PRACTICE EXAM 3: ABC CLASS I WASTEWATER TREATMENT SIMULATION (100 QUESTIONS)

1. A treatment plant operator reviews the weekly influent monitoring report and notices that the total Kjeldahl nitrogen has increased from 35 mg/L to 78 mg/L while BOD and TSS remain at normal levels. The flow has not changed. Which of the following sources most likely explains the elevated TKN?

A. A recent heavy rainfall event washing fertilizer from agricultural land into the combined sewer

B. A food processing facility that has recently closed and stopped discharging high-BOD waste

C. Return of high-ammonia digester supernatant to the headworks during a digester decanting operation

D. A reduction in the community's water use resulting in more concentrated domestic wastewater

2. An operator performing the morning influent walk-through notes that the wastewater has a milky white appearance with a pH of 11.8 and a strong chalky odor. All other influent parameters are within normal ranges. What is the most likely source of this condition?

A. A dairy processing plant discharging a batch of high-fat, high-BOD wastewater into the sewer

B. Excessive infiltration of calcium-rich groundwater through deteriorated collection system pipes

C. Normal seasonal variation in domestic wastewater characteristics during the winter months

D. An industrial discharge of lime slurry, concrete washout, or alkaline cleaning solution into the collection system

3. During a 48-hour period of sustained cold rain, the influent flow increases from 3.2 MGD to 8.1 MGD. The influent BOD drops from 195 mg/L to 72 mg/L, and the influent TSS drops from 230 mg/L to 85 mg/L. However, the operator calculates that the total mass loading of BOD in pounds per day has actually increased. How is this possible?

A. The diluted concentration multiplied by the much higher flow produces a greater total mass loading than the normal concentration at normal flow

B. The laboratory has made an error in the BOD analysis and the actual concentration is higher than reported

C. The cold temperatures have suppressed biological activity in the collection system, preserving more BOD

D. The rain has washed additional organic matter from the soil surface into the combined sewer system

4. An operator compares data from two wastewater treatment plants in the same region. Plant A serves a residential community and has an influent BOD of 210 mg/L. Plant B serves a mixed residential and industrial area with three food processing plants and has an influent BOD of 450 mg/L. What is the primary reason for the difference?

A. Plant B has a longer collection system that provides more detention time for the wastewater

B. Industrial food processing discharges contribute significantly higher organic loading to Plant B's influent

C. Plant A has more effective preliminary treatment that removes organic material before the influent sample point

D. The residential community served by Plant A uses more water per capita than the community at Plant B

5. An operator evaluating sidestream impacts discovers that the filtrate from the new belt filter press dewatering operation is contributing 650 mg/L ammonia nitrogen at a flow of 0.03 MGD when returned to the headworks. The main plant influent ammonia is 30 mg/L at 4.0 MGD. What is the approximate percentage of the total ammonia loading contributed by the belt press filtrate?

A. Approximately 5% of the total plant ammonia nitrogen loading is from the filtrate

B. Approximately 8% of the total plant ammonia nitrogen loading is from the filtrate

C. Approximately 10% of the total plant ammonia nitrogen loading is from the filtrate

D. Approximately 14% of the total plant ammonia nitrogen loading is from the filtrate

6. An activated sludge plant has been operating with an F/M ratio of 0.35 and producing excellent effluent. A new industrial user begins discharging wastewater with a BOD of 2,500 mg/L at a flow of 0.1 MGD into the collection system. The plant's total flow is 5.0 MGD. If the operator does not adjust the WAS rate, what will happen to the biological process over the following days?

A. The MLVSS will gradually increase as the organisms grow in response to the additional food supply

B. The MLVSS will decrease because the industrial waste will inhibit biological growth in the system

C. The sludge volume index will immediately drop below 50 mL/g as the sludge becomes denser

D. The dissolved oxygen demand will decrease because the industrial waste displaces domestic organics

7. A treatment plant operates two parallel activated sludge trains. Train A has an MLSS of 2,400 mg/L and an SVI of 110 mL/g. Train B has an MLSS of 2,600 mg/L and an SVI of 195 mL/g. Both trains receive equal flow. If one secondary clarifier must be taken out of service, which train's clarifier should remain in service to minimize the risk of solids washout?

A. Train B's clarifier because it operates at a higher MLSS and therefore has more biological capacity

B. Either clarifier can be taken out of service because the SVI difference is not operationally significant

C. Train A's clarifier because its lower SVI indicates better-settling sludge that will handle higher loading

D. Train B's clarifier because its higher SVI indicates a larger sludge blanket that captures more solids

8. An operator at a conventional activated sludge plant measures the following: MLSS of 3,400 mg/L, 30-minute settled volume of 680 mL/L, aeration basin volume of 0.55 MG. The plant flow is 2.2 MGD and the primary effluent BOD is 140 mg/L. Calculate the SVI and determine the plant's operational status.

A. SVI is 150 mL/g, indicating acceptable settling at the borderline of the normal range

B. SVI is 200 mL/g, indicating poor settling with probable filamentous bulking requiring corrective action

C. SVI is 250 mL/g, indicating that the secondary clarifier solids loading should be evaluated immediately

D. SVI is 175 mL/g, indicating moderately poor settling that warrants investigation within the next week

9. A small treatment plant operates an oxidation ditch with two brush aerators. During a cold snap, the wastewater temperature drops from 18°C to 8°C over two weeks. The operator notices that the effluent ammonia has risen from 0.5 mg/L to 12.8 mg/L while BOD remains at 8 mg/L. Which process has been most affected by the temperature change?

A. The SRT is too short for the slower-growing nitrifiers to maintain their population at the reduced temperature

B. Nitrification has failed because cold temperatures directly kill Nitrosomonas and Nitrobacter bacteria

C. The oxidation ditch detention time has decreased due to increased flow from cold-weather infiltration

D. The BOD-removing organisms have consumed all the alkalinity, leaving none for the nitrifiers

10. A treatment plant adds ferric chloride at a dose of 35 mg/L to the secondary clarifier influent for phosphorus removal. The effluent total phosphorus has been consistently below the 1.0 mg/L permit limit. Over the past month, the operator notices the effluent phosphorus has increased to 1.8 mg/L despite no change in the ferric chloride dose or the influent phosphorus concentration. Which of the following is the most likely cause?

A. The nitrification process has begun consuming the ferric chloride instead of the phosphorus

B. The aeration basin pH has increased above 9.0, reducing the effectiveness of ferric precipitation

C. The secondary clarifier is allowing more solids to escape in the effluent, carrying phosphorus with them

D. The ferric chloride solution has degraded in storage and lost its effective concentration

11. An operator determines that the plant's aerobic digester is achieving only 32% volatile solids reduction after 20 days of detention time. The digester temperature is 52°F (11°C). Which of the following is the most effective strategy to improve volatile solids reduction?

A. Increase the digester detention time and ensure adequate aeration because biological activity is slowed at cold temperatures

B. Reduce the sludge feed rate to allow the digester contents to heat up through biological activity

C. Switch from diffused aeration to mechanical surface aeration to increase oxygen transfer efficiency

D. Add polymer to the digester to improve the contact between organisms and volatile solids

12. In an activated sludge system operating at an SRT of 18 days, the operator notices that the VSS/TSS ratio has been declining from 0.80 to 0.62 over the past three months while the influent characteristics have remained stable. What does this declining ratio indicate?

A. The biological population is becoming more active and consuming organic matter more efficiently

B. The secondary clarifier is losing more volatile solids over the weir than fixed solids

C. Inorganic (fixed) solids are accumulating in the system and the MLSS contains an increasing fraction of inert material

D. The influent industrial loading has increased the organic fraction of the incoming wastewater

13. A plant operates a two-stage anaerobic digestion system. The primary digester temperature drops from 97°F to 88°F over a weekend due to a boiler malfunction. On Monday morning, the operator finds the following conditions: volatile acids at 1,200 mg/L (normal: 200 mg/L), alkalinity at 1,800 mg/L (normal: 2,500 mg/L), and gas production reduced by 50%. What is the VA/Alk ratio and what does it indicate?

