PRACTICE EXAM 3: WPI/ABC WATER DISTRIBUTION OPERATOR SIMULATION (100 QUESTIONS)

1. An operator measures a pressure of 72 psi at a point in the distribution system where the ground elevation is 580 feet. A nearby elevated storage tank has a water surface elevation of 748 feet. Accounting for the HGL, approximately how many feet of head have been lost to friction between the tank and the measurement point?

A. 72 feet of friction loss between the two points

B. 2 feet of friction loss between the two points

C. 580 feet of friction loss between the two points

D. 2 feet of friction loss between the two points

2. A water utility is evaluating whether to rehabilitate or replace a 50yearold unlined cast iron main that has experienced four breaks in the past two years and has a tested Cfactor of 45. Which factor most strongly supports replacement rather than rehabilitation?

A. The main's location beneath a recently repaved arterial road makes excavation costly

B. The extremely low Cfactor combined with frequent structural failures indicates the pipe wall has deteriorated beyond the point where lining alone would restore adequate service

C. Rehabilitation would temporarily disrupt water service to customers during the cleaning process

D. The main is located in a residential area where construction noise would generate complaints

3. During a routine inspection of a groundlevel welded steel storage tank, an operator discovers several areas where the interior epoxy coating has peeled away, exposing bare steel. What is the primary consequence of this coating failure?

A. The exposed steel will increase water pressure inside the tank due to reduced friction

B. The peeled coating material will clog customer service lines and reduce meter accuracy

C. Corrosion will attack the exposed steel, weakening the tank wall and releasing iron into the stored water

D. The tank will lose its thermal insulation properties, causing water temperature fluctuations

4. An operator is tasked with collecting a firstdraw lead and copper sample at a customer's home. The customer mentions they ran the kitchen faucet for five minutes about two hours ago. Can the operator collect a valid sample now?

A. No, because the tap must remain unused for at least 6 hours before a valid firstdraw sample can be collected

B. Yes, because two hours of stagnation is sufficient for lead to leach into the standing water

C. Yes, as long as the operator runs the tap for 30 seconds before collecting to clear the aerator

D. No, but the operator can collect from the bathroom tap if it has not been used for 6 hours

5. A centrifugal pump in a booster station has been running for 18 months without maintenance. The operator notices that the packing gland is completely dry with no visible drip. What problem has likely developed?

A. The pump suction strainer is clogged, reducing the water available to lubricate the packing

B. The lantern ring has shifted out of alignment with the seal water inlet port

C. The mechanical seal has automatically engaged to replace the worn packing

D. The packing has been overtightened or has worn to the point where it no longer allows the necessary lubricating drip

6. A water distribution operator receives a call from a restaurant owner who reports that ice cubes made from tap water have a strong chlorine taste that is driving away customers. The operator tests the chlorine residual at the restaurant's tap and finds 3.2 mg/L free chlorine. What is the most likely explanation?

A. The restaurant is located immediately adjacent to the chlorine injection point at a booster station

B. The restaurant is located near the point of entry into the distribution system where residual is highest

C. A chemical feed pump malfunction has caused a temporary overdose throughout the entire system

D. The restaurant's plumbing contains a chlorinegenerating device that is adding additional chlorine

7. When performing a hydrant flow test, the operator attaches a pitot gauge to the discharge nozzle of the flow hydrant. What does the pitot gauge measure?

A. The velocity pressure of the water stream, which is used to calculate the flow rate

B. The static pressure in the distribution main before any hydrants are opened

C. The residual pressure remaining in the system while the hydrant is flowing

D. The total dynamic head developed by the nearest pump station

8. An operator needs to disinfect 400 feet of newly installed 6inch PVC water main. The pipe volume is calculated to be approximately 585 gallons. Using the tablet method (AWWA C651 Method 1) at a target concentration of 25 mg/L, approximately how many pounds of chlorine are needed?

A. 12.20 pounds of chlorine for this volume at 25 mg/L

B. 1.22 pounds of chlorine for this volume at 25 mg/L

C. 0.12 pounds of chlorine for this volume at 25 mg/L

D. 0.012 pounds of chlorine for this volume at 25 mg/L

9. A customer on a deadend street complains that their water is always warm, has a flat taste, and sometimes has a faint musty odor. These symptoms are worst during summer months. What is the underlying cause?

A. A crossconnection in the customer's plumbing is allowing stagnant water from a garden hose to enter the house

B. High water age in the deadend main results in loss of disinfectant residual, temperature increase, and potential biological activity

C. The customer's water heater thermostat is set too high, causing the hot water to mix with the cold supply

D. The treatment plant reduces chemical dosing during summer to conserve supplies

10. In the context of a water distribution system, what does the term "firm capacity" of a pump station refer to?

A. The pumping capacity available with the largest single pump out of service

B. The maximum possible output when all pumps are running simultaneously at full speed

C. The pumping rate needed to maintain minimum pressure at the farthest point in the system

D. The output of the smallest pump in the station operating at its best efficiency point

11. A contractor installing a new subdivision water system uses standard pushon joint ductile iron pipe. At a 90degree bend, the contractor installs the fitting without any thrust restraint, stating that the soil will hold the fitting in place once backfilled. Is this acceptable?

A. Yes, because backfill soil provides adequate frictional resistance for fittings up to 90 degrees

B. Yes, as long as the contractor compacts the backfill to at least 95% standard Proctor density

C. No, but only if the main diameter is 8 inches or larger where thrust forces become significant

D. No, because unrestrained pushon joints at fittings require either thrust blocks or restrained joints to resist the forces created by internal water pressure

12. A water system's annual consumer confidence report (CCR) must include information about which of the following?

A. The salary and qualifications of each licensed operator employed by the utility

B. A detailed breakdown of the utility's operating and capital budgets for the reporting year

C. The source of the water, detected contaminants and their levels, and compliance with drinking water standards

D. The scheduled dates of all planned maintenance activities for the coming year

13. During an emergency main break repair at night in a busy intersection, the operator's crew must establish traffic control. What is the minimum class of highvisibility safety apparel required for nighttime work?

A. Class 1 with a minimum of one reflective stripe on the torso

B. Class 3 with a larger area of both fluorescent and reflective material than Class 2

C. Class 2 is sufficient for all conditions regardless of time of day

D. No highvisibility apparel is required at night because vehicle headlights provide adequate illumination

14. A well pump motor's nameplate indicates it draws 45 amps during normal operation. During a routine check, the operator measures 52 amps on all three phases. What does the elevated amperage most likely indicate?

A. A mechanical problem such as a binding impeller, failed bearing, or sand in the pump that is increasing the load on the motor

B. Normal variation that occurs when the power grid is under heavy load during peak demand hours

C. The voltage regulator on the pump's variable frequency drive is boosting current to compensate for low supply voltage

D. The ammeter needs recalibration because a 15% reading increase exceeds the instrument's normal drift range

15. An operator discovers that a pressure reducing valve at a zone boundary is vibrating and producing a loud chattering noise during periods of low demand. What is the most likely cause?

A. The PRV spring has broken, causing the valve to cycle rapidly between open and closed

B. Debris trapped between the valve disc and seat is preventing the valve from seating properly

C. The downstream pressure is too close to the upstream pressure, causing the valve to hunt

D. The PRV is oversized for the current flow conditions, causing it to operate in a nearly closed position where it hunts between open and closed

16. When collecting a bacteriological sample from a distribution system tap, how long should the tap be flushed before collecting the sample?

A. 30 seconds to clear the aerator and fixture of standing water

B. At least 10 minutes to draw fresh water from the transmission main

C. 2 to 3 minutes to flush stagnant water from the service line and draw fresh water from the distribution main

D. No flushing is required — the sample should capture the first water from the tap to reflect true conditions

17. A water utility operates two wells that pump into a common header feeding the distribution system. Well 1 produces water with a pH of 7.2 and Well 2 produces water with a pH of 8.1. When both wells operate simultaneously, the blended water pH is approximately 7.6. What is the operational significance of monitoring this blended pH?

A. Blended pH affects the aesthetic appearance of the water but has no operational significance

B. The blended pH directly affects chlorine disinfection effectiveness and the stability of the corrosion control program

C. The utility should always operate only one well at a time to maintain consistent pH

D. pH monitoring is only required for surface water systems, not groundwater systems

18. Which component of a drilled well prevents surface water and water from undesirable formations from migrating downward along the outside of the casing into the aquifer?

A. Cement grout filling the annular space between the casing and the borehole wall

B. The well screen installed at the producing aquifer depth

C. The pitless adapter installed below the frost line on the casing

D. The gravel pack surrounding the well screen in the aquifer zone

19. A distribution operator is investigating a customer complaint about low pressure. The operator connects a calibrated pressure gauge to the customer's outside hose bibb and reads 28 psi with no water flowing inside the house. What should the operator check next?

A. The chlorine residual at the customer's tap to rule out a water quality cause

B. The customer's water heater temperature setting to determine if thermal expansion is involved

C. The system pressure at the nearest hydrant or mainline pressure monitoring point to determine whether the low pressure is a system problem or a customerside problem

D. The customer's water meter for signs of tampering that may be restricting flow

20. A water system's SCADA system generates a highlevel alarm for an elevated storage tank at 2:00 AM. The alarm indicates the water level has reached the maximum setpoint, but the fill pump continues to run. What is the most likely malfunction?

A. The level transmitter has failed and is sending an incorrect lowlevel signal to the pump controls

B. The pump motor has overheated and is running in a degraded mode at reduced speed

C. The discharge check valve has failed, allowing water to recirculate back through the idle pump

D. The altitude valve or pump control relay has failed to respond to the highlevel signal and shut off the pump

21. An operator calculates the velocity in a 14inch main carrying 1,800 GPM. After converting to cfs and calculating the pipe area, the velocity is approximately 3.8 fps. The same main must also deliver fire flow during an emergency, increasing the total flow to 3,500 GPM. What is the approximate velocity during fire flow?

