

1. The basic goal for water treatment is to \_\_\_\_\_.
  - a. \*Protect public health
  - b. Make it clear
  - c. Make it taste good
  - d. Get stuff out
  
2. Greensand can be operated in either \_\_\_\_\_ regeneration or \_\_\_\_\_ regeneration modes.
  - a. \*Continuous or intermittent
  - b. Fast or slow
  - c. Hot or cold
  - d. Constant or unusual
  
3. The two most common types of chlorine disinfection by-products include:
  - a. \*TTHM and HAA5
  - b. TTHA of HMM5
  - c. Turbidity and color
  - d. Chloride and fluoride
  
4. GAC contactors are used to reduce the amount of \_\_\_\_\_ contaminants in water.
  - a. Inorganic
  - b. Turbidity
  - c. Particle
  - d. \*Organic
  
5. List the five types of surface water filtration systems.
  - a. \*Bag filtration, cartridge filtration, fine filtration, coarse filtration, media filtration
  - b. Conventional treatment, direct filtration, slow sand filtration, diatomaceous earth filtration, membrane filtration
  - c. Turbidity filtration, color filtration, bag filtration, fine filtration, media filtration
  - d. None of the above
  
6. Describe two primary methods used to control taste and odor?
  - a. \*Oxidation and adsorption
  - b. Filtration and sedimentation
  - c. Mixing and coagulation
  - d. Sedimentation and clarification

7. The adsorption process is used to remove:
  - a. \*Organics or inorganics
  - b. Bugs or salts
  - c. Organisms or dirt
  - d. Color or particles
  
8. The solid that adsorbs a contaminant is called the:
  - a. \*Adsorbent
  - b. Adsorbate
  - c. Sorbet
  - d. Rock
  
9. What is a method of reducing hardness?
  - a. \*Softening
  - b. Hardening
  - c. Lightning
  - d. Flashing
  
10. What percentage of all the earth's water is readily available as a potential drinking water supply in the form of lakes, rivers, and near-surface groundwater?
  - a. 97%
  - b. 50%
  - c. 2%
  - d. 1%
  - e. 0.34%
  
11. To prevent the entry of surface contamination into a well is the purpose of
  - a. The well casing
  - b. The water table
  - c. The louvers or slots
  - d. Well development
  - e. The annular grout seal
  
12. An aquifer that is located underneath an aquiclude is called
  - a. An unconfined aquifer
  - b. A confined aquifer
  - c. A water table
  - d. Unreachable groundwater
  - e. An Artesian spring

13. The process by which water changes from the gas to the liquid phase is termed
- Condensation
  - Evaporation
  - Percolation
  - Precipitation
  - Runoff
14. The free surface of the water in an unconfined aquifer is known as the
- Pumping water level
  - Artesian spring
  - Water table
  - Drawdown
  - Percolation
15. The type of organisms that can cause disease are said to be \_\_\_\_\_ microorganisms.
- Bad
  - Pathogenic
  - Undesirable
  - Sick
16. Four types of aesthetic contaminants in water include the following:
- Odor, turbidity, color, hydrogen sulfide gas
  - Pathogens, microorganisms, arsenic, disinfection by-products
  - Odor, color, turbidity, hardness
  - Color, pathogens, metals, organics
17. What is the purpose of adding fluoride to drinking water?
- Increase tooth decay
  - \*Reduce tooth decay
  - Make teeth white
  - Government conspiracy
18. The test used to determine the effectiveness of disinfection is called the:
- Coliform bacteria test
  - Color test
  - Turbidity test
  - Particle test
19. Turbidity is measured as:
- Mg/L
  - mL

- c. gpm
  - d. NTU
20. Giardia and cryptosporidium are a type of:
- a. Mineral
  - b. Organism
  - c. Color
  - d. Bird
21. Head is measured in
- a. absolute pressure.
  - b. gauge pressure.
  - c. \*feet.
  - d. foot-pounds.
22. A plat is a.
- a. a map.
  - b. a corrosion point on a pipe.
  - c. organelle found in some protozoans.
  - d. a highly corrosive soil type.
23. Which type of valve will prevent the collapse of a pipe?
- a. Pressure-relief valve
  - b. Needle valve
  - c. Pinch valve
  - d. \*Air-and-vacuum relief valve
24. The highest degree of protection for the exterior of a coated steel pipe is
- a. \*cathodic protection.
  - b. bituminous materials.
  - c. plastic coatings.
  - d. polyethylene tapes.
25. At which time of day is the age of the water stored in the distribution system the highest?
- a. \*Early morning
  - b. Late morning
  - c. Early afternoon
  - d. Late evening
26. The amount of liquid that can be raised vertically by a given pressure is called
- a. \*pressure head.
  - b. total head.
  - c. velocity head.
  - d. pump head.