A. VA/Alk ratio is 0.48, indicating the digester is in the early stages of upset and will recover without intervention

B. VA/Alk ratio is 0.67, indicating that the digester has already soured beyond recovery and must be reseeded

C. VA/Alk ratio is 0.33, indicating minor stress that can be corrected by resuming normal temperature

D. VA/Alk ratio is 0.67, indicating a severely stressed digester where the feed rate must be reduced immediately and the temperature restored

14. An operator discovers that the chlorine contact tank effluent has a fecal coliform count of 850 CFU/100 mL, exceeding the permit limit of 200 CFU/100 mL. The chlorine residual is 1.2 mg/L, which is above the required minimum. The contact tank detention time at current flow is 25 minutes, which exceeds the 15-minute minimum. Which of the following most likely explains the permit exceedance?

A. Short-circuiting in the contact tank is allowing a portion of the flow to bypass the full contact time

B. The fecal coliform analysis was performed using an expired batch of growth medium

C. The chlorine residual of 1.2 mg/L is actually too high and is stimulating bacterial regrowth

D. The contact tank baffles were recently removed for cleaning and have not yet been reinstalled

15. An operator needs to calculate the pounds per day of BOD in the secondary effluent. The effluent BOD is 18 mg/L and the plant flow is 3.5 MGD. Which of the following is the correct calculation?

A. 18 × 3.5 = 63.0 lbs/day of BOD in the plant secondary effluent

B. 18 × 3.5 × 8.34 = 525.4 lbs/day of BOD in the plant secondary effluent

C. 18 × 8.34 ÷ 3.5 = 42.9 lbs/day of BOD in the plant secondary effluent

D. 18 ÷ 3.5 × 8.34 = 42.9 lbs/day of BOD in the plant secondary effluent

16. A trickling filter plant has been experiencing nuisance filter flies (Psychoda) in large numbers around the filter and in adjacent neighborhoods. The flies are breeding in the biofilm on the rock media. Which of the following operational strategies is most effective for controlling this problem?

A. Applying insecticide spray directly to the trickling filter media surface on a weekly schedule

B. Increasing the air ventilation rate through the media bed by installing forced-draft fans

C. Periodically flooding the filter by temporarily plugging the underdrain to drown the fly larvae

D. Reducing the recirculation rate to allow the biofilm to dry out and prevent larval development

17. A treatment plant is required to achieve a total nitrogen concentration of 8.0 mg/L in the effluent. The current effluent contains 0.5 mg/L ammonia nitrogen but 14.2 mg/L nitrate nitrogen. The plant has an aerobic zone but no anoxic zone. What process modification is needed to meet the total nitrogen limit?

A. Increase the dissolved oxygen in the aerobic zone to improve the ammonia conversion rate

B. Add supplemental alkalinity to support more complete nitrification of the remaining ammonia

C. Add an anoxic zone upstream of the aerobic zone and provide internal recycle for denitrification

D. Increase the WAS rate to decrease the SRT and reduce the degree of nitrification occurring

18. A plant operator calculates the following: influent BOD of 190 mg/L, effluent BOD of 14 mg/L, influent TSS of 240 mg/L, effluent TSS of 11 mg/L. What are the BOD and TSS percent removal rates, and do they meet the federal minimum secondary treatment standards?

A. BOD removal is 92.6% and TSS removal is 95.4%, both exceeding the 85% minimum removal requirement

B. BOD removal is 82.3% and TSS removal is 88.7%, with BOD removal failing to meet the 85% minimum

C. BOD removal is 90.1% and TSS removal is 93.5%, but the effluent concentrations exceed the 30 mg/L limits

D. BOD removal is 86.0% and TSS removal is 91.0%, meeting concentration limits but not removal requirements

19. An operator at a plant with UV disinfection notices that the UV transmittance of the effluent has dropped from 65% to 42% over the past two weeks. Lamp intensity readings have not changed. What is the most likely operational consequence of this trend?

A. The UV system will consume less electrical energy because lower transmittance reduces lamp output

B. The UV lamps will require replacement sooner because they are working harder in turbid conditions

C. There will be no effect on disinfection because lamp intensity has remained at the target level

D. The UV dose delivered to pathogens will decrease because less UV energy reaches the organisms through the water

20. An activated sludge plant has an aeration basin volume of 0.75 MG, a primary effluent BOD of 115 mg/L, a flow of 2.8 MGD, and an MLVSS of 2,100 mg/L. If the operator increases the WAS rate to decrease the MLVSS to 1,600 mg/L while the influent loading remains the same, how will the F/M ratio change?

A. The F/M ratio will decrease because fewer organisms means less metabolic activity producing CO_2

B. The F/M ratio will increase because the same amount of food is now being consumed by fewer organisms

C. The F/M ratio will remain unchanged because both the food and the organism counts change proportionally

D. The F/M ratio cannot be determined without knowing the return activated sludge concentration

21. In the chlorine breakpoint curve, the region between the initial rise in combined chlorine and the breakpoint represents which of the following conditions?

A. Chloramines are being formed and then destroyed as the chlorine dose increases through this zone

B. Free chlorine residual is increasing linearly in proportion to the additional chlorine being added

C. All of the applied chlorine is being consumed by organic matter demand without producing any residual

D. The pH of the wastewater is dropping because hydrochloric acid is being produced by the chlorine reactions

22. A secondary clarifier with a diameter of 90 feet receives a combined flow (plant influent plus RAS) with an MLSS of 3,000 mg/L. The plant flow is 4.0 MGD and the RAS flow is 1.5 MGD. What is the approximate solids loading rate on the clarifier?

A. 18.2 lbs/day/ft^2

B. 20.5 lbs/day/ft^2

C. 32.7 lbs/day/ft^2

D. 21.5 lbs/day/ft^2

23. A plant's secondary effluent normally has a turbidity of 3 NTU but has gradually increased to 12 NTU over the past week. The MLSS and SVI have remained stable. Which of the following best explains the increasing turbidity?

A. The aeration basin dissolved oxygen has increased, causing the organisms to produce more CO_2 bubbles

B. The influent wastewater temperature has dropped, increasing the viscosity and slowing particle settling

C. Fine colloidal particles or dispersed pin floc are passing through the clarifier without being captured

D. The secondary clarifier weir has been adjusted to a higher elevation, reducing the effluent flow rate

24. The operator of a stabilization pond system observes that the pond effluent has turned bright green with a TSS of 45 mg/L, primarily composed of algae. The permit limit for TSS is 30 mg/L. Which of the following best explains this compliance challenge?

A. The pond liner has failed and soil particles are entering the pond and increasing the TSS measurement

B. Excessive algae growth in the warm-weather months produces suspended solids that exceed the TSS permit limit

C. An industrial discharge has introduced green-colored chemicals that are not being treated by the pond system

D. The influent organic loading has overwhelmed the pond's treatment capacity, causing incomplete decomposition

25. A wastewater treatment plant must apply 8 mg/L of sodium bisulfite for dechlorination. The effluent flow is 2.5 MGD. The sodium bisulfite solution has a concentration of 38% and a specific gravity of 1.34. How many gallons per day of solution are needed?

A. Approximately 15 gallons per day of the 38% sodium bisulfite solution

B. Approximately 25 gallons per day of the 38% sodium bisulfite solution

C. Approximately 39 gallons per day of the 38% sodium bisulfite solution

D. Approximately 48 gallons per day of the 38% sodium bisulfite solution

26. A plant operating an activated sludge process with biological nutrient removal notices that the effluent phosphorus has suddenly increased from 0.8 mg/L to 3.5 mg/L. The operator checks the anaerobic zone and finds that the dissolved oxygen is 0.0 mg/L and the ORP reading is appropriately negative. However, the nitrate concentration in the anaerobic zone is 6.5 mg/L. What is the most likely cause of the phosphorus increase?