A. 5.0 fps, which is above the normal range but acceptable for fire flow conditions

B. 3.8 fps because the pipe diameter increases to accommodate the additional flow

C. 7.4 fps, which may cause excessive friction loss and pressure drop during the fire event

D. 15.2 fps, which will cause immediate pipe failure from excessive velocity

22. A water system operator notices that the sodium hypochlorite solution in the chemical storage tank has turned from clear yellow to a dark amber color and has visible sediment at the bottom. The solution was delivered three months ago. What has happened?

A. The sodium hypochlorite has degraded, losing available chlorine concentration and forming degradation byproducts

B. Bacteria have colonized the chemical tank, producing a biofilm that discolors the solution

C. The HDPE storage tank has begun to dissolve, releasing polymer particles into the solution

D. The solution has absorbed iron from the fill water used to dilute it at the time of delivery

23. During a confined space entry into a valve vault, the atmospheric monitor alarms for hydrogen sulfide (H_2S) at 12 ppm. The OSHA permissible exposure limit (PEL) for H_2S is 10 ppm. What should the entry team do?

A. Continue the entry because 12 ppm is only slightly above the PEL and poses minimal risk

B. Evacuate the space immediately, increase ventilation, and retest the atmosphere before reentering

C. Put on cartridgetype respirators rated for H_2S and continue the work

D. Record the reading in the entry permit log and continue monitoring at 15minute intervals

24. An operator is reviewing fire flow test results for a residential area. The test shows a static pressure of 62 psi and a residual pressure of 18 psi while flowing 1,200 GPM from two hydrants. What does the residual pressure of 18 psi indicate?

A. The system has excellent capacity and can support significantly more fire flow

B. The area meets all fire flow requirements because any measurable residual is acceptable

C. The flow test was performed incorrectly because residual pressure should never drop below 30 psi

D. The system pressure dropped below the generally accepted minimum of 20 psi for fire flow, indicating inadequate capacity for the tested demand

25. What is the purpose of the breakaway (safety) flange on a modern dry barrel fire hydrant?

A. To allow the hydrant barrel to be extended or shortened to match changes in ground elevation

B. To provide a connection point for specialized firefighting equipment and adapters

C. To allow the upper barrel to separate cleanly if the hydrant is struck by a vehicle, without damaging the lower barrel or main valve

D. To facilitate annual maintenance by allowing the upper barrel to be removed for internal inspection

26. An operator measures the flow rate from a well and calculates daily production at 576,000 gallons. The well ran for 16 hours that day. What is the well's flow rate in gallons per minute?

A. 36,000 GPM based on dividing daily production by 16

B. 600 GPM based on dividing daily production by the number of operating minutes

C. 400 GPM based on dividing daily production by 1,440 minutes per day

D. 960 GPM based on doubling the daily production to account for a full 24hour cycle

27. A customer reports a bluegreen discoloration in their toilet tank and a metallic taste in the water. The customer's home was built in 1985 with copper plumbing and has a copper service line. Laboratory analysis of a firstdraw sample shows copper at 1.8 mg/L. What regulatory threshold has been exceeded?

A. The MCL for copper at 1.0 mg/L established under the Safe Drinking Water Act

B. The SMCL for copper at 0.3 mg/L established as a secondary aesthetic standard

C. The MCLG for copper at 0.0 mg/L establishing zero as the healthbased goal

D. The action level for copper at 1.3 mg/L under the Lead and Copper Rule

28. A distribution system has experienced three total coliformpositive routine samples in the past month, triggering a Level 2 Assessment under the Revised Total Coliform Rule. What does a Level 2 Assessment require?

A. A detailed evaluation of the system including the source, treatment, distribution, and storage to identify the cause and determine corrective actions

B. Replacement of all bacteriological sampling taps with new, sterile fixtures

C. An immediate switch from chloramine to free chlorine disinfection systemwide

D. Shutdown of the entire distribution system until three consecutive negative samples are obtained

29. An operator is installing a new residential water meter. The meter box is located in the customer's front yard, and the operator notices that the service line enters the box from the left side. The meter has a flow direction arrow cast into the body. How should the meter be positioned?

A. With the flow arrow pointing upward toward the meter register for proper reading

B. With the flow arrow pointing toward the street regardless of the service line direction

C. With the flow arrow pointing in the same direction as the water flow — from the main toward the customer's building

D. The flow arrow orientation does not matter for positive displacement meters

30. A water utility's asset management program requires condition assessments of all distribution system assets. For buried water mains that cannot be visually inspected, which approach is most commonly used to assess condition?

A. Excavating a random sample of mains each year for direct visual inspection of pipe walls

B. Analyzing break history, pipe age, material, soil conditions, and operational data to estimate remaining useful life

C. Using groundpenetrating radar to scan every main in the system on an annual basis

D. Draining each main annually and inserting a camera for internal inspection

31. A pump station operator notices that Pump 2's discharge check valve is not seating properly — water flows backward through the pump when it shuts off, causing the impeller to spin in reverse before the pump fully stops. What damage can result from this condition?

A. Reverse rotation can damage the motor, unscrew the impeller from the shaft, and cause water hammer when the pump restarts against reverse flow

B. The backward flow will improve the pump's priming capability for the next start cycle

C. Reverse rotation has no effect on centrifugal pumps because the impeller is symmetrical

D. The only consequence is increased electricity consumption as the motor acts as a generator

32. An operator is scheduling chemical deliveries for sodium hypochlorite. The current inventory is 800 gallons, the average daily usage is 45 gallons, and the supplier requires 5 business days for delivery. What is the latest day the operator can place the order without risking running out?

A. When inventory reaches 450 gallons, providing exactly 10 days of supply

B. When inventory reaches 100 gallons, providing 2 days of emergency reserve

C. When inventory reaches 600 gallons, providing one full month of buffer supply

D. When inventory reaches approximately 225 gallons to cover the 5day delivery lead time, but ordering earlier provides a safety margin

33. A water system serves an area with highly corrosive soil conditions (low resistivity, high chloride content). The system installs new ductile iron mains with polyethylene encasement. Five years later, an operator excavates a section for a new service tap and discovers that the polyethylene wrap has multiple tears and holes. What is the operational concern?

A. The tears have allowed tree roots to penetrate and grow around the pipe

B. The exposed areas of pipe are unprotected from soil corrosion and may be developing external pitting

C. The pipe's internal Cfactor has been reduced by the damaged encasement

D. The polyethylene wrap is no longer providing thrust restraint at the nearby fittings

34. A customer calls to report that a fire hydrant near their home has been running continuously for several hours and no utility crews are present. What should the operator do?

A. Advise the customer that hydrants are sometimes opened for routine flushing and no action is needed

B. Ask the customer whether the water appears discolored and take no action if the water is clear

C. Dispatch a crew to investigate immediately — an unattended flowing hydrant may indicate unauthorized use, vandalism, or a failed hydrant mechanism

D. Contact the fire department to determine whether they have a hydrant in use for a training exercise

35. A water utility plans to install 2,000 feet of new 12inch water main along a county road. The design engineer asks the distribution operator for input on pipe material selection. Which factor from the operator's field experience is most relevant to this decision?

A. The soil conditions along the route, including corrosivity, groundwater level, and the presence of rocky terrain that affects installation and longterm pipe protection

B. The color preference that matches the existing infrastructure for visual consistency during future repairs

C. The weight of the pipe sections, which determines how many crew members will be needed for installation

D. The price per linear foot of each material option, which is the primary factor in all pipe selection decisions

36. An operator is investigating the cause of a significant increase in nonrevenue water identified through the utility's annual water audit. The audit shows that real losses have increased by 30% compared to the previous year. What is the most effective first step in addressing this increase?

A. Replace all residential water meters with new meters to eliminate apparent losses from underregistration

B. Increase the chlorine dose at the treatment plant to compensate for the additional water moving through the system

C. Implement mandatory water conservation restrictions for all customers to reduce overall production

D. Conduct a comprehensive leak detection survey of the distribution system to identify and locate hidden leaks

37. Which of the following scenarios represents a backpressure backflow condition rather than a backsiphonage condition?

A. A commercial building's booster pump creates pressure higher than the distribution system, pushing water backward from the building into the main

B. A main break on the street drops the pressure below atmospheric, pulling water from a garden hose submerged in a swimming pool into the main

C. A fire department pumper truck draws water from a hydrant at a rate that creates a vacuum in the nearby mains

D. Power failure at a pump station causes negative pressure in the distribution system, siphoning water from customer plumbing

38. What is the primary purpose of a surge tank or air chamber installed in a pump station discharge system?

A. To store excess chemical solution during periods of low demand for use during peak periods

B. To provide additional storage capacity that supplements the elevated tank during peak demand

C. To absorb pressure surges (water hammer) caused by sudden pump starts, stops, or valve closures

D. To remove dissolved air from the discharge water before it enters the distribution system

39. An operator performing a valve exercising round discovers that a 6inch gate valve in a residential neighborhood requires only 3 turns to close, but the valve record indicates it should require 14 turns. What does this discrepancy suggest?

A. The valve stem has corroded and shortened, reducing the number of turns needed

B. The valve gate has broken and fallen into the pipe, allowing the stem to turn freely with minimal resistance after only a few turns

C. The valve was manufactured with a different thread pitch than the standard, requiring fewer turns

D. The valve record is incorrect and should be updated to reflect the 3turn observation

40. An operator is using the pounds formula to calculate chlorine dosage and accidentally enters the flow in GPM instead of MGD. How will this error affect the calculated pounds of chlorine?

A. The calculated amount will be approximately 694 times too high, resulting in a massive overdose if applied

B. The calculated amount will be approximately half of what is actually needed

C. The error will have no significant effect because GPM and MGD are close in magnitude

D. The calculated amount will be approximately 694 times too low, resulting in inadequate disinfection

41. Which type of valve is specifically designed for precise throttling and flow regulation, uses a disc that moves perpendicular to the flow path, and creates significant friction loss even when fully open?

