NEEDS TO KNOW GUIDE
FOR
WELL WATER SYSTEM OPERATORS

Presented by
NORTH CAROLINA WATERWORKS OPERATORS ASSOCIATION
BOARD OF EXAMINERS

2015

PART I
NEED TO KNOW GUIDE - SMALL WATER SYSTEM OPERATION AND MAINTENANCE
Sections Listed are from 5th Edition

Guide for Small Water System Operation and Maintenance, 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 2010

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 - WELL CONSTRUCTION STANDARDS
Sections Listed are from August 1, 2002

Guide for "Well Construction Standards, "Section .0100, Title 15A, Subchapter 2C of the North Carolina Administrative Code, Department of Environment, Health and Natural Resources, Division of Environmental Health.

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

Guide for "Rules Governing Water Treatment Facility Operators", Section .0100 through Section .0700, Title 15A, Subchapter 18D of the North Carolina Administrative Code, Department of Environment, Health and Natural Resources, Division of Environmental Health.

SMALL WATER SYSTEM OPERATION AND MAINTENANCE

SECTION	TOPIC	D	C	B	A
1.	**THE SMALL WATER SYSTEM OPERATOR**				
1.0	NEED FOR SMALL WATER SYSTEM OPERATOR	X	X	X	X
1.10	Source Of Water	X	X	X	X
1.11	Storage Facilities	X	X	X	X
1.12	Treatment Facilities	X	X	X	X
1.13	Distribution System	X	X	X	X
1.20	Operation And Maintenance	X	X	X	X
1.21	Supervision And Administration	X	X	X	X
1.22	Public Relations	X	X	X	X
1.23	Safety	X	X	X	X
1.34	What Does It Take To Be A Small Water System Operator?	X	X	X	X
1.41	Your Personal Training Program		X	X	X
1.42	Certification	X	X	X	X
2.	**WORDS: WATER SOURCES AND TREATMENT**		X	X	X
2.0	IMPORTANCE OF WATER	X	X	X	X
2.140	Sources	X	X	X	X
2.141	Wells	X	X	X	X
2.20	Sanitary Survey	X	X	X	X
2.21	Precipitation	X	X	X	X
2.22	Physical Characteristics	X	X	X	X
2.23	Chemical Characteristics	X	X	X	X
2.24	Biological Factors	X	X	X	X
2.25	Radiological Factors		X	X	X
2.3	The Safe Drinking Water Act	X	X	X	X
2.4	Water Treatment	X	X	X	X
3.	**WORDS: WELLS**	X	X	X	X
3.00	Importance Of Groundwater	X	X	X	X
3.01	Water (Hydrological) Cycle	X	X	X	X
3.02	Aquifers	X	X	X	X
3.020	Porosity And Specific Yield		X	X	X
3.021	Overdraft		X	X	X
3.022	Salt Water Intrusion			X	X
3.030	Pollution Control	X	X	X	X
3.031	Geological And Hydrological Data		X	X	X
3.040	Statement Of The Problem	X	X	X	X
3.041	National Program		X	X	X
3.042	Community Involvement And Support			X	X
3.043	Step One- Community Participation			X	X
3.044	Step Two- Collecting Existing Data			X	X
3.045	Step Three- Filling In The Data Gap			X	X
3.046	Step Four- Which Land Uses Constitute A Threat To Groundwater Quality?			X	X
3.047	Step Five- Learning From What Has Been Collected			X	X
3.048	Step Six- Now What?			X	X
3.049	Step Seven- Establishing Wellhead Protection Area (WHPA)			X	X
3.0410	Step Eight- FINALLY			X	X
3.05	Groundwater Protection Tips			X	X
3.050	Agriculture			X	X

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SECTION	TOPIC	D	C	B	A
3.051	Gas Stations			X	X
3.052	Fuel Storage			X	X
3.053	Photo Labs/Printers, Dry Cleaners, Furniture Strippers/Painting, Medical Labs			X	X
3.054	Septic Systems, Subsurface Waste Disposal			X	X
3.055	What To Tell Homeowners			X	X
3.06	Summary	X	X	X	X
3.10	Purpose Of Surface Features	X	X	X	X
3.11	Well-Casing Vent	X	X	X	X
3.12	Gravel Tube			X	X
3.13	Sounding Tube		X	X	X
3.14	Pump Pedestal		X	X	X
3.15	Pump Motor Base Seal		X	X	X
3.16	Sampling Taps	X	X	X	X
3.17	Air Release-Vacuum Valves		X	X	X
3.18	Pump Blowoff	X	X	X	X
3.20	Typical Well Pump And Pressure Tank	X	X	X	X
3.210	Check Valves	X	X	X	X
3.211	Pump Control Valves		X	X	X
3.212	Foot Valves	X	X	X	X
3.22	Flowmeters	X	X	X	X
3.23	Sand Traps And Sand Separators			X	X
3.230	Sand Traps			X	X
3.231	Sand Separators			X	X
3.24	Tank Coatings	X	X	X	X
3.25	Surge Suppressors		X	X	X
3.26	Air And Vacuum Valves		X	X	X
3.27	Pressure Relief Valves	X	X	X	X
3.280	Methods Of Air Charging	X	X	X	X
3.281	Hydraulic Principle Air Chargers	X	X	X	X
3.282	Air Compressor Air Charger	X	X	X	X
3.290	Application	X	X	X	X
3.291	Tank Size	X	X	X	X
3.292	Operation	X	X	X	X
3.30	Importance Of Well Maintenance	X	X	X	X
3.310	Adverse Conditions	X	X	X	X
3.311	Overpumping	X	X	X	X
3.312	Clogging Or Collapse Of Screen		X	X	X
3.313	Corrosion Or Incrustation		X	X	X
3.314	Biofouling		X	X	X
3.315	Field Testing of Deposits		X	X	X
3.32	Preventive Maintenance And Repair	X	X	X	X
3.33	Casing And Screen Maintenance	X	X	X	X
3.330	Surging			X	X
3.331	High-Velocity Jetting			X	X
3.332	Acid Treatment		X	X	X
3.333	Chlorine Treatment	X	X	X	X
3.334	Polyphosphates		X	X	X