27. The amount of energy in feet that a pump supplies to a fluid is called
- velocity head.
  - pump head.
  - total head.
  - pressure head.
28. The C-value is a measure of a pipe's wall
- smoothness.
  - smoothness giving even flow.
  - smoothness that retards turbulent flow.
  - \*roughness that retards flow due to friction.
29. Which one of the following is a type of joint for ductile iron piping?
- Expansion joint
  - \*Push-on joint
  - Bell and spigot with rubber o-ring
  - Rubber gasket joint
30. The correct protective methods for backflow-prevention devices in order of decreasing effectiveness are
- air gap, VB, RPZ, and DCVA.
  - air gap, VB, DCVA, and RPZ.
  - air gap, RPZ, VB, and DCVA.
  - \*air gap, RPZ, DCVA, and VB.
31. One of chlorine's advantages is that it
- is not influenced much by pH changes.
  - does not produce chlorinated by-products.
  - \*has a persistent residual.
  - does not cause taste and odor problems.
32. Chlorine gas is times heavier than air.
- 1.5
  - 2.5
  - 3.5
  - 4.5
33. After a water storage tank has been chlorinated, which bacteriological test must prove negative before the tank is put back into service?
- Gram negative test
  - HPC test
  - \*Coliform test
  - Chloramine test
34. Which is the best and most reliable method for finding a very small chlorine leak?
- Use soap on possible areas of leak and watch for bubbles
  - Use a strong ammonia solution on a cloth swab and place it by the

- suspected leak
- c. Use methane gas and watch for a dark brown smoke
  - d. Use a chlorine gas detector and place it next to any area suspected of leaking
35. The minimum required free chlorine residual anywhere in the distribution system is
- a. \*a detectable level.
  - b. 0.2mg/L.
  - c. 0.4mg/L.
  - d. 0.5mg/L.
36. Sodium hypochlorite (NaOCl) solution is available with available chlorine.
- a. 2 to 5%
  - b. \*5 to 20%
  - c. 25 to 50%
  - d. 50 to 70%
37. Booster chlorination is chlorine added
- a. in the coagulation mixing chamber.
  - b. before the filters.
  - c. at the clearwell.
  - d. \*somewhere in the distribution system.
38. According to AWWA Standard C651, disinfection of water mains requires 24-hour exposure to which minimum free chlorine residual?
- a. 10mg/L
  - b. \*25mg/L
  - c. 50mg/L
  - d. 100mg/L
39. Which must be measured at least at the same time and at the same sampling points in the distribution system that total coliforms are sampled for a water system that only uses surface water?
- a. pH
  - b. Langelier Index
  - c. \*Residual disinfectant concentration
  - d. Heterotrophic bacteria
40. Hypochlorous acid is
- a. \*a weak acid.
  - b. a strong acid.
  - c. easily dissociatable.
  - d. hydrophobic.
41. First draw samples for the analysis of lead and copper water must be collected from taps where the water has stood motionless in the plumbing for at least

- a. 4 hours.
  - b. 6 hours.
  - c. 8 hours.
  - d. \*24 hours.
42. Samples to be tested for coliforms are collected in plastic bottles that must contain
- a. sodium thiocarbonate.
  - b. sodium thiooxalate.
  - c. \*sodium thiosulfate.
  - d. sodium thiocyanate.
43. The volume of a sample for coliform compliance is
- a. \*100 mL.
  - b. 200 mL.
  - c. 300 mL.
  - d. 0 ; there is no volume compliance for coliforms.
44. If a water sample is not analyzed immediately for chlorine residual, it is acceptable if it is analyzed within
- a. 10 minutes.
  - b. \*15 minutes.
  - c. 20 minutes.
  - d. 30 minutes.
45. Which may be substituted for the analysis of residual disinfectant concentration, when total coliforms are also sampled at the same sampling point?
- a. \*Heterotrophic plate count (HPC)
  - b. Fecal coliforms
  - c. Giardia lamblia
  - d. Combined chlorine
46. Which water quality parameter requires a grab sample because it cannot be collected as a composite sample?
- a. \*pH
  - b. Iron
  - c. Nitrate
  - d. Zinc
47. One chemical characteristic of an acid is that it will
- a. \*accept an electron pair.
  - b. donate an electron pair.
  - c. accept a proton.
  - d. accept a neutron.
48. Which chemical contains calcium?
- a. Soda ash