A. Gate valve with a resilient wedgeshaped gate

B. Globe valve with a disc and stationary ring seat

C. Butterfly valve with a disc on a central rotating shaft

D. Plug valve with a cylindrical plug and throughhole

42. An operator discovers that the vent screen on the top of an elevated storage tank has been torn, leaving the vent opening exposed. Why must this be repaired immediately?

A. Unscreened vents allow excessive air flow that creates turbulence inside the tank, reducing water quality

B. The torn screen will cause the tank's overflow pipe to malfunction during high water level conditions

C. Unscreened vents increase the rate of chlorine residual decay due to exposure to ambient air

D. Birds, insects, and debris can enter the tank through the unscreened vent, contaminating the stored drinking water

43. An operator receives a work order to install a new fire hydrant on an existing 8inch distribution main. The hydrant will be connected to the main by a 6inch lateral. What valve must be installed on the lateral between the main and the hydrant?

A. An auxiliary gate valve that allows the hydrant to be isolated for maintenance without shutting down the main

B. A pressure reducing valve to protect the hydrant from excessive main pressure

C. A check valve to prevent water from flowing backward from the hydrant into the main

D. A corporation stop identical to those used on residential service connections

44. During a water quality sampling round, an operator collects a total coliform sample and places it in the vehicle. Two hours later, the operator realizes the ice in the cooler has melted and the sample temperature has risen to 18°C (64°F). What should the operator do?

A. Deliver the sample to the lab and note the elevated temperature on the chain of custody form

B. Add additional ice to cool the sample back down and then deliver it to the laboratory

C. Discard the sample and recollect from the same location because the sample was not properly preserved at below 10°C

D. Deliver the sample but request that the laboratory apply a temperature correction factor to the results

45. The HazenWilliams formula is used to calculate friction head loss in water distribution systems. Which variable in the formula has the most dramatic effect on head loss — meaning a small change in this variable produces the largest change in head loss?

A. The length of the pipe, which affects head loss linearly

B. The flow rate, which affects head loss to the 1.85 power

C. The Cfactor, which affects head loss inversely to the 1.85 power

D. The pipe diameter, which affects head loss inversely to approximately the 4.87 power

46. A water utility with 12,000 service connections is conducting a citywide valve exercising program. The utility has approximately 3,400 buried gate valves. If the goal is to exercise every valve on a 3year cycle, approximately how many valves must be exercised per year?

A. Approximately 1,133 valves per year, divided across the available work days

B. Approximately 3,400 valves per year to complete the entire system annually

C. Approximately 4,000 valves per year to include reexercising of problem valves

D. Approximately 340 valves per year, focusing only on transmission main valves

47. A pump station experiences a complete power failure at 3:00 PM on a hot summer day. The system has one elevated storage tank that is currently at 75% capacity. What keeps the distribution system pressurized while the pumps are offline?

A. The inertia of water in the distribution mains maintains pressure for several hours after pumps stop

B. The elevated storage tank provides gravityfed pressure to the system as water flows out of the tank to meet demand

C. The pressure reducing valves at zone boundaries lock in their current setting and maintain pressure

D. Emergency generator systems at the pump station automatically start within 10 seconds of power loss

48. An operator is reviewing a crossconnection control survey report for a dental office. The survey identifies a connection between the potable water supply and a dental vacuum system that uses water for suction and rinse. What type of backflow prevention device is appropriate for this connection?

A. A hose bibb vacuum breaker because the dental vacuum operates at low pressure

B. A double check valve assembly because dental offices are classified as lowhazard

C. A reduced pressure zone assembly because dental offices handle substances that pose a health hazard

D. An atmospheric vacuum breaker because the dental vacuum creates only intermittent siphon conditions

49. An operator performing acoustic leak detection on a 12inch ductile iron main places a leak noise correlator sensor on a hydrant at Station A and another sensor on a hydrant at Station B, which is 600 feet away. The correlator calculates that the leak is located 225 feet from Station A. Where should the operator mark the ground for excavation?

A. At a point 225 feet from Station A, measured along the path of the main between the two hydrants

B. At the midpoint between Station A and Station B, which is 300 feet from each sensor

C. At a point 375 feet from Station A, on the opposite side from the correlator's calculation

D. At both Station A and Station B because the correlator can only narrow the search to one of the sensor locations

50. What does AWWA Manual M36 establish as the standard methodology for evaluating water system losses?

A. Procedures for conducting hydrant flow tests to measure system capacity and fire flow

B. Methods for testing and calibrating residential water meters for accuracy

C. Protocols for disinfecting new and repaired water mains before service

D. A standardized water audit framework that categorizes water production into authorized consumption, apparent losses, and real losses

51. An operator observes that a centrifugal pump's vibration levels have been steadily increasing over the past three months. The most recent vibration reading is 50% above the baseline established at installation. What is the primary concern?

A. Increasing vibration is normal for centrifugal pumps as they age and does not require investigation

B. Increasing vibration indicates a developing mechanical problem that should be investigated before catastrophic failure occurs

C. The vibration increase is caused by changes in water temperature that affect the pump's hydraulic balance

D. The vibration sensor has likely drifted out of calibration and needs to be rechecked before taking action

52. An operator notices that the chlorine residual at a monitoring point in the middle of the distribution system has dropped from a consistent 1.0 mg/L to 0.3 mg/L over the past week, even though the chlorine dose at the plant has not changed. What should the operator investigate first?

A. Whether the DPD reagent lot has expired and is producing falsely low readings

B. Whether the treatment plant has changed source water that has higher chlorine demand

C. Whether there has been a change in the system that is increasing water age or chlorine demand in the affected area, such as a valve closure, storage tank offline, or main break

D. Whether the customer at the monitoring location has installed a wholehouse carbon filter

53. A trench for a water main installation is 6 feet deep in Type B soil. The contractor is using sloping as the cavein protection method. What is the maximum allowable slope angle for Type B soil?

A. 53 degrees from horizontal (¾:1), which is the steepest allowable slope for any soil

B. 34 degrees from horizontal (1½:1), the maximum for the least stable soil

C. 90 degrees (vertical), as long as the trench is less than 8 feet deep

D. 45 degrees from horizontal (1:1), the maximum allowable slope for Type B soil

54. An operator is developing a budget request for a new leak detection survey of the entire distribution system. Which of the following provides the strongest financial justification for this expenditure?

A. The volume of water saved by finding and repairing leaks will reduce production, treatment, and pumping costs and recover revenue from water that is currently unbilled

B. Leak detection surveys are mandated by OSHA and failure to comply results in financial penalties

C. The leak detection equipment purchased for the survey can be resold after the project is complete

D. Customer complaints about discolored water will decrease after leaks are repaired

55. A water main installation project calls for 500 feet of 8inch ductile iron pipe with polyethylene encasement and restrained joints at all fittings. During installation, the inspector notices that the crew is not installing tracer wire alongside the pipe. Is tracer wire necessary for ductile iron pipe?

A. Yes, because all buried pipe regardless of material must have tracer wire per federal mandate

B. No, because ductile iron is a metallic pipe that can be located with standard electromagnetic locating equipment without tracer wire

C. Yes, because the polyethylene encasement prevents electromagnetic signals from reaching the pipe

D. No, because the restrained joint locking mechanism contains sufficient metal to serve as a locating target

56. An operator performing routine maintenance on a chemical metering pump discovers that the pump is delivering only 60% of the volume indicated by the pump setting during a timed volumetric calibration test. What is the most likely cause?

A. The pump motor has lost speed due to bearing wear, reducing the stroke frequency

B. The pump suction line has an air leak that reduces the volume drawn on each suction stroke

C. Worn or fouled check valves are allowing chemical to leak back on each stroke, reducing net delivery

D. The graduated calibration cylinder is inaccurate and should be replaced with a certified vessel

57. A distribution system experiences a water main break at 7:00 AM on a weekday during peak morning demand. The break is on a 16inch transmission main that feeds a large portion of the system. SCADA shows tank levels dropping rapidly. What is the highest priority action?

A. Begin excavation at the break site immediately to minimize repair time

B. Contact the media to issue a press release about the service disruption

C. Activate the mutual aid agreement with a neighboring utility to request supplemental water supply

D. Isolate the break by closing the appropriate valves to stop the water loss and protect remaining system pressure

58. An operator receives laboratory results showing that E. coli was confirmed in a repeat sample from the distribution system. Under the SDWA, what public notification tier is required?

A. Tier 3 — annual notification through the consumer confidence report

B. Tier 1 — notification within 24 hours using methods designed to reach all affected customers quickly

C. Tier 2 — notification within 30 days by mail or direct delivery

D. No notification is required for repeat samples — only for routine samples

59. A water system treats well water that has a pH of 6.8 and low alkalinity. Without treatment, what water quality problem is most likely to occur in the distribution system?

A. Aggressive corrosion of metallic pipes and plumbing, leading to elevated levels of lead, copper, and iron in customers' drinking water

B. Excessive scale buildup on pipe interiors that reduces carrying capacity over time

C. High concentrations of trihalomethanes caused by the low pH enhancing chlorine's reaction with organic matter

D. Rapid degradation of PVC pipe walls from acid attack at pH below 7.0

60. During a new service connection installation, the operator completes the tap on the distribution main and connects the service line pipe. Before opening the corporation stop to pressurize the service line, what must the operator verify?

A. That the customer has signed a service agreement authorizing the new connection

B. That the hydrant nearest to the tap location has been opened to reduce pressure during activation

C. That all joints on the service line are complete, the curb stop is closed, and the meter is installed — ensuring the service line is ready to receive pressure without leaking at an open end

D. That the chlorine residual in the main at the tap location is at least 2.0 mg/L

61. A distribution system serves a hospital that has an emergency backup water supply from an onsite well that is not connected to the municipal system. The hospital also has a fire sprinkler system supplied by the municipal system with chemical additives for corrosion prevention. How many backflow prevention concerns exist at this facility?