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SECTION	TOPIC	D	C	B	A
3.335	Explosive Charges			X	X
3.336	Summary	X	X	X	X
3.34	Water Quality Monitoring	X	X	X	X
3.35	Downhole Video Inspection		X	X	X
3.360	Decline In Yield	X	X	X	X
3.361	Charges In Water Quality	X	X	X	X
3.37	Summary	X	X	X	X
3.400	Well Pumps	X	X	X	X
3.401	Shallow Well Pumps	X	X	X	X
3.402	Deep Well Pumps	X	X	X	X
3.410	Centrifugal Pumps	X	X	X	X
3.411	Volute-Type Pumps			X	X
3.412	Turbine-Type Pumps		X	X	X
3.413	Deep Well Turbine Pumps		X	X	X
3.414	Other Pumps	X	X	X	X
3.42	Column Pipe		X	X	X
3.43	Right-Angle Gear Drivers			X	X
3.44	Selecting A Pump	X	X	X	X
3.45	Service Guidelines		X	X	X
3.46	Motors	X	X	X	X
3.50	New Wells- During Construction				
3.51	New Wells- After Construction				
3.52	Existing Wells- After Well Or Pump Repairs	X	X	X	X
3.53	Contaminated Wells	X	X	X	X
3.54	Chlorine Requirement Calculation	X	X	X	X
3.60	Health And Safety	X	X	X	X
3.61	Operator Responsibility	X	X	X	X
3.62	Knowledge Of The Water Production Facilities		X	X	X
3.63	Routine Facility Servicing		X	X	X
3.64	What To Look For	X	X	X	X
3.65	Forms	X	X	X	X
3.66	Records	X	X	X	X
3.70	Source Of Sand		X	X	X
3.71	Problems Associated With Sand		X	X	X
3.72	Flushing Mains	X	X	X	X
3.73	Test For Sand, Volumetric Method			X	X
3.74	Acceptable Concentrations			X	X
3.75	Responding To Complaints	X	X	X	X
3.80	Purpose Of Electrical Supply And Controls		X	X	X
3.810	Electricity		X	X	X
3.811	Motor Starters		X	X	X
3.812	Auxiliary Power		X	X	X
3.820	Types Of Controls		X	X	X
3.821	Control Systems		X	X	X
3.822	Pressure	X	X	X	X
3.823	Water Level	X	X	X	X
3.83	Equipment		X	X	X
3.84	Common Electrical Control Definitions		X	X	X

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SECTION	TOPIC	D	C	B	A
3.85	Instrumentation			X	X
3.90	Need For Troubleshooting	X	X	X	X
3.91	Troubleshooting Guide	X	X	X	X
3.910	Pump Will Not Start		X	X	X
3.911	Pump Will Not Shut Off		X	X	X
3.912	Pump Starts Too Frequently		X	X	X
3.913	Fusses Blow, Circuit Breaker or Overload Relays Trip When Pump Is In Operation		X	X	X
3.914	Pump Will Not Deliver Normal Amount of Water		X	X	X
3.915	Pump Takes Too Much Power		X	X	X
3.916	Excessive Operating Noise		X	X	X
	APPENDIX (Chapter 3 Wells)				
3.12	WELL SITE SELECTION	X	X	X	X
3.120	Factors To Be Considered	X	X	X	X
3.121	Safe Horizontal Distance	X	X	X	X
3.123	Design Of Well Fields				X
3.126	Sanitary Control Of Future Construction	X	X	X	X
3.13	TYPES OF WELLS		X	X	X
3.130	Dug Wells		X	X	X
3.131	Bored Wells		X	X	X
3.132	Driven Wells		X	X	X
3.133	Drilled Wells	X	X	X	X
3.1330	Percussion Method			X	X
3.1331	Hydraulic Rotary Drilling Method			X	X
3.1322	Reverse Circulation Rotary Drilling Method			X	X
3.1333	Air Rotary Drilling Method			X	X
3.134	Shallow Collector Wells- Ranny Type			X	X
3.140	Rules And Regulations Regarding Well Construction	X	X	X	X
3.141	Subsurface Features Of A Well	X	X	X	X
3.142	Conductor Casing			X	X
3.143	Well Casing	X	X	X	X
3.1440	Purpose Of Intake Section		X	X	X
3.1441	Well Screens		X	X	X
3.1442	Mill-Cut Slots			X	X
3.1443	Formed Louvers			X	X
3.1444	Torch-Cut Slots			X	X
3.1445	Hydraulic Or Mechanical Slots			X	X
3.145	Annular Grout Seal	X	X	X	X
3.146	Sealing Material			X	X
3.147	Placement Of Sealing Material			X	X
3.148	Gravel Pack		X	X	X
3.15	DETERMINATION OF WORKING PRESSURE		X	X	X
3.160	Well Performance Testing	X	X	X	X
3.161	Types Of Pumping Tests			X	X
3.1610	Bailing Test Method			X	X
3.1611	Air Blow Test Method			X	X
3.1612	Variable Rate Method			X	X
3.1613	Constant Rate Method			X	X

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SECTION	TOPIC	D	C	B	A
3.1614	Step-Continuous Composite Method			X	X
3.170	Mechanical Wear Of Pumps			X	X
3.171	Guidelines For Testing			X	X
3.172	Operator Responsibility			X	X
3.173	Terminology			X	X
3.174	Calculations			X	X
3.175	Performance Values			X	X
3.176	Pump Electrical			X	X
4.	**WORDS: SMALL WATER TREATMENT PLANTS**		X	X	X
4.02	Groundwater	X	X	X	X
4.03	Operator Responsibility	X	X	X	X
4.4	FILTRATION		X	X	X
4.5	DISINFECTION	X	X	X	X
4.6	CORROSION CONTROL		X	X	X
4.70	Solids-Contact Clarification- Process Description				
4.9	IRON AND MANGANESE CONTROL		X	X	X
4.100	Lime-Soda Ash Softening			X	X
4.101	Ion Exchange Softening		X	X	X
4.11	OPERATION	X	X	X	X
4.120	MAINTENANCE - Program	X	X	X	X
4.121	Tools			X	X
4.13	SAFETY	X	X	X	X
5.	**WORDS: DISINFECTION**		X	X	X
5.00	Making Water Safe For Consumption	X	X	X	X
5.01	Safe Drinking Water Act (SDWA)	X	X	X	X
5.10	pH	X	X	X	X
5.11	Temperature	X	X	X	X
5.12	Turbidity	X	X	X	X
5.120	Organic Matter	X	X	X	X
5.121	Inorganic Matter	X	X	X	X
5.13	Reducing Agent	X	X	X	X
5.140	Number And Types Of Microorganisms	X	X	X	X
5.141	Removal Processes			X	X
5.20	Purpose Of Process	X	X	X	X
5.210	Physical Means Of Disinfection	X	X	X	X
5.211	Chemical Disinfectants			X	X
5.220	Properties Of Chlorine		X	X	X
5.221	Chlorine Disinfection Action	X	X	X	X
5.222	Reaction With Water		X	X	X
5.223	Reaction With Impurities In Water		X	X	X
5.230	Hypochlorite Reactions With Water	X	X	X	X
5.231	Differences Between Chlorine Gas And Hypochlorite Compound Reaction		X	X	X
5.232	Onsite Chlorine Generation		X	X	X
5.240	Chlorine Dioxide Reaction With Water			X	X
5.241	Reaction With Impurities In Water				X
5.25	Breakpoint Chlorination	X	X	X	X
5.26	Critical Factors	X	X	X	X

