Minnesota Pollution Control Agency

NEED TO KNOW

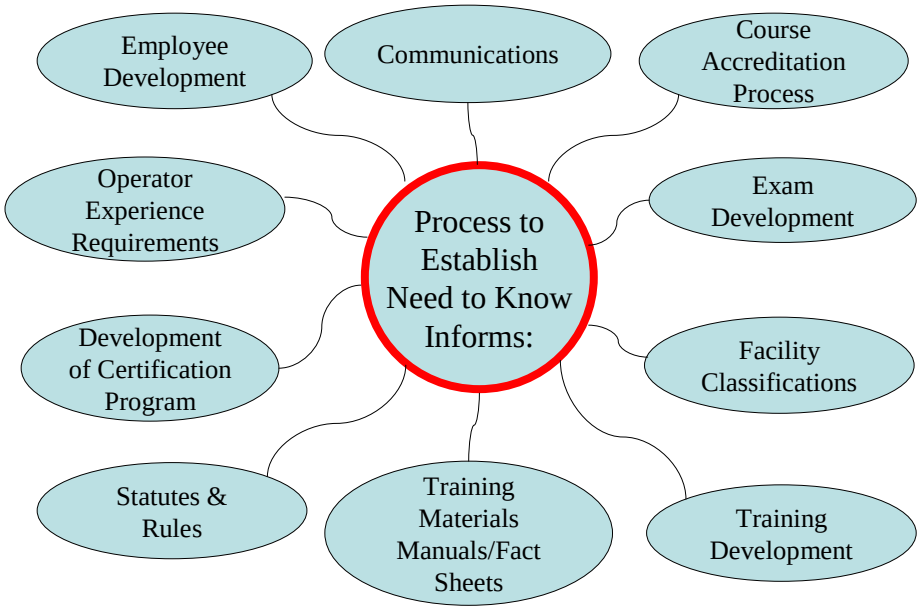
WASTEWATER AND COLLECTION SYSTEM OPERATORS

The Minnesota Pollution Control Agency (MPCA) in conjunction with a Steering Team and Sounding Board has developed this document to help operators, trainers, city administrators, and regulators understand the nature of working at a wastewater or collection system facility. This document is not intended to serve solely as a study guide for operator certification exams. The intent of this document is to identify those subjects which individuals are expected to know (Need to Know) in order to serve as wastewater or collection system operators. An operator must also possess knowledge gained through formal education and training as well as on-the-job experience to successfully operate a facility.

The Need to Know process is a cycle. During each progressive cycle, the criteria will be further refined with the ultimate goal being standardized requirements for each of the operator classifications. The Need to Know criteria will directly influence: exam questions, training courses, training materials (manuals and fact sheets), and the certification program.

RELATIONSHIP DIAGRAM

"The Octopus"



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AUDIENCE:

- Wastewater and Collection System Operators – responsible for operating a wastewater or collection system facility.
- Trainers – responsible for developing and conducting training for operators.
- City Administrators – responsible for overall management and effective operation of the treatment facilities in their communities.
- Regulators – responsible for permitting, compliance, training and certification functions.

GOALS:

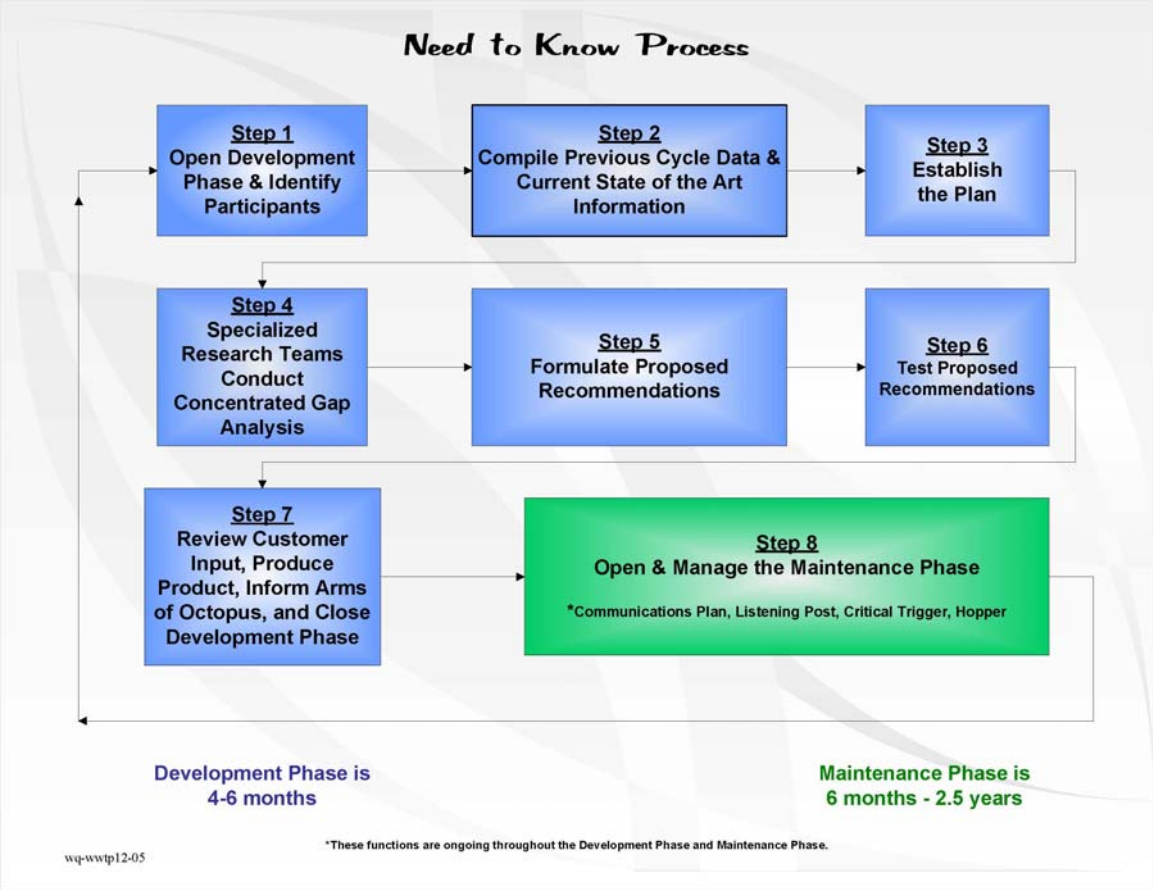
- To develop a process for identifying, validating, and updating Need to Know criteria for wastewater and collection system operators.
- To help wastewater and collection system operators understand the basic skills necessary to operate a plant.
- To develop a shared, consistent vision for the program among the MPCA and the four customer groups.
- To develop expertise and experience.

WHY: Clean water is essential for everyday life. Wastewater travels through the collection systems to the wastewater treatment plants where it is treated and returned to rivers, lakes, and streams. Operators control processes and equipment to remove or destroy harmful substances, chemical compounds, and microorganisms in the water.

Operators read, interpret, and adjust meters and gauges to make sure equipment and processes are working properly. They operate chemical-feeding devices, take samples of the water and liquid waste, perform chemical and biological laboratory analysis, and adjust the amount of chemicals, such as chlorine, in the water. They use a variety of instruments to sample and measure water quality, and hand and power tools to make repairs. Operators are increasingly relying on computers to help monitor equipment, store sample results, make process-control decisions, schedule and record maintenance activities, and produce reports. The specific duties of plant operators depend upon the type and size of plant. Plants operate 24 hours a day, 7 days a week.

THE NEED TO KNOW PROCESS: The Development Phase. With the help of stakeholders, the *Development Phase* is launched to identify, validate, and renew "Need to Know" criteria for wastewater and collection system operators. The *Development Phase* began by: (1) identifying a Steering Team consisting of the various customer groups, and other interested parties; (2) collecting, and researching/reviewing historical and state of the art information; (3) identifying gaps in the information; (4) formulating and testing proposed recommendations; and (5) accepting updated criteria. At the end of the 4-6 month *Development Phase*, the MPCA will integrate the updated Need to Know criteria into the training and certification program.

The Maintenance Phase. During the *Maintenance Phase*, customers will provide feedback on the process and criteria. This feedback will trigger the Steering Team to reconvene anywhere from 6 months – 2.5 years after the *Development Phase* has closed, or sooner if a danger is eminent to wastewater or collection system facilities.



FACILITY CLASSIFICATIONS: Treatment facilities are classified as A, B, C, and D according to a rated point system based on: the unit processes, loading to the plant, and the final permit effluent limitations. Collection systems are classified S-A, S-B, S-C, and S-D which are determined by the population of the community. Operators will need different expertise based on the type of facility they operate.

TRAINING AND OTHER QUALIFICATIONS: At minimum, a high school diploma or equivalent is required to become a wastewater or collection system operator. Operators should also be competent in basic math, chemistry, and biology and have a working knowledge of areas covered by the Need to Know document.

CERTIFICATION: The MPCA administers the certification program. Certain requirements including experience and knowledge must be met before an operator is eligible to take a certification exam. Students applying for certification must meet minimum requirements and pass the exam.

This document is divided into fourteen sections. Each section identifies a topic that is important for an operator to understand in order to operate a collection system or run a wastewater treatment plant. The document is not currently broken down by operator classification. Further refinement will occur in the future with the goal being standardized requirements for each of the operator classifications.

Table of Contents

SECTION 1 – RULES AND REGULATIONS

I. Federal and State Regulations

A. The Minnesota Pollution Control Agency (MPCA)

B. The Environmental Protection Agency (EPA)

C. Permitting and Enforcement Authority for Wastewater Treatment and Collection Systems

*Which agencies are responsible for regulation and enforcement? What is their role?

*What regulations do they enforce?

*Describe the regulations, acts, and other legal requirements that are applicable to wastewater and collection system operations.

D. National Pollutant Discharge Elimination System (NPDES) - must understand the permitting system that regulates the discharge of pollutants.

1. Individual
2. General
3. State Disposal System (SDS)

*What does the NPDES permit regulate?

*What effluent limitations are specified by the NPDES Permit?

*What other requirements are found in the permit?