- b. \*Lime
  - c. Caustic soda
  - d. Sodium bicarbonate
49. The best choice to collect a water sample from a customer's faucet in regards to a complaint would be a
- a. \*faucet without threads.
  - b. faucet that can swivel.
  - c. single-lever handle faucet.
  - d. faucet with an aerator.
50. When measuring for free chlorine residual, which method is the quickest and simplest?
- a. \*DPD color comparater
  - b. Orthotolidine method
  - c. Amperometric titration
  - d. 1, 2 nitrotoluene di-amine method
51. It is standard practice to install fire hydrants on mains that are at a minimum or larger.
- a. \*6 inches
  - b. 8 inches
  - c. 10 inches
  - d. 12 inches
52. A corporation stop is used for a
- a. \*service line.
  - b. pump discharge line.
  - c. tank inlet.
  - d. tank outlet.
53. When PVC pipe is stacked loose, it should not be stacked more than how high?
- a. 2.0 feet
  - b. \*3.0 feet
  - c. 5.0 feet
  - d. 7.5 feet
54. Which is the most common cause for pipe joint failure (leaking) in newly laid pipe
- a. The use of a cracked gasket
  - b. Not pushing the spigot end the full distance into the bell
  - c. \*Not having the joint completely clean
  - d. An incorrect trench bedding angle
55. Which should be installed at a dead-end water main?
- a. Vacuum valve
  - b. Air valve



- c. \*Blowoff valve
  - d. Water quality sampling station
56. Compression fittings used with copper or plastic tubing seal by means of
- a. beveled sleeve.
  - b. compression ring.
  - c. \*compressed beveled gasket.
  - d. compressed o-rings located at either end of the fitting's beveled neck.
57. The breaking of a buried pipe when it is unevenly supported is called
- a. stress breakage.
  - b. shear breakage.
  - c. \*beam breakage.
  - d. flexural breakage.
58. Thrust from a water surge almost always acts pushes against. to the inside surface that it
- a. vertically
  - b. horizontally
  - c. perpendicular
  - d. vertically and horizontally
59. Which thrust control is easy to use, especially in locations where existing utilities or structures are numerous?
- a. \*Restraining fittings
  - b. Tie rods
  - c. Thrust anchors
  - d. Thrust blocks
60. The backfill material for a pipe installation should contain enough to allow for thorough compaction.
- a. \*moisture
  - b. sand
  - c. gravel
  - d. mixed sizes
61. The "heart" of a pump is called the
- a. volute case.
  - b. \*impeller.
  - c. motor.
  - d. pump.
62. Which device serves the same function as the packing?
- a. Inline suction gland
  - b. Packing gland
  - c. \*Mechanical seal
  - d. Lantern seal

63. Which is used to stop air leakage into the casing around a pump shaft?
- a. Packing gland
  - b. Lantern ring
  - c. \*Seals
  - d. Shaft sleeves
64. Which is at the top of a stuffing box?
- a. \*Packing gland
  - b. Lantern ring
  - c. Mechanical seal
  - d. Seal cage
65. Which assembly holds the lantern ring and packing?
- a. Shaft assembly
  - b. Casing ring assembly
  - c. Packing gland casing
  - d. \*Stuffing box
66. Which of the following prevents the impeller of a pump from turning on the shaft?
- a. Lock nut on threaded shaft
  - b. \*Key
  - c. Steel pin
  - d. Caliper pin
67. Which type of valve is used to isolate a pump on the suction side?
- a. Butterfly valve
  - b. Globe valve
  - c. \*Gate valve
  - d. Ball valve
68. Water hammer can be described as
- a. particle waves.
  - b. \*acoustic waves.
  - c. rogue waves.
  - d. longitudinal waves.
69. When fully opened, which valve will have the highest head loss?
- a. Gate valve
  - b. Plug valve
  - c. \*Globe valve
  - d. Ball valve
70. Which type of pressure sensor uses a wire fastened to a diaphragm?
- a. Bellows sensor
  - b. \*Strain gauge
  - c. Helical sensor
  - d. Diaphragm element