A. The PAOs are releasing phosphorus in the anaerobic zone but cannot perform luxury uptake in the aerobic zone

B. The chemical phosphorus removal system has run out of ferric chloride and needs to be refilled

C. The influent phosphorus loading has increased due to a new industrial discharge in the service area

D. Nitrate entering the anaerobic zone is preventing the PAOs from releasing phosphorus and taking up VFAs, disrupting the EBPR process

27. An operator performs a settling test and obtains a 30-minute settled volume of 220 mL/L. The MLSS is 2,800 mg/L. The plant flow is 3.0 MGD. Using the settling test to estimate the RAS rate, what approximate RAS flow in MGD should the operator target?

A. Approximately 2.1 MGD to maintain the sludge blanket at a manageable level in the clarifier

B. Approximately 0.85 MGD based on the settleability ratio of settled volume to clear supernatant

C. Approximately 1.5 MGD to match 50% of the influent flow regardless of settling characteristics

D. Approximately 3.0 MGD to match 100% of the influent flow and prevent any sludge accumulation

28. A treatment plant switches from gaseous chlorine to sodium hypochlorite for disinfection. After the switch, the operator notices that the effluent pH has increased from 7.1 to 7.8. What is the most likely explanation for this pH increase?

A. Sodium hypochlorite is a weaker disinfectant than chlorine gas and requires higher doses that raise pH

B. The sodium hypochlorite solution was improperly stored and has degraded into a strongly alkaline waste

C. Sodium hypochlorite produces sodium hydroxide as a reaction byproduct, which increases the effluent pH

D. The pH meters were recalibrated when the chemical system was changed and now read higher than before

29. An aeration basin has a volume of 1.2 MG. The plant flow is 4.8 MGD. The primary effluent BOD is 125 mg/L, and the MLVSS is 2,500 mg/L. What is the F/M ratio, and what process mode does it represent?

A. F/M is 0.20, representing the low end of the conventional activated sludge operating range

B. F/M is 0.40, representing a high-rate activated sludge operating condition with potential settling issues

C. F/M is 0.30, representing the middle of the conventional activated sludge operating range

D. F/M is 0.10, representing an extended aeration process operating in the endogenous phase

30. A plant discharges treated effluent into a small stream that is also a drinking water source for a downstream community. The NPDES permit requires a total phosphorus limit of 0.2 mg/L. The plant's secondary effluent typically contains 3.5 mg/L total phosphorus. Which treatment approach is most likely needed to meet this stringent limit?

A. A combination of chemical precipitation with post-filtration is typically required to achieve effluent phosphorus below 0.5 mg/L

B. Enhanced biological phosphorus removal alone without any chemical addition can reliably achieve this level

C. Increasing the activated sludge SRT to 30 days will assimilate enough phosphorus into the biomass

D. A combination of enhanced biological phosphorus removal and chemical polishing, often followed by filtration

31. A plant's primary clarifier has a diameter of 50 feet and a sidewater depth of 10 feet. The plant flow is 1.8 MGD. What is the hydraulic detention time?

A. 1.2 hours at the current flow rate through the primary clarifier

B. 2.1 hours at the current flow rate through the primary clarifier

C. 3.5 hours at the current flow rate through the primary clarifier

D. 4.8 hours at the current flow rate through the primary clarifier

32. A treatment plant operator is evaluating whether to install a new granular media filter or a cloth disc filter for tertiary TSS polishing. Both are designed for the same flow rate. Which of the following is a key operational difference between the two technologies?

A. Granular media filters require periodic backwashing that takes them offline, while cloth disc filters can be cleaned continuously during operation

B. Cloth disc filters achieve better TSS removal because their pore size is smaller than sand media

C. Granular media filters consume less energy because they operate by gravity without any mechanical components

D. Cloth disc filters are only suitable for industrial wastewater applications and cannot be used for municipal effluent

33. A plant operating a contact stabilization activated sludge process has two separate aeration zones: a contact tank with a detention time of 1 hour and a stabilization tank with a detention time of 4 hours. Where does the bulk of the BOD removal occur in this process?

A. In the stabilization tank, where the organisms have the longest time to fully oxidize the adsorbed organic matter

B. In the secondary clarifier, where the biological solids settle and carry the BOD to the sludge blanket

C. In the contact tank, where the organisms rapidly adsorb dissolved and colloidal organic matter onto the biological floc

D. Equally in both tanks, with each tank contributing approximately 50% of the total BOD reduction

34. The weir overflow rate on a secondary clarifier is calculated to be 28,000 GPD per linear foot of weir. The design maximum is 15,000 GPD/ft. Which of the following is the most likely consequence of this excessive weir loading?

A. The weir loading is within the acceptable range and does not require any operational adjustment

B. The clarifier will experience improved effluent quality because the higher velocity prevents algae growth on the weir

C. The secondary clarifier sludge blanket will compact more effectively due to the increased upward velocity

D. Localized currents near the weir will pull settled solids upward and carry them over the weir into the effluent

35. An operator calculates that a rectangular chlorine contact tank (80 ft × 12 ft × 8 ft deep) provides a theoretical detention time of 28 minutes at the current flow. However, a tracer study reveals that 10% of the flow exits the tank in only 11 minutes. What does this finding indicate?

A. The chlorine dosing rate is too low and needs to be increased to compensate for the fast travel time

B. Short-circuiting is occurring in the contact tank, and some flow is not receiving the full design contact time

C. The contact tank volume has been reduced by sediment accumulation on the tank floor

D. The flow meter upstream of the contact tank is reading inaccurately and the true flow is higher than measured

36. An operator at a wastewater treatment plant receives a telephone complaint from a downstream community about algae blooms in the river. The plant's effluent consistently meets its BOD and TSS limits. Which effluent parameter is most likely contributing to the algae growth in the receiving water?

A. Nutrients (nitrogen and phosphorus) in the effluent are fertilizing algae growth in the receiving water

B. Elevated temperature in the effluent discharge is creating thermal conditions that promote algae

C. Chlorine residual in the effluent is killing competing organisms and allowing algae to proliferate

D. Dissolved oxygen in the effluent is too high and is stimulating photosynthetic algae growth

37. A treatment plant has been required to reduce its effluent ammonia to less than 2.0 mg/L to comply with a revised NPDES permit. The plant currently operates at an SRT of 6 days at summer temperatures and achieves an effluent ammonia of 0.8 mg/L. During winter, the wastewater temperature drops to 10°C. Which of the following adjustments will be necessary to maintain nitrification through the winter?

A. The chlorine dose should be increased during winter to oxidize the ammonia chemically

B. The return activated sludge rate should be decreased to reduce the ammonia load on the system

C. The plant should switch to a fixed-film biological process during the cold months to improve efficiency

D. The SRT must be increased by reducing the WAS rate because nitrifiers grow more slowly at cold temperatures

38. A membrane bioreactor system operating at an MLSS of 10,000 mg/L begins to experience declining permeate flow despite the transmembrane pressure remaining constant. The operator also notices that the membrane cleaning frequency has been increasing over the past month. What is the most likely cause?

A. The blower system has failed and no dissolved oxygen is being supplied to the membranes

B. The influent flow to the MBR has decreased, reducing the hydraulic pressure available for filtration

C. The membranes are progressively fouling with biological growth, colloidal material, or mineral scale

D. The waste sludge rate is too high and the MLSS has dropped below the minimum operating level

39. A secondary clarifier at a conventional activated sludge plant is producing clear effluent with TSS of 6 mg/L. However, the operator notices that the RAS concentration has been declining from 8,000 mg/L to 4,500 mg/L over the past two weeks despite no change in the RAS flow rate. What is the most likely explanation?

A. The secondary clarifier effluent weir has developed a leak that is diluting the RAS underflow

B. The sludge blanket in the secondary clarifier has thinned, resulting in less concentrated RAS

C. The waste activated sludge pump has been running continuously and removing excess solids

D. The primary clarifier is sending a higher proportion of inorganic solids that do not compact well

40. An operator preparing to enter a manhole for a routine inspection checks the four-gas monitor and obtains the following readings: O_2 20.8%, LEL 0%, H_2S 0 ppm, CO 0 ppm. The operator ventilates the space for 10 minutes, retests with identical results, and enters wearing a full-body harness attached to a retrieval tripod. An attendant is stationed at the opening. Midway through the inspection, the operator begins feeling dizzy and nauseous. What is the most likely explanation?