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SECTION	TOPIC	D	C	B	A
5.27	Chlorine Residual Testing	X	X	X	X
5.290	Use Of Chloramination		X	X	X
5.291	Methods For Producing Chloramines		X	X	X
5.292	Chlorine To Ammonia-Nitrogen Ratios		X	X	X
5.293	Special Water Users		X	X	X
5.294	Blending Chloriminated Waters		X	X	X
5.295	Chloramine Residuals		X	X	X
5.295	Nitrification		X	X	X
5.297	Nitrification Prevention And Control		X	X	X
5.301	Sample Problems	X	X	X	X
5.302	Procedures	X	X	X	X
5.303	Continuous Disinfecting Of Wells	X	X	X	X
5.310	Mains- Procedures	X	X	X	X
5.311	Emergency Or Maintenance Disinfection	X	X	X	X
5.312	Disinfection Specifications	X	X	X	X
5.313	Areas Of Disinfection Problems	X	X	X	X
5.314	Sample Problems	X	X	X	X
5.321	Sample Problems	X	X	X	X
5.34	Sampling	X	X	X	X
5.400	Operation Of Chlorination Equipment- Description Of Various Units- Field Equipment	X (1)	X	X	X
5.401	Chlorine Containers	X (1)	X	X	X
5.41	Chlorine Handling		X	X	X
5.420	Hypochlorinators	X	X	X	X
5.421	Chlorinators		X	X	X
5.43	Laboratory Tests	X	X	X	X
5.44	Troubleshooting	X	X	X	X
5.45	Chlorination System Failure	X	X	X	X
5.50	Methods Of Measuring Chlorine Residual	X	X	X	X
5.51	Amperometric Titration For Free Chlorine Residual		X	X	X
5.52	DPD Colorimetric Method For Free Chlorine Residual	X	X	X	X
5.6	CHLORINE SAFETY PROGRAM		X	X	X
5.60	Chlorine Hazards		X	X	X
5.61	Why Chlorine Must Be Handled With Care		X	X	X
5.62	Protect Yourself From Chlorine		X	X	X
5.63	First Aid Measures		X	X	X
5.64	Hypochlorite Safety	X	X	X	X
5.65	Chlorine Dioxide Safety				X
5.66	Operators Safety Training	X	X	X	X
5.67	CHEMTREC (800) 424-9300	X	X	X	X
5.7	CHLORINATION ARITHMETIC	X	X	X	X
5.700	Disinfection Of Facilities- Wells And Pumps	X	X	X	X
5.701	Mains	X	X	X	X
5.702	Tanks	X	X	X	X
5.710	Disinfection Of Water From Wells- Chlorine Dose	X	X	X	X
5.711	Chlorinator		X	X	X
5.712	Hypochlorinator	X	X	X	X

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SECTION	TOPIC	D	C	B	A
6.	**WORDS: SAFETY**		X	X	X
6.00	Think Safety	X	X	X	X
6.01	What Is Safety?	X	X	X	X
6.10	Objective Of Safety Program	X	X	X	X
6.11	Unsafe Acts	X	X	X	X
6.12	Driving Safety	X	X	X	X
6.16	Corrosive Chemicals	X	X	X	X
6.17	Tailgate Safety Sessions	X	X	X	X
6.18	Employee "Right To Know" Laws	X	X	X	X
6.2	PERSONAL SAFETY	X	X	X	X
6.20	Monitoring Equipment	X	X	X	X
6.21	Protective Clothing	X	X	X	X
6.22	Slips And Falls	X	X	X	X
6.23	Handling And Lifting	X	X	X	X
6.24	Electrical Safety	X	X	X	X
6.30	Safety Arounf Wells - Importance Of Well Safety	X	X	X	X
6.31	Location Of Well Site	X	X	X	X
6.33	Sanitary Seals	X	X	X	X
6.35	Tank Coating	X	X	X	X
6.360	Well Chemicals- Acid Cleaning		X	X	X
6.361	Chlorine Treatment	X	X	X	X
6.362	Polyphosphate		X	X	X
6.37	Working Around Electrical Units	X	X	X	X
6.39	Safety Inspections	X	X	X	X
6.40	PUMP SAFETY - Uses Of A Pump	X	X	X	X
6.41	Guards Over Moving Parts	X	X	X	X
6.42	Maintenance And Repair	X	X	X	X
6.43	Lockout/Tagout Procedures	X	X	X	X
6.44	Storage Of Lubricants And Fuel	X	X	X	X
6.50	Working in the Streets- Need for Trafic Control		X	X	X
6.51	Definition of Terms	X	X	X	X
6.52	Individuals Qualified to Control Traffic	X	X	X	X
6.53	Permission to Work Within the Right-of-Way of Streets & Highways	X	X	X	X
6.54	General Responsibilities	X	X	X	X
6.550	Regulations Concerning All Street or Hwy Work - Time of Work	X	X	X	X
6.551	Specific Situations	X	X	X	X
6.552	Partial Street or Highway Closures	X	X	X	X
6.553	Complete Street or Highway Closures or Detours	X	X	X	X
6.554	Emergency Situations	X	X	X	X
6.56	Trafic Control Zones	X	X	X	X
6.560	Advanced Warning Area	X	X	X	X
6.561	Transition Area	X	X	X	X
6.562	Buffer Space	X	X	X	X
6.563	Work Area	X	X	X	X
6.564	Termination Area	X	X	X	X
6.57	How to Use Traffic Control Devices - Genaral Requirements	X	X	X	X
6.571	Signs	X	X	X	X

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SECTION	TOPIC	D	C	B	A
6.572	Chanelizing Devices	X	X	X	X
6.573	Barricades	X	X	X	X
6.574	Trafic Cones & Tubular Markers	X	X	X	X
6.575	Drums	X	X	X	X
6.576	Vertical Panels	X	X	X	X
6.577	Lighting Devices	X	X	X	X
6.578	Arrow Panels	X	X	X	X
6.579	Flashing Yellow Vehicle Lights	X	X	X	X
6.5710	High-Level Flag Tree Warning Devices	X	X	X	X
6.5711	Portable Changeable Message Sign	X	X	X	X
6.5712	Flagger Control	X	X	X	X
6.580	Pedestrians, Bicyclists, & Persons with Disabilities	X	X	X	X
6.581	Worker Visibility	X	X	X	X
6.582	Speed Limit in Work Zone	X	X	X	X
6.583	Worker Considerations	X	X	X	X
6.590	Safety Rules for Excavations	X	X	X	X
6.591	Trenches	X	X	X	X
6.592	Cave-Ins	X	X	X	X
6.593	Ladders	X	X	X	X
6.594	WARNING: Look Out for Underground Utilities	X	X	X	X
6.60	Safety Around Storage Facilities- Slips And Falls	X	X	X	X
6.610	Ladders- Fixed Ladders	X	X	X	X
6.611	Climbing Safety Devices	X	X	X	X
6.612	Training	X	X	X	X
6.613	Fixed Ladders Inspection	X	X	X	X
6.62	Application Of Coating			X	X
6.63	Confined Spaces	X	X	X	X
6.7	WORKING NEAR NOISE	X	X	X	X
6.8	SAFETY INSPECTIONS	X	X	X	X
7.	**WORDS: LABORATORY PROCEDURES**		X	X	X
7.00	Importance Of Laboratory Procedures	X	X	X	X
7.01	Metric System		X	X	X
7.02	Chemical Names And Formulas	X	X	X	X
7.03	Helpful References	X	X	X	X
7.10	Laboratory Equipment And Techniques- Water Laboratory Equipment			X	X
7.11	Use Of Laboratory Glassware			X	X
7.12	Chemical Solutions			X	X
7.13	Titrations		X	X	X
7.14	Data And Recording And Record Keeping	X	X	X	X
7.15	Laboratory Quality Control		X	X	X
7.16	Laboratory Safety			X	X
7.160	Laboratory Hazards			X	X
7.161	Personal Safety And Hygiene			X	X
7.162	Prevention Of Laboratory Accidents			X	X
7.1620	Chemical Storage			X	X
7.1621	Movement Of Chemicals			X	X
7.1622	Proper Laboratory Techniques			X	X