A. At least two — the auxiliary well supply (if it could be crossconnected to the municipal system) and the fire sprinkler system with chemical additives, each requiring appropriate backflow protection

B. Only one — the fire sprinkler system, because the auxiliary well is not physically connected

C. None, because hospitals are exempt from crossconnection control requirements

D. Only one — the auxiliary well, because fire sprinkler systems do not require backflow prevention

62. An operator notices that one of three pumps in a station consistently runs at a higher amperage than the other two identical pumps, even though all three are producing similar flow rates and pressures. What should the operator investigate?

A. Whether Pump 1 and Pump 3 have faulty ammeters that are reading artificially low

B. Whether the pump with higher amperage is on a different electrical phase that runs at higher voltage

C. Whether the higheramperage pump is more efficient and therefore drawing more current productively

D. Whether the pump with higher amperage has a mechanical issue — such as worn bearings, tight packing, or impeller damage — that is increasing the load on the motor

63. An operator needs to convert 45 psi to feet of head. What is the result?

A. 19.5 feet of head based on dividing 45 by 2.31

B. 103.95 feet of head based on multiplying 45 by 2.31

C. 336.6 feet of head based on multiplying 45 by 7.48

D. 45 feet of head because psi and feet of head are equivalent units

64. When performing a cutandreplace repair on a broken water main, why is it important to thoroughly clean the inside of the existing pipe ends before installing the replacement section and couplings?

A. Clean pipe ends improve the aesthetic appearance of the repair when photographed for records

B. Cleaning removes sharp edges that could cut the operator's hands during coupling installation

C. Dirt, debris, and corrosion on the pipe surface prevent the coupling gaskets from sealing properly against the pipe, causing the repair to leak

D. Clean pipe ends allow the coupling bolts to be tightened with less torque, reducing installation time

65. A water utility implements an AMI (Advanced Metering Infrastructure) system. Three months after installation, the system data shows that a customer's meter records continuous flow of approximately 0.5 GPM between 2:00 AM and 5:00 AM every night when the household should have zero consumption. What does this pattern indicate?

A. A probable leak on the customer's side of the meter, such as a leaking toilet, underground pipe break, or irrigation system malfunction

B. Normal water usage from an automatic ice maker and humidifier operating during overnight hours

C. A malfunctioning AMI transmitter that is generating false flow readings during offpeak hours

D. Backflow from the customer's plumbing into the distribution system caused by thermal expansion

66. A confined space rescue plan specifies the use of a nonentry retrieval system consisting of a tripod and mechanical winch with a body harness on the entrant. When is this type of rescue system most effective?

A. In large, complex confined spaces with multiple chambers and obstacles

B. When the entrant has been unconscious for more than 15 minutes inside the space

C. In confined spaces where the entry point is large enough for multiple rescuers to enter simultaneously

D. In verticalentry confined spaces where the entrant can be pulled straight up through the opening without obstruction

67. What is the minimum air gap distance required between a water supply outlet and the flood rim of a receiving fixture?

A. One inch regardless of the pipe diameter supplying the fixture

B. At least twice the diameter of the supply pipe, with a minimum of one inch

C. Six inches for all residential fixtures and twelve inches for commercial fixtures

D. The air gap must be equal to the diameter of the supply pipe with no minimum specified

68. A water system's operations supervisor asks an operator to develop a standard operating procedure (SOP) for the utility's hydrant flushing program. What is the most important principle for developing a useful SOP?

A. The SOP should be developed with input from the operators who actually perform the flushing work, ensuring it reflects actual field conditions and practical procedures

B. The SOP should be written by the engineering department to ensure technical accuracy

C. The SOP should reference all applicable federal and state regulations in full legal citation

D. The SOP should be as brief as possible to encourage operators to read it

69. During a water main installation, an operator notices that the bedding material being used is a coarse, angular crushed rock with pieces up to 3 inches in diameter. The project specifications call for clean granular bedding material of ¾inch maximum size. Should the operator accept this bedding material?

A. Yes, because larger stones provide better drainage beneath the pipe than fine material

B. Yes, as long as the crushed rock is compacted to at least 95% standard Proctor density

C. No, because oversized angular material can create point loads that damage pipe coatings and crack pipe, and it does not provide the uniform support required by the specifications

D. No, but only if the pipe being installed is PVC — ductile iron pipe can tolerate coarse bedding

70. A water system experiences a confirmed waterborne disease outbreak traced to contamination entering the distribution system through a crossconnection. Investigation reveals that the contamination occurred when a main break reduced system pressure below atmospheric, causing backsiphonage through an unprotected garden hose connected to a pesticide sprayer. Which program, if fully implemented, would have prevented this incident?

A. A comprehensive valve exercising program that ensured all isolation valves were operable

B. An advanced metering infrastructure program that detected the backflow in real time

C. A capital improvement program that replaced all aging mains to prevent future breaks

D. A crossconnection control program that identified and eliminated the unprotected garden hose connection or required installation of a backflow prevention device

71. An operator performs a pump efficiency test and determines that Pump 3 is operating at 62% efficiency, compared to its design efficiency of 82%. What is the primary operational consequence of this reduced efficiency?

A. The pump consumes significantly more energy to produce the same output, increasing electricity costs

B. The pump produces water at a higher temperature due to wasted energy converted to heat

C. The pump creates excessive noise that exceeds OSHA workplace exposure limits

D. The pump's discharge pressure increases because the wasted energy is converted to additional head

72. An operator is reviewing the results of a meter accuracy test performed on a 5/8inch positive displacement meter. The test shows 95% accuracy at the low flow rate, 98% accuracy at the medium flow rate, and 99% accuracy at the high flow rate. According to AWWA guidelines, what action should be taken?

A. The meter is within acceptable limits at all flow rates and can be returned to service

B. The meter should be repaired or replaced because accuracy at the low flow rate (95%) is below the AWWA recommended minimum of 98.5%

C. Only the highflow accuracy matters for billing purposes, so the meter passes the test

D. The meter should be recalibrated to improve lowflow accuracy before being returned to service

73. An operator is disinfecting a repaired water main by spraying the interior of the pipe and all new fittings with a 200 mg/L chlorine solution before closing the repair. After the isolation valves are opened and the repair section is flushed, the operator tests the chlorine residual and finds it at 1.8 mg/L, which matches the normal system residual. Is the repair ready to be returned to service?

A. No, because the operator must also perform a pressure test at 150% of working pressure before restoring service

B. No, because the repair section must be held with 50 mg/L chlorine for 24 hours per AWWA C651

C. Yes, but only if the state regulatory agency provides written approval before service restoration

D. Yes, if the utility's repair disinfection procedures only require surface chlorination, flushing, and verification of normal residual for this size of repair

74. A water utility is required to maintain records of all water quality monitoring results. What is the typical minimum record retention period for bacteriological monitoring data?

A. One year from the date of collection

B. Three years from the date of collection

C. Five years from the date of collection, though some states require longer

D. Records must be maintained permanently and can never be discarded

75. During a pressure test of a newly installed main, the pressure drops steadily from 200 psi to 175 psi over the 2hour test period. The allowable leakage for this test section would permit a maximum drop of 5 psi. What should happen next?

A. The test fails — the contractor must locate and repair all leaks and then retest the main

B. The contractor should extend the test for an additional 2 hours to see if the pressure stabilizes

C. The 25 psi drop is acceptable because some pressure loss is always expected during new pipe testing

D. The inspector should approve the test with a notation that the main may need repair within the first year

76. An operator uses a steel tape coated with carpenter's chalk to measure the static water level in a well. After lowering the tape and retrieving it, the operator observes that the chalk has been washed off from the bottom 38 feet of the tape. The tape was lowered to the 120foot mark at the top of the casing. What is the depth to the static water level?

A. 38 feet below the top of the casing

B. 82 feet below the top of the casing

C. 120 feet below the top of the casing

D. 158 feet below the top of the casing

77. An operator is planning work that requires entering a large, buried concrete water reservoir for inspection. The reservoir is 80 feet long, 40 feet wide, and 15 feet deep. It has a single roof hatch for entry. Besides atmospheric testing and ventilation, what additional confined space concern is specific to this type of space?

A. The reservoir's concrete walls may emit toxic gases that standard fourgas monitors cannot detect

B. The large volume of the space means that ventilation will be ineffective regardless of blower capacity

C. The reservoir does not qualify as a confined space because it is too large for the OSHA definition

D. The single entry point and large interior distance from the hatch make rescue extremely difficult if a worker is incapacitated far from the exit

78. A distribution operator is asked to explain to a new employee why the utility maintains minimum pressure of at least 20 psi throughout the system at all times. What is the primary reason?

A. Pressures below 20 psi cause customer appliances such as washing machines and dishwashers to malfunction

B. Water mains are structurally weakened by low internal pressure and may collapse under soil loading

C. Maintaining positive pressure prevents contaminated water from being drawn into the system through crossconnections by backsiphonage

D. State regulations require a minimum of 20 psi to ensure adequate fire flow at all hydrants at all times

79. An operator discovers a residential water meter that is installed backward — the flow direction arrow points from the customer's house toward the distribution main instead of toward the customer. What effect does this have?

A. The meter will either not register, register inaccurately, or may be damaged — it must be reinstalled in the correct orientation

B. The meter will read accurately because positive displacement meters work in both directions

C. The meter will overregister, charging the customer for more water than they actually use

D. The meter will register in reverse, subtracting consumption from the register total over time

80. An operator performing maintenance on a chemical feed system needs to disconnect a section of tubing that carried sodium hypochlorite solution. Before beginning the work, the operator should perform which lockout/tagoutrelated action?

A. Only lock out the electrical supply to the building where the chemical feed system is located

B. Lock out the metering pump and close and lock the chemical supply valve to isolate both electrical and chemical energy sources

C. Post a warning sign on the chemical tank but no physical lockout is required for chemical systems

D. Only lock out the metering pump motor because chemical lines are not considered an energy source under LOTO

81. A system using chloramines for disinfection detects nitrite levels of 0.15 mg/L at a monitoring point where nitrite has historically been undetectable. Chloramine residual at the same point has dropped from 2.0 mg/L to 0.8 mg/L. These readings together are strong indicators of what condition?