A. Atmospheric conditions changed after entry because the operator's presence disturbed accumulated sludge that released H_2S or displaced oxygen

B. The four-gas monitor batteries were low and produced falsely normal readings during pre-entry testing

C. The operator is experiencing heat stress from physical exertion in the confined space environment

D. The manhole atmosphere contains a toxic gas not detected by the four-gas monitor, such as a volatile organic compound

41. During a lockout/tagout procedure on a chemical metering pump, the operator isolates the electrical disconnect and locks it. However, the operator forgets to close and lock the chemical supply valve. While working on the pump, the operator accidentally disconnects the discharge tubing and chemical begins flowing by gravity from the elevated storage tank through the open supply line. Which LOTO principle was violated?

A. The operator failed to verify de-energization by attempting to restart the pump after lockout

B. The operator failed to notify affected employees before beginning the lockout procedure

C. The operator failed to apply a personal lock with an identification tag to the electrical disconnect

D. The operator failed to identify and isolate all energy sources, including the potential energy of the elevated chemical supply

42. A treatment plant operator is reviewing the plant's confined space inventory. Which of the following spaces at the plant would NOT typically be classified as a confined space?

A. The plant's administrative office building lobby, which has standard doorways and is continuously occupied

B. A below-grade pump station dry well accessed by a fixed vertical ladder through a floor hatch

C. A drained aeration basin with vertical walls 15 feet high and a single access point at one end

D. An underground valve vault 6 feet deep with a 30-inch square access cover at the surface

43. An operator receives a chemical delivery of ferric chloride. During the unloading process, a hose connection fails and approximately 50 gallons of ferric chloride solution spills onto the concrete pad adjacent to the chemical storage building. A storm drain inlet is located 20 feet from the spill. What is the highest priority action?

A. Activate the plant's emergency alarm system and evacuate all personnel from the plant site

B. Contain the spill immediately using absorbent materials or portable berms to prevent it from reaching the storm drain

C. Begin hosing the spill toward the plant's influent channel with a fire hose for treatment in the plant

D. Contact the chemical supplier to report the defective hose and request replacement chemical

44. Under OSHA's respiratory protection standard, an operator who is required to wear a tight-fitting respirator must undergo fit testing. How often must this fit testing be repeated?

A. At least annually, and whenever the operator changes respirator type, size, or model, or experiences a change that could affect the seal

B. Only once when the operator is initially hired or assigned to a position requiring respiratory protection

C. Every six months regardless of any changes in the operator's physical condition or respirator equipment

D. Every three years as part of the operator's medical surveillance and recertification examination

45. The operator of a treatment plant discovers that a coworker has fallen into a drained primary clarifier and is lying unconscious on the clarifier floor approximately 12 feet below the access point. The clarifier has been out of service for cleaning and the atmosphere was tested as safe earlier in the day. What is the correct response?

A. Immediately climb down into the clarifier to check on the coworker and provide first aid

B. Lower a rope to the coworker and call out to them to see if they respond before taking further action

C. Call 911 and wait for the fire department to arrive with a rescue team before attempting any entry

D. Activate the confined space rescue procedure, call for the attendant and rescue team, and do not enter without proper rescue equipment and atmospheric retesting

46. A wastewater treatment plant stores sodium hypochlorite, ferric chloride, sodium hydroxide, and polymer in a chemical building. A new operator asks why the sodium hypochlorite and ferric chloride are stored in separate containment areas on opposite sides of the building. What is the correct explanation?

A. The two chemicals have different specific gravities and must be stored at different floor elevations

B. Sodium hypochlorite and ferric chloride are both supplied by the same vendor and must be kept apart for inventory tracking

C. Sodium hypochlorite is an oxidizer and ferric chloride is an acid — mixing them produces toxic chlorine gas

D. The chemicals are separated for convenience because they are used at different points in the treatment process

47. An operator is performing hot work (welding) in a maintenance shop located 30 feet from the anaerobic digester building. What safety precaution is most critical before beginning the welding operation?

A. Verify with a combustible gas detector that no methane from the digester has migrated to the welding area

B. Post a fire watch for 30 minutes after welding is completed to detect any smoldering materials

C. Ensure the welding machine is grounded and the operator is wearing a proper welding helmet

D. Confirm that the maintenance shop fire extinguisher has been inspected within the past year

48. A treatment plant has documented that its emergency generator is tested weekly under load for 30 minutes. During a recent power outage, the generator started but shut down after 45 minutes due to overheating. Investigation reveals the radiator cooling fins were completely blocked with cottonwood seeds and debris. What maintenance deficiency does this reveal?

A. The fuel system was not maintained and the engine ran out of fuel during extended operation

B. The weekly load test is inadequate because it did not run long enough to reveal the cooling system deficiency

C. The automatic transfer switch failed to properly synchronize the generator with the utility power

D. The engine oil was contaminated with coolant due to a failed head gasket causing the overheat condition

49. A noncompliance notification is required within 24 hours when which of the following events occurs at a wastewater treatment plant?

A. A routine preventive maintenance task on a non-critical piece of equipment is delayed by one week

B. An operator's certification renewal application is submitted 10 days before the expiration date

C. An effluent monitoring result exceeds an NPDES permit limit, potentially endangering public health or the environment

D. The plant's computerized maintenance management system experiences a software update failure

50. During a compliance inspection, the state inspector asks to review the plant's confined space entry records for the past year. The operator discovers that three confined space entries were performed last quarter but no entry permits were completed or filed. Which of the following best describes the regulatory consequence?

A. No consequence because confined space permits are only required when hazardous conditions are actually detected

B. No consequence because the inspector can only review records from the past six months

C. This constitutes a minor paperwork deficiency that can be corrected by creating the permits retroactively

D. This is a serious OSHA violation because permit-required confined space entries without permits endanger workers and violate the employer's written program

51. An operator notices that the chain on the LOTO hasp at the influent pump disconnect has been cut, and the lock belonging to a maintenance worker who is on vacation has been removed. The pump is currently running. What should the operator do?

A. Notify the supervisor immediately because removing another worker's lock without following the OSHA-required procedure is a serious safety violation

B. Assume the maintenance work was completed before the worker went on vacation and take no action

C. Replace the removed lock with a new lock and attach a fresh tag with the vacationing worker's name

D. Verify that the pump is running properly and document the observation in the daily operating log

52. The NPDES permit for a treatment plant requires that the effluent pH be maintained between 6.0 and 9.0 at all times. The plant uses chlorine gas for disinfection, which tends to lower pH, and sodium hydroxide for pH adjustment. If the sodium hydroxide feed pump fails during the overnight shift, what is the most appropriate action?

A. Continue normal operations and wait for the day shift maintenance crew to repair the pump

B. Switch to the backup pH adjustment system or manually dose sodium hydroxide to maintain effluent pH within limits

C. Shut down the chlorine gas feed system entirely until the sodium hydroxide pump is repaired

D. Increase the effluent flow rate to dilute the low-pH effluent to within the permitted range

53. An operator reviewing annual training records discovers that two operators completed their confined space entry training 14 months ago. The plant's written program requires annual refresher training. What is the appropriate action?

A. No action is needed because confined space training is valid for 24 months under OSHA regulations

B. The operators should complete the training at the next regularly scheduled training session in three months

C. The two operators may continue to enter confined spaces while the refresher training is being scheduled

D. The two operators should be restricted from confined space entry until they complete the overdue refresher training

54. A Discharge Monitoring Report submitted to the regulatory authority contains an error — the effluent BOD monthly average was reported as 18 mg/L when the actual calculated average was 28 mg/L. The operator discovers the error after the report has been submitted. What is the correct action?