E. Biosolids

1. Federal: Part 503 – Title 40 of the Code of Federal Regulations – "The Standards for the Use or Disposal of Sewage Sludge"
2. State
3. Local

F. Clean Water Act

*What are the possible effects to the environment and public health of inadequate treatment of wastewater?

*What Act legislates wastewater standards?

G. Minnesota Department of Transportation (MNDOT)

*What driver's license requirements apply to wastewater operators?

*What agency enforces drug testing requirements for commercial vehicle drivers?

H. Types of Regulated Dischargers

I. Occupational Safety and Health Administration (OSHA)

*What agency has the duty of developing and enforcing regulations to protect workers?

*Describe the role of this agency.

J. Ten States Standards

1. Design criteria for sewage systems
2. Minimum standards for design and construction of wastewater collection, pumping, treatment, and disposal systems

K. Storm Water

1. Run off
2. Holding pond
3. Phosphorus
4. Federal and state regulations

*What are the stormwater regulations?

L. Total Maximum Daily Load (TMDL)

II. Wastewater Sources

A. Industrial/Commercial
B. Domestic
C. Combined (wastewater and stormwater)
D. Inflow/infiltration

*What are the sources of wastewater and their characteristics?

III. Definitions

A. Facility
B. On-site Operator
C. On-site Representative
D. Sewage
E. Operator
F. Receiving Waters
G. Influent
H. Effluent
I. Bypass

*What are the basic permit definitions of wastewater flow and quality parameters?

*Define these nine terms.

IV. Operator Requirements

A. Facility and Operator Classes
B. Operator in Responsible Charge (ORC)
C. Penalties for Non-compliance

*Who must be a licensed wastewater operator?

*What are the minimum requirements for licensing at the various certification levels?

*How is a wastewater plant classified?

*What is the difference between direct and related contact hours for license renewal?

V. Records, Reporting, and Cost of Operation

A. Records
    1. Ability to determine what information needs to be recorded
    2. Knowledge of monitoring and reporting requirements
    3. Knowledge of recordkeeping functions and policies
    4. Knowledge of regulations

*How long must records be maintained?

B. Reporting
    1. Write internal, state, and federal reports
    2. Ability to communicate verbally and in writing

*What reports are required, and when are they due?

C. Cost of Operation
    1. Compute chemical cost based on feed rate
    2. Calculate power costs using electricity and horsepower formulas
    3. Estimate materials, equipment and personnel needed for tasks

4. Budget sheets

VI. Emergency Situations
1. Spill – facility or during transportation
2. Bypass
3. Flooding

*Who do you contact in an emergency situation?
*Who is the Minnesota Duty Officer?

VII. Penalties
*Describe the regulatory violation procedure and identify penalties that can be imposed (civil, criminal, administrative actions) for non-compliance.

SECTION 2 - BASIC KNOWLEDGE

I. Wastewater Sources
A. Industrial/Commercial
B. Domestic
C. Combined (wastewater and stormwater)
D. Inflow/Infiltration
E. Groundwater

II. Documentation
A. Municipal
B. Private
C. As-Builts
D. Paper vs. Computer Records
E. Backups - Complaints
F. Global Positioning System (GPS)
*What maps, plans, and records should an operator understand?
*How long must records be maintained?

III. Pumps – Motors – Compressors
A. Centrifugal
1. Gas and Diesel
2. Electric
3. Dry Pit
4. Submersible
B. Positive Displacement (PD) – Diaphragm
1. Peristaltic
2. Progressive Cavity
3. Piston Pump
C. Motors
1. Gas
2. Electric
a. Single phase
b. Three phase
3. Horsepower
D. Air Compressors

1. Piston
2. Vane
3. Screw
4. Centrifical

*What pumping and processing equipment is used?

IV. Health Concerns
- A. Contain wastewater in system
- B. Spills – Backups
- C. Working with sewage-related equipment
- D. Hazards – Diseases
- E. Personal Protective Equipment (PPE)

*What has the potential to affect the health of operators and/or the environment?
*What immunizations are recommended?

V. Electricity
- A. Electrical Theory
  1. Amps/Volts/Watts
  2. Single or type of three phase
- B. Testing Procedures
  1. Amps - Watts
  2. Mega Ohms Motors
- C. Ground Fault Interrupter (GFI)
- D. Requirements to MN Station
- E. Motor Starters
  1. Relays
  2. Breakers

VI. Controls
- A. Floats
- B. Transducers
- C. Sonars
- D. Sealed Electrodes
- E. Air Bubblers

VII. Equipment Maintenance
- A. Pump Packing – Seals
  1. Seals – Adjust – Replace – Install
  2. Packing – Adjust – Replace – Install
- B. Bearings – Lubrication
- C. Belts – Pulleys
  1. Adjust – Replace
  2. Lubricate
- D. Preventative/Corrective Maintenance
- E. Corrosion Control

*Why is a preventative maintenance program important?
*What resources are necessary to maintain equipment?

VIII. Pipes and Valves
- A. Pipe Materials
  1. Clay

2. Plastics, PVC, ABS, Poly, Fiberglass, HDPE, Tygon tubing, Corrugated
3. Cast/Ductile Iron
4. Concrete

B. Valves
1. Knife
2. Plug
3. Butterfly
4. Gate
   a. Double disc
   b. Resilient wedge
   c. Air
5. Ball

C. Check Valves
1. Swing check
2. Ball check
3. Flexible flap check

D. Corrosion Control

*What is corrosion, what causes it, and how can it be prevented?
*Where in wastewater is corrosion control an issue?
*What type of maintenance should be performed on valves?

IX. Hydraulics
A. Grade – Slope – Velocity
B. Volumes
C. Pressures

X. Flow Measurement
A. Weirs – Gates
1. Parshall flume
2. V-notch
3. Mass flow meter

B. Mechanical – Electrical
1. Dippers – electrical conductive
2. Transducers
3. Sonar/mag meter
4. Air bubblers

C. In-Pipe Meters
1. Mag meters
2. Venturi flow meters
3. Orifice place meters

D. Flow Verification/Management
1. Manual
2. Calibrations
3. Running time

XI. Customer Relations
A. Complaints
B. Public Perception of Utility
C. External Communications

*Why is public relations important?
*What steps do you take if you get a complaint from the community?

XII. Cross Connection – Backflow Prevention
- A. Devices
  1. Air gap
  2. Double check valves
  3. Vacuum breaker
  4. Reduced pressure zone (RPZ) backflow preventer
- B. Laws

*What methods control potential backflow hazards?
*Identify backflow and cross connections – when are they needed?
*What is the Uniform Building Code?

XIII. Competent Person
- A. Requirements to Certify
- B. Knowledge and Certification
- C. Training

*What are the responsibilities of the competent person?

SECTION 3 - SAFETY

I. General Safety Procedures
- A. Confined Space Entry
  1. Definition
  2. Permit or non-permit entry
  3. Supervisor, attendant and entrant responsibilities
  4. Entry procedure - steps
  5. Rescue procedures - implementation
  6. Record keeping
  7. Atmospheric metering, gas detectors
  8. Required equipment

*When is a permit required and who issues the permit?
*Who is responsible for keeping records, and how long do they need to be kept?
*What gases should be monitored in a confined space?
*Why is confined space an important issue for operators?
*What are the requirements for identifying and working in confined spaces?
*Understand how to calibrate a gas monitor.

- B. Lockout/Tag Out (LOTO)
  1. Procedures
  2. Energy, education, engineering, and enforcement
  3. Lock-cutting policy
  4. Record keeping

*What are the potential sources of energy (hydraulic, hydrologic, electrical, etc.)?
*Who shares the responsibility to assure LOTO training?
*Who is responsible for enforcement?

*When is it acceptable to remove a lock from an energy source; who is authorized to cut the lock; and under what conditions?
*Who is responsible for keeping records; and how long do they need to be kept?

C. Personal Protective Equipment (PPE)
   1. Hardhats, safety glasses, goggles, face shield, gloves and shoes
   2. Hearing protection
   3. Safety harness/fall protection

*When are they required; who is responsible for maintenance; and who is required to supply PPE?
*What PPE is required when performing First Aid procedures?

D. Fire Safety
   1. Fire extinguisher Classes A, B, and C – type and application
   2. Extinguisher training (classroom and hands-on)
   3. Electrical hazards
   4. Flammable and combustible liquids – use, storage, and container type

*Who is responsible for providing training; and who needs to attend?
*What are the concerns in a wastewater facility relative to electrical fires?

E. Respiratory Protection
   1. Self Contained Breathing Apparatus (SCBA) – required or not required
   2. Respirator program
   3. Medical evaluation
   4. Fit testing
   5. Training

*What medical conditions must be met prior to using respiratory protection?
*What is a "Fit Test," and who must pass?
*Who is responsible for providing training?

F. First Aid
   1. First report of injury – timeline to report
   2. Cardio Pulmonary Resuscitation (CPR)/defibrillators
   3. Blood borne pathogens – identification and prevention
   4. Heat/cold exposure – identification and procedures

*Who is responsible for providing defibrillators; and who must be certified?
*What are the different types of First Aid training?

G. Hazardous Conditions (HazCon)
   1. Right to Know
   2. Material Safety Data Sheets (MSDS) chemical properties, hazards and exposure
   3. Safe work practices and procedures
   4. Personal hygiene –methods and use
   5. Housekeeping responsibilities
   6. Spill response and reporting – timeframe, retention time of hazards, and notification procedures
   7. Process safety management of hazardous chemicals – monitoring and maintenance
   8. Hazard communications (verbal/nonverbal)

*What state law regulates the employer regarding informing employees about their responsibilities and the hazards associated with those responsibilities?
*When must a chemical have a MSDS; and where will the MSDS be filed?
*Who is responsible for administering and maintaining the MSDS system?
*What communication methods are necessary in hazardous conditions; and when should the practices for a specific job be identified and discussed?