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7.1623	Accident Prevention			X	X
7.20	Sampling- Importance Of Sampling	X	X	X	X
7.210	Importance Of Representative Sampling	X	X	X	X
7.211	Source Water Sampling	X	X	X	X
7.212	In-Plant Sampling		X	X	X
7.213	Distribution System Sampling	X	X	X	X
7.22	Types Of Sampling	X	X	X	X
7.220	Grab Sampling	X	X	X	X
7.221	Composite Samples	X	X	X	X
7.23	Sampling Devices			X	X
7.242	Water Tap Sampling	X	X	X	X
7.25	Sampling Containers And Preservation Of Sampling	X	X	X	X
7.3 1.	Water Laboratory Tests- Alkalinity			X	X
2.	Chlorine Residual	A/B	X	X	X
3.	Chlorine Demand	A	A	X	X
4.	Coliform Bacteria	A	A/B	X	X
5.	Hardness		A	X	X
6.	Jar Test			X	X
7.	pH		A	X	X
8.	Temperature			X	X
9.	Turbidity			X	X
	APPENDIX: HOW TO SOLVE SMALL SYSTEM ARITHMETIC PROBLEMS				
A.1	BASIC ARITHMETIC	X	X	X	X
A.10	Addition	X	X	X	X
A.11	Subtraction	X	X	X	X
A.12	Multiplication	X	X	X	X
A.13	Division	X	X	X	X
A.14	Rules For Solving Equations	X	X	X	X
A.15	Actual Problems		X	X	X
A.20	Area- Units		X	X	X
A.21	Rectangle		X	X	X
A.23	Circle	X	X	X	X
A.24	Cylinder	X	X	X	X
A.30	VOLUMES- Rectangle		X	X	X
A.32	Cylinder	X	X	X	X
A.43	METRIC - Temperature			X	X
A.44	Milligrams Per Liter	X	X	X	X
A.5	WEIGHT- VOLUME RELATIONS		X	X	X
A.6	FORCE, PRESSURE AND HEAD		X	X	X
A.70	Velocity			X	X
A.71	Flow Rate			X	X
A.80	Pumps- Pressure			X	X
A.81	Work			X	X
A.82	Power			X	X
A.83	Horsepower			X	X
A.84	Head			X	X
A.85	Pump Characteristics			X	X
A.86	Evaluation Of Pump Performance			X	X

SMALL WATER SYSTEM OPERATION AND MAINTENANCE

SECTION	TOPIC	D	C	B	A
A.87	Pump Speed- Performance Relationships			X	X
A.90	Identification Of Problem	X	X	X	X
A.91	Selection Of Formula		X	X	X
A.92	Arrangement Of Formula		X	X	X
A.93	Unit Conversion	X	X	X	X
A.94	Calculation		X	X	X
A.95	Significant Figures		X	X	X
A.96	Check Your Results		X	X	X
A.10	BASIC CONVERSION FACTORS	X	X	X	X
A.11	BASIC FORMULAS	X	X	X	X
A.12	HOW TO USE THE BASIC FORMULAS	X	X	X	X
A.13	TYPICAL SMALL WATER SYSTEMS PROBLEMS- ENGLISH	X	X	X	X
A.130	Flows	X	X	X	X
A.131	Chemical Doses	X	X	X	X
A.132	Wells	X	X	X	X
A.133	Small Water Treatment Plants	X	X	X	X
A.134	Disinfection	X	X	X	X
A.135	Laboratory Procedures		X	X	X
A.154	Disinfection		X	X	X
	APPENDIX: WATER WORDS				X

WATER TREATMENT PLANT OPERATION - VOLUME II

SECTION	TOPIC	C	B	A
12.	**WORDS: IRON AND MANGANESE CONTROL**	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	X
12.2	REMEDIAL ACTION	X	X	X
12.20	Alternate Source	X	X	X
12.21	Phosphate Treatment	X	X	X
12.22	Removal By Ion Exchange	X	X	X
12.23	Oxidation By Aeration	X	X	X
12.24	Oxidation With Chlorine	X	X	X
12.25	Oxidation With Permanganate	X	X	X
12.26	Operation Of Filters	X	X	X
12.27	Proprietary Processes	X	X	X
12.28	Monitoring Of Treated Water	X	X	X
12.29	Summary	X	X	X
12.3	OPERATION OF AN IRON & MANGANESE REMOVAL PLANT	X	X	X
12.30	Description Of Equipment And Process	X	X	X
12.31	Regeneration Of Manganese Greensand	X	X	X
12.32	Troubleshooting	X	X	X
12.4	MAINTENANCE OF A CHEMICAL FEEDER	X	X	X
12.5	TROUBLESHOOTING RED WATER PROBLEMS	X	X	X
13.	**WORDS: FLUORIDATION**		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
13.3	FLUORIDATION SYSTEMS		X	X
13.30	Chemical Feeders		X	X
13.31	Saturators		X	X
13.32	Downflow Saturators		X	X
13.33	Upflow Saturators		X	X
13.34	Large Hydrofluosilicic Acid Systems		X	X
13.40	Avoid Overfeeding		X	X
13.41	Review Of Designs And Specifications		X	X
13.5	CHEMICAL FEEDER START-UP		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
13.8	UNDERFEEDING		X	X
13.9	SHUTTING DOWN CHEMICAL SYSTEMS		X	X
13.10	MAINTENANCE		X	X
13.11	SAFETY IN HANDLING FLUORIDE COMPOUNDS		X	X
13.110	Avoid Overexposure		X	X
13.111	Symptoms Of Fluoride Poisoning		X	X
13.112	Basic First Aid		X	X
13.113	Protecting Yourself And Your Family		X	X
13.114	Training		X	X
13.12	CALCULATING FLUORIDE DOSAGES		X	X
14.	**WORDS: SOFTENING**		X	X
14.0	WHAT MAKES WATER HARD?	X	X	X