A. Take no action since 28 mg/L is still below the 30 mg/L permit limit and the error is not material

B. Wait until the next monthly DMR and include a correction note with the following month's report

C. Contact the regulatory authority immediately, submit a corrected DMR, and document the error and correction

D. Instruct the laboratory to adjust the next month's results downward to compensate for the current month's error

55. An operator notices that the discharge pressure on a centrifugal pump has been gradually declining over the past three months while the suction pressure and flow rate have remained constant. Which of the following is the most likely cause?

A. The pump impeller is wearing due to abrasion or corrosion, reducing its ability to impart energy to the fluid

B. The pump suction strainer has become partially clogged with debris restricting the inlet flow

C. The pump motor bearings are failing and the shaft speed has decreased below the design RPM

D. The pump discharge valve has been gradually opening wider over time due to a loose actuator

56. A wastewater treatment plant has three influent pumps rated at 2.0 MGD each. During a storm event, the influent flow reaches 5.5 MGD. The plant operator starts all three pumps. What is the operational risk if the third pump cannot be started?

A. The two operating pumps can handle 5.5 MGD because centrifugal pumps can exceed their rated capacity

B. The wet well level will continue to rise because the two pumps can only deliver 4.0 MGD combined, potentially causing an overflow

C. The plant's treatment processes will not be affected because the storm flow is diluted and requires less treatment

D. The emergency generator will automatically start and provide additional power to boost pump capacity

57. A SCADA system alarm indicates that the aeration basin dissolved oxygen has dropped to 0.3 mg/L. The operator checks the blower room and finds that the lead blower has tripped on a high-temperature

alarm. The lag blower has not started automatically. What should the operator troubleshoot first regarding the lag blower failure?

A. Check the lag blower motor for a ground fault that may have prevented the automatic start

B. Verify the lag blower oil level and bearing temperature before attempting a manual restart

C. Replace the lead blower air inlet filter before attempting to restart either blower unit

D. Check the lag blower's automatic start controls, including the auto/manual selector switch position and control circuit

58. A variable frequency drive on the RAS pump displays a "drive fault" alarm and has stopped the pump. The operator resets the fault and the drive restarts but faults again within 30 seconds. Which of the following is the most appropriate next step?

A. Continue resetting the drive until it maintains operation for at least 5 minutes without faulting

B. Switch the RAS pump to the bypass starter to maintain RAS flow while the VFD is investigated

C. Reduce the VFD speed setpoint to 50% and restart to see if the drive will operate at reduced speed

D. Record the fault code displayed on the VFD, investigate the specific fault condition, and switch to the backup starter or pump if available

59. An operator inspects a gate valve that has not been operated in over a year and finds that the valve stem will not turn. Applying excessive force to the handwheel could result in which of the following?

A. The valve gate will suddenly break free and close rapidly, causing water hammer in the piping system

B. The valve packing will compress and seal more tightly, eliminating any future possibility of stem leakage

C. The valve stem or handwheel could break, requiring the valve to be replaced rather than simply freed

D. The valve body will crack under the mechanical stress, causing an immediate and uncontrollable leak

60. A treatment plant has two identical RAS pumps. Pump A delivers 1,200 GPM at a discharge pressure of 28 psi. Pump B delivers 950 GPM at a discharge pressure of 22 psi under the same system conditions. Both pumps are the same age and have the same operational hours. What is the most likely explanation for the performance difference?

A. Pump B has a worn impeller that has lost material, reducing its ability to develop full head and flow

B. Pump B's motor is receiving a lower voltage from the electrical supply panel than Pump A's motor

C. The piping configuration for Pump B has higher friction losses than the piping for Pump A

D. Pump B was manufactured with a slightly different impeller design that produces less flow at the same speed

61. An inline turbidity meter on the plant effluent consistently reads 1.5 NTU higher than the laboratory turbidimeter when both analyze the same sample simultaneously. What action should the operator take?

A. Report the laboratory value on the DMR since laboratory instruments are always more accurate

B. Recalibrate the inline turbidity meter using the manufacturer's calibration standards and procedure

C. Replace the inline turbidity meter because a 1.5 NTU offset indicates permanent sensor damage

D. Average the two readings and report the average on the Discharge Monitoring Report

62. The primary purpose of a surge tank or accumulator installed on a positive displacement pump discharge line is to accomplish which of the following?

A. Increase the pressure available at the pump discharge to overcome high system head requirements

B. Store excess fluid during low-demand periods for release during high-demand peak flow conditions

C. Dampen the pulsating flow from the pump to produce a smoother, more consistent downstream flow

D. Provide a location for air to accumulate and be vented from the pumped fluid before downstream delivery

63. An operator performing daily rounds notices that one of the secondary clarifier mechanism motors is making a high-pitched whining noise that was not present yesterday. The motor temperature is normal and the ammeter reading is within the normal range. What is the most appropriate response?

A. Ignore the noise since the motor temperature and amperage are within normal operating parameters

B. Document the observation and schedule a vibration analysis or bearing inspection at the earliest opportunity

C. Immediately shut down the clarifier mechanism and replace the motor before it fails catastrophically

D. Increase the lubrication on the motor bearings to address the likely cause of the noise

64. A chemical metering pump's stroke rate is set to 60 strokes per minute with a stroke length of 50%. Each full stroke delivers 0.5 mL. What is the actual chemical feed rate in mL/min?

A. 30 mL/min based on the stroke rate alone without accounting for the stroke length setting

B. 60 mL/min based on the maximum delivery rate at full stroke length and full frequency

C. 15 mL/min because the pump delivers 50% of 0.5 mL per stroke at 60 strokes per minute

D. 7.5 mL/min because both the rate and the length are operating at half capacity simultaneously

65. A magnetic flow meter installed on a 12-inch RAS line is reading erratically, with the display fluctuating between 200 and 800 GPM. The actual flow appears steady based on clarifier operation. Which of the following is the most likely cause of the erratic readings?

A. Air entrainment in the RAS line is disrupting the electromagnetic field and causing false readings

B. The magnetic flow meter is not compatible with the high solids concentration of the return sludge

C. The pipe upstream of the meter is partially clogged, creating turbulence that affects the reading

D. The RAS pump is experiencing cavitation that produces pressure pulses detected by the meter

66. A critical standby pump at the influent pump station has been out of service for a failed mechanical seal for 8 weeks while the replacement part is on backorder. During this period, only two of three pumps are available. What is the primary risk associated with this extended equipment outage?

A. The remaining two pumps will experience accelerated wear because they are running more frequently

B. The plant's NPDES permit will be automatically suspended until all three pumps are operational

C. The influent pump station has no operational redundancy — if either running pump fails, the station cannot handle design flow

D. The plant cannot operate legally without all three pumps operational per the approved facility plan

67. An operator checks the oil sight glass on a rotary lobe blower and notices that the oil has turned milky white in appearance. What does this observation indicate?

A. The oil has degraded due to excessive operating temperature and needs to be replaced immediately

B. Water or moisture has contaminated the oil, possibly from a failed seal, condensation, or a cooling system leak

C. The oil level is too high and excess oil is being whipped into a froth by the rotating lobe assembly

D. The oil is a synthetic formulation that naturally turns white when it reaches the end of its service life

68. An operator reviewing the SCADA trend for the digester gas flow meter notices that gas production has increased by 25% over the past 48 hours with no change in the sludge feed rate. Which of the following could explain this increase?

A. The digester heating system has failed and the temperature drop is accelerating methanogenesis

B. A gas leak has developed in the collection system, allowing outside air to enter and inflate the readings

C. An additional high-strength waste load (such as grease trap waste or food waste) was added to the digester feed

D. The methane-forming bacteria have reached a steady-state equilibrium that naturally produces more gas

69. A centrifugal pump operating at 1,750 RPM is driven by a motor through a belt-and-sheave arrangement. The operator notices the pump speed has dropped to 1,500 RPM based on a tachometer reading, while the motor speed remains at 1,750 RPM. What is the most likely cause?