H. Ergonomic Procedures
    1. Back safety/lifting
    2. Repetitive motion
    3. Posture

II. Work Zone Safety
A. Minnesota Department of Transportation (MNDOT) Regulations
    1. Traffic control
        a. Short term
        b. Long term
        c. Equipment and materials
    2. Site control and protection procedures
        a. Barricades (cones)
        b. Signs (arrows)
B. Occupational Safety and Health Administration (OSHA) Regulations
C. Personal Protective Equipment (PPE)
    1. Hardhat
    2. Vests - class type
    3. Shoes, gloves
D. Required Permits (county, state, local)
E. Gopher State One Call

*What types of equipment are required to work in a traffic area?
*What are the requirements/procedures necessary to establish a safe work zone?

F. Vehicle

III. Safe Work Practices
A. Trenching/Shoring
B. Ladder Safety – proper use
C. Cranes and Hoists – knowledge of and certification requirements
D. Machine Guards
E. Power Tools – storage and maintenance
F. Personal Hygiene
G. Housekeeping
H. Slip, Trip, Fall Hazards
I. Hydraulics

*What are proper safe work practices and application?
*Understand safe equipment operation.

IV. Facility Emergency Action Plan
A. Evacuation Procedures - Head Count
B. Exit Routes
C. Security Breech
D. Mutual Aid

E. Notification

*Who is responsible for implementation and updates?
*Who is the incident commander?
*Who is in charge during an emergency?
*What do the emergency action plans cover – facility, community?
*Do you have any contracts to provide emergency services? (i.e. hospital/emergency room)?

V. Miscellaneous
- A. A Workplace and Accident Injury Reduction Program (AWAIR)
- B. Occupational Safety and Health Administration (OSHA) – federal and state
- C. Minnesota Municipal Utilities Association (MMUA)
- D. Employee/Employer Rights and Responsibilities
- E. Right to Know
- F. General Knowledge
- G. Health Protection
- H. Audits
- I. Training
  1. Who must be trained and on what types of equipment (meters)
  2. Value of on-the-job training
- H. Awareness of Hazards
- I. Safety Committees
- J. Record Keeping
- K. Tailgate Training Sessions

*Who is responsible for providing training; which agencies monitor safety requirements; and what internal steps should be taken to assure compliance?
*What must be done if an employee is hurt on the job?

VI. Health Risks
- A. Pathogens
  1. Blood Borne – Hepatitis A, B, and C, AIDS
  2. Air Borne
- B. Disabilities
- C. Loss of Life
- D. Heat/Cold Exposure

*What are the potential risks?
*How can risks be reduced?

SECTION 4 - PRELIMINARY WASTEWATER TREATMENT

I. Flow Equalization
- A. Purpose
- B. Methods

II. Screening
- A. Process Description
- B. Types of Equipment
- C. Normal Operations

D. Manual Operations
E. Automatic Operations
F. Process Control
G. Maintenance
H. Recycle Flows
I. Disposal

*What is the most common disposal method?

III. Grinding
A. Process Description
B. Types of Equipment
C. Normal Operations
D. Manual Operations
E. Automatic Operations
F. Process Control
G. Maintenance
H. Recycle Flows
I. Disposal

IV. Grit
A. Process Description
B. Types of Equipment
C. Normal Operations
D. Manual Operations
E. Automatic Operations
F. Process Control
G. Maintenance
H. Recycle Flows
I. Disposal

*What are the consequences of improper grit removal?

V. Chemical Pretreatment
A. Purpose
B. Types of Equipment
C. Automation
D. Control

VI. Odor Control
A. Purpose
B. Equipment
C. Control and Automation

VII. Records
A. Purpose
B. Methods

SECTION 5 - PRIMARY WASTEWATER TREATMENT

I. Purpose
- A. Solids Separation, Reduction & Removal
  1. Sedimentation
  2. Floatation
  3. Chemical Treatment

*What chemicals are used to remove phosphorus?

- B. Biochemical Oxygen Demand (BOD) Reduction
  1. 25%-35% removal
  2. BOD reduction through sedimentation
- C. Solids Reduction Percentages
  1. Settable solids reduction (90%+)
  2. Total Suspended Solids (TSS) reduction (40%-60%)
  3. Floatable solids (visible and not visible)
- D. Flow Velocity Control – purpose
  1. Less than 2 feet per minute
  2. Short circuiting prevention
  3. Dye testing to determine short circuiting

II. Primary Treatment Processes
- A. Rectangular Clarifiers
  1. Description
  2. Rectilinear flow (straight lines)
  3. Normal detention time (1-4 hours)
  4. Sludge collection
- B. Peripheral Feed Circular Clarifiers
  1. Description
  2. Wastewater enters outer ring
  3. Axial flow
  4. Normal detention time (1-4 hours)
- C. Center Feed Clarifiers
  1. Description
  2. Wastewater enters middle of tank
  3. Radial flow
  4. Normal detention time (1-4 hours)
- D. Dissolved Air Floatation

*Where would a primary center feed clarifier be located in this process?

*When would dissolved air floatation be used in this process?

III. Process Components
- A. Circular Clarifiers
  1. Tank
  2. Peripheral feed/influent zone
     a. Flow distribution
     b. Receives influent
     c. Disperses flow evenly into tank
     d. Inner baffle directs flow down into tank

3. Center feed/influent well
   a. Flow distribution
   b. Receives influent
   c. Disperses flow evenly into tank
   d. Baffle directs flow downward into tank
   e. Flash mixers - chemical treatment
4. Influent channel/pipe
   a. Closed pipe
   b. Feeds center well or outer channel of peripheral feed system
5. Influent valves
   a. Gate valves
   b. Plug valves
   c. Butterfly valves
6. Influent baffle
   a. Wood
   b. Metal
   c. Flow dispersion
   d. Short circuit prevention
7. Drive unit
   a. Motor
   b. Gear reducer
   c. Drive chain
   d. Controls scrapers/cross collectors/flights
8. Scum trough
   a. Half pipe
   b. Box type
   c. Fats, Oil, Grease (FOG) removal
   d. Plastics/wood/other floatable material
9. Scum baffle
   a. Location
   b. Material
   c. Purpose
10. Effluent Weirs
   a. Locations
   b. V-notch
   c. Weir length
11. Types of sludge scrapers
12. Sludge sump
   a. Location
   b. Purpose
   c. Types of pd pistons
13. Sludge withdrawal pipe
   a. Sump to suction side of pump
   b. Conduit for solids removal
14. Sludge pump(s)
   a. Piston

b. Progressive cavity
c. Centrifugal

*What is the advantage of a recessed impeller centrifugal pump?

B. Rectangular Clarifiers
1. Tank
2. Influent channel/pipe
a. Closed pipe
b. Open channel
3. Influent valve
a. Gate valves
b. Plug valves
c. Butterfly valves
4. Influent baffle
a. Wood
b. Metal
c. Flow dispersion
d. Short circuit prevention
5. Drive unit
a. Motor
b. Gear reducer/sheer pin
c. Drive chain
d. Controls/ cross collectors/flights
6. Chain/sprocket/flights (scraper boards)
a. Scrapes sludge to sump
b. Scrapes floatables to scum trough
c. Supported by angle track
d. Endless loop
e. Runs constantly, very slow rotation
7. Angle Track
a. Supports flight and flight chains
b. Mounted on floor and near surface
8. Scum trough
a. Half pipe
b. Helix type
c. Fats, Oil, Grease (FOG) removal
d. Plastics/wood/other floatable material
9. Scum baffle
a. Location
b. Material
c. Purpose
10. Cross collector
a. Resembles flights
b. Scrapes sludge to sump
c. Slow rotation and runs continuously
d. Located at head end of tank
e. Perpendicular to main flights

11. Sump
    a. Receives sludge for removal
    b. Located in tanks lowest point (corner of tank)
    c. Supplied by cross collector
12. Sludge withdrawal pipe
    a. Sump to suction side of pump
    b. Conduit for solids removal
13. Sludge pump(s)
    a. Piston
    b. Progressive cavity
    c. Centrifugal
14. Effluent launders/troughs/weirs
    a. Shape (describe)
    b. Location
    c. V-notch weirs

C. Scum Pit(s)/Tank(s)
1. Receive scum from troughs
2. Scum disposal
   a. Digesters
   b. Incinerator
   c. Landfill (burial)
3. Maintenance of piping with regular cleaning

D. Sludge Removal
1. Maximum depth in tank (= 25% of tank depth)
2. Directly to digester
3. Pumped to additional sludge thickening process(es)
   a. Centrifuge
   b. Gravity belt
   c. Sludge press
   d. DAF thickener
   e. Other

E. Oil and Grease Removal
1. Skimmers
2. Manual removal methods
3. Automatic removal methods

F. Flow Equalization
1. Prevent hydraulic overload
2. Prevent/minimize toxic loads
3. Prevent/minimize shock loads

*What components does a drive unit control?
*Typically, where is the discharge from a scum pit/tank?
*What is the difference between a baffle and a weir?
*Who is responsible for basic electrical troubleshooting?

IV. Solids Identification

A. Settleable Solids – solids with a specific gravity greater than 1, that will settle out of the wastewater

B. Floating Solids – solids with a specific gravity of less than 1, that will float to the surface of the wastewater
C. Dissolved Solids – salt and sugar
D. Colloidal Solids – solids that are not heavy enough to settle in a one hour test
E. Total Solids – all solids in wastewater determined by removing the liquid portion of a sample and weighing the remaining contents
F. Organic Solids – burnable solids containing carbon
G. Inorganic Solids – not burnable and lacking carbon
H. Volatile Solids – burnable solids, organic solids, and carbon-based solids
I. Non-Volatile Solids – not burnable, lacking carbon, and inorganic solids. The ash portion of solids remaining after burning in the Volatile Solids test at 500 degrees Celsius +/- 50 degrees Celsius for one hour.
J. Raw Sludge – sludge removed from the bottom of the primary clarifier. The ultimate destination for this waste product is the digesters.
K. Fats, Oil, Grease (FOG) – a group of floatable solids that are mostly removed in the primary clarifier

*Identify and describe the solid types?

*What causes foam, and what is the process for removal?

