The study guide is for water supply operator practices involving primary skill and knowledge levels. The outline topics are the general subjects which are the basis for the examination questions. The applicant should be knowledgeable of the subject matter outlined and contained in the reference material list.

- PHYSICAL CHARACTERISTICS OF WATER

    o Turbidity
    o Odor and taste – rotten egg smell H_2S
    o Temperature
    o Color

- CHEMICAL CHARACTERISTICS OF WATER

    o Milligrams per liter (mg/l) or parts per million (ppm)
        - Milligrams   =   weight
        - Liter   =   volume
    o pH – acid range and base range
    o Inorganic contaminants (many are metals)
        ▪ Primary – lead, mercury, silver, etc.
        ▪ Secondary – sodium, calcium, etc.
    o Organic contaminants (pesticides and herbicides)
    o Iron and manganese – problem concentrations

- RADIOLOGICAL CHARACTERISTICS

    o Sampling period
    o Number of samples required to form composite sample

- WATER SOURCES AND CHARACTERISTICS

    o Define hydrological cycle
    o Define ground water
        ▪ Aquifer – confined or unconfined
        ▪ Movement of ground water
    o Define surface water
    o Compare quality of ground water and surface water
    o Water consumption and supply problems

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- WELL CONSTRUCTION AND MAINTENANCE

- Define static water level
- Define drawdown and freeboard (measurement of drawdown)
- Define radius of influence and cone of depression
- Basic well construction practices
  - Minimum distance from cesspool, septic tank, sources of pollution (100 feet – city well)
  - Wells may not be in a pit or basement
  - Proper grouting of well casing
  - Disinfection practices for wells
- Basic well operation – relationship of static water level, drawdown, and specific capacity

- TREATMENT (Potable water – define)

  - Sedimentation – define
    - Water velocity control
    - Calculation of detention time
    - Chemicals used as aids in sedimentation process
  - Coagulation – define
    - Flocculation – define
    - Calculation of detention time
    - Chemicals used as aids in sedimentation process
  - Softening – define carbonate hardness, noncarbonate hardness, and negative noncarbonate hardness
    - Ion exchange
    - Chemical precipitation
      - Chemical tests used to determine total hardness and calcium hardness
      - Factors influencing magnesium precipitation
      - Use of soda ash
    - Recarbonation – define (increase or decrease of carbon dioxide influences calcium carbonate)
    - Alkalinity – define
      - Define bicarbonates, carbonates, and hydroxides
      - Chemical tests used in determining P and M readings
      - Interpretation of P and M readings
  - Filtration
    - Types of filters
    - Different types of media available
    - Structure of rapid sand filter
    - Proper operation and backwash techniques
    - Formation of surface mat

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- ▪ Air binding (causes)
- ▪ Interpretation of head loss readings

- o Disinfection – define
    - ▪ Define sterilization
    - ▪ Chlorination – reasons why chlorination is necessary
        - • Physical and chemical properties of chlorine
        - • Breakpoint chlorination
        - • Define chlorine demand, free available residual chlorine, combined available residual chlorine, total available residual chlorine
        - • Factors influencing chlorination (pH, temperature, turbidity, etc.)
        - • Recommended free chlorine concentration in water distribution system (1.0 mg/l)
    - ▪ Chlorinator operation, maintenance, and safety
    - ▪ Chlorine cylinders
        - • Proper valve operation
        - • Proper hookup techniques
        - • Ventilation system
- o Fluoridation
    - ▪ Fluoride chemicals
    - ▪ Operation and maintenance of upflow fluoride saturators and fluoride equipment
    - ▪ Proper fluoride level (1.2 mg/l)
- o Aeration
    - ▪ Oxidation of iron and manganese
    - ▪ Carbon dioxide removal
    - ▪ Odor removal

- • VII.   CORROSION CONTROL

    - o Factors influencing rate
    - o Methods of control
        - ▪ Addition of metaphosphates
        - ▪ Depositing of lime (factors influencing)
        - ▪ Cathodic protection

- • VIII.   HYDRAULICS

    - o Minimum pressure in distribution system (20 psi)
    - o Application of venturi
    - o Q = VA   Rate of flow = Velocity of water x Area of pipe

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- VIX. PUMPING STATIONS, PUMPS, AND APPURTENANCES

  o Types and classification of pumps
    - Centrifugal pumps
      - Mechanical parts and function
      - Proper packing techniques
      - Pump priming
      - Shutoff head
      - Conditions causing overheating of motors
      - Conditions causing loss of suction
      - Factors influencing pump output
      - Interpretation of a pump curve

    - Positive displacement pumps
      - Mechanical parts and function
      - Operation and maintenance
  o Booster pumping
    - Function
    - Control systems
  o Reservoirs
    - Protection from vandalism
    - Manhole for entry – overlapping and locked
    - Vents and overflows screened
  o Basic cross-connection control
    - Air gap
    - Vacuum breakers
    - Reduced pressure zone backflow preventor
  o Types of valves and function
    - Diaphragm, globe, rotary, slide, check, relief, altitude, pressure reducing
    - Proper repair
    - Proper opening and closing of valves