71. Why is it so important to monitor the speed of a variable-speed pump?
  - a. To prevent excessive temperatures from developing
  - b. To prevent vibration from developing
  - c. To prevent speed oscillation from occurring
  - d. \*To prevent cavitation from occurring
72. Which basic electrical unit is used to measure a material's opposition to the flow of electricity?
  - a. Ampere
  - b. \*Ohm
  - c. Volts
  - d. Resistance or impedance
73. The first oil change on a new pump should be done
  - a. after the first two weeks of operation.
  - b. \*after one month of operation.
  - c. after three months of operation.
  - d. after six months of operation.
74. How often should the temperature of centrifugal pump motor bearings be checked with a thermometer?
  - a. Every day
  - b. Once a week
  - c. Twice a month
  - d. \*Once a month
75. All sensors that respond to liquid pressure will perform poorly if enter(s) the sensor.
  - a. \*air
  - b. corrosive chemicals from water treatment processes
  - c. corrosive chemicals from piping
  - d. iron bacteria
76. Packing replacement is usually performed when
  - a. water leakage sprays out of the pump housing.
  - b. \*no further tightening can be done on the packing gland.
  - c. the packing gland bolts are exposed by more than  $2^{1/2}$  inches above the nut.
  - d. the packing has completely disintegrated.
77. Which device changes alternating current to direct current by allowing the electric current to flow in one direction but blocking flow in the opposite direction?
  - a. Regulator
  - b. Converter
  - c. Inverter
  - d. \*Rectifier

78. To ease installation of impeller wear rings, they can be
- a. lubricated with a light oil.
  - b. greased with lithium.
  - c. \*heated.
  - d. cooled.
79. Packing is designed to
- a. add lubricant to the shaft.
  - b. expand and deteriorate with normal use.
  - c. protect the shaft.
  - d. \*wear and deteriorate with normal use.
80. Bearings on a line shaft turbine can be lubricated with
- a. \*oil or water.
  - b. grease or oil.
  - c. lithium or grease.
  - d. graphite or grease.
81. Which agency sets legal limits on the concentration levels of harmful contaminants in potable water distributed to customers?
- a. National Primary Drinking Water Regulations
  - b. \*United States Environmental Protection Agency
  - c. United States Public Health Service
  - d. Occupational Health and Safety Organization
82. Which violations are the most serious?
- a. \*Tier I
  - b. Tier II
  - c. Tier III
  - d. Tier IV
83. A positive fecal coliform test must be reported to the primacy agency within
- a. 8 hours.
  - b. 12 hours.
  - c. \*24 hours.
  - d. 48 hours.
84. The number of monthly distribution system bacteriological samples required is
- a. based on water withdrawal permit limit.
  - b. based on system size.
  - c. \*based on population served.
  - d. different for each state.
85. Which is the approximate angle of repose for average soils when using the sloping method for the prevention of cave-ins? (Note: horizontal to vertical distance, respectively)

- a. 0.5 : 1.0
  - b. \*1.0 : 1.0
  - c. 1.5 : 1.0
  - d. 2.0 : 1.0
86. A well yields 2,840 gallons in exactly 20 minutes. What is the well yield in gpm?
- a. 140gpm
  - b. \*142 gpm
  - c. 145gpm
  - d. 150gpm
87. Convert 37.4 degrees Fahrenheit to degrees Celsius.
- a. 3.0°C
  - b. 5.3°C
  - c. 7.9°C
  - d. 9.7°C
88. What is the area of a circular tank pad in ft<sup>2</sup>, if it has a diameter of 102ft ?
- a. 6,160ft<sup>2</sup>
  - b. 6,167ft<sup>2</sup>
  - c. 8,170ft<sup>2</sup>
  - d. 8,200ft<sup>2</sup>
89. What is the pressure 1.85 feet from the bottom of a water storage tank if the water level is 28.7 feet?
- a. 11.6psi
  - b. 12.4psi
  - c. 62.0psi
  - d. 66.3 psi
90. Calculate the well yield in gpm, given a drawdown of 14.1ft and a specific yield of 31 gpm/ft.
- a. 2.2gpm
  - b. 7.3gpm
  - c. 45.1gpm
  - d. 440gpm
91. How many gallons are in a pipe that is 18.0 in. in diameter and 1,165ft long?
- a. 2,060 gal
  - b. 10,300 gal
  - c. 15,400gal
  - d. 17,200 gal
92. A water tank with a capacity of 5.75 million gallons (mil gal) is being filled at a rate of 2,105 gpm. How many hours will it take to fill the tank?