V. Maintenance

A. Preventative Maintenance Programs
1. Identification of components
2. Recommendations of manufacturers
3. Operator developed programs
4. Operation and maintenance manuals

B. Unit Inspections
1. Timeframe for inspections
2. Operation and maintenance manual recommendations
3. Smooth operation/rotation
4. Motor temperatures/noises/vibrations
5. Physical observations
6. Tank corrosion
7. Sludge level checks
8. Oil and other lubricant leaks
9. Missing bolts
10. Cracks/breaks in structures and other components
11. Sheer pins

C. Process Drive Units
1. Oil changes
2. Greasing
3. Vibration check
4. Protective coatings

*Observe for excessive drag or load (sound of motor, toughness of drive chain).

D. Weir Leveling
1. Uneven overflow of water
2. Adjustment bolts
3. Annual check

E. Flight/Cross Collectors
   1. Preventative maintenance
   2. End clearances (1-2 inches from wall)
   3. Equal chain lengths
   4. Wear shoes
   5. Angle track (support)
   6. Sprockets

F. Electrical
   1. Preventative maintenance
   2. Amperage draws
   3. 3 phase power
   4. Wiring inspections
   5. Troubleshooting
   6. Qualified electrician or instrumentation technician

G. Baffles
   1. Maintenance
   2. Leveling
   3. Replacement
   4. Protective coatings

H. Sludge Pump(s)
   1. Progressive cavity
   2. Centrifugal
   3. Piston
   4. Rotary lobe
   5. Peristaltic

I. Scum Trough(s)
   1. Maintenance
   2. Protective coatings

J. Protective Coatings (tank & components)
   1. Types
   2. Mastic (pastelike cement)

*What types of materials are found in wastewater treatment plants that would increase the wear and tear of a sludge pump?

VI. Operational Strategies/Process Control

A. Solids Removal
B. Weir Overflow Rates
C. Surface Settling Rates
D. Detention Time
E. Flow Velocity
F. Efficiency
G. Dye Tests – method
H. Hydraulic Short Circuiting
   1. Definition
   2. Identification of causes
   3. Short circuiting prevention methods
I. Sludge Depth

1. Measuring devices
2. Evaluation of sludge depth
3. Percent solids content

J. Solids Handling
1. Removal rates
2. Calculations

K. Scum Removal
1. Definition
2. Identify methods of removal

L. Sampling & Testing
1. Carbonaceous Biological Oxygen Demand (CBOD)
2. TSS
3. Temperature
4. TS and TVS
5. pH

*Items A through G, require math calculations, and interpretation of those calculations.

*Items A through E placement upstream flow and chemical tracking – know your customers.

*Understand the use of torque measurements with circular clarifiers or thickeners.

VII. Terminology

By Reference or Developed WW Dictionary

VIII. Chemical Addition

A. Phosphorus Removal
1. Purpose
2. Methods of removal
   a. Chemical precipitation
   b. Physical setting
   c. Others
3. Test procedure/methods

B. Solids Separation
1. Chemical addition
2. Physical setting
3. Floatation

C. BOD Reduction
1. Coagulation/flocculation
2. 25-35% normal reduction range removal

D. Calculating Chemical Dosages
1. Formulas used
2. Interpretation of results
3. Function and handling of polymers

E. Chemical Flocculants and Precipitants

*What chemicals are used for phosphorus removal and solids separation?

*How do chemicals affect TSS and BOD reduction?

*What is the difference between flocculants and precipitants?

IX. Sampling, Handling & Analysis (see Laboratory Section)

A. Containers
    1. Glass
    2. HDPE
    3. Plastic
B. Holding Times
C. Preservations
D. TSS & TVSS
    1. Influent to clarifiers
    2. Effluent leaving clarifiers
E. TS & TVS – sludge analysis
F. CBOD
    1. Influent to clarifiers
    2. Effluent leaving clarifiers
G. pH – influent and effluent
H. Temperature - influent
I. Efficiency - (% removals)
    1. Solids removal
    2. BOD removal
    3. Nutrient removal
J. Settleable Solids
    1. Influent to clarifiers
    2. Effluent leaving clarifiers
K. Testing Methods
L. Types of Samplers

*For Testing methods, refer to Standard Methods for the Examination of Water and Wastewater.

X. Records, Record Keeping & Reports
A. Daily Logs
B. Preventative Maintenance Records
C. NPDES Reports
D. Monthly Reports
E. Annual Pretreatment and Biosolids Reports
F. Spreadsheets & Worksheets

*Which items are developed by the facility? (A and B)
*When are reports due? (NPDES – monthly, Annual Reports – by March 1st)
*Who requires the reports? (MPCA or utility)
*Are there any manufacturer's recommendations that must be followed?

SECTION 6 - SECONDARY WASTEWATER TREATMENT

I. Purpose
A. Biological Oxidation Definition
B. Clarification - purpose
C. Entrapment Definition

II. Aerated Ponds

A. Theory, Design & Process Description
    1. Understand design parameters
    2. Describe theory of operation
    3. Using aerated ponds versus other methods
B. Operational Strategies/Process Control
    1. Hydraulic loading rate
    2. Organic loading rate
    3. Process efficiency
C. Maintenance
    1. Weed, animal, and erosion control
    2. Control structures
    3. Liner protection
    4. Snow removal (dike access)
    5. Mowing
D. Water Level Management - purpose
E. Flow Monitoring
    1. Time clocks/run time meters
    2. Flow metering
F. Piping Systems - arrangement
G. Preliminary Treatment
    1. Screening
    2. Grit removal
    3. Disposal
H. Aeration System(s)
    1. Types
    2. Dissolved oxygen (DO) levels
I. Determine Discharge and Storage Calculations
J. Control Structures
    1. Components
    2. Operation
    3. Uses
    4. Locations
K. Sampling, Handling & Analysis
    1. pH
    2. DO
    3. BOD
    4. TSS
    5. Fecal Coliform
    6. Nutrients

*Be able to identify the processes associated with aerated ponds.

III. Stabilization Ponds

A. Theory, Design & Process Description
B. Operational Strategies/Process Control
    1. Process efficiency
    2. Series/parallel operation
C. Maintenance

D. Water Level Management
E. Determine Discharge & Storage Calculations
F. Piping Systems
G. Flow Monitoring
H. Control Structures
I. Sampling, Handling & Analysis

IV. Spray Irrigation
A. Theory, Design & Process Description
B. Operational Strategies/Process Control – loading rates
C. Maintenance
1. Pipe network
2. Pumps
3. Sprinkler heads
D. Irrigation systems
1. Pipe network
2. Pumps
3. Sprinkler heads
4. Land application/soil treatment system
5. Timers
E. Determine Discharge Storage Calculations
F. Flow Monitoring - metering
G. Sampling, Handling & Analysis

V. Trickling Filters (TF)
A. Theory, Design & Process Description
B. Operational Strategies/Process Control
1. Recirculation
2. Series operation
3. Parallel operation
4. Single stage
5. Multi-stage
C. Design Modifications – packed towers
D. Tank Configuration - cylindrical
E. Identification of Filter Media
1. Synthetic
a. Random ring
b. Bundles of corrugated sheets
2. Rock
3. Tile (vitrified clay)
F. Underdrain Systems
1. Support media
2. Collect effluent
3. Provide for air flow
4. Maintenance
G. Distribution Systems
1. Influent
2. Gravity actuated rotary distribution

3. Motor actuated rotary distribution
4. Stationary/fixed
5. Tip trough

H. Biological Life/Processes (zoogleal mass)
1. Bacteria
2. Protozoa
3. Viruses
4. Molds

I. Maintenance
1. Debris removal
2. Center bearings (seal and oil level)
3. Distribution systems
4. Zoogleal mass
5. Air flow
6. Filter flies
7. Surface ponding

J. Sampling, Handling & Analysis

K. Loading Rates
1. Organic loading rate
2. Hydraulic loading rate

VI. Rotating Biological Contactors (RBC)

A. Theory, Design & Process Description

B. Operational Strategies/Process Control – loading rates

C. Design Modifications – submerged biological contactors

D. Tank Configurations
1. Conforms to shape of drums
2. Baffled or compartmentalized
3. Individual tank per drum
4. Bulkheads and baffles

E. Media
1. Synthetic
2. High or low density

F. Drive Systems
1. Direct
2. Chain and sprocket
3. Air

G. Drums
1. Shaft and media
2. Supported by bearings
3. Submergence in wastewater
4. Diameter (12 feet)
5. Length (25-27 feet)

H. Biological Life/Processes (zoogleal mass)
1. Bacteria
2. Protozoa
3. Viruses

4. Molds

I. Maintenance
   1. Lubrication
   2. Sloughing of zoogleal mass
   3. Drum weighing

J. Flow and Flow Patterns
   1. Parallel flow
   2. Perpendicular flow
   3. Series operation
   4. Parallel operation

K. Sampling, Handling & Analysis

L. Loading Rates
   1. Synthetic media
   2. Rock media

VII. Activated Sludge

A. Theory, Design & Process Description

B. Operational Strategies/Process Control
   1. Waste Activated Sludge (WAS) Rate
   2. Return Activated Sludge (RAS) Rate
   3. Food to Mass (F/M) ratios
   4. Solids Retention Time (SRT)
   5. Solids Age (SA)
   6. Mean Cell Residence Time (MCRT)
   7. Detention times
   8. Aeration rates
   9. BOD/Nitrogen/Phosphorus Ratio
   10. Mixed Liquor Suspended Solids (MLSS)
   11. Mixed Liquor Volatile Solids (MLVS)

C. Design Modifications
   1. Step feed
   2. Oxidation Ditch
   3. Step Aeration
   4. Modified Aeration
   5. Sequential Batch Reactors (SBR)
   6. Pure Oxygen
   7. Conventional Treatment
   8. Contact Stabilization
   9. Extended Aeration
   10. Complete Mix

D. Maintenance
   1. Tank inspections
   2. Diffuser cleaning
   3. Oil changes and lubrication
   4. Probe replacement, cleaning, and calibration
   5. Corrosion control