- X. SAFETY

  o Housekeeping techniques
  o Handling hazardous materials
  o Construction safety
  o Ventilation of all underground areas – pits, vaults, manholes
  o No smoking in manholes, vaults, and pits
  o First aid

- STATE AND FEDERAL SAFE DRINKING WATER ACT (SDWA) REGULATIONS

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- Responsibility (lawsuits and fines)
- Sampling responsibility lies with provider
- Requirements for submission of plans and specifications (required for new facilities, but also for changes in existing systems)
- Sampling frequencies – physical, chemical, microbiological, radiological
  - Microbiological – number of monthly samples from distribution system based on population
  - Radiological sampling – four samples collected during the year and combined to form one composite sample – once every four years
  - Organic chemicals – sampled once every three years, applies to surface water only
  - Inorganic chemicals
    - Ground water sampled once every three years
    - Surface water sampled yearly
- Proper written reports
- Public notification responsibilities

- RECORDKEEPING

  - Need for records – some required by state and federal law
  - Types of records
    - Treatment
    - Operation
    - Maintenance
    - Repair work
  - Operation and maintenance manuals

REFERENCES

1.   "Basic Level Water Treatment Operator's Practices"
       American Water Works Association Manual No. M18

2.   "Manual of Instruction for Water Treatment Plant Operators"
       New York State Department of Health

3.   "Environmental Data Sheets for Municipal Utilities"
       North Dakota Water and Pollution Control Conference

4.   North Dakota Administrative Code Title 33 – Department of Health, Chapter 33-17 Public
Water Supply Systems (Safe Drinking Water Regulations)

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Study Guide for Grade 1A, 1 & 2

Water Treatment Plant Operators

SAMPLE QUESTIONS

Grade 1 Water Treatment Plant Operators

1. A pump discharging at >50 pounds per square inch can pump
   into a 110-foot tower.   T   F

2. An iron content in the water of 0.5 milligrams per liter (mg/l)
   will cause staining problems in a laundry operation.   T   F

3. After a well has been developed and tested, it should be disinfected with _____ mg/l
   chlorine.

   a.   0.3
   b.   0.5
   c.   125
   d.   50

4. Which of the following items must be replaced when connecting a new chlorine cylinder?

   a.   Needle valve and seat
   b.   Air and water regulator
   c.   Pressure regulator
   d.   Lead washer

5. Water has physical, chemical, and biological characteristics. Which of the following is a
   physical characteristic?

   a.   Coliform
   b.   Turbidity
   c.   Hardness
   d.   All the above

6. The Environmental Protection Agency's "National Interim Primary Drinking Water
   Regulations" require that analysis for inorganic chemicals in ground water supplies be
   repeated at _____ Intervals.

   a.   One-year
   b.   Five-year
   c.   Three-year
   d.   None of the above

7. If a water plant used 1.5 pounds of chlorine per day, and pumped 120,000 gallons of water,

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what is the dosage in mg/l? (8.34 pounds = weight of one (1) gallon of water)

8.   How many gallons of water are contained in a 2000-foot length of 12" main?
        Πr^2 = circular area) (7.5 gallons = 1 cubic foot)

ANSWERS TO SAMPLE QUESTIONS

Grade 1 Water Treatment Plant Operators

1.   True   Pounds per square inch must be converted to feet
                 2.307 psi = 1 foot of water
                 50 psi x 2.307 (conversion factor) = 115.4 feet

2.   True

3.   d)   50 mg/l

4.   d)   lead washer

5.   b)   turbidity

6.   c)   three years

7.   1.5 mg/l

        If 1 mg/l = 8.34 pounds of 100% chlorine in one million gallons, the total pounds of chlorine used divided by 8.34 pounds = mg/liters in one million gallons. This value is then multiplied by the ratio of one million gallons to water treated.

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mg/l   = $\dfrac{1 \text{ mg/l x 1.5 lb. Chlorine/day}}{8.34 \text{ lb.}}$ x $\dfrac{1{,}000{,}000 \text{ gal}}{120{,}000 \text{ gal/day}}$ = 1.5

Note: Refer to Environmental Data Sheet for Municipalities WS-75-2.

8.   11,775 gallons

The volume of a pipe or cylinder in gallons is calculated by taking the cross-sectional area in feet times the length in feet to obtain the volume in cubic feet. To convert cubic feet to gallons, multiply by 7.5 (gallons/cubic foot). All terms must be in feet, therefore, the pipe diameter of 12 inches is one foot. The radius would be 0.5 feet.

Gallons   = Π x 0.5' x 0.5' x 2000' x 7.5 gallons/cubic feet

Gallons =   3.14 x 0.5' x 0.5' x 2000' x 7.5 gal/ft^3

Gallons =   11,775

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