SECTION	TOPIC	C	B	A
14.1	WHY SOFTEN WATER?	X	X	X
14.2	CHEMISTRY OF SOFTENING		X	X
14.20	Hardness		X	X
14.21	pH		X	X
14.22	Alkalinity		X	X
14.30	Basic Methods of Softening		X	X
14.31	Chemical Reactions	X	X	X
14.310	Lime			X
14.311	Removal of Carbon Dioxide			X
14.312	Removal of Carbonate Hardness			X
14.313	Removal of Noncarbonate Hardness			X
14.314	Stability			X
14.315	Caustic Soda Softening			X
14.316	Calculation of Chemical Dosages			X
14.32	Lime Softening		X	X
14.33	Split Lime Treatment		X	X
14.34	Lime-Soda Ash Softening		X	X
14.35	Caustic Soda Softening		X	X
14.36	Handling, Application, and Storage of Lime		X	X
14.4	INTERACTIONS WITH COAGULANTS		X	X
14.5	STABILITY		X	X
14.6	SAFETY		X	X
14.7	SLUDGE RECIRCULATION AND DISPOSAL		X	X
14.8	RECORDS		X	X
14.9	JAR TESTS			X
14.90	Typical Procedures			X
14.91	Examples			X
14.92	Calculation of Chemical Feeder Settings			X
14.10	DESCRIPTION OF ION EXCHANGE SOFTENING PROCESS	X	X	X
14.11	OPERATIONS	X	X	X
14.110	Service	X	X	X
14.111	Backwash	X	X	X
14.112	Brine	X	X	X
14.113	Rinse	X	X	X
14.12	CONTROL TESTING OF ION EXCHANGE SOFTENERS	X	X	X
14.13	LIMITATIONS CAUSED BY IRON AND MANGANESE	X	X	X
14.14	DISPOSAL OF SPENT BRINE	X	X	X
14.15	MAINTENANCE	X	X	X
14.160	Test Units	X	X	X
14.161	Service Stage	X	X	X
14.162	Backwash Stage	X	X	X
14.163	Brine Injection Stage	X	X	X
14.164	Rinse Stage	X	X	X
14.17	START-UP AND SHUTDOWN OF UNIT	X	X	X
14.18	ION EXCHANGE ARITHMETIC	X	X	X
14.19	BLENDING	X	X	X
14.20	RECORDKEEPING	X	X	X
15.	**WORDS: TRIHALOMETHANES**	X	X	X
15.0	THE TRIHALOMETHANES (THM) PROBLEM	X	X	X
15.1	FEASIBILITY ANALYSIS PROCESS	X	X	X
15.2	PROBLEM DEFINITION	X	X	X
15.20	Sampling	X	X	X
15.21	THM Calculations	X	X	X
15.22	Chemistry of THM Formation	X	X	X

SECTION	TOPIC	C	B	A
15.3	CONTROL STRATEGIES	X	X	X
15.4	EXISTING TREATMENT PROCESSES	X	X	X
15.50	Consider Options	X	X	X
15.51	Remove THM's After They Are Formed	X	X	X
15.52	Remove THM Precursors	X	X	X
15.53	Alternative Disinfectants	X	X	X
15.6	SELECTION & IMPLEMENTATION OF A COST-EFFECTIVE ALTERNATIVE	X	X	X
15.7	REGULATORY UPDATE	X	X	X
15.8	SUMMARY AND CONCLUSIONS	X	X	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
16.	**WORDS: DEMINERALIZATION**		X	X
16.0	MEMBRANE TREATMENT TECHNOLOGIES		X	X
16.10	Pressure Units or Submerged Flow		X	X
16.11	Membrane Flow Types		X	X
16.12	Membrane Fouling		X	X
16.130	Pretreatment - Operation Experience		X	X
16.131	Summary of Experiences		X	X
16.132	Need for Bench- or Pilot-Scale Studies		X	X
16.20	O & M - SCADA System		X	X
16.21	Components of a Typical Plant		X	X
16.22	Operational Proceedures		X	X
16.23	Membrane Performance Monitoring		X	X
16.24	Troubleshooting Equipment & Process Failures		X	X
16.30	Records		X	X
16.31	Summary of Records		X	X
16.310	Water Quality Monitoring Records		X	X
16.311	Plant Operation & Water Production		X	X
16.312	Troubleshooting Records		X	X
16.313	Membrane Filter Maintenance & Inspection		X	X

SECTION	TOPIC	C	B	A
16.40	Types of Maintenance		X	X
16.41	Routine Maintenance		X	X
16.42	Preventive Maintenance		X	X
16.43	Breakdown or Corrective Maintenance		X	X
16.5	SOURCES OF MINERALIZED WATER		X	X
16.6	DEMINERALIZING PROCESS		X	X
16.70	What is Reverse Osmosis?		X	X
16.71	Reverse Osmosis Membrane Structure and Composition		X	X
16.72	Membrane Performance and Properties		X	X
16.73	Definition of Flux		X	X
16.74	Mineral Rejection		X	X
16.75	Effects of Feedwater Temperature and pH on Membrane Performance		X	X
16.76	Recovery		X	X
16.8	COMPONENTS OF A REVERSE OSMOSIS UNIT		X	X
16.80	Pressurization Pump			X
16.81	Piping			X
16.82	Pressure Vessel Housings			X
16.83	Concentrate Control Valve			X
16.84	Sample Valves			X
16.85	Flush Connections			X
16.86	Cleaning Connections			X
16.87	Permeate Rinse			X
16.88	Permeate Drawback Tank			X
16.89	Energy Recovery Devices			X
16.810	Membranes			X
16.90	Pretreatment		X	X
16.91	Removal of Turbidity and Suspended Solids		X	X
16.92	pH and Temperature Control		X	X
16.93	Other Potential Scalants		X	X
16.94	Microbiological Organisms		X	X
16.95	RO Plant Operation		X	X
16.96	Typical RO Plant Operations Checklist		X	X
16.97	Membrane Cleaning		X	X
16.98	Safety			
16.980	Use of Proper Procedures		X	X
16.981	Chemical Safety		X	X
16.982	Hydraulic Safety		X	X
16.983	Electrical Safety		X	X
16.10	ELECTRODIALYSIS			X
16.110	PRINCIPLES OF ELECTRODIALYSIS - Anions and Cations in Water			X
16.111	Effect of Direct Current (D.C.) Potential on Ions			X
16.112	Anion- and Cation-Permeable Membranes and Three-Cell Unit			X
16.113	Multi-Compartment Unit			X
16.120	PARTS OF AN ELECTRODIALYSIS UNIT - Flow Diagram			X
16.121	Pretreatment			X
16.122	Pumping Equipment and Piping			X
16.123	D.C. Power Supply			X
16.124	Membrane Stack			X
16.125	Chemical Flush System			X
16.13	ROUTINE OPERATING PROCEDURES			X
16.130	Design Specifications for Feedwater			X
16.131	Detailed Operating Procedures			X
16.14	SAFETY PRECAUTIONS			X