A. A crossconnection allowing agricultural runoff containing nitrogen fertilizer to enter the main

B. Chemical incompatibility between the chloramine residual and a new pipe lining material

C. Nitrification — ammoniaoxidizing bacteria are converting the ammonia component of chloramine to nitrite, depleting the disinfectant residual

D. Normal seasonal variation in nitrogen compounds that requires no corrective action

82. A water distribution system operates with a single elevated storage tank. If the tank is taken offline for cleaning and inspection during a period of normal demand, how must the system maintain pressure?

A. The pump station must operate continuously with pressurebased controls to maintain the target pressure since the tank is no longer available to regulate the HGL

B. Portable pressure relief valves must be installed at all hydrant locations throughout the zone

C. The system cannot operate without the tank and all customers must be notified of a service interruption

D. Gravity from the elevated terrain at the treatment plant provides sufficient pressure without the tank

83. An operator opens a fire hydrant for flushing and the discharge water is initially dark brown. After 10 minutes, the water gradually clears to a light tea color. The operator tests the chlorine residual and obtains 0.6 mg/L free chlorine. Should flushing continue?

A. No, because any measurable chlorine residual indicates the water quality is acceptable

B. No, because 10 minutes exceeds the maximum recommended flushing time for any hydrant

C. Yes, but only if the operator receives authorization from the supervisor to use more water

D. Yes, because the water is still discolored — flushing should continue until the water is completely clear and the residual is stable

84. A water utility installs a new 8inch PVC main in a trench alongside an existing gas line. The onecall locator marked the gas line with yellow paint. During installation, the contractor notices the PVC pipe is only 18 inches from the gas line at one point. What concern does this proximity raise?

A. PVC pipe may react chemically with natural gas leaking from the gas line

B. If either utility needs to be excavated in the future, the close proximity increases the risk of damaging the adjacent utility — and PVC is vulnerable to damage from hydrocarbon permeation if the gas line leaks

C. The electromagnetic locating signal from the gas line will interfere with future efforts to locate the water main

D. The gas line will heat the water in the PVC pipe above safe drinking water temperature limits

85. A pump station with three parallel pumps experiences a failure of Pump 2 during the peak demand period. Pumps 1 and 3 continue to operate. If the pump station's firm capacity is defined as the capacity with the largest pump out of service, and all three pumps are identical at 500 GPM each, what is the station's firm capacity?

A. 500 GPM because firm capacity equals the output of a single pump

B. 1,500 GPM because all three pumps are still installed even if one is not running

C. Approximately 1,000 GPM from the two remaining operational pumps, which equals the firm capacity

D. 750 GPM because the two remaining pumps must operate at reduced speed to prevent overheating

86. Under what circumstances may a worker's personal lockout/tagout lock be removed by someone other than the worker who placed it?

A. Only under a documented, employerspecific procedure that includes verification that the worker is not at the facility and that all reasonable efforts have been made to contact them

B. Whenever the shift supervisor determines that the work is complete and the area is safe

C. After 24 hours have elapsed since the lock was placed, regardless of the worker's status

D. Under no circumstances — a personal lock may only be removed by the worker who placed it

87. An operator is reviewing laboratory results for the quarterly disinfection byproduct monitoring. The TTHM result at monitoring site #5 is 0.095 mg/L for this quarter. The previous three quarterly results at this site were 0.072, 0.068, and 0.079 mg/L. What is the locational running annual average (LRAA) at this site?

A. 0.095 mg/L because compliance is based on the single highest quarterly result

B. 0.072 mg/L because compliance is based on the single lowest quarterly result

C. 0.080 mg/L, which is the simple arithmetic average of the 8 most recent quarterly results

D. 0.0785 mg/L, which is the arithmetic average of the four most recent quarterly results at that location

88. An operator discovers that several valve boxes in a recently paved street have been buried under 2 inches of asphalt. What is the consequence of this condition?

A. The buried valve boxes pose a trip hazard to pedestrians walking on the paved surface

B. The valves cannot be operated during an emergency because the operating nut is inaccessible, potentially expanding the area affected by a main break

C. The asphalt will accelerate corrosion of the valve box casting due to chemical reaction

D. The paving contractor is financially responsible and the utility needs to take no immediate action

89. A water utility's well produces water with naturally occurring iron at 0.8 mg/L, which exceeds the SMCL of 0.3 mg/L. Customers frequently complain about reddishbrown staining on fixtures and laundry. Is the utility in violation of a drinking water standard?

A. No, because the SMCL for iron is a nonenforceable aesthetic guideline, not a healthbased standard — but the utility should address the complaints through treatment or operational improvements

B. Yes, the utility is in violation of the primary MCL for iron and must issue a Tier 1 public notification

C. No, because iron is not regulated under any federal drinking water standard

D. Yes, the utility must immediately shut down the well until iron levels are below 0.3 mg/L

90. An operator is troubleshooting a booster pump station where the discharge pressure has dropped significantly. The suction pressure is normal, the pump speed is normal, and there are no visible leaks. Upon inspection, the operator finds that the suction strainer is completely clogged with debris. How is the clogged strainer causing the pressure drop?

A. The clogged strainer is restricting flow to the pump discharge, reducing velocity in the discharge pipe

B. The debris from the strainer has lodged in the pump impeller, reducing its ability to add energy to the water

C. The clogged strainer is reducing the available suction pressure (NPSH) at the pump inlet, potentially causing cavitation and reducing the pump's ability to develop full discharge pressure

D. The strainer debris is creating water hammer in the suction piping that dissipates pump energy

91. A distribution operator is planning a systematic unidirectional flushing program for the spring. The operator must develop a flushing sequence map. What is the first step in developing this map?

A. Identify the locations of all deadend mains so they can be flushed first

B. Determine the number of hydrants available for discharge at each flushing location

C. Calculate the chlorine dose needed to maintain residual in the flushed water

D. Identify the supply source(s) and plan the flushing sequence starting from the source and working outward toward system extremities

92. A customer complains that their water pressure is excellent in the early morning but drops to barely usable levels every afternoon between 3:00 and 7:00 PM. Several neighbors report the same pattern. System SCADA shows that the elevated tank serving this area drops to its lowest level during this same period. What is the most likely cause of the pressure pattern?

A. The pump station serving this area is programmed to shut down during afternoon hours for energy savings

B. Afternoon peak demand draws down the storage tank, lowering the HGL and reducing pressure in the zone — particularly at higher elevations or distant points

C. A pressure reducing valve at the zone boundary closes partially during the afternoon to protect downstream customers

D. Temperature expansion of the pipe during warm afternoon hours restricts flow and reduces pressure

93. An operator discovers that a construction crew working near a well site has stored diesel fuel in an aboveground tank within 50 feet of the well. The well is protected by a wellhead protection program that restricts chemical storage within 100 feet. What action should the operator take?

A. Notify the utility's wellhead protection coordinator and request that the construction crew relocate the fuel tank outside the protection zone

B. Shut down the well immediately and do not restart until the construction project is complete

C. Test the well water for diesel contamination and take no further action if the results are negative

D. Place absorbent pads around the fuel tank as a precautionary measure but allow it to remain

94. An operator is calculating the chlorine demand for a section of the distribution system. The applied dose at the treatment plant is 2.8 mg/L. The residual measured at the farthest sampling point is 0.3 mg/L. At a sampling point halfway between the plant and the farthest point, the residual is 1.4 mg/L. What is the total chlorine demand between the plant and the farthest point?

A. 1.4 mg/L because demand equals the residual at the midpoint

B. 0.3 mg/L because demand equals the residual at the farthest point

C. 2.8 mg/L because the entire dose is consumed by the time water reaches the farthest point

D. 2.5 mg/L because demand equals the applied dose minus the residual at the farthest point

95. A newly constructed pump station has three pumps, each rated at 400 GPM. The pumps are connected in parallel with individual check valves, isolation valves, and flow meters on each discharge line. The station has been in operation for one week. During a routine check, the operator notices that Pump 2's check valve is leaking — when Pump 2 is off and Pumps 1 and 3 are running, water flows backward through Pump 2 and out its suction line. What should the operator do?

A. Increase the speed of Pumps 1 and 3 to compensate for the water lost through the leaking check valve

B. Close the suction valve on Pump 2 to prevent backflow through the idle pump

C. Take Pump 2 out of service by closing its discharge isolation valve and schedule repair or replacement of the check valve

D. Reverse the motor leads on Pump 2 so that it runs in reverse to counteract the backflow

96. An operator receives a locate request through the 811 system for excavation at a site where the utility's GIS records show no water facilities. However, the operator knows from experience that an old 4inch cast iron main was installed in this area decades ago and may not be in the GIS. What should the operator do?

A. Respond to the onecall center that no facilities exist at this location based on the GIS records

B. Visit the site to investigate, use electronic locating equipment to search for the suspected main, and mark any facilities found

C. Ask the excavator to proceed carefully and call the utility if they encounter any pipe

D. Update the GIS to show the suspected main without conducting a field investigation

97. What is the primary purpose of maintaining a consistent chlorine residual throughout the distribution system — not just at the point of entry?

A. A residual throughout the system provides ongoing protection against recontamination from main breaks, crossconnections, and other intrusion events that may occur anywhere in the distribution network

B. The residual prevents pipe corrosion by creating an oxidizing environment on the pipe interior

C. Federal law requires a minimum residual of 2.0 mg/L at every customer's tap in the system

D. The residual is needed to maintain the required pH level throughout the system

98. An operator discovers a section of distribution main where the APWA locate markings from a previous excavation show the main running in a straight line, but field conditions suggest the main may actually curve to avoid a large storm drain structure. What is the safest approach before excavating?

A. Rely on the locate markings because they are legally authoritative and override field observations

B. Begin mechanical excavation following the locate markings and adjust if the main is not found

C. Skip this section entirely and report that excavation is not possible at this location

D. Pothole the main at several points using vacuum excavation or hand digging to physically confirm its actual location and alignment before any mechanical excavation occurs

99. An operator is reviewing the utility's emergency response plan and notices that the mutual aid agreement with the neighboring utility expired two years ago. Why is this a significant deficiency?