E. Aeration Methods/Systems

1. Diffused air
   a. Fine
   b. Coarse bubble
2. Surface aerators
3. Updraft and downdraft aerators
4. Pure Oxygen

F. Sampling, Handling & Analysis
G. Microscopic Examination
   1. Identification
      a. Organisms
      b. Organism counts
   2. Floc structure
   3. Staining procedures
   4. Filament identification
H. Control Processes and Adjustments – various methods
I. Loading Rates
   1. Hydraulic loading rates
   2. Organic loading rates
   3. Oxygen rates
J. Dissolved Air Floatation (DAF)
K. Peripheral Components
   1. Blowers
   2. Electrical systems
   3. Anoxic zone mixers
   4. Dissolved Oxygen (DO) monitors
   5. pH monitors
   6. RAS and WAS flow meters
   7. Pumping and pipe systems
   8. Chlorination systems
L. Nutrient Removal
   1. Phosphorus (polymers)
   2. Nitrogen

VIII. Constructed Wetlands
A. Theory, Design & Process Descriptions
B. Operational Strategies/Process Control
C. Design Modifications
D. Septic Tanks – sizing determinations
E. Pumps
F. Drain Fields
G. Vegetation
H. Piping Systems
I. Sampling, Handling & Analysis
J. Flow Monitoring

IX. Onsite Systems
A. Theory, Design & Process Descriptions
B. Onsite System Designs

C. Operational Strategies/Process Control
D. Septic Tanks
E. Drain Fields
F. Regulations
G. Lift Station
    1. Pump calibrations
    2. Volume calculation
H. Pathogen Removal
I. Nutrient Removal
J. Pumping/Pumping Cycles
K. Inspections
L. Maintenance
M. Sampling, Handling and Analysis

X. Secondary Clarification
A. Theory, Design & Process Descriptions
B. Design Modifications
C. Operational Strategies/Process Control
D. Tank Configurations
E. Internal Components (all)
F. Drive Units
G. Maintenance
H. Sampling, Handling & Analysis
I. Solids Handling System
J. Flow Meters and Monitoring
K. Loading Rates
    1. Hydraulic
    2. Solids

XI. Records, Record Keeping & Reports
A. Required by Permit
B. Required by Municipality
    1. Local
    2. State
    3. Federal
C. Retention

** Terminology used in this section is expected to be understood at all certification levels with an expanded level of understanding at the higher levels.*

SECTION 7 – ADVANCED WASTEWATER TREATMENT

I. Physical-Chemical Treatment
A. Types of Nitrogen Removal
B. Breakpoint Chlorination - definition
C. Ion Exchange – types and uses
D. Ammonia Stripping - definition

E. Benefits of Solids Removal – coagulation/flocculation
F. Process Control Methods
*What are process control troubleshooting methods?

II. Nitrogen Removal – Biological
A. Types and Applications of Processes
B. Denitrification
1. Definition
2. Process control measures
3. Nitrogen cycle
C. Suspended Growth Processes - definition
D. Process Control Methods
*When is denitrification required?
*Why is a suspended growth process used?
*What are the process control troubleshooting methods?
*How does nitrification affect alkalinity?

III. Phosphorus Removal
A. Process Types
1. Chemical removal
2. Biological removal
3. Polymers
B. Process Control Methods
*What are the process control troubleshooting methods?
*What is the affect on Biosolids, and why?

IV. Filtration
A. Process Types
B. Microfiltration - application
C. Process Control Methods
*What are troubleshooting methods?

V. Biological Treatment
A. Process Types - options
B. Process Control Methods
*What are troubleshooting methods?

VI. Effluent disposal/re-use options
A. Process Types
B. Process Control Methods
*What are the standards and criteria for re-use of effluent?

VII. Records and Administrative Requirements
A. NPDES Reporting Requirements for Advanced Treatment Process Facilities
B. Recordkeeping
C. Regulation for Effluent Disposal/Re-use Options
D. Certified Lab - Quality Control Parameter
*Who must sign reports, and when are they due?

SECTION 8 - DISINFECTION

I. Chlorination
- A. Equipment
- B. Process Control
- C. Detention Time - purpose
- D. Oxidation Reduction Potential
- E. Bacteria Indicator Results
- F. Analysis
- G. Operations and Troubleshooting
- H. Preventive Maintenance
- I. Sample Collection and Handling
- J. Mixing
- K. Hazards

*What are the main components of a gas and liquid feed chlorination system?
*How do you calculate dosages for a chlorination system?
*Why must oxidation potential be determined?
*What type of bacteria is identified and used as an indicator of pathogenic organisms?

II. Dechlorination
- A. Equipment
- B. Process Control
- C. Mixing
- D. Residual
- E. Operations and Troubleshooting
- F. Preventive Maintenance
- G. Sample Collection and Handling
- H. Analysis
- I. Hazards

*What are the different types of chemicals used for dechlorination?

III. Ultraviolet Irradiation (Radiation)
- A. Equipment
- B. Process Control Variables
- C. Intensity
- D. Hydraulic Characteristics
- E. Exposure Time
- F. Effluent Quality
- G. Age of Lamps
- H. Operations and Troubleshooting
- I. Preventive Maintenance
- J. Sampling and Analysis
- K. Hazards

IV. Ozonation
- A. Equipment
- B. Process Control
- C. Operations and Troubleshooting

D. Preventive Maintenance
E. Sample Collection and Handling
F. Analysis
G. Hazards

V. Hypochlorination
A. Equipment
B. Process Control
C. Mixing
D. Residual
E. Operation and Troubleshooting
F. Preventive Maintenance
G. Sample Collection and Handling
H. Analysis
I. Hazards
J. Safety Leaks

SECTION 9 - SLUDGE DIGESTION AND SOLIDS HANDLING

I. Solids Handling
A. Solids
1. Sources
2. Characteristics
3. Quantities
B. Solids Processing Flow Diagrams
C. Sludge and Scum Pumping
1. Pumps
2. Math calculations
3. Sludge piping
4. Valves
5. Flow monitoring
6. Maintenance
D. Preliminary Operations
1. Grinding
2. Screening
3. Degritting
4. Blending
5. Storage
E. Alkaline Stabilization
1. Chemical reactions in lime stabilization
2. Heat generation
3. Application of alkaline stabilization processes
4. Process equipment
5. Storage facilities
6. Chemical feed equipment
7. Process control

8. Maintenance
9. Process description

F. Anaerobic Digestion
1. Process fundamentals, purpose, and description
2. Mesophilic anaerobic digestion process, description, and design
3. Psycrophylic anaerobic digestion process
4. Selection of tank design and mixing system
5. Methods for enhancing solids loading and digester performance
6. Gas production, collection, and use
   a. Cogeneration
   b. Scrubbing Hydrogen Sulfide (H2S)
7. Digester heating
8. Solids pumping
9. Maintenance
10. Mixing
11. Thermophilic anaerobic digestion
12. Two-Phased anaerobic digestion
13. Pipelines and valves
14. The anaerobic digester
   a. Fixed cover tanks
   b. Floating cover
   c. Digesting depth
   d. Raw sludge inlet
   e. Supernatant tube
   f. Sludge draw-off line
   g. Methane use

G. Aerobic Digestion
1. Process description
2. Conventional aerobic digestion
3. Dual digestion
4. Autothermal thermophilic aerobic digestion (ATAD)
5. High-purity oxygen digestion
6. Heated aerobic digestion

H. Composting
1. Process microbiology
2. Process description
3. Design considerations
4. Co-composting with municipal solid waste
5. Public health and environmental issues

I. Conditioning
1. Chemical conditioning
2. Other conditioning methods

J. Dewatering
1. Centrifugation
2. Belt filter press
3. Filter presses

4. Sludge drying beds
5. Reed beds
6. Lagoons
7. Gravity belts
8. Sedimentation basins

K. Heat Drying
1. Process description
2. Product characteristics
3. Product transport and storage
4. Fire and explosion hazards
5. Air pollution and odor control

L. Incineration
1. Fundamental aspects of complete combustion
2. Multiple-hearth incineration
3. Fluidized-bed incineration
4. Co-incineration with municipal solid waste
5. Air-pollution control
6. Ash disposal

*What are the heat transfer methods?

II. Solid Mass Balances
1. Math calculations
2. Preparation of solids mass balances
3. Performance data for solids process facilities
4. Impact of return flows and loads

III. Solids Storage
1. Conveyance Methods
2. Facilities

SECTION 10 - COLLECTION SYSTEMS

I. Types of Collection Systems
A. Pressure
B. Gravity
C. Vacuum
D. Combined (Ejector system)
E. Force Mains
F. Low Pressure Systems – small diameter force mains with grinder pump systems

II. Pipes
A. Composition
1. Plastic
2. Cast iron/ductile
3. Concrete
4. Clay

B. Rehabilitation

1. Proper fittings
2. Proper bedding and backfill - materials and methods
3. Chemical grouts
4. Shoring
5. Traffic control
6. Gopher State One-Call
7. Excavation techniques/Tailgate meetings

III. Manholes
- A. Materials
  1. Brick/Block
  2. Concrete
  3. Plastic
- B. Fittings
  1. Adjusting rings
  2. Manhole castings, covers, etc.
- C. Drops
  1. Inside
  2. Outside
- D. Steps – Ladders
- E. Taps – Services – Cleanouts

IV. Manhole Repair and Rehabilitation
- A. Sealing Methods and Types
- B. Confined Space Entry
- C. Proper Lifting of Repair Materials
- D. Gopher State One-Call
- E. Excavation Techniques/Tailgate Meetings
- F. Excavation – Shaft Repairs
- G. Cure-In-Place Epoxy
- H. Chemical Grouts
- I. Replace Adjusting Rings
- J. Replace Bench

V. Cleaning
- A. High Pressure Flushing – jet truck
- B. Mechanical rodding – manual or truck
- C. Hydraulics
  1. Balling
  2. Pigging
- D. Porcupine – scrapers – squeegee with bucket machine
- E. Bucketing dirt – bucket machine
- F. Root Control – foaming preventative

VI. Maintenance Line Repair
- A. Slip Lining
- B. Pipe Bursting – replace with poly pipe
- C. Excavation – spot repair
- D. Stent Spot Repair
- E. Complete Replacement – excavate

F. Service Taps

VII. Pipe Fittings
- A. Invert
- B. Drops, Inside, Outside
- C. Customer Hookups
- D. Joint restraints – force mains
- E. Joint types