- a. 31.6hr
  - b. 37.8hr
  - c. 42.9hr
  - d. 45.5hr
93. Determine the detention time in hours for the following water treatment system:
- Distribution pipe from water plant to storage tank is 549ft in length and 14 in. in diameter
  - Storage tank averages 2,310,000 gal of water at any given time
  - Flow through system is 6.72mgd
- a. 7.2hr
  - b. 7.4hr
  - c. 8.0hr
  - d. 8.3hr
94. Convert 28.7 cubic feet per second (cfs) to gallons per minute (gpm).
- a. 12,477gpm
  - b. 12,700gpm
  - c. 12,880gpm
  - d. 12,900gpm
95. Convert 16,912,000 liters to acre-feet.
- a. 13.7 acre-ft
  - b. 41.5 acre-ft
  - c. 51.9 acre-ft
  - d. 767 acre-ft
96. Convert  $-22.6^{\circ}\text{C}$  to degrees Fahrenheit.
- a.  $-4.6^{\circ}\text{F}$
  - b.  $-8.7^{\circ}\text{F}$
  - c.  $-11.8^{\circ}\text{F}$
  - d.  $-12.8^{\circ}\text{F}$
97. A sodium hypochlorite solution contains 11.3% hypochlorite. Calculate the mg/L hypochlorite in the solution.
- a. 11.3mg/L sodium hypochlorite
  - b. 1,130mg/L sodium hypochlorite
  - c. 11,300mg/L sodium hypochlorite
  - d. 113,000mg/L sodium hypochlorite
98. Records for a pump show that on June 1st at exactly 9:00 a.m. the number of pumped gallons was 71,576,344 and on July 1st at exactly 9:00 a.m. it was 72,487,008 gallons. Determine the average gallons pumped per day (gal/day) for this month to the nearest gallon.

- a. 18,605gal/day
  - b. 25,875gal/day
  - c. 30,355gal/day
  - d. 34,325gal/ day
99. If chlorine is being fed at a rate of 260lb/ day for a flow rate of 23cfs, which should be the adjustment on the chlorinator when the flow rate is decreased to 16cfs, if all other water parameters remain the same?
- a. 160lb/ day
  - b. 180lb/day
  - c. 310lb/ day
  - d. 370lb/day
100. Calculate the diameter of a clarifier with a circumference of 215ft.
- a. 34.8ft
  - b. 56.7ft
  - c. 68.5ft
  - d. 76.2ft

## SOLUTION

1. Answer: a. Protect public health
2. Answer: a. Continuous or intermittent
3. Answer: a. TTHM and HAA5
4. Answer: d. Organic
5. Answer: a. Bag filtration, cartridge filtration, fine filtration, coarse filtration, media filtration
6. Answer: a. Oxidation and adsorption
7. Answer: a. Organics or inorganics
8. Answer: a. Adsorbent
9. Answer: a. Softening
10. Answer: e. 0.34
11. Answer: e. The annular grout seal
12. Answer: b. A confined aquifer
13. Answer: a. Condensation
14. Answer: c. Water table
15. Answer: b. Pathogenic
16. Answer: c. Odor, color, turbidity, hardness
17. Answer: b. Reduce tooth decay
18. Answer: a. Coliform bacteria test
19. Answer: d. NTU
20. Answer: b. Organism
21. Answer: 21 c. feet.
22. Answer: a. a map.
23. Answer: d. Air-and-vacuum relief valve
24. Answer: a. cathodic protection.
25. Answer: a. Early morning
26. Answer: a. pressure head.



27. Answer: b. pump head.
28. Answer: d. roughness that retards flow due to friction.
29. Answer: b. Push-on joint
30. Answer: 30 d. air gap, RPZ, DCVA, and VB.
31. Answer: c. has a persistent residual.
32. Answer: b. 2.5
33. Answer: c. Coliform test
34. Answer: d. Use a chlorine gas detector and place it next to any area suspected of leaking
35. Answer: a. a detectable level
36. Answer: b. 5 to 20%
37. Answer: d. somewhere in the distribution system.
38. Answer: b. 25mg/L
39. Answer: c. Residual disinfectant concentration
40. Answer: a. a weak acid.
41. Answer: b. 6 hours.
42. Answer: c. sodium thiosulfate.
43. Answer: a. 100 mL.
44. Answer: b. 15 minutes.
45. Answer: a. Heterotrophic plate count (HPC)
46. Answer: a. pH
47. Answer: a. accept an electron pair.
48. Answer: b. Lime
49. Answer: a. faucet without threads.
50. Answer: a. DPD color comparater
51. Answer: a. 6 inches
52. Answer: a. service line.
53. Answer: b. 3.0 feet