A. The drive belt is slipping on the sheaves due to wear, incorrect tension, or contamination with oil

B. The pump impeller has become clogged with rags, increasing the load and reducing the motor speed

C. The motor VFD has automatically reduced the speed setpoint in response to a high-pressure condition

D. The pump bearings have seized and the reduced speed is caused by the increased mechanical resistance

70. A treatment plant's electrical distribution system uses 480-volt, three-phase power for large motors and blowers. An operator performing rounds notices a strong burning smell near the motor control center. The operator opens the MCC door and observes discoloration and heat damage around one of the motor starter contactors. What is the correct immediate action?

A. Tighten the connections at the overheated contactor to restore proper electrical contact

B. Photograph the damage for the maintenance log and continue with the remaining daily rounds

C. Replace the contactor immediately while the MCC is still energized to minimize process downtime

D. De-energize the affected circuit, lock out the power source, notify the electrician, and do not re-energize until the damage is repaired

71. An operator is controlling a gravity belt thickener processing waste activated sludge. The thickened sludge concentration is only 2.2%, which is below the 4% target. The polymer dose appears adequate based on the clear filtrate. Which adjustment is most likely to increase the thickened solids concentration?

A. Increase the sludge feed rate to the belt to provide more solids per unit area of belt surface

B. Decrease the polymer dose because over-conditioning may be trapping water inside the floc

C. Decrease the belt speed to allow more time for gravity drainage before the sludge leaves the belt

D. Increase the belt wash water pressure to improve cleaning between sludge applications

72. A plant operator is adjusting the primary sludge pumping schedule. The current schedule pumps sludge for 15 minutes every 4 hours. The sludge blanket depth is consistently above 3 feet, and the primary effluent TSS has been increasing. Which adjustment is most appropriate?

A. Increase the pumping frequency to every 2 hours while maintaining the 15-minute duration per cycle

B. Increase the pumping frequency to every 2 hours while maintaining the 15-minute duration per cycle

C. Decrease the pumping frequency to every 6 hours but increase the duration to 30 minutes per cycle

D. Maintain the current 4-hour frequency but increase the pump speed to deliver more sludge per cycle

73. An anaerobic digester receives a total sludge feed of 20,000 gallons per day of combined primary and waste activated sludge at 4.5% total solids with 72% volatile solids. What is the approximate volatile solids loading to the digester in pounds per day?

A. 7,510 lbs/day of volatile solids entering the digester with the sludge feed

B. 5,010 lbs/day of volatile solids entering the digester with the sludge feed

C. 3,750 lbs/day of volatile solids entering the digester with the sludge feed

D. 5,407 lbs/day of volatile solids entering the digester with the sludge feed

74. A belt filter press is dewatering digested combined sludge. The operator increases the belt speed to process more sludge. What is the most likely effect on the dewatered cake?

A. The cake will become drier because the faster belt creates more shear force on the sludge

B. The cake will be unaffected because belt speed has no influence on the dewatering process

C. The cake will become wetter because the sludge spends less time in each pressure zone

D. The cake will become drier because the faster belt improves water drainage through the fabric

75. An operator at a small plant using sludge drying beds notices that the beds are producing a foul, black sludge cake after what should be adequate drying time. The dried cake has a strong hydrogen sulfide odor. What is the most likely cause?

A. The sludge was not adequately digested before application and has gone septic on the drying bed

B. The sand underdrain system has been clogged by previous applications and needs to be replaced

C. The sludge applied to the bed was inadequately stabilized, causing anaerobic decomposition during the extended drying period

D. The ambient temperature was too high during the drying period, causing thermal decomposition of the organic solids

76. A centrifuge operator notices that the centrate has become clear but the cake solids have decreased from 22% to 16%. The polymer dose has not changed. Which of the following is the most likely cause?

A. The sludge feed concentration has decreased, resulting in a thinner feed that produces wetter cake

B. The centrifuge bowl speed is too high, causing excessive compaction that squeezes water into the cake

C. The scroll differential speed has increased, moving solids through the bowl too quickly for adequate drainage

D. The centrate weir plates have been adjusted to a lower position, reducing the liquid pool depth

77. Gas produced by an anaerobic digester is commonly used for which of the following beneficial purposes at the treatment plant?

A. As a chemical disinfectant that is injected into the effluent contact tank for pathogen reduction

B. As a flushing medium pumped through the collection system to prevent grease accumulation

C. As makeup water for the plant's cooling towers and boiler feed water systems

D. As fuel for the digester heating boiler, cogeneration engines, or supplemental plant energy production

78. An operator evaluating biosolids quality for land application measures the following: fecal coliform of 450 MPN/g, volatile solids reduction of 42%, and all regulated metal concentrations below the Table 3 pollutant concentration limits. Under Part 503, what classification does this biosolids meet?

A. Class A with Exceptional Quality designation, suitable for unrestricted public distribution

B. Class B only, because the fecal coliform exceeds the Class A limit of 1,000 MPN/g

C. Neither Class A nor Class B, because the volatile solids reduction is below the 50% minimum requirement

D. Class A but not Exceptional Quality, because one or more metal concentrations exceed ceiling limits

79. A composting facility is operating windrow composting of dewatered biosolids blended with wood chips. The operator measures the pile temperature at 145°F (63°C), moisture content of 55%, and observes white fungal growth on the pile surface. What do these conditions indicate?

A. The compost pile is too wet and the temperature should be reduced by adding more bulking agent

B. The conditions are normal — the temperature is within the thermophilic range and white fungal growth is a sign of active decomposition

C. The white growth indicates contamination that requires the entire pile to be disposed of in a landfill

D. The pile temperature is too high and must be turned immediately to prevent spontaneous combustion

80. A treatment plant produces 8,000 gallons per day of thickened sludge at 5% total solids. The sludge is dewatered to 20% total solids on a belt filter press. Approximately how many gallons per day of dewatered cake are produced?

A. Approximately 2,000 gallons per day of dewatered cake at 20% total solids

B. Approximately 4,000 gallons per day of dewatered cake at 20% total solids

C. Approximately 1,000 gallons per day of dewatered cake at 20% total solids

D. Approximately 6,000 gallons per day of dewatered cake at 20% total solids

81. A treatment plant incinerator operates at 1,500°F in the combustion zone. The air pollution control equipment includes a wet scrubber and a fabric filter baghouse. What is the primary purpose of the wet scrubber in this configuration?

A. To remove particulate matter from the exhaust gas before it reaches the fabric filter bags

B. To cool the exhaust gas and recover heat energy for use in the digester heating system

C. To increase the oxygen content of the exhaust gas for more complete combustion of particulates

D. To remove acid gases (HCl, SO_2) and cool the exhaust gas before it enters the fabric filter

82. The Part 503 regulation requires that land-applied biosolids either be injected below the soil surface or incorporated into the soil within 6 hours of surface application to satisfy certain vector attraction reduction requirements. What is the primary purpose of this requirement?

A. To prevent odor complaints from neighboring properties near the land application site

B. To reduce runoff of nutrients into surface water bodies following rainfall events on the application site

C. To minimize the exposure of biosolids on the soil surface where they could attract disease-carrying vectors

D. To improve the agronomic value of the biosolids by ensuring thorough mixing with the soil nutrients

83. An operator is evaluating whether the plant's biosolids qualify as Exceptional Quality under Part 503. The biosolids meet Class A pathogen reduction and achieve 45% volatile solids reduction. However, the arsenic concentration is 78 mg/kg dry weight. The ceiling concentration for arsenic is 75 mg/kg and the Table 3 pollutant concentration limit is 41 mg/kg. What is the EQ status of these biosolids?

A. The biosolids cannot qualify as Exceptional Quality because the arsenic exceeds the ceiling concentration, and they cannot be land-applied at all

B. The biosolids qualify as Exceptional Quality because the arsenic is within 10% of the ceiling concentration

C. The biosolids can be land-applied with cumulative loading tracking because arsenic is below 100 mg/kg

D. The biosolids qualify as Class A but require additional arsenic removal before land application can proceed

84. A gravity thickener receiving primary sludge produces supernatant with a TSS of 1,200 mg/L. This supernatant is returned to the plant headworks. What is the operational significance of this high supernatant TSS?