A. Expired mutual aid agreements result in regulatory fines from the state drinking water program

B. The neighboring utility's operators are no longer trained to work on this system's equipment

C. Without a current mutual aid agreement, the utility cannot rely on the neighboring system for emergency personnel, equipment, chemicals, or water supply — leaving the utility more vulnerable during a major emergency

D. The expired agreement means the utility's emergency response plan no longer qualifies for FEMA funding

100. A water treatment plant operator reports to the distribution operator that the plant's pH adjustment system malfunctioned overnight, and water with a pH of 6.2 (instead of the target 7.5) was pumped into the distribution system for approximately 4 hours. What is the primary distribution system concern?

A. The lowpH water will cause a taste complaint but has no operational significance

B. The acidic water may destabilize the protective scale on lead and copper surfaces throughout the distribution system, potentially causing a spike in lead and copper levels at customer taps

C. The low pH will cause excessive disinfection byproduct formation in the distribution system

D. The acidic water will dissolve PVC pipe joints, causing immediate leaks throughout the system

Practice Exam 3: Answer Key and Explanations

1. D — The HGL at the measurement point equals elevation plus pressure head: 580 + (72 × 2.31) = 580 + 166.3 = 746.3 feet. The tank HGL is 748 feet. Friction loss = 748 − 746.3 = 1.7 feet, approximately 2 feet. The small friction loss indicates the mains between the tank and the measurement point are in good condition with minimal resistance.

2. B — A C-factor of 45 indicates severe internal deterioration — new ductile iron has a C-factor of 140. Combined with four structural failures in two years, the pipe wall has deteriorated to the point where rehabilitation (cleaning and lining) would restore flow capacity but would not address the structural weakness causing repeated breaks. Replacement addresses both problems simultaneously.

3. C — When the protective interior epoxy coating peels away, the underlying bare steel is exposed to treated water. Corrosion attacks the exposed steel, weakening the tank wall over time and releasing dissolved iron into the stored water, which causes discoloration, taste complaints, and increased chlorine demand. Recoating during the next scheduled maintenance is essential.

4. A — Lead and copper first-draw samples require a minimum 6-hour stagnation period where no water is drawn from any tap in the building. Two hours of stagnation is insufficient because lead leaching from plumbing materials is time-dependent — shorter stagnation produces lower, non-representative lead concentrations that underestimate the customer's actual exposure.

5. D — A completely dry packing gland indicates either overtightening (the gland has been compressed so far that no water can pass) or wear (the packing has compressed and hardened to the point of sealing completely). Either condition eliminates the 40–60 drop per minute leakage that lubricates and cools the packing, causing overheating and accelerated shaft sleeve wear.

6. B — Customers near the point of entry into the distribution system receive water with the highest chlorine residual because the water has had the least time and distance for the residual to decay. A reading of 3.2 mg/L is not uncommon near the injection point. Increasing distance from the source allows demand reactions to reduce the residual to lower, more palatable levels.

7. A — The pitot gauge measures the velocity pressure (also called dynamic pressure) of the water stream exiting the hydrant nozzle. This velocity pressure reading, combined with the nozzle diameter and a discharge coefficient, is used in the formula $Q = 29.83 \times c \times d^2 \times \sqrt{P}$ to calculate the flow rate from the hydrant.

8. C — Volume in MG = 585 ÷ 1,000,000 = 0.000585 MG. Pounds = 0.000585 × 25 × 8.34 = 0.122 pounds, approximately 0.12 pounds. For small pipe volumes, the chlorine requirement is very small. This calculation demonstrates why the tablet method works well for short main sections — only a few tablets may be needed.

9. B — Dead-end mains experience high water age because water enters from only one direction and sits with minimal flow. During summer, warm soil heats the stagnant water, chlorine residual decays to near zero, and biological activity (biofilm growth) produces taste and odor compounds. Regular flushing of dead ends mitigates these problems.

10. A — Firm capacity is the pumping capacity available with the largest single pump out of service, simulating a worst-case equipment failure scenario. It ensures the system can meet demand even when one pump fails. A station with three 500 GPM pumps has a firm capacity of approximately 1,000 GPM (two pumps operating in parallel).

11. D — Standard push-on joints are not restrained — internal water pressure at a 90-degree bend creates significant thrust forces that can push the spigot out of the bell, causing joint separation and a catastrophic failure. Either concrete thrust blocks bearing against undisturbed soil or restrained joint systems must be installed at every fitting.

12. C — The consumer confidence report must include the source of the water (groundwater, surface water, purchased), all detected regulated contaminants with their levels compared to MCLs, any violations and health effects language, and information about the system's compliance status. It is a federally mandated transparency document delivered annually to all customers.

13. B — ANSI/ISEA 107 requires Class 3 high-visibility safety apparel for nighttime work. Class 3 provides a larger area of both fluorescent background material and retroreflective striping than Class 2, making the worker visible from a greater distance and at wider angles under vehicle headlight illumination.

14. A — A 15% increase in motor amperage above the nameplate rating indicates an increased mechanical load on the motor. Common causes include a binding impeller (from sand intrusion, debris, or corrosion), a failing bearing, or sand pumping that creates additional resistance. The operator should investigate the cause before motor damage occurs.

15. D — PRV chattering during low demand is a classic symptom of an oversized valve. At low flows, the valve operates in a nearly closed position where the disc is barely off the seat. Small changes in downstream pressure cause the valve to rapidly cycle between open and closed (hunting), producing vibration and noise. The solution is installing a smaller PRV for low-flow conditions.

16. C — Flushing the tap for 2 to 3 minutes clears stagnant water from the service line and fixture, drawing fresh water from the distribution main to the sampling point. This ensures the sample represents the quality of water in the distribution system, not water that has been sitting in the customer's plumbing where conditions differ.

17. B — The blended pH directly affects two critical operational parameters: chlorine disinfection effectiveness (lower pH produces more HOCl, the stronger disinfectant) and corrosion control stability (the corrosion treatment program is optimized for a specific pH range). A change in blending ratio that shifts pH can compromise both disinfection and corrosion control.

18. A — Cement grout injected into the annular space between the outside of the casing and the borehole wall creates a continuous, impermeable seal from the surface to the producing formation. This seal prevents surface water, shallow groundwater, and contaminants from migrating downward along the casing exterior into the aquifer.

19. C — The critical next step is determining whether the low pressure is a system-wide problem or isolated to this customer's service. Checking pressure at the nearest hydrant or monitoring point provides a direct comparison. If system pressure is normal, the problem is on the customer's side. If system pressure is also low, the problem is in the distribution system.

20. D — The altitude valve (or SCADA-controlled pump relay) should shut off the fill pump when the tank reaches its high-level setpoint. If the pump continues running after the high-level alarm, the altitude valve has failed to close or the pump control relay has failed to respond to the signal. The tank may overflow if the pump is not manually shut off.

21. C — Velocity is proportional to flow rate when pipe area is constant: if flow approximately doubles (1,800 to 3,500 GPM), velocity approximately doubles (3.8 to approximately 7.4 fps). Velocities above 5 fps are acceptable during short-duration fire flow events but produce significantly higher friction losses, reducing the pressure available for firefighting.

22. A — Sodium hypochlorite degrades over time through chemical decomposition, accelerated by heat and light. The degradation produces chlorate and perchlorate byproducts that darken the solution and form sediment. The available chlorine concentration decreases — a solution delivered at 12.5% may decline to 8% or less after three months. Operators must test solution strength and adjust feed rates.

23. B — At 12 ppm, hydrogen sulfide exceeds the OSHA PEL of 10 ppm. The space must be evacuated immediately. Increased ventilation should be applied to dilute and displace the H_2S, and the atmosphere must be re-tested and confirmed below the PEL before anyone re-enters. Cartridge respirators are not acceptable substitutes for removing the hazard.

24. D — A residual pressure of 18 psi during fire flow falls below the generally accepted minimum of 20 psi. This indicates the distribution system cannot support 1,200 GPM of fire flow at this location without dropping pressure to unsafe levels where backsiphonage becomes a risk. The area may need larger mains, additional supply, or looping to improve fire flow capacity.

25. C — The breakaway (safety) flange is designed to shear cleanly if the hydrant is struck by a vehicle, allowing the upper barrel to separate without damaging the lower barrel, the main valve, or the underground piping. This prevents uncontrolled water release and protects the buried infrastructure from a surface impact event.

26. B — Operating minutes = 16 hours × 60 = 960 minutes. Flow rate = 576,000 gallons ÷ 960 minutes = 600 GPM. Daily production is calculated by multiplying the flow rate by the actual run time in minutes, so working backward: total gallons divided by total operating minutes gives the instantaneous flow rate.

27. D — The action level for copper under the Lead and Copper Rule is 1.3 mg/L measured at customer taps. At 1.8 mg/L, this sample exceeds the action level. If the 90th percentile of all tap samples in the system exceeds 1.3 mg/L, the utility must optimize corrosion control treatment, conduct public education, and potentially replace copper service lines.

28. A — A Level 2 Assessment is a comprehensive, detailed evaluation that examines the entire system — source water, treatment processes, distribution system, and storage — to identify the cause of recurring coliform detections and determine specific corrective actions. It is more thorough than a Level 1 Assessment and is triggered by repeated positive samples or E. coli detection.

29. C — The flow direction arrow cast into the meter body must point in the same direction as the water flow — from the distribution main toward the customer's building. A meter installed against the flow direction will not register accurately and may be damaged. Always verify the arrow orientation before completing the installation.

30. B — For buried mains that cannot be visually inspected without excavation, utilities assess condition indirectly by analyzing available data: break history (frequency, type, and cause of failures), pipe age, material, soil corrosivity data, operational performance (C-factor tests, pressure issues), and complaint records. This data-driven approach prioritizes replacement of the worst-performing mains.