SECTION	TOPIC	C	B	A
17.	**WORDS: HANDLING AND DISPOSAL OF PROCESS WASTES**		X	X
17.0	NEED FOR HANDLING AND DISPOSAL OF PROCESS WASTES		X	X
17.1	SOURCES OF TREATMENT PROCESS WASTES		X	X
17.2	PROCESS SLUDGE VOLUMES		X	X
17.3	METHODS OF HANDLING AND DISPOSING OF PROCESS WASTES		X	X
17.4	DRAINING AND CLEANING TANKS		X	X
17.5	BACKWASH RECOVERY PONDS (SOLAR LAGOONS)		X	X
17.6	SLUDGE DEWATERING PROCESSES			
17.60	SLUDGE DEWATERING PROCESS - Solar Drying Lagoons		X	X
17.61	Sand Drying Beds		X	X
17.62	Belt Filter Presses		X	X
17.63	Centrifuges		X	X
17.64	Filter Presses		X	X
17.65	Vacuum Filters		X	X
17.7	DISCHARGE INTO COLLECTION SYSTEMS (SEWERS)		X	X
17.8	DISPOSAL OF SLUDGE		X	X
17.9	EQUIPMENT			
17.90	Vacuum Trucks		X	X
17.91	Sludge Pumps		X	X
17.10	PLANT DRAINAGE WATERS		X	X
17.11	MONITORING AND REPORTING		X	X
18.	**WORDS: MAINTENANCE**		X	X
18.0	TREATMENT PLANT MAINTENANCE - GENERAL PROGRAM	X	X	X
18.00	Preventive Maintenance Records	X	X	X
18.01	Library of Manufacturers' Operation and Parts Manuals	X	X	X
18.02	Emergencies	X	X	X
18.03	Lockout/Tagout Procedures	X	X	X
18.10	Beware of Electricity	X	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	X
18.120	Tools, Meters and Testers		X	X
18.121	Voltage Testing		X	X
18.122	Ammeter		X	X
18.123	Megger		X	X
18.130	Ohmmeters	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	X
18.140	Classifications	X	X	X
18.141	Troubleshooting	X	X	X
18.142	Record Keeping	X	X	X
18.150	Safety First	X	X	X
18.151	Standby Power Generation	X	X	X
18.152	Emergency Lighting	X	X	X
18.153	Batteries	X	X	X
18.160	Transmission	X	X	X

SECTION	TOPIC	C	B	A
18.161	Switch Gear		X	X
18.162	Power Distribution Transformers		X	X
18.17	Electrical Safety Checklist	X	X	X
18.20	Repair Shop		X	X
18.21	Pumps		X	X
18.210	Centrifugal Pumps		X	X
18.211	Let's Build a Pump		X	X
18.212	Vertical Centrifugal Pumps		X	X
18.213	Horizontal Centrifugal Pumps		X	X
18.214	Reciprocating or Piston Pumps		X	X
18.215	Progressive Cavity (Screw-Flow) Pumps		X	X
18.216	Chemical Metering Pumps		X	X
18.220	Purpose of Lubrication	X	X	X
18.221	Properties of Lubrication		X	X
18.222	Lubrication Schedule		X	X
18.223	Precautions		X	X
18.224	Pump Lubrication		X	X
18.225	Equipment Lubrication		X	X
18.230	Section Format		X	X
18.231	Preventative Maintenance		X	X
1.	Pumps, General		X	X
2.	Reciprocating Pumps, General		X	X
3.	Propeller Pumps, General		X	X
4.	Progressive Cavity Pumps, General		X	X
5.	Pump Controls		X	X
6.	Electric Motors		X	X
7.	Belt Drives		X	X
8.	Chain Drives		X	X
9.	Variable Speed Belt Drives		X	X
10.	Couplings		X	X
11.	Shear Pins		X	X
18.240	Starting a New Pump		X	X
18.241	Pump Shutdown		X	X
18.242	Pump-Driving Equipment		X	X
18.243	Electrical Controls		X	X
18.244	Operating Troubles		X	X
18.245	Starting and Stopping Pumps		X	X
18.2450	Centrifugal Pumps		X	X
18.2451	Positive Displacement Pumps		X	X
18.25	Compressors	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
12.	Gate Valves	X	X	X
18.263	Globe Valves	X	X	X
18.264	Eccentric Valves	X	X	X
18.265	Butterfly Valves	X	X	X
18.266	Check Valves	X	X	X
18.267	Maintenance of Check Valves	X	X	X
13.	Check Valves	X	X	X
18.268	Automatic Valves	X	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

SECTION	TOPIC	C	B	A
18.302	Starting Problems	X	X	X
18.303	Running Problems	X	X	X
18.304	How to Start a Gasoline Engine	X	X	X
18.3040	Small Engines	X	X	X
18.3041	Large Engines	X	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	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	X
18.334	Natural Gas	X	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	X
18.46	Calibration of Chemical Feeders	X	X	X
18.460	Large-Volume Metering Pumps	X	X	X
18.461	Small-Volume Metering Pumps	X	X	X
18.462	Dry Chemical Systems	X	X	X
18.47	Chlorinators	X	X	X
18.50	Scheduling Inspections	X	X	X
18.51	Steel Tanks	X	X	X
18.52	Cathodic Protection		X	X
18.53	Concrete Tanks		X	X
18.6	BUILDING MAINTENANCE	X	X	X
19.	**WORDS: INSTRUMENTATION**		X	X
19.00	Importance & Nature of Instrumentation & Control Systems		X	X
19.01	Importance to 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 Contol 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

SECTION	TOPIC	C	B	A
19.25	Process Instrumentation		X	X
19.26	Signal Transmitters/Transducers		X	X
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	X
19.33	Pump Controllers		X	X
19.34	Air Supply Systems		X	X
19.35	Laboratory Instruments		X	X
19.36	Test and Calibration Equipment		X	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	Preventive Maintenance		X	X
19.44	Operational Checks		X	X
20.	**WORDS: SAFETY**		X	X
20.00	What is Safety?		X	X
20.01	Causes of Accidents		X	X
20.02	Steps to Avoid Accidents		X	X
20.10	Safe Handling of Chemicals		X	X
20.11	Acids		X	X
20.110	Acetic Acid (Glacial)			X
20.111	Hydrofluosilic Acid		X	X
20.112	Hydrogen Fluoride			X
20.113	Hydrochloric Acid			X
20.114	Nitric Acid			X
20.115	Sulfuric Acid			X
20.12	Bases		X	X
20.120	Ammonia	X	X	X
20.121	Calcium Hydroxide			X
20.122	Sodium Hydroxide (Caustic Soda)	X	X	X
20.123	Sodium Silicate			X
20.124	Hypochlorite	X	X	X
20.125	Sodium Carbonate			X
20.13	Gases		X	X
20.130	Chlorine	X	X	X
20.131	Carbon Dioxide			X
20.132	Sulfur Dioxide			X
20.14	Salts	X	X	X
20.145	Fluoride Compounds	X	X	X
20.150	Potassium Permanganate	X	X	X
20.151	Powdered Activated Carbon		X	X
20.152	Other Powders		X	X
20.17	Chemical Storage Drains		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

SECTION	TOPIC	C	B	A
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
20.6	LABORATORY SAFETY			
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
20.72	Safety Equipment		X	X
20.73	Eye Protection		X	X
20.74	Foot Protection		X	X
20.75	Hand Protection		X	X
20.76	Head Protection		X	X
20.77	Water Safety		X	X
20.8	PREPARATION FOR EMERGENCIES	X	X	X
21	**ADVANCED LABORATORY PROCEDURES**			
21.0	USE OF A SPECTROPHOTOMETER		X	X
21.1	TEST PROCEDURES		X	X
2.	Calcium		X	X
3.	Chloride		X	X
4.	Color			X
5.	Dissolved Oxygen			X
6.	Fluoride		X	X
7.	Iron (Total)		X	X
8.	Manganese		X	X
9.	Marble Test (Calcium Carbonate Saturation Test)			X

