   | X |
| .1528   | ALTERNATE ANALYTICAL TECHNIQUES                              |   |   | X |
| .1529   | POINT-OF-ENTRY, BOTTLED WTER, AND OTHER TREATMENT DEVICES    |   |   | X |
| .1531   | SITING REQUIREMENTS  |   |   | X |
| .1532   | VARIANCES AND EXEMPTIONS                                     |   |   | X |
| .1534   | COLIFORM SAMPLING  | X | X | X |
| .1535   | MAXIMUM CONTAMINANT LEVELS FOR COLIFORM BACTERIA             | X | X | X |
| .1536   | TREATMENT TECHNIQUES   |   | X | X |
| .1537   | DRINKING WATER TREATMENT CHEMICALS AND SYSTEM COMPONENTS     |   | X | X |
| .1538   | CONSUMER CONFIDENCE REPORT                                   |   | X | X |
| .1601   | REQUIREMENTS FOR A VARIANCE                                  |   | X | X |

## PART III

RULES GOVERNING PUBLIC WATER SYSTEMS

| SECTION | TOPIC   | C | B | A |
|---------|---|---|---|---|
| .1602   | VARIANCE REQUEST  |   |   | X |
| .1603   | CONSIDERATION OF A VARIANCE REQUEST   |   |   | X |
| .1604   | DISPOSITION OF A VARIANCE REQUEST   |   |   | X |
| .1605   | PUBLIC HEARING OF VARIANCES AND SCHEDULES   |   |   | X |
| .1606   | VARIANCES FOR FLUORIDE  |   |   | X |
| .1607   | VARIANCES AND EXEMPTIONS FOR CHEMICALS, LEAD AND COPPER, AND RADIO-NUCLIDES                 |   |   | X |
| .1608   | REQUIREMENTS FOR AN EXEMPTION   |   |   | X |
| .1609   | EXEMPTION REQUEST   |   |   | X |
| .1610   | CONSIDERATION OF AN EXEMPTION REQUEST   |   |   | X |
| .1611   | DISPOSITION OF AN EXEMPTION REQUEST   |   |   | X |
| .1612   | PUBLIC HEARINGS ON EXEMPTION SCHEDULES  |   |   | X |
| .1613   | FINAL SCHEDULE  |   |   | X |
| .1614   | BOTTLED WATER AND POINT-OF-USE DEVICES  |   |   | X |
| .1904   | WHEN PENALTIES MAY BE ASSESSED  | X | X | X |
| .1905   | AMOUNT OF PENALTY ASSESSMENT  | X | X | X |
| .1913   | RIGHT OF ENTRY AND INSPECTION   | X | X | X |
| .2001   | GENERAL REQUIREMENTS (FILTRATION AND DISINFECTION)  | X | X | X |
| .2002   | DISINFECTION  | X | X | X |
| .2003   | FILTER BACKWASH RECYCLING RULE  |   | X | X |
| .2004   | ANALYTICAL AND MONITORING REQUIREMENTS  |   | X | X |
| .2005   | CRITERIA FOR AVOIDING FILTRATION  |   | X | X |
| .2006   | REPORTING AND RECORD KEEPING RULES  |   | X | X |
| .2007   | SUBPART P - ENHANCED FILTRATION AND DISINFECTION (Systems serving 10,000 or more people)    |   |   | X |
| .2007   | SUBPART T - ENHANCED FILTRATION AND DISINFECTION (Systems serving fewer than 10,000 people) |   | X | X |
| .2008   | DISINFECTANTS AND DISINFECTION BYPRODUCTS   |   | X | X |
| .2101   | PERMITS   | X | X | X |
| .2102   | APPLICATION FOR PERMITS   | X | X | X |
| .2103   | INITIAL PERMIT PERIOD   | X | X | X |
| .2104   | RENEWAL FEES  | X | X | X |
| .2105   | REVOCATION  | X | X | X |
|         | APPENDIX B - FIGURE 2 - NORTH CAROLINA GUIDELINES CROSS CONNE                               | X | X | X |

## PART IV

RULES GOVERNING WATER TREATMENT FACILITY OPERATORS

| <b>SECTION</b> | <b>TOPIC</b>  | <b>C</b> | <b>B</b> | <b>A</b> |
|----------------|---|----------|----------|----------|
| 0.0100         | GENERAL POLICIES  | X        | X        | X        |
| .0105          | Definitions   | X        | X        | X        |
| .0200          | QUALIFICATIONS OF APPLICANTS AND CLASSIFICATION OF FACILITIES | X        | X        | X        |
| .0201          | Grades of Certification                                       | X        | X        | X        |
| .0202          | Examinations  | X        | X        | X        |
| .0205          | Classification of Water Treatment Facility                    | X        | X        | X        |
| .0206          | Certified Operator Required                                   | X        | X        | X        |
| .0300          | APPLICATIONS AND FEES   | X        | X        | X        |
| .0301          | Application for Exam  | X        | X        | X        |
| .0302          | Application for Reciprocity                                   | X        | X        | X        |
| .0303          | Application for Temporary Certificate                         | X        | X        | X        |
| .0304          | Fee Schedule  | X        | X        | X        |
| .0307          | Revocation of Certificate                                     | X        | X        | X        |
| .0308          | Continuing Education  | X        | X        | X        |
| .0309          | Certification Reinstatement                                   | X        | X        | X        |
| .0400          | ISSUANCE OF CERTIFICATE                                       | X        | X        | X        |
| .0401          | Notification of Classification                                | X        | X        | X        |
| .0403          | Issuance of Grade Certificate                                 | X        | X        | X        |
| .0404          | Temporary Certificate   | X        | X        | X        |
| .0501          | Petitions   | X        | X        | X        |
| .0508          | Declaratory Rules   | X        | X        | X        |
| .0601          | Opportunity for Licensee or Applicant to Have Hearing         | X        | X        | X        |
| .0701          | Operator in Responsible Charge                                | X        | X        | X        |