- 54. Answer: c. Not having the joint completely clean
- 55. Answer: c. Blowoff valve
- 56. Answer: c. compressed beveled gasket.
- 57. Answer: c. beam breakage.
- 58. Answer: c. perpendicular
- 59. Answer: a. Restraining fittings
- 60. Answer: a. moisture.
- 61. Answer: b. impeller.
- 62. Answer: c. Mechanical seal
- 63. Answer: c. Seals
- 64. Answer: a. Packing gland
- 65. Answer: d. Stuffing box
- 66. Answer: b. Key
- 67. Answer: c. Gate valve
- 68. Answer: b. acoustic waves.
- 69. Answer: c. Globe valve
- 70. Answer: b. Strain gauge
- 71. Answer: d. To prevent cavitation from occurring
- 72. Answer: b. Ohm
- 73. Answer: b. after one month of operation.
- 74. Answer: d. Once a month
- 75. Answer: a. air
- 76. Answer: b. no further tightening can be done on the packing gland.
- 77. Answer: d. Rectifier
- 78. Answer: c. heated.
- 79. Answer: d. wear and deteriorate with normal use.
- 80. Answer: a. oil or water.
- 81. Answer: b. United States Environmental Protection Agency

82. Answer: a. Tier I
83. Answer: c. 24 hours.
84. Answer: c. based on population served.
85. Answer: b. 1.0 : 1.0
86. Answer: b. 142gpm  
Equation: Well yield, gpm =  $\frac{\text{Gallons produced}}{\text{Test duration, min}}$   
Well yield, gpm =  $\frac{2,840\text{gpm}}{20 \text{ min}} = 142\text{gpm}$
87. Answer: a. 3.0°C  
Equation: °C =  $(\text{°F} - 32) \times 5/9$   
First:  $37.4 - 32 = 5.4$   
Then:  $5.4 \times 5 = 270 \div 9 = 3.0\text{°C}$
88. Answer: c. 8,170ft<sup>2</sup>  
Equation: Area =  $\pi r^2$ , where  $\pi = 3.14$   
First find the radius: Radius = Diameter / 2 = 102/2 = 51ft  
Area of tank =  $(3.14)(51\text{ft})(51\text{ft}) = 8,167.14\text{ft}^2$ , round to 8,170ft<sup>2</sup>
89. Answer: a. 11.6psi  
Equation: First subtract water level from the level in question, 1.85 feet.  
Number of feet in question = 28.7ft – 1.85ft = 26.85ft  
Pressure, psi =  $(26.85\text{ft})(0.433\text{psi/ft}) = 11.626\text{psi}$ , round to 11.6psi
90. Answer: d. 440gpm  
Equation: Well yield, gpm = (Specific yield, gpm/ft)(Drawdown, ft)  
Substitution: Well yield, gpm =  $(31\text{gpm/ft})(14.1\text{ft}) = 437.1\text{gpm}$ , round to 440gpm
91. Answer: c. 15,400 gal  
First convert the diameter from inches to feet.  
Number of feet =  $\frac{18.0\text{in.}}{12\text{in./ft}} = 1.50\text{ft}$   
Next, calculate the volume.  
Equation: Pipe volume, gal =  $(0.785)(\text{Diameter, ft})^2(\text{Length, ft})(7.48\text{gal/ft}^3)$   
Pipe volume, gal =  $(0.785)(1.50\text{ft})(1.50\text{ft})(1,165\text{ft})(7.48\text{gal/ft}^3)$   
= 15,391gal, round to 15,400gal

92. Answer: d. 45.5hr

First, convert gpm to gal per hour (gph):  $(2,105\text{gpm})(60\text{ min/hr}) = 126,300\text{gph}$

Next, convert million gallons (mil gal) to gallons.

Water tank, gal =  $(5.75\text{mil gal})(1,000,000) = 5,750,000\text{gal}$

Equation: Time, hr = Number of gallons  $\div$  gph

Time, hr =  $5,750,000\text{gal} \div 126,300\text{gph} = 45.527\text{hr}$ , round to 45.5hr

93. Answer: d. 8.3hr

First, convert pipe diameter from inches to feet.