SECTION	TOPIC	C	B	A
10.	Metals		X	X
11.	Nitrate		X	X
12.	pH	X	X	X
13.	Specific Conductance (Conductivity)		X	X
14.	Sulfate			X
15.	Taste and Odor		X	X
16.	Trihalomethanes	X	X	X
17.	Total Dissolved Solids		X	X
22.	**WORDS: DRINKING WATER REGULATIONS**		X	X
22.0	HISTORY OF DRINKING WATER LAWS AND STANDARDS	X	X	X
22.1	HOW EPA DEVELOPS DRINKING WATER STANDARDS	X	X	X
22.10	Types of Contaminants	X	X	X
22.11	Identifying Contaminants To Be Regulated	X	X	X
22.12	Unregulated Contaminants	X	X	X
22.14	Setting Standards	X	X	X
22.15	Types of Water Systems	X	X	X
22.2	PRIMARY DRINKING WATER STANDARDS	X	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
22.206	Cadmium		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
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)			
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
22.23	Disinfectants and Disinfection By-Products (D/DBPs)		X	X
22.24	Radiological Standards		X	X

SECTION	TOPIC	C	B	A
22.3	SECONDARY DRINKING WATER STANDARDS	X		
22.30	Enforcement of Regulations	X	X	X
22.31	Secondary Maximum Contaminant Levels	X	X	X
22.32	Monitoring	X	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
22.44	Use of Dedicated SamplingStations		X	X
22.45	Sampling Points		X	X
22.46	Sampling Point Selection		X	X
22.47	Sampling Schedule		X	X
22.48	Sampling Route		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	**WORDS: ADMINISTRATION**			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
22.430	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

SECTION	TOPIC	C	B	A
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
23.5	COMMUNICATION			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
23.93	Benefits of Managing Maintenance			X
23.94	SCADA Systems			
23.940	Description of SCADA Systems			X
23.941	Typical Water Treatment and Distribution SCADA Systems			X
23.95	Cross Connection Control Program			
23.950	Importance of Cross Connection Control			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) - THIS SECTION IS NEW			X
23.100	Planning for Emergency Response			X
23.101	Homeland Defense			X
23.1021	Handling the Threat of Contaminated Water Supply - 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
23.110	Safety Program Responsibilities			X
23.1100	SAFETY PROGRAM - Everyone is Responsible for Safety			X
23.1101	Regulatory Agencies			X
23.1102	Managers			X
23.1103	Supervisors			X
23.1104	Operators			X
23.111	First Aid			X
23.112	Hazard Communication Program and Worker Right-To-Know (RTK) Laws			X

SECTION	TOPIC	C	B	A
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
23.121	Types of Records			X
23.122	Types of Plant Operations Data			X
23.123	Maintenance Records			X
23.124	Procurement Records			X
23.125	Inventory Records			X
23.126	Equipment Records			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
23.1329	Wholesale Agency Assistance Programs			X
23.13210	Conservation Pricing			X
23.13211	Conservation Coordinator			X
23.13212	Water Wast 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
	APPENDIX			
A.2	BASIC FORMULAS		X	X
A.30	Iron and Manganese Control		X	X
A.31	Fluoridation		X	X
A.32	Softening		X	X
A.33	Specialized Treatment Processes		X	X
A.34	Membrane Treatment Processes		X	X
A.35	Maintenance		X	X
A.36	Advanced Laboratory Procedures		X	X
A.37	Regulations		X	X
A.38	Administration, Safety		X	X

PART III

"RULES GOVERNING PUBLIC WATER SUPPLY"

SECTION	TOPIC	D	C	B	A
.0102	DEFINITIONS	X	X	X	X
	G.S. 130A-2. Definitions	X	X	X	X
	G.S. 130A-313. Definitions	X	X	X	X
	141.2 Definitions	X	X	X	X
.0203	PUBLIC WELL WATER SUPPLIES	X	X	X	X
.0301	APPLICABILITY: PRIOR NOTICE	X	X	X	X
.0303	SUBMISSIONS REQUIRED BY ENGINEER AND APPLICANT	X	X	X	X
.0304	APPLICATION FOR APPROVAL: BY WHOM MADE	X	X	X	X
.0305	APPROVALS NECESSARY BEFORE CONTRACTING OR CONSTRUCTING	X	X	X	X
.0306	CHANGES IN ENGINEERING PLANS OR SPECIFICATIONS AFTER APPROVAL	X	X	X	X
.0307	ENGINEER'S REPORT, WATER SYSTEM MANAGEMENT PLAN AND OTHER PLANS	X	X	X	X
.0309	FINAL APPROVAL	X	X	X	X
.0402	WATER SUPPLY WELLS	X	X	X	X
.0404	WATER TREATMENT FACILITIES	X	X	X	X
.0405	STORAGE OF FINISHED WATER	X	X	X	X
.0406	DISTRIBUTION SYSTEMS	X	X	X	X
.0407	ELECTRICAL SYSTEMS	X	X	X	X
.0408	LEAD FREE CONSTRUCTION	X	X	X	X
.0409	SERVICE CONNECTIONS	X	X	X	X
.0708	GRAVITY FILTERS			X	X
.0709	PREVENTION OF BACKFLOW AND BACK SIPHONAGE			X	X
.0801	CAPACITIES: DETERMINING MINIMUM EFFECTIVE VOLUME			X	X
.0802	CAPACITIES: DETERMINING PEAK DEMAND			X	X
.0803	CAPACITIES: DETERMINING TOTAL VOLUME			X	X
.0804	CAPACITIES: GROUND STORAGE PLUS HYDROPNEUMATIC TANKS			X	X
.0805	CAPACITIES: ELEVATED STORAGE		X	X	X
.0901	SIZE OF WATER MAINS	X	X	X	X
.0902	NUMBER OF RESIDENCES ON A WATER MAIN	X	X	X	X
.0903	DEAD END WATER MAINS	X	X	X	X
.0904	PIPE LAYING	X	X	X	X
.0905	TESTING NEW WATER MAINS	X	X	X	X
.0906	RELATION OF WATER MAINS TO SEWERS	X	X	X	X
.0907	VALVES	X	X	X	X
.1001	DISINFECTION OF NEW SYSTEM	X	X	X	X
.1002	DISINFECTION OF WELLS	X	X	X	X
.1003	DISINFECTION OF STORAGE TANKS & DISTRIBUTION SYSTEM	X	X	X	X
.1004	DISINFECTION OF FILTERS		X	X	X
.1108	CONTINUOUS DISINFECTION OF WATER SUPPLY	X	X	X	X
.1301	GENERAL REQUIREMENTS	X	X	X	X
.1302	TESTS, FORMS & REPORTING	X	X	X	X
.1303	FACILITY OVERSIGHT	X	X	X	X
.1304	WATER SYSTEM OPERATION AND MAINTENANCE	X	X	X	X
.1400	FLUORIDATION OF PUBLIC WATER SUPPLIES			X	X
.1401	POLICY			X	X
.1402	FORMAL APPLICATION			X	X
.1404	FEEDING EQUIPMENT			X	X
.1405	PROTECTION OF OPERATORS			X	X
.1406	CONTROL OF TREATMENT PROCESS			X	X
.1407	APPROVAL MAY BE RESCINDED			X	X
.1501	WATER QUALITY STANDARDS - PURPOSE	X	X	X	X
.1502	MONITORING OF CONSECUTIVE PUBLIC WATER SYSTEMS		X	X	X
.1503	MICROBIOLOGICAL CONTAINMENT SAMPLING AND ANALYSIS	X	X	X	X
.1504	MAXIMUM MICROBIOLOGICAL CONTAINMENT LEVELS	X	X	X	X
.1505	TURBIDITY SAMPLING AND ANALYSIS	X	X	X	X
.1506	MAXIMUM CONTAINMENT LEVELS FOR TURBIDITY	X	X	X	X
.1507	CORROSION CONTROL AND LEAD AND COPPER MONITORING	X	X	X	X