31. A — Reverse rotation from a leaking check valve can unscrew the impeller from the shaft (if the impeller is threaded on in the direction of normal rotation), damage the motor from reverse current, and cause severe water hammer when the pump restarts against the reverse-flowing column of water. Check valve repair or replacement should be scheduled promptly.

32. D — Minimum lead time inventory = 45 gallons/day × 5 days = 225 gallons. The operator should order when inventory reaches approximately 225 gallons — but ordering earlier (at 300–400 gallons) provides a safety margin for delivery delays, increased usage, or supply disruptions. Running out of disinfection chemical is a public health emergency.

33. B — The torn polyethylene encasement has exposed areas of the ductile iron pipe directly to the corrosive soil. In highly corrosive soil (low resistivity, high chloride), unprotected ductile iron develops external pitting corrosion that progressively weakens the pipe wall and can lead to leaks or failures. The exposed areas should be re-wrapped during the excavation.

34. C — An unattended, continuously flowing hydrant requires immediate investigation. It may indicate unauthorized water use, vandalism, a hydrant mechanism failure (stuck open), or deliberate tampering. The operator should dispatch a crew to close the hydrant, inspect it for damage, and report any signs of unauthorized activity.

35. A — Soil conditions along the route directly affect pipe material selection, installation method, and long-term performance. Corrosive soils require enhanced corrosion protection (polyethylene encasement, cathodic protection). Rocky soils affect bedding requirements. High groundwater affects excavation and installation procedures. This is practical knowledge that engineers need from experienced operators.

36. D — A 30% increase in real losses means the system has developed significant new leaks. A comprehensive leak detection survey is the most direct way to find these hidden leaks so they can be repaired. Meter replacement addresses apparent losses, not real losses. Conservation reduces demand but does not fix the infrastructure problem.

37. A — Backpressure occurs when the customer's system pressure exceeds the supply pressure. A booster pump inside a commercial building can create pressure higher than the distribution system, pushing potentially contaminated water backward through the service connection into the main. The other scenarios all describe negative pressure conditions causing backsiphonage.

38. C — Surge tanks and air chambers absorb the pressure waves (water hammer) created when pumps start or stop suddenly, or when valves close rapidly. The air space in the chamber compresses when pressure spikes and expands when pressure drops, dampening the pressure fluctuations and protecting pipes, fittings, and equipment from damage.

39. B — A gate valve that has a recorded 14-turn count but turns freely after only 3 turns has likely suffered an internal failure — the gate has broken from the stem or has fallen into the pipe. The stem spins freely because it is no longer connected to the gate. This valve cannot provide shutoff and must be excavated, inspected, and replaced.

40. A — GPM is approximately 694 times larger than MGD (since 1 MGD = 694.4 GPM). Using GPM instead of MGD in the pounds formula produces a result 694 times too high. If applied, this would result in a massive chlorine overdose. Always verify that flow is in MGD before using the pounds formula.

41. B — Globe valves are specifically designed for throttling and flow regulation. Their disc moves perpendicular to the flow through a tortuous path, allowing precise adjustment of flow rate. However, this design creates high friction loss even when fully open, making globe valves unsuitable for main-line isolation where minimal pressure drop is essential.

42. D — The vent screen is the barrier that prevents birds, insects, rodents, and airborne debris from entering the storage tank through the vent opening. Without an intact screen, contaminants can fall directly into the drinking water supply. This is a sanitary deficiency that must be repaired immediately to protect the stored water.

43. A — An auxiliary gate valve on the hydrant lateral allows the hydrant to be isolated from the distribution main for maintenance, repair, or replacement without shutting down the main and disrupting

service to other customers. Every fire hydrant should have an auxiliary valve — its absence means a main shutdown is required for any hydrant work.

44. C — Bacteriological samples must be maintained below 10°C (50°F) from the time of collection until delivery to the laboratory. A sample at 18°C has not been properly preserved — bacterial populations may have changed (either growing or dying) in ways that do not represent the water quality at the time of collection. The sample must be discarded and recollected.

45. D — Pipe diameter affects head loss to approximately the 4.87th power in the Hazen-Williams formula. This is by far the most sensitive variable — a small reduction in effective diameter (from tuberculation, for example) produces an enormous increase in friction loss. This is why C-factor decline and tuberculation have such dramatic impacts on system performance.

46. A — 3,400 valves ÷ 3 years = approximately 1,133 valves per year. Dividing this by available work days (approximately 250 per year) gives about 4 to 5 valves per day. A systematic plan that assigns valves to specific work periods makes the program manageable and ensures complete coverage over the cycle.

47. B — During a power failure, the elevated storage tank becomes the sole pressure source for the system. Water flows out of the tank by gravity to meet demand, maintaining pressure at a level determined by the tank's water surface elevation. This gravity-fed pressure continues until the tank is empty — a key reason why elevated storage is essential for system reliability.

48. C — A dental office handles biohazardous materials — blood, saliva, amalgam waste, and chemical solutions — that could contaminate the drinking water supply through backflow. This constitutes a high-hazard cross-connection requiring a reduced pressure zone (RPZ) assembly, not a lower-level device like a DCVA or vacuum breaker.

49. A — The leak noise correlator calculates the exact leak position based on the time difference of noise arrival at each sensor. A calculated position of 225 feet from Station A means the operator should measure 225 feet along the main from Station A and mark that point for excavation. This precision reduces unnecessary digging.

50. D — AWWA Manual M36, "Water Audits and Loss Control Programs," establishes the internationally recognized water audit methodology. The audit framework accounts for all water

entering the system and categorizes it into authorized consumption, apparent losses, and real losses, providing the utility with a clear picture of where water is going and where losses are occurring.

51. B — Steadily increasing vibration over months indicates a progressive mechanical problem — bearing wear, shaft misalignment, impeller imbalance, loose components, or cavitation damage. Left unaddressed, vibration degrades bearings, seals, and couplings until catastrophic failure occurs. Investigation and corrective maintenance should be performed before the pump fails.

52. C — A sudden, localized drop in chlorine residual with no change in treatment plant dosing suggests something has changed in the distribution system that is either increasing water age or introducing additional chlorine demand in the affected area. Common causes include a closed valve rerouting flow, a storage tank taken offline, or a main break increasing demand.

53. D — OSHA allows Type B soil to be sloped at a maximum angle of 45 degrees from horizontal (1:1 ratio). This means for every foot of trench depth, the wall must be cut back one foot horizontally. Type A allows 53 degrees (¾:1), and Type C requires the shallowest slope at 34 degrees (1½:1).

54. A — The financial return on leak detection investment comes from multiple sources: reduced water production costs (treatment chemicals, pumping energy), recovered revenue from water that was produced but never billed, reduced infrastructure damage from ongoing leaks that erode soil and undermine pavement, and deferred capital replacement of mains damaged by persistent leaks.

55. B — Ductile iron is a ferrous (iron-based) metallic pipe that conducts electromagnetic signals readily. Standard pipe and cable locators can induce a signal onto the pipe and trace it without tracer wire. Tracer wire is required only for non-metallic pipes (PVC, HDPE) that do not conduct electromagnetic signals.

56. C — When check valves inside a metering pump become worn, fouled with crystallized chemical, or weakened by chemical attack, they fail to seal properly. On the suction stroke, the discharge check leaks backward; on the discharge stroke, the suction check leaks backward. Either condition allows chemical to slip past without being delivered, reducing net output.

57. D — The highest priority during a major transmission main break with rapidly falling tank levels is to isolate the break by closing the appropriate valves. This stops the water loss, stabilizes system pressure, and preserves the remaining storage for customer demand. Excavation, media contact, and mutual aid are important but secondary to stopping the hemorrhage.

58. B — A confirmed E. coli-positive result — whether from a routine or repeat sample — is a Tier 1 violation under the SDWA, requiring public notification within 24 hours. Tier 1 applies to acute violations that may pose an immediate risk to public health. The notification must use methods that reach customers quickly — media broadcasts, direct delivery, or automated calling.

59. A — Water with pH 6.8 and low alkalinity is aggressive — it attacks metallic pipe surfaces through electrochemical corrosion. Without corrosion control treatment (pH and alkalinity adjustment, phosphate inhibitors), the water will dissolve lead from service lines and solder, copper from plumbing, and iron from mains, causing elevated metal levels in customers' drinking water.

60. C — Before pressurizing a new service line, the operator must verify that the line is complete and sealed at all points — all joints are made, the curb stop is closed (to prevent uncontrolled flow at the meter location), and the meter is installed. Opening the corporation stop with an incomplete service line would result in uncontrolled water discharge at the open end.

61. A — This facility has at least two backflow prevention concerns: the fire sprinkler system with chemical additives is a high-hazard cross-connection requiring an RPZ, and the auxiliary well — while not currently connected — represents a potential future cross-connection risk that should be documented and monitored. Each connection requires appropriate protection.

62. D — When one identical pump consistently draws higher amperage than the others while producing similar output, it is working harder mechanically. The most likely causes are worn bearings (increased friction), tight packing (shaft drag), impeller contact with wear rings, or accumulated debris on the impeller — all of which increase the load and draw more current.

63. B — To convert psi to feet of head, multiply by 2.31: 45 × 2.31 = 103.95 feet of head. Remember that the feet value is always larger than the psi value for the same pressure, which is why you multiply by the larger conversion factor (2.31) when going from psi to feet.

64. C — Mechanical coupling gaskets require a clean, smooth pipe surface to seal properly. Dirt, corrosion scale, and debris on the pipe exterior prevent the gasket from making uniform contact with the pipe, creating pathways for water to leak through. Thoroughly cleaning the pipe ends with a wire brush before coupling installation ensures a reliable, watertight seal.

65. A — Continuous flow of 0.5 GPM during hours when no one is awake or using water is a strong indicator of a leak — likely a running toilet, underground service line break, or malfunctioning irrigation

system. At 0.5 GPM, the leak wastes approximately 263,000 gallons per year. AMI data enables the utility to proactively notify the customer.