VIII. Flow Monitoring
- A. Manual Dipping – measure
- B. Flow Measurement – recording paper or computer
- C. Electrode Dipper
- D. Sonar
- E. Air Bubbler
- F. Transducer
- G. Samplers

IX. TV Inspection
- A. Self-propelled
- B. String Line Pull
- C. Problems – limitations
- D. Records – tapes

X. Inflow and Infiltration (I/I)
- A. Smoke
- B. Dye Water
- C. Air
- D. Mandrel
- E. Sources of I/I
- F. Closed Circuit TV (CCTV) and Wet Weather Televising Methods
- G. Private Property Plumbing
- H. Flow Monitoring Equipment
- I. Analyze Monitoring Data
- J. Inspect Main Pipes and Manholes
  1. Excess flow
  2. Groundwater testing
- K. Communication - customers, subordinates, and supervisors
- L. Working with Contractors and Consultants
- M. Service Lateral Rehabilitation Methods
- N. Flow Measurement

XI. Sources of Gasses in Sewers
- A. Debris – decaying matter (low DO)
- B. Types
  1. H_2S
  2. Methane
  3. Carbon monoxide
  4. Explosives
- C. Illegal or Unintentional Dumping or Spills

XII. Types of Lift Stations

A. Dry/Wet pit
B. Submersible
C. Air Ejector
D. Grinder Pump

XIII. Pump Types
A. Centrifugal
B. Positive Displacement
C. Grinder Pump

XIV. Lift Station Controls
A. Ball Floats
B. Sealed Electrodes
C. Transducer
D. Air Bubblers
E. Sonar

XV. Maintenance
A. Grease Control and Removal
1. Wet wells
2. Valve piping
3. Floats
4. Wiring and cables
5. Chains
B. Sump Pumps
1. Check valves – grit and debris
2. Pit – cleaning and debris
C. Mechanical Rodders
D. Hydraulic Rodders
E. CCTV
F. Root Removal - chemical
G. Bucket Machines
H. High Velocity Jetting / Vacuuming procedures

XVI. Types of Check Valves
A. Swing
B. Ball
C. Flap Flexible

XVII. Blowers – Air
A. Adjust/Replace Belts
B. Lubricate Motors – bearing blocks, oilers
C. Types
1. Positive Displacement (PD)
2. Centrifugal

XVIII. Cleaning and Maintenance of Shredders – Comminutors

XIX. Odor Control
A. Ionizing Brine
1. Brine strength – monitoring and replace
2. Current, volts, amps monitoring
3. Records

- B. Masking Agents
  1. Sprayers
  2. Maintenance
  3. Air source – compressor
- C. Media
  1. Sampling – monitoring
  2. Replacement
  3. Maintenance
- D. Filtering Exhaust Air
- E. Records

XX. Seals
- A. Mechanical - cartridge
- B. Packing
  1. Replace – adjust
  2. Lubrication
  3. Type

XXI. Maps
- A. Read and Interpret Maps
- B. Document and Draw Changes Observed in the Field
- C. Global Positioning System (GPS) Units

XXII. Documentation and Records
- A. Pump Maintenance Records
- B. Equipment Manuals
- C. Confined Space Records
- D. Locates
- E. Daily Work Logs – preparation and submittal
- F. By-pass or Sanitary Sewer Overflow (SSO) Report – preparation and submittal
- G. Preparing Work Orders
- H. As/Builts

XXIII. Emergency Operation
- A. Electrical Generators
  1. Stationary
  2. Portable
  3. Phasing
- B. Pumping Bypass
  1. From receiving manhole over land
  2. In station
- C. Gas Pumps
- D. Submersible
- E. Power Take-off (PTO) Pumps

XXIV. Trouble shooting
- A. Pumps
  1. Vibration
  2. Calibration
  3. Clogging

4. Bearing failure
5. Failure to start - electrical problems

B. Controls
1. Stuck/dirty floats
2. Transducer failure
3. Air bubblers
4. Air failure
5. Failure to start pump
6. Volts/amps - changes
7. Intermittent problems – monitors
8. Sonar

XXV. Customer Service
A. Communication Skills
B. Complaints
1. Aesthetics
2. Odors
3. Noise – emergency generators, etc.
4. Blown plumbing, etc.
C. Lift Station Failures/Backups
D. Collection System Ownership - public vs. private
E. Local Sewer Ordinances and Codes
F. Locating Mains and Service

XXVI. Working with Consultants and Contractors

SECTION 11 - MATH

I. Essential Math
A. Unit Conversions
1. English to metric
2. Metric to English
3. Weight measurements
4. Flow measurements
5. Time measurements
6. Velocity measurements
7. Pressure measurements
8. Power measurements
9. Linear/circular measurements
10. Volume measurements
a. Gallons
b. Cubic feet
11. Area measurements

B. Circumference
1. Rectangle
2. Circle

C. Area

1. Rectangle
2. Circle
3. Triangle
4. Trapezoid

D. Volume
1. Rectangle
2. Cylinder
3. Cone
4. Sphere
5. Pyramid

E. Velocity
F. Flow Rate
G. Population Equivalents
H. Loading

*Must have the ability to calculate water/wastewater formulas; addition, subtraction, multiplication and division; volume, area, flow rates, feed rates, percentages, ratios, squares, cubes, and roots.

II. Clarifiers
A. Weir Overflow Rate
B. Surface Settling Rate
C. Percent Removal
D. Detention Time
E. Volume
F. Area
G. Circumference

III. Calculation of Pumping
A. Pump Calibration
B. Brake/Water Horsepower
C. Pumping Rate
D. Pump Curves
E. Pumping Efficiency
F. Energy Losses
G. Static Head
H. Dynamic Head

IV. Trickling Filter
A. Hydraulic Loading Rate
B. Organic Loading Rate
C. Recirculation Rates and Ratios

V. Activated Sludge
A. Aeration Basin Organic Loading Rate
B. Detention Time
C. MLVSS
D. Food/Mass Ratio
E. Mean Cell Residence Time (MCRT)
F. Solids Retention Time (SRT)
G. Sludge Age

H. Sludge Volume Index
I. Waste Sludge Rate
J. Return Sludge Rate

VI. Rotating Biological Contactors
A. Organic Loading Rate
B. Hydraulic Loading Rate

VII. Pond Systems
A. Pond Discharge Amount
B. Detention Time
C. Organic Loading Rate
D. Storage Volume
E. Discharge Flow Rate
F. Influent Flow (Using running time meters)

VIII. On-Site/Septic Tanks Systems
A. Area
B. Volume
C. Slope
D. Influent Flow (Using running time meters)

IX. Sludge Digestion
A. Volatile Acids/Alkalinity Ratio
B. Total Solids Loading
C. Volatile Solids Loading
D. Volatile Solids Reduction
E. Digester Loading
F. Digester Gas Production
G. Pumping Rate
H. Solids Residence Time

X. Disinfection
A. Feed Rate
B. Chlorine Dosage, Demand, Residual
C. Geometric Mean (For Fecal Coliform Bacteria)
D. Detention Time

XI. Establishing a Budget
A. Personnel Costs
B. Chemical Costs
C. Equipment and Material Costs
D. Electrical Costs

XII. Collection Systems (*NOTE: Only Applicable to Collection System Operators*)
A. Velocity
B. Flow Rate
C. Slope
D. Detention Time
E. Pump Calibration
F. Chemical Feed Rate
G. Project Costs

SECTION 12 – SUPERVISORY CONTROL AND DATA ACQUISTION (SCADA)

I. General Concepts - benefits and use
   A. Capabilities
   B. Monitoring
   C. Real Time Data
   D. Records / Events
   E. Maintenance Programs

II. Security
   A. Benefits
   B. Risks

III. Data
   A. Graphical Process Visualization
   B. Alarm
      1. Advanced
      2. Monitoring
   C. Historical and Real Time Trending
   D. Built-in Reporting
   E. Statistical Process Control

*How to use and interpret data?
*What level of visual aids is needed for Graphical Process Visualization?
*Who gets called when an alarm sounds, and what level of response is needed?
*How to use data to make procedural and operational changes?
*Can data be accumulated to determine necessary maintenance and compliance?
*What is the proper use of historical data to make process control changes (verification of calibration, and accuracy?)

IV. Hardware/Software Equipment – use and application
   A. Computer
      1. Software
      2. Maintenance programs
      3. Printer
      4. Data back-ups
   B. Alarms
   C. Telephone
   D. Radio
   E. Work Stations - location
   F. Programmable Logic Control (PLC) – use and application
   G. Variable Frequency Drives (VFD)
      1. Monitoring
      2. Use
      3. Application
   H. Inputs / Outputs (I/0)
   I. Remote Terminal Use (RTU)

SECTION 13 – LABORATORY OPERATIONS

I. Basic Knowledge
- A. Characteristics of Wastewater
- B. References
  1. Standard
  2. United States Geological Survey (USGS)
  3. EPA
- C. Biological Science
- D. Physical Science
- E. General Chemistry
- F. Basic and Applied Math– See Section 11 regarding: Addition, Subtraction, Multiplication, and Division of Whole Numbers and Decimals
- G. Using Conventional Formulas
  1. Areas of rectangles, triangles, and circles
  2. Surface areas of cylinders, cones, and spheres
  3. Direct and inverse proportions
  4. Conversions
  5. Plot and interpret graphs including line, bar, percentage, broken line
  6. Developing and reading tables
  7. Units of expression
     a. Parts Per Million (ppm)
     b. Milligrams/Liter (mg/l)
     c. Micrograms/Liter (ug/l)
     d. What is the relationship between ppm and mg/l, etc.?
  8. Formulas for standard dilutions, serial dilutions, and ratios
- H. Laboratory Safety
  1. General
  2. Handling of glassware
  3. Cleanup and disposal of chemicals
     a. Mercury
     b. Acids, Bases, Oxidizers
  4. Chemical Properties
     a. Corrosive materials
     b. Chemical handling and storage
        i. Interpret chemical labels
        ii. Labeling containers
        iii. Acid/Base
        iv. Corrosive materials
        v. Carcinogens
        vi. Mercury handling
        vii. Flammables
        viii. Oxidizers
        ix. Potentially hazardous lab chemicals

x. Shelf life
5. Bloodborne pathogens
6. Personal Protective Equipment (PPE)
7. Housekeeping
8. Chemical Hygiene Plan
9. MN AWAIR
10. OSHA
11. Material safety data sheets (MSDS)
12. Chemical handling and storage
13. Chemical safety