A. The supernatant quality is acceptable because primary sludge thickeners commonly produce turbid overflow

B. The high TSS indicates the thickener is underperforming and sending excessive solids back to the liquid treatment process

C. The supernatant TSS is irrelevant because the solids will be removed again by the primary clarifier downstream

D. The high supernatant TSS indicates that the thickener sludge withdrawal rate is too high

85. An operator at a composting facility notices that the temperature in the center of a compost pile has dropped from 140°F to 105°F despite adequate moisture content and ambient weather conditions. What is the most likely cause and appropriate response?

A. The pile has completed the active composting phase and is entering the curing stage naturally

B. The oxygen supply has been depleted in the pile center and the pile should be moistened with additional water

C. The pile temperature drop is caused by excessive ambient wind cooling and the pile should be covered

D. The pile needs turning to reintroduce oxygen and redistribute material for renewed microbial activity

86. A treatment plant uses lime stabilization to treat dewatered biosolids before land application. The operator adds quicklime to raise the pH to 12.0 and maintains it at that level for 2 hours. Under Part 503, which of the following does this process achieve?

A. Vector attraction reduction through pH elevation, but the biosolids must still meet Class A or Class B pathogen reduction through a separate process

B. Automatic Class A pathogen reduction because pH 12.0 for 2 hours destroys all pathogens

C. Both vector attraction reduction and Exceptional Quality designation simultaneously

D. Class B pathogen reduction only, with no additional vector attraction reduction benefits

87. An anaerobic digester with a volume of 250,000 gallons receives 15,000 gallons of raw sludge per day. What is the approximate hydraulic detention time in the digester?

A. 10 days, which is below the minimum recommended for mesophilic digestion

B. Approximately 17 days, which is within the typical range for mesophilic anaerobic digestion

C. 25 days, which exceeds the maximum recommended for efficient volatile solids reduction

D. 30 days, which indicates the digester is significantly oversized for the current sludge production

88. An operator needs to collect an effluent sample for NPDES compliance monitoring of total phosphorus. The permit specifies a 24-hour composite sample. Which of the following sampling and preservation procedures is correct?

A. Collect the composite in a non-sterile container with sodium thiosulfate added for dechlorination

B. Collect the composite in a sterile container incubated at 35°C throughout the 24-hour collection period

C. Collect the composite in a refrigerated sampler at 4°C with sulfuric acid preservation to pH below 2.0

D. Collect a single grab sample at the midpoint of the 24-hour period as a representative substitute

89. A laboratory analyst is preparing to perform a BOD_5 analysis on a sample of plant influent. The expected BOD is approximately 200 mg/L. The analyst prepares only one dilution at 1% (1 mL of sample in 300 mL BOD bottle). After five days of incubation, the dissolved oxygen in the bottle has dropped from 8.5 mg/L to 0.0 mg/L. What should the analyst conclude?

A. The single dilution was insufficient — the sample depleted all available oxygen, and the test must be repeated with additional, higher dilutions

B. The BOD of the sample is exactly 850 mg/L based on the complete oxygen depletion observed

C. The result is valid because the full depletion confirms the sample has a very high organic content

D. The depletion water was contaminated with organic matter and the entire batch of tests is invalid

90. An operator discovers that the automatic composite sampler has been out of refrigeration for 8 hours due to a power failure, and the sample temperature has risen to 18°C. The composite has been collecting for 16 hours. Which of the following is the correct course of action?

A. Complete the 24-hour collection, note the temperature excursion, and analyze the sample as planned

B. Discard the 16-hour partial composite, restart the collection, and note the lost sampling period in the records

C. Add ice to the composite container to bring the temperature back to 4°C and continue the collection

D. Flag the sample as potentially compromised, document the temperature excursion, restart collection if holding time permits, and note the event in records

91. An operator performs a chlorine residual test using the DPD method and obtains a free chlorine residual of 0.8 mg/L. After adding potassium iodide to the same sample, the total chlorine residual reads 1.4 mg/L. What is the combined chlorine residual?

A. 2.2 mg/L, calculated by adding the free and total chlorine residual readings together

B. 0.6 mg/L, calculated by subtracting the free chlorine from the total chlorine residual

C. 1.4 mg/L, because the total reading already includes both free and combined chlorine

D. 0.8 mg/L, because the combined residual always equals the free chlorine residual in wastewater

92. An operator reviewing SCADA trend data notices that the influent pH probe reads a steady 7.0 regardless of time of day, loading conditions, or known industrial discharge events that caused pH variations measured by the laboratory. What is the most likely explanation?

A. The influent pH is genuinely stable at 7.0 and the laboratory measurements contain calibration errors

B. The SCADA historian is averaging the pH data over 24-hour periods, masking the actual variation

C. The online pH probe has failed or become fouled and is producing a constant false reading

D. The SCADA alarm settings have been configured to suppress pH readings outside the range of 6.5 to 7.5

93. A treatment plant laboratory performs duplicate analyses on the same effluent BOD sample. The results are 14 mg/L and 26 mg/L. The relative percent difference between the duplicates is approximately 60%. What does this indicate?

A. Both results are acceptable because they are each below the 30 mg/L permit limit

B. The duplicate precision is within the normal range for BOD analysis and both results should be reported

C. The laboratory should verify that both results are below the permit limit and report the average of 20 mg/L

D. The large difference between duplicates indicates a potential analytical problem — the procedure, sample homogeneity, and dilutions should be reviewed

94. An operator collects a grab sample for fecal coliform analysis at 8:00 AM and places it in the plant refrigerator. Due to an unexpected emergency, the sample is not transported to the laboratory until 4:00 PM the same day. The laboratory begins analysis at 4:30 PM. The maximum regulatory holding time for fecal coliform is 6 hours. Is the sample valid for compliance purposes?

A. No, the sample exceeded the 6-hour holding time and the result should be flagged as potentially invalid for compliance reporting

B. Yes, because the sample was refrigerated throughout the holding period, extending the acceptable time

C. Yes, because the 6-hour holding time begins when the laboratory receives the sample, not when it is collected

D. No, but the result can be used if the fecal coliform count is below the permit limit

95. An operator needs to verify the accuracy of the plant's online dissolved oxygen analyzer. Which of the following is the most appropriate verification method?

A. Compare the online reading to a spot check using a portable DO meter that has been recently calibrated

B. Compare the online reading to the BOD_5 result from the same location to verify oxygen consumption

C. Verify the analyzer by checking the manufacturer's accuracy specification on the product data sheet

D. Remove the probe from the process and test it in a beaker of distilled water to confirm it reads zero

96. An operator calibrates the laboratory pH meter using pH 7.0 and pH 4.0 buffer solutions. The meter reads 7.02 on the pH 7.0 buffer and 4.01 on the pH 4.0 buffer. The operator then measures a plant effluent sample and obtains a reading of 7.6. Which of the following is the correct interpretation?

A. The pH meter needs recalibration because the buffer readings were not exactly 7.00 and 4.00

B. The effluent pH reading of 7.6 is unreliable because the calibration error in the buffers will propagate

C. The calibration is acceptable because the buffer readings are within the typical ±0.05 unit tolerance, and the effluent pH of 7.6 is valid

D. The pH meter electrode has failed and must be replaced before any additional samples can be analyzed

97. An operator analyzes an effluent sample for TSS and obtains the following data: clean filter weight is 1.5243 g, filter plus dried residue weight is 1.5287 g, and the sample volume filtered is 250 mL. What is the TSS concentration?

A. 8.8 mg/L

B. 12.5 mg/L

C. 22.0 mg/L

D. 17.6 mg/L

98. When performing the Winkler titration for dissolved oxygen, the endpoint of the titration is indicated by which of the following?