66. D — Non-entry retrieval systems (tripod and winch with body harness) are most effective in vertical-entry spaces where the entrant can be pulled straight up through the opening. The system works by lifting the incapacitated entrant vertically — if the space has obstructions, horizontal passages, or multiple levels, the retrieval line cannot navigate these obstacles.

67. B — The minimum air gap distance is at least twice the diameter of the supply pipe, with a minimum of one inch. For example, a ½-inch supply pipe requires a minimum 1-inch air gap (since 2 × 0.5 = 1.0 inch, meeting the minimum). A 2-inch supply requires a 4-inch air gap. The air gap provides complete protection against both backpressure and backsiphonage.

68. A — SOPs are most useful and most likely to be followed when they are developed with input from the operators who perform the work. Operators know the practical challenges, the equipment quirks, the field conditions, and the shortcuts that don't work. Their input ensures the SOP reflects reality rather than theory.

69. C — Oversized angular crushed rock (up to 3 inches) creates point loads against the pipe — sharp edges concentrate the weight of the pipe and overburden onto small contact areas that can crack PVC, damage protective coatings on ductile iron, and cause uneven settlement. Specifications requiring ¾-inch maximum material exist to prevent exactly this damage.

70. D — A comprehensive cross-connection control program would have identified the garden hose connection to the pesticide sprayer as a cross-connection, required the homeowner to install a backflow prevention device (at minimum a hose bibb vacuum breaker), and through public education, informed the homeowner about the danger of submerging hoses in chemical containers.

71. A — A pump operating at 62% efficiency versus 82% design efficiency wastes 20% of its input energy as heat and turbulence. The pump must draw significantly more electricity to produce the same useful output. Over months of continuous operation, the excess energy cost is substantial — often enough to justify the cost of pump rehabilitation.

72. B — AWWA M6 recommends that positive displacement meters register between 98.5% and 101.5% accuracy at medium and high flow rates. At 95% accuracy at low flow, the meter is under-

registering by 5% at low flows, allowing unbilled water to pass. The meter should be repaired or replaced to restore accuracy across all flow ranges.

73. D — Disinfection requirements for repairs vary by the scope of the repair and the utility's procedures. For a repair where surface chlorination, flushing, and residual verification are the standard procedure, a confirmed residual of 1.8 mg/L matching the normal system level indicates the repair area has been adequately flushed and is receiving normally disinfected water.

74. C — Most state regulatory agencies require water quality monitoring records to be retained for a minimum of 5 years from the date of collection. Some states require longer retention (10 years for certain parameters), and infrastructure records such as as-built drawings should be retained permanently. Always check your specific state's retention requirements.

75. A — A 25 psi pressure drop far exceeds the 5 psi maximum allowable leakage for this test section. The main has significant leaks that must be found and repaired. The contractor must locate the leaking joints or fittings (often by visual inspection or by pressurizing sections individually), make repairs, and retest until the main passes within the allowable leakage.

76. B — The depth to water equals the total tape length lowered minus the wet portion: 120 − 38 = 82 feet below the top of the casing. The chalk was washed off the bottom 38 feet of tape because that portion was submerged. The dry chalk above the waterline (from 38 feet to 120 feet on the tape) remained intact.

77. D — In a large reservoir with a single entry point, a worker who becomes incapacitated far from the hatch cannot be easily reached by rescue personnel. The distance from the hatch to the far corners of an 80 × 40-foot space (approximately 90 feet diagonally) means that non-entry retrieval systems cannot reach the worker, and entry rescue requires traversing a long distance inside the confined space.

78. C — The primary reason for maintaining minimum positive pressure is to prevent backsiphonage — the process by which negative or sub-atmospheric pressure draws contaminated water into the distribution system through cross-connections. As long as positive pressure is maintained, water flows outward through any leak or opening rather than inward.

79. A — A meter installed backward will either fail to register flow (the measuring element cannot operate in reverse), register erratically and inaccurately, or suffer mechanical damage from water

flowing against its designed direction. The meter must be removed and reinstalled with the flow arrow pointing in the correct direction.

80. B — LOTO applies to all forms of hazardous energy, including chemical energy in pressurized chemical lines. The operator must lock out the metering pump (electrical energy) and close and lock the chemical supply valve (chemical energy) to ensure no chemical can flow or be pumped while the tubing is disconnected. Chemical contact during maintenance causes burns and exposure.

81. C — Elevated nitrite levels combined with declining chloramine residual are the hallmark indicators of nitrification. Ammonia-oxidizing bacteria (Nitrosomonas) consume the ammonia released from chloramine decay, converting it to nitrite. This biological process depletes the chloramine residual and can accelerate to a system-wide problem if not addressed through flushing, breakpoint chlorination, or other interventions.

82. A — Without the elevated tank to regulate the HGL, the pump station must operate continuously with pressure-based controls (pressure switches, transducers, or VFDs) that maintain the target system pressure by adjusting pump operation in real time. This is operationally more demanding than tank-regulated operation and leaves no reserve for peak demand or fire flow.

83. D — The water still has visible discoloration (tea color), indicating that sediment remains in the flow and the flush has not yet achieved its objective. A measurable residual is encouraging — it means fresh, chlorinated water is reaching the hydrant — but flushing must continue until the discharge is completely clear and the residual is stable.

84. B — Close proximity between water and gas utilities creates two concerns: future excavation near either utility risks damaging the other, and PVC is susceptible to permeation by hydrocarbons. If the gas line develops a leak, gasoline or natural gas liquids can permeate through the PVC wall and contaminate the drinking water inside. Most codes require minimum separation distances between utilities.

85. C — Firm capacity equals the station's output with the largest pump out of service. Since all three pumps are identical (500 GPM each), removing any one leaves two pumps operating in parallel for approximately 1,000 GPM (slightly less due to increased system head). This is the capacity the system can rely on during a single-pump failure.

86. A — Under very specific, documented employer procedures, a personal lock may be removed by an authorized person other than the worker who placed it — but only after verifying the worker is not at the

facility, making reasonable efforts to contact them, and ensuring the worker is informed before their next shift. This is a rare exception, not a routine practice.

87. D — The LRAA is the arithmetic average of the four most recent quarterly results at a specific monitoring location: (0.072 + 0.068 + 0.079 + 0.095) ÷ 4 = 0.314 ÷ 4 = 0.0785 mg/L. This LRAA of 0.0785 is just below the MCL of 0.080 — dangerously close to a violation, warranting immediate operational attention.

88. B — Valve boxes buried under pavement render the valves inaccessible. During a main break emergency, operators cannot reach the operating nut to close the valve, forcing them to find the next available valve farther away — isolating a larger area and affecting more customers. Buried valve boxes must be raised to grade as soon as discovered.

89. A — The SMCL for iron (0.3 mg/L) is a non-enforceable secondary standard that addresses aesthetic quality — taste, color, and staining — not health effects. Exceeding the SMCL is not a regulatory violation, but the resulting customer complaints indicate a service quality problem that the utility should address through treatment (iron removal) or operational changes.

90. C — A clogged suction strainer restricts the flow of water to the pump intake, reducing the net positive suction head available (NPSHa). When NPSHa drops too low, the pump cannot develop full head and may begin cavitating. The result is reduced discharge pressure even though the pump motor is running at normal speed. Cleaning the strainer restores normal performance.

91. D — The flushing sequence must start at the supply source where water quality is highest and work outward systematically. This ensures clean water from the source pushes sediment ahead of it toward the extremities where it is discharged. Starting at the dead ends would push dirty water backward into cleaner areas of the system.

92. B — The pattern of excellent morning pressure and poor afternoon pressure correlates directly with the elevated tank's daily cycle. During afternoon peak demand, the tank draws down to its lowest level, reducing the HGL and the pressure available to customers — especially those at higher elevations or greater distances from the tank where friction losses further reduce pressure.

93. A — The wellhead protection program restricts chemical storage within 100 feet of the well for good reason — a fuel spill at that proximity could contaminate the aquifer. The operator should notify the

wellhead protection coordinator, who can require the construction crew to relocate the tank outside the protection zone. This is a preventive action, not an emergency response.

94. D — Chlorine demand equals dose minus residual: 2.8 − 0.3 = 2.5 mg/L. The midpoint reading of 1.4 mg/L shows that demand accumulates progressively along the flow path — approximately half the total demand occurs in each half of the distance. The total demand between the plant and the farthest point is 2.5 mg/L.

95. C — A leaking check valve on Pump 2 allows water from the operating pumps to flow backward through the idle pump, wasting energy and reducing net system output. The correct action is to close Pump 2's discharge isolation valve (stopping the backflow) and schedule check valve repair. This allows Pumps 1 and 3 to operate at full effectiveness.

96. B — The operator knows from field experience that an old main may exist at this location even though the GIS does not show it. Responding based solely on GIS records could result in the excavator striking the unmapped main. The operator must visit the site, use locating equipment to search for the suspected main, and mark any facilities found.

97. A — A chlorine residual maintained throughout the system provides a continuous barrier against recontamination. Main breaks, cross-connections, pressure transients, and repair activities can all introduce contaminants at any point in the distribution network. The residual kills or inactivates pathogens that may enter through these pathways, protecting customers between the treatment plant and their taps.

98. D — When field observations suggest that the actual pipe location differs from the locate markings, the safest approach is to physically verify the pipe's position by potholing — using vacuum excavation or hand digging to expose the pipe at several points. This confirms the actual alignment before any mechanical equipment is used that could strike the main.

99. C — Mutual aid agreements provide access to emergency resources — trained personnel, pumps, generators, pipe, chemicals, and even water supply from interconnections — that a single utility cannot maintain on its own. Without a current agreement, the utility loses this critical safety net. The agreement should be renewed immediately.

100. B — Low-pH water (6.2 instead of 7.5) is significantly more aggressive and will attack the protective scale that has built up on lead, copper, and iron surfaces throughout the distribution system.

Destabilized scale releases previously immobilized lead and copper into the water, potentially causing dangerous spikes in lead levels at customer taps — exactly the condition the corrosion control program is designed to prevent.