II. Sampling and Preservation

A. Sampling Techniques
1. Grab sampling
2. Multiple grab sampling
3. Flow proportional composite sampling
4. Flow measurement
5. Flow calibration
6. Transporting samples - procedures
7. Sampling frequency
8. Determining sampling locations
9. Sample volume – selection and dilution

B. Sample Handling
1. Selecting proper containers
2. Sample identification
3. Sample preparation
4. Sample preservation
5. Chain of custody
6. Sample delivery and shipping
7. Sample tracking
8. Sample reporting

C. Sample Holding Times and Conditions
1. Alkalinity
2. Ammonia - ionized and un-ionized
3. Chlorine
4. CBOD/BOD
5. Chemical Oxygen Demand (COD)
6. Total Organic Carbon (TOC)
7. Cyanide/Amenable Cyanide
8. DO
9. Bacteriological sampling
10. Microscopic examinations
11. Jar testing
12. Oxidation Reduction Potential (ORP)
13. Nitrate
14. Nitrite
15. pH

16. Phosphorous
    a. Total
    b. Orthophosphorus
    c. Inorganic
17. Total Suspended Solids
18. Dissolved Solids
19. Turbidity
20. Settleability
21. Settleable Solids
22. Sulfide
23. Sulfate
24. Sodium
25. Oil & Grease
26. Specific Oxygen Uptake Rate (SOUR)
27. Nitrogen Ammonia
28. Total Kjeldahl Nitrogen
29. Metals
30. Mercury
31. Dissolved Metals
32. Volatile Organics
33. Biosolids
34. Pesticides

III. Laboratory Operations
- A. Instrument Calibrations
  1. Balances
  2. Spectrophotometer
  3. pH/Ionic Strength Electrodes (ISE) Meter
  4. DO Meter
- B. Chain of Custody
- C. Standard Operating Procedures (SOP)
- D. Laboratory Equipment
- E. Use and Care of Glassware
- F. Use and Care of Instrumentation
- G. Principles of Measurement
- H. Calculations
- I. Analytical Procedures and Results
- J. Sample Analysis - procedures
- K. Data Interpretation
  1. Perform necessary calculations
  2. Record necessary information on all required reports
  3. Communicate information to others
- L. Reference Manuals

IV. Laboratory Procedures
- A. Alkalinity
- B. Ammonia
  1. Ionized and un-ionized

2. Dilutions
   a. Serial
   b. Known addition
3. Distillation
4. Ionic Strength Adjustor (ISA)
5. Ammonium Chloride Stock Solution
6. Slope
7. Sodium Hydroxide
8. Linear regression
9. Calibration range

C. Chlorine
1. Total, free, and combined - difference
2. Reactions with Ammonia
3. Residual
4. Demand
5. Dose
6. Breakpoint Chlorination
7. Methods of Determination
8. Incubation
9. Dilutions

D. Centrifuge Test – Correlation Study (Centrifuge vs. MLSS)

E. CBOD/BOD
1. Dilution water
2. Glucose Glutamic Acid Standard
3. Nitrification Inhibitor
4. Sample Dilutions
5. DO Meter Calibration
6. DO Saturation
7. BOD Seed
8. Toxic Slide
9. Seed Strength

F. COD/TOC

G. Cyanide/Amenable Cyanide

H. DO
1. Saturation
2. Calibration Methods
3. Barometric Pressure Correction

I. Pathogens
1. Coliforms
2. E. Coli
3. Sterilization and disinfection
4. Sanitation
5. Bacteriological sampling
6. Methods of testing
   a. Most Probable Number (MPN)
   b. Membrane Filtration (MF)

7. Definition of aseptically

J. Jar Testing

K. Nutrients
   1. Nitrogen and Ammonia
      a. Total
      b. Kjeldahl
   2. Phosphorus
      a. Total
      b. Orthophosphorus
      c. Soluble
      d. Insoluble

L. pH
   1. pH/Temperature Relationship
   2. Slope

M. Oxidation Reduction Potential (ORP)

N. Solids
   1. Total Solids
   2. Total Suspended Solids (TSS)
   3. Total Volatile Solids (TVS)
   4. Total Volatile Suspended Solids (TVSS)
   5. Dissolved Solids
   6. Settleable Solids
   7. Settleability

O. Turbidity

P. Sulfide

Q. Sulfate

R. Sodium

S. Oil & Grease

T. Microscopic Examinations

U. Metals

V. Volatile Organics

W. Biosolids
   1. Specific Oxygen Uptake Rate (SOUR)
   2. Pathogen reduction
   3. Vector attraction reduction
   4. Metal reduction

V. Laboratory Monitoring and Reporting Requirements

A. Develop, Maintain and Interpret Control Charts

B. Establish and Maintain Method Detection /Reporting Limits - Chlorine per MPCA

C. Maintain Training Records

D. Perform Corrective Actions

E. Conduct Proficiency Testing

F. Data Validation

G. Federal

H. State

I. Process Control
J. Baseline Monitoring

VI. Laboratory Maintenance
A. Vacuum Pump
B. Balances
C. DO Meter
D. Oven
E. Muffle Furnace
F. Autoclave
G. Spectrophotometer
H. pH/ISE Meter
I. BOD Incubator
J. Laboratory Refrigerator
K. Water Bath
L. Samplers
M. Calibration of Instruments
N. Routine Cleaning of Samplers
O. Instrument Maintenance
P. Desiccants
Q. Drying Ovens
R. Gas Burners (Sterilization)

VII. Laboratory Calculations
A. Conversion Factors
B. Ratio and Proportion
C. Volume Concentrations
D. Flow Conversion Calculations
E. Loading Calculations
F. Chemical Dosage Calculations
G. Detention Time Calculations
H. Efficiency and General Percent Calculations
I. Molarity
J. Normality
K. Composite Sampling Calculation (Proportioning Factor)
L. Composite Sampling Procedure and Calculation
M. Significant Figures
N. Scientific Rounding (EPA Rounding)
O. Percent Removal
P. Total Suspended Solids
Q. Total and Percent Volatile Suspended Solids
R. Total Solids
1. Fixed Solids
2. Volatile Solids
3. Percent Volatile Solids
S. Moisture Percent
T. Dry Weight vs. Wet Weight
U. CBOD Calculations

1. Seeded vs. unseeded calculations
2. Seed control
3. Seed correction factor
4. Seed strength
5. Determining proper dilutions for sample setup
6. BOD - 7 day moving average

V. Food to Mass (F/M) ratios
W. Sludge Volume Index (SVI)
X. SOUR
Y. Wasting Rates
Z. Return Rates
1. Solids Retention Time (SRT)
2. Detention time
3. Removal efficiencies

VIII. Laboratory Certification
A. Minnesota Department of Health
B. Operations
C. Maintenance

IX. Laboratory QA/QC
A. Linear Regression
B. Calibration Curves
C. Performance Evaluation Samples
D. Minimum Detection Limits
E. Reporting Limits
F. Precision
G. Accuracy
H. Blanks
I. Duplicate and Duplicate Ranges
J. Relative Percent Deviation (RPD)
K. Student Test
L. Warning Limits
M. Upper vs. Lower Control Limits
N. Mean
O. Average
P. Geometric Mean
Q. Logarithms and Logarithm Duplicate Ranges
R. Records Maintenance

X. Standard Operating Procedures
A. Writing
B. Determining proper method to use

XI. Management
A. Staffing
B. Reporting
C. Analyzing and Interpreting Data
D. Application of Data
E. Permitted vs. Process Control

F. 503 Regulations
G. Selecting a Contract Laboratory
H. Reviewing Contract Laboratory Reports
I. NPDES Reporting
J. Public Health Significance
K. Significance of Discharge
L. Industrial Wastes
M. Hazardous Wastes
N. Order Supplies
O. Organize and Plan Work Activities
P. Writing reports
    1. Federal
    2. State
    3. Local
R. Establish Recordkeeping System
S. Maintain Records
    1. Analytical
    2. Raw data documentation
    3. Computer based documentation
    4. Personnel
    5. Financial

XII. Laboratory Regulatory Knowledge
A. Federal
B. State

SECTION 14 - SECURITY

I. Locations
A. Wastewater Treatment Plants
B. Lift Stations/Pumping Stations
C. Collection System and Manholes
*When assessing vulnerability, what locations should be included?

II. Security Measures
A. Control Gates, Locks, Fencing, Signage, and Lighting
B. Cameras, Motion Detectors, Alarms, and Telemetry
C. Control Access
    1. Photo IDs
    2. Background Checks
D. Clearance Required for Contractors, Vendors, and Septage haulers
E. Employee Panic Button
F. Relocate Parking
*Define the various measures that can be employed to secure your facility?

III. Personal Threats
A. Disgruntled Employee, Relative or Ex-employee
B. Neighborhood Prankster/Vandal

C. Environmental Terrorist
D. International Terrorist

*What are the sources of potential threats?

*What is the most likely threat potential?

IV. Physical threats
A. Weapons Attack
B. Car Bomb at Treatment Plant
C. Explosion in Interceptor
D. Toxin Introduced into Wastewater
E. Electric Power Disruption
F. Insider Sabotage (intentional chemical release, destruction of Motor Control Center (MCC), etc.)
G. Chlorine, Sulfur Dioxide, Natural Gas, Gasoline, Propane On-site, Methane

*How can you minimize physical threats?