Pipe diameter, ft =  $(14\text{in})(1\text{ft}/12\text{in}) = 1.167\text{ft}$

Next, find the number of gallons in the pipeline.

Number of gal =  $(0.785)(\text{Diameter, ft})^2(\text{Length, ft})(7.48\text{gal/ft}^3)$

Number of gal =  $(0.785)(1.167\text{ft})(1.167\text{ft})(549\text{ft})(7.48\text{gal/ft}^3) = 4,390\text{gal}$

Add the pipe and tank volume to get the total number of gallons.

Pipe and tank volume, gal =  $4,390\text{gal} + 2,310,000\text{gal} = 2,314,390\text{gal}$

Then convert mgd to gallons per day.

Number of gal =  $(6.72\text{mgd})(1,000,000) = 6,720,000\text{gal/day}$

Using the following equation, solve for the detention time.

Equation: Detention time, hr =  $\frac{(\text{Total Volume})(24\text{hr/day})}{\text{Flow, gal/day}}$

Substitute known values and solve:

$\frac{(2,314,390\text{gal})(24\text{hr/day})}{6,720,000\text{gal/day}} = 8.266\text{hr}$ , round to 8.3hr

94. Answer: d. 12,900 gpm

Number of gpm =  $(28.7\text{cfs})(60\text{sec/min})(7.48\text{gal/ft}^3)$

=  $12,880.56\text{gpm}$ , round to 12,900gpm

95. Answer: a. 13.7 acre-ft

First, convert the number of liters to gallons.

Number of gal =  $\frac{16,912,000\text{ liters}}{3.785\text{gal/liter}} = 4,468,164\text{gal}$

Next convert gallons to acre-feet.

Number of acre-ft =  $\frac{(\text{Number of gal})}{(43,560\text{ft}^3/\text{acre-ft})(7.48\text{gal/ft}^3)}$

Number of acre-ft =  $\frac{(4,468,164\text{gal})}{(43,560\text{ft}^3/\text{acre-ft})(7.48\text{gal/ft}^3)} = 13.713\text{acre-ft}$ , round to 13.7 acre-ft

96. Answer: b.  $-8.7^{\circ}\text{F}$

$$\text{Equation: } ^{\circ}\text{F} = (9/5 \times ^{\circ}\text{C}) + 32$$

$$\begin{aligned} ^{\circ}\text{F} &= (9/5 \times -22.6^{\circ}\text{C}) + 32 = [(9 \times -22.6) \div 5] + 32 = (-203.4 \div 5) + 32 \\ &= -40.68 + 32 = -8.68^{\circ}\text{F}, \text{ round to } -8.7^{\circ}\text{F} \end{aligned}$$

97. Answer: d. 113,000mg/L sodium hypochlorite

$$\text{Know: } 1\% \text{ solution} = 10,000\text{mg/L}$$

$$(11.3\%)(10,000\text{mg/L}) = 113,000\text{mg/L}$$

98. Answer: c. 30,355gal/day

$$\text{Equation: Pumped, gal/day} = \frac{(\text{Last read of gal pumped} - \text{First read of gallons pumped})}{\text{Number of days}}$$

$$\begin{aligned} \text{Pumped, gal/day} &= \frac{(72,487,008\text{gal} - 71,576,344\text{gal})}{30 \text{ days}} = \frac{910,664\text{gal}}{30 \text{ days}} \\ &= 30,355.467, \text{ round to } 30,355 \text{ gal/day} \end{aligned}$$

99. Answer: b. 180lb/ day

Set up a ratio and solve for the unknown,  $x$

$$\begin{aligned} \frac{x\text{lb/ day}}{16\text{cfs}} &= \frac{260\text{lb/ day}}{23\text{cfs}} \\ x &= \frac{(260\text{lb/ day})(16\text{cfs})}{23\text{cfs}} = 180\text{lb/ day} \end{aligned}$$

100. Answer: c. 68.5ft

$$\text{Equation: Circumference} = (\pi)(\text{Diameter})$$

Rearrange the equation to solve for the diameter.

$$\text{Diameter} = \frac{\text{Circumference}}{\pi}$$

$$\text{Diameter} = \frac{215\text{ft}}{3.14} = \mathbf{68.5\text{ft}}$$