"RULES GOVERNING PUBLIC WATER SUPPLY"

SECTION	TOPIC	D	C	B	A
.1508	INORGANIC CHEMICAL SAMPLING AND ANALYSIS	X	X	X	X
	141.23 (a-e) Inorganic Chemical Sampling and Analytical Requirements	X	X	X	X
.1509	SPECIAL MONITORING FOR SODIUM	X	X	X	X
.1510	MAXIMUM CONTAMINANT LEVEL FOR INORGANIC CHEMICALS	X	X	X	X
.1511	CONCENTRATION OF IRON	X	X	X	X
.1512	CONCENTRATION OF MANGANESE	X	X	X	X
.1516	SPECIAL MONITORING FOR ORGANIC CHEMICALS	X	X	X	X
.1517	MAXIMUM CONTAMINANT LEVEL FOR ORGANIC CHEMICALS			X	X
.1518	MAXIMUM CONTAMINANT LEVEL FOR ORGANIC CONTAMINANTS	X	X	X	X
.1519	MONITORING FREQUENCY FOR RADIOACTVITY		X	X	X
.1520	MAXIMUM CONTAMINANT LEVELS FOR RADIUM		X	X	X
.1521	MAXIMUM CONTAMINANT LEVEL GOALS FOR RADIONUCLIDES				X
.1523	PUBLIC NOTIFICATION REQUIREMENTS	X	X	X	X
.1524	REPORTING FOR ORGANIC CHEMICALS	X	X	X	X
	Subpart Q - Public Notification of Drinking Water Violations	X	X	X	X
.1525	REPORTING FOR REQUIREMENTS	X	X	X	X
.1526	RECORD MAINTENANCE	X	X	X	X
.1527	CERTIFIED LABORATORIES	X	X	X	X
.1529	POINT-OF-ENTRY AND OTHER TREATMENT DEVICES				X
.1532	VARIANCES AND EXEMPTIONS				X
.1534	COLIFORM SAMPLING	X	X	X	X
.1535	MAXIMUM CONTAMINANT LEVELS FOR COLIFORM BACTERIA	X	X	X	X
.1536	TREATMENT TECHNIQUES			X	X
.1537	DRINKING WATER ADDITIVES	X	X	X	X
.1538	CONSUMER CONFIDENCE REPORT		X	X	X
.1601	REQUIREMENTS FOR VARIANCE				X
.1602	VARIANCE REQUEST				X
.1603	CONSIDERATION OF VARIANCE REQUEST				X
.1604	DISPOSITION OF VARIANCE REQUEST				X
.1605	PUBLIC HEARINGS ON VARIANCES AND SCHEDULES				X
.1606	VARIANCES FOR FLUORIDE				X
.1607	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	X
.1905	AMOUNT OF PENALTY ASSESSMENT	X	X	X	X
.1913	RIGHT OF ENTRY AND INSPECTION	X	X	X	X
.2001	GENERAL REQUIREMENTS (FILTRATION AND DISINFECTION)		X	X	X
.2008	DISINFECTANTS AND DISINFECTION BYPRODUCTS	X	X	X	X
.2100	OPERATING PERMITS		X	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
.2201	GROUNDWATER - APPLICABILITY & RESIDUAL DISINFECTANT CONCENTRATIONS	X	X	X	X
.2202	GROUND WATER RULE	X	X	X	X
	APPENDIX A - General Statutes	X	X	X	X
	APPENDIX B - (FIGURE 2) - NORTH CAROLINA GUIDELINES CROSS CONNECTION CONTROL IN WATER DISTRIBUTION SYSTEMS	X	X	X	X

PART IV

WELL CONTRUCTION STANDARDS

SECTION	TOPIC	D	C	B	A
.0101	GENERAL PROVISIONS	X	X	X	X
.0102	DEFINITIONS	X	X	X	X
.0105	PERMITS	X	X	X	X
.0107 (d)	CASING	X	X	X	X
.0107 (e)	GROUTING	X	X	X	X
.0107 (f)	WELL SCREENS		X	X	X
.0107 (g)	GRAVEL-AND SAND-PACKED WELLS		X	X	X
.0107 (h)	WELL DEVELOPMENT	X	X	X	X
.0107 (i)	WELL HEAD COMPLETION	X	X	X	X
.0109	PUMP AND PUMPING EQUIPMENT		X	X	X
.0110	WELL TESTS FOR YIELD		X	X	X
.0111	DISINFECTION OF WATER SUPPLY WELLS	X	X	X	X
.0112	WELL MAINTENANCE: REPAIR: GROUNDWATER RESOURCES	X	X	X	X
.0113	ABANDONMENT OF WELLS	X	X	X	X
.0114	DATA AND RECORDS REQUIRED	(b) X	(b) X	(b) X	(b) X

PART V

RULES FOR WATER TREATMENT FACILITY OPERATORS

SECTION	TOPIC	D	C	B	A
.0105	Definitions	X	X	X	X
.0201	Grades of Certification	X	X	X	X
.0202	Examinations	X	X	X	X
.0205	Classification of Water Treatment Facility	X	X	X	X
.0206	Certified Operator Required	X	X	X	X
.0301	Application for Exam	X	X	X	X
.0302	Application for Reciprocity	X	X	X	X
.0303	Application for Temporary Certificate	X	X	X	X
.0304	Fee Schedule	X	X	X	X
.0307	Revocation of Certificate	X	X	X	X
.0308	Continuing Education	X	X	X	X
.0309	Certification Reinstatement	X	X	X	X
.0401	Notification of Classification	X	X	X	X
.0403	Issuance of Grade Certificate	X	X	X	X
.0404	Temporary Certificate	X	X	X	X
.0501	Petitions	X	X	X	X
.0508	Declaratory Rules	X	X	X	X
.0601	Opportunity for Licensee or Applicant to Have Hearing	X	X	X	X
.0701	Operator in Responsible Charge	X	X	X	X