V. Vulnerability Security Assessments (VSA)

Appendix 1 – References

Section 2

1. Operation and Maintenance of Wastewater Collection Systems, California State University, Sacramento
2. Manual of Wastewater Collection by Texas Water Utilities Association
3. Wastewater Collection System Maintenance by Michael Parker
4. How Electric Meters Start and Run by W. Harold Parady, 3rd Edition
5. Wastewater Treatment Technology Manual, Minnesota Pollution Control Agency
6. Safe Practices for Water Utilities by American Water Works Association
7. Collection System Math Workbook, Minnesota Pollution Control Agency
8. Electric Motors Selection/Protection Drives, American Association for Vocational Instructional Manuals
9. Understanding Electricity and Electrical Terms, American Association of Vocational Instructional Manuals
10. Competent Person Training for Excavations, American Water Works Association
11. Collection Systems Operator's Guide, Water Environmental Federation and Association of Boards of Certification
12. Wastewater Collection System Operator Certification Study Book, by Water Environmental Federation and ABC
13. Collection Systems Methods for Evaluating and Improving Performance, California State University, Sacramento
14. Introduction to Wastewater, Minnesota Pollution Control Agency
15. Collection Systems, by Minnesota Pollution Control Agency
16. City of Bloomington Department of Public Works Safety Manual, City of Bloomington
17. Standard Methods for the Examination of Water and Wastewater, APWA, American Water Works Association, and WPCF
18. Recommended Practice for Backflow Prevention and Cross Connection Control, American Water Works Association

Section 3

1. Temporary Traffic Control Zone Layout Manual, Minnesota Department of Transportation

Section 5

1. Operation of Wastewater Treatment Plants, California State University, Sacramento – Volume 1.
2. Operation of Wastewater Treatment Plants – A Field Study Training Program, California State University, Sacramento – Volume 2.
3. Operation of Wastewater Treatment Plants – A Field Study Training Program Prepared by Sacramento State, California State University, Sacramento – Volume 3.
4. Texas Natural Resource Conservation Commission

5. Spellman's Standard Handbook for Wastewater Operators, Frank R. Spellman, Technomic Publishing Company, ISBN No. 1-56676-741-5Volume 1, Fundamental Level.
6. Water Environment Technologies Program, St. Cloud Technical College, Program Course Content, Keith Redmond – Developer
7. Water Resources Technology Program, Vermilion Community College, Program Course Content, Steve Kleist – Developer
8. Manual of Practice No. 11, Water Environment Federation. http://www.wef.org/index.jhtml

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1. Operation of Wastewater Treatment Plants, California State University, Sacramento – Volume 1.
2. Operation of Wastewater Treatment Plants – A Field Study Training Program, California State University, Sacramento – Volume 2.
3. Design Guidance for Large Subsurface Wastewater Treatment Systems (LSTS), Minnesota Pollution Control Agency.
4. State of Arkansas – DEQ
5. Manual of Practice No. 11, Water Environment Federation.
6. Wastewater Treatment Technology Manual, Minnesota Pollution Control Agency.
7. Stabilization Pond Operation and Maintenance Manual, Minnesota Pollution Control Agency
8. Onsite Sewage Treatment Manual, University of Minnesota
9. National Onsite Recycling Association (NORA)

Section 9

1. Wastewater Engineering Treatment and Reuse, Metcalf and Eddy, 4th Edition, International Edition.
2. Operation of Wastewater Treatment Plants – A Field Study Guide, California State University, Sacramento, Volume #2, 6th Edition
3. How Anaerobic Sludge Digestions Works by William Garber
4. Manual of Practice No. 8, Water Environment Federation.

Section 10

1. Operation and Maintenance of Wastewater Collection Systems, California State University, Sacramento
2. Manual of Wastewater Collection by Texas Water Utilities Association
3. Wastewater Collection System Maintenance by Michael Parker
4. Wastewater Treatment Technology Manual, Minnesota Pollution Control Agency
5. Safe Practices for Water Utilities by American Water Works Association
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14. Standard Methods for the Examination of Water and Wastewater, APWA, American Water Works Association, and WPCF

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1. Operation of Wastewater Treatment Plants, California State University, Sacramento – Volume 1.
2. Operation of Wastewater Treatment Plants – A Field Study Training Program, California State University, Sacramento – Volume 2.
3. Wastewater Mathematics Made Easy by Dan Cortinovis, 1988.
4. Applied Math for Wastewater Operators by Joanne Kirkpatrick Price, 1991.

Section 12

http://www.citect.com
Citect is an independent supplier of SCADA, industrial automation, and Industrial Information Management (IIM) solutions.

Section 13

1. Standard Methods for the Examination of Water and Wastewater by American Public Health Association, American Water Works Association; and Water Environment Federation, (latest EPA approved edition), Washington D.C: (http://www.apha.org)
2. Operation of Wastewater Treatment Plants, California State University, Sacramento – Volume 6. http://www.owp.csus.edu)
3. Code of Federal Regulations Title 40: Protection of Environment, Chapter I parts 136, 261, 433, 501, and 503 by United States Environmental Protection Agency. http://www.gpo.gov
4. Environmental Sampling and Analysis for Technicians by Maria Csuros, 1994. http://www.crcpress.com
5. Environmental Sampling and Analysis Lab Manual by Maria Csuros, 1997. http://www.crcpress.com
6. Microbiological Examination of Water and Wastewater by Maria Csuros and Csaba Csuros, 1999. http://www.crcpress.com
7. Water and Wastewater Laboratory Techniques by Water Environment Federation, 1995.
8. Handbook of Environmental Analysis by Genium Publishing, 1999, 4th Edition
9. Code of Federal Regulations, Title 40: Standards for the Use and Disposal of Sewage Sludge, Parts 257, 403, and 503 by the United States Environmental Protection Agency.

10. Handbook for Analytical Quality Control in Water and Wastewater Laboratories by United States Environmental Protection Agency, 1979 (EPA-600/4-79-019). http://www.epa.gov/nepis/
11. Methods for Chemical Analysis of Water and Wastewater, by United States Environmental Protection Agency, 1983 (EPA-600/4-79-020).
12. Handbook for Sampling and Sample Preservation of Water and Wastewater, by United States Environmental Protection Agency 1982 (EPA-600/4-82-029m).

Section 14
Water Environment Federation and Vulnerability Self Assessment Tool Software Package

APPENDIX 2 - ACRONYMS

ABC = Association of Boards of Certification

ATAD = Autothermal Thermophilic Aerobic Digestion-

AWAIR = A Workplace and Accident Injury Reduction Program

BMP = Best Management Practice

BOD = Biological Oxygen Demand

CBOD = Carbonaceous Biological Oxygen Demand

CIP = Capital Improvement Project or Cast Iron Pipe

CIP = Cast Iron Pipe

COD = Chemical Oxygen Demand

CWA = Clean Water Act

DAF = Dissolved Air Floatation

DMR = Discharge Monitoring Report

DO = Dissolved Oxygen

EPA = United States Environmental Protection Agency

F/M = Food to Mass Ratio

FOG = Fats, Oil, and Grease

GPS = Global Positioning System

I/O = Inputs and Outputs

ISA = Ionic Strength Adjustor

ISE = Ionic Strength Electrodes

ISI = Ionic Strength Indicator

ISTS = Individual Sewage Treatment Systems

MCRT = Mean Cell Residence Time

MF = Membrane Filtration

MLSS = Mixed Liquor Suspended Solids

MLVS = Mixed Liquor Volatile Solids

MMUA = Minnesota Municipal Utilities Association

MOP = Manual of Practice

MPCA = Minnesota Pollution Control Agency

MPN = Most Probable Number

MSDS = Material Safety Data Sheets

NPDES = National Pollutant Discharge Elimination System

ORC = Operator in Responsible Charge

ORP = Oxidation Reduction Potential

OSHA = Occupational Safety and Health Administration

PD = Positive Displacement

PLC = Programmable Logic Control

POTW = Publically-Owned Treatment Works

PTO = Power Takeoff

QA/QC = Quality Assurance/Quality Control

RAS = Return Activated Sludge

RBC = Rotating Biological Contactors

RPD = Relative Percent Deviation

RPZ = Reduced Pressure Zone

RTU = Remote Terminal Use

SA = Solids Age

SCADA = Supervisory Control and Data Acquisition

SBR = Sequential Batch Reactor

SDS = State Disposal System

SOP = Standard Operating Procedures

SOUR = Specific Oxygen Uptake Rate

SRT = Solids Retention Time

SSO = Sanitary Sewer Overflow

SVI = Sludge Volume Index

TOC= Total Organic Carbon

TMDL = Total Maximum Daily Loads

TSS = Total Suspended Solids

TVS = Total Volatile Solids

TVSS = Total Volatile Suspended Solids

VFD = Variable Frequency Drive

VSA = Vulnerability Security Assessment

VSAT = Vulnerability Self Assessment Tool

WAS = Waste Activated Sludge

WEF = Water Environment Federation

APPENDIX 3 - GLOSSARY

Clean Water Act: Federal legislation which provides statutory authority for the National Pollutant Discharge Elimination System program.

Commissioner: The Commissioner of the Minnesota Pollution Control Agency or the Commissioner's designee.

Discharge: The volume of water (and suspended sediment if surface water) that passes a given location within a certain period of time.

General permit: A permit issued under Minn. R. 7001.0210 to a category of permittees whose operations, emissions, activities, discharges, or facilities are the same or substantially similar.

National Pollutant Discharge Elimination System (NPDES): The name of the surface water quality program authorized by Congress as part of the 1987 Clean Water Act. This is EPA's program to control the discharge of pollutants to waters of the United States (see 40 CFR 122.2). In Minnesota, the MPCA is the permitting authority.

Operator: The person with primary operational control and legal responsibility for the wastewater treatment plant.

Runoff: Surface water drainage or flood discharge that leaves an area as surface flow or as pipeline flow and can reach a channel or pipeline by either surface or sub-surface routes.

Sanitary Sewer: A system of underground pipes that carries sanitary waste or process wastewater to a treatment plant.

Surface Water: Water that remains on the surface of the ground, including rivers, lakes, reservoirs, streams, wetlands, impoundments, seas, estuaries, etc.

Total Maximum Daily Load: The process established by the EPA for the allocation of pollutant loads, including storm water, to a particular water body or reach of a water body.

APPENDIX 4 - TRAINING PROVIDERS AND OPPORTUNITIES

http://www.pca.state.mn.us/water/wwotrain.html

http://www.pca.state.mn.us/news/training/index.html#water