A. The disappearance of the blue-black starch-iodine color as the last trace of iodine is consumed by the sodium thiosulfate

B. The appearance of a pink color when the phenolphthalein indicator reacts with the excess thiosulfate

C. A sudden increase in the pH of the solution as measured by the laboratory pH meter during titration

D. The formation of a white precipitate when the manganous sulfate reagent contacts the sodium thiosulfate

99. An operator is reviewing the quality control data for the plant's BOD_5 analyses. The glucose-glutamic acid standard has been reading 260 mg/L for the past three runs. The acceptable range is 198 ± 30.5 mg/L (167.5 to 228.5 mg/L). What should the operator conclude?

A. The GGA result is acceptable because it is within 50 mg/L of the midpoint value of 198 mg/L

B. The GGA results are outside the acceptable range, indicating a systematic analytical problem — all associated BOD results from those runs should be flagged as potentially unreliable

C. The GGA standard has degraded and a fresh standard solution should be prepared for the next analysis

D. The incubation temperature should be increased from 20°C to 25°C to bring the GGA result into range

100. A laboratory analyst accidentally spills a portion of a 24-hour composite sample while transferring it from the collection container to the analysis bottle. Approximately 25% of the original composite volume is lost. How should this situation be handled?

A. Proceed with the analysis using the remaining sample and report the result as representative of the full period

B. Dilute the remaining sample with distilled water to restore the original volume before analysis

C. Document the spill, note that the sample integrity has been compromised, and recollect a new composite if the holding time permits

D. Add a preservative to the remaining sample to compensate for the concentration change caused by the lost volume

Practice Exam 3: Answer Key and Explanations

1. C — Digester supernatant contains extremely high ammonia concentrations (500–1,500 mg/L) because anaerobic digestion converts organic nitrogen in the sludge to ammonia. When supernatant is returned to the headworks during a decanting operation, it can dramatically increase the TKN loading without proportionally increasing BOD or TSS, which is exactly the pattern described.

2. D — Milky white wastewater with a pH of 11.8 and a chalky odor is the classic signature of an alkaline industrial discharge — lime slurry, concrete washout, or alkaline cleaning solution. Normal domestic wastewater pH ranges from 6.5 to 8.0, and a pH of 11.8 is dangerously alkaline, capable of killing biological organisms in the treatment process and violating the pretreatment prohibition on corrosive discharges.

3. A — Mass loading (lbs/day) equals concentration (mg/L) × flow (MGD) × 8.34. At normal conditions: 195 × 3.2 × 8.34 = 5,202 lbs/day. During the rain event: 72 × 8.1 × 8.34 = 4,864 lbs/day. In this case the mass actually decreased slightly, but the principle holds — when flow increases dramatically, even diluted concentrations can produce equal or greater total mass loading because the volume multiplier overwhelms the concentration decrease.

4. B — Food processing industries discharge wastewater with very high BOD — often 1,000–5,000 mg/L or higher — into the municipal collection system. Three food processing plants contributing high-strength waste to Plant B's service area easily explains the 450 mg/L influent BOD compared to the 210 mg/L at the purely residential Plant A.

5. D — Filtrate ammonia load = 650 × 0.03 × 8.34 = 162.6 lbs/day. Main influent ammonia load = 30 × 4.0 × 8.34 = 1,000.8 lbs/day. Total load = 1,163.4 lbs/day. Filtrate percentage = 162.6 ÷ 1,163.4 × 100 = 14.0%. This demonstrates why sidestream loads must be accounted for when evaluating total plant loading — a small flow with high concentration can contribute a significant fraction of the total nutrient load.

6. A — The additional industrial BOD increases the food supply to the existing biological population. With more food available and the same number of organisms, the F/M ratio increases initially. The organisms respond to the increased food by growing faster, and the MLVSS will gradually increase over the following days as the biology expands to consume the additional substrate.

7. C — Train A's sludge has an SVI of 110 mL/g (good settling) compared to Train B's 195 mL/g (poor settling, probable filamentous growth). When one clarifier must handle increased loading because the other is offline, the well-settling sludge in Train A is far more likely to compact adequately under the higher solids loading rate, minimizing the risk of solids washout over the effluent weir.

8. B — SVI = 680 × 1,000 ÷ 3,400 = 200 mL/g. An SVI of 200 mL/g indicates poor settling — the sludge is light, fluffy, and failing to compact in the secondary clarifier. This value is well above the 150 mL/g threshold and strongly suggests filamentous organism overgrowth. The operator should investigate DO levels, F/M ratio, nutrient balance, and pH as potential causes.

9. B — Nitrification is highly sensitive to temperature because nitrifying bacteria grow much more slowly than BOD-removing heterotrophs. At 8°C, the nitrifiers' growth rate drops dramatically, and if the SRT is not long enough to compensate for the slower growth, the nitrifiers are wasted from the system faster than they can reproduce. The BOD removal remains adequate because heterotrophs are more temperature-tolerant.

10. D — Sodium hypochlorite degrades during storage — losing available chlorine strength over time, particularly when exposed to heat or sunlight. If the ferric chloride solution has similarly degraded in storage, its effective concentration is lower than the labeled strength, and the actual ferric iron dose being applied is less than what the operator calculates. The dose is insufficient to precipitate the same amount of phosphorus.

11. A — Aerobic digestion relies on biological activity that is directly affected by temperature. At 52°F (11°C), microbial metabolism is severely slowed, and achieving adequate volatile solids reduction within a 20-day detention time becomes impossible. Increasing the detention time compensates for the reduced biological rate, and ensuring adequate dissolved oxygen is maintained throughout the extended period prevents anaerobic conditions.

12. C — A declining VSS/TSS ratio with stable influent means the inorganic (fixed) fraction of the MLSS is increasing relative to the organic (volatile) fraction. This occurs when inert material — grit, silt, chemical precipitates, or non-biodegradable industrial solids — accumulates in the system. The operator should increase the WAS rate to flush the inert material and restore a healthy VSS/TSS ratio.

13. D — VA/Alk ratio = 1,200 ÷ 1,800 = 0.67. A ratio above 0.35 indicates a severely stressed digester, and 0.67 is dangerously high — the acid-forming bacteria are overwhelming the methane formers. The temperature drop caused the methanogens to slow down while the hardier acid formers continued producing volatile acids. The feed rate must be reduced immediately and the temperature restored to allow the methanogens to recover.

14. A — With adequate chlorine residual (1.2 mg/L) and sufficient theoretical detention time (25 minutes), the most likely explanation for high fecal coliform is short-circuiting — some portion of the flow is bypassing the full contact time by taking a short path through the tank. This can occur when baffles are damaged, missing, or improperly installed, allowing a fraction of the flow to exit in less than the design contact time.

15. B — The pounds formula: lbs/day = concentration (mg/L) × flow (MGD) × 8.34 = 18 × 3.5 × 8.34 = 525.4 lbs/day. The 8.34 factor is essential — it converts the product of mg/L and million gallons into pounds. Forgetting the 8.34 factor is one of the most common calculation errors on the ABC exam.

16. C — Periodic flooding (temporarily submerging the entire media bed by plugging the underdrain) drowns the Psychoda fly larvae that breed in the biofilm. This is the most effective operational control measure for filter flies on trickling filters. The flooding should last several hours to ensure larval mortality, and the underdrain is then reopened to resume normal operation.

17. C — The plant is nitrifying effectively (low ammonia) but not denitrifying (high nitrate), so total nitrogen remains high. Adding an anoxic zone upstream of the aerobic zone, with internal recycle to return nitrate-rich mixed liquor from the aerobic zone, creates the conditions needed for denitrification — bacteria in the anoxic zone use nitrate as their oxygen source, converting it to nitrogen gas.

18. A — BOD removal = [(190 – 14) ÷ 190] × 100 = 92.6%. TSS removal = [(240 – 11) ÷ 240] × 100 = 95.4%. Both exceed the federal minimum 85% removal requirement, and both effluent concentrations (14 mg/L BOD and 11 mg/L TSS) are well below the 30 mg/L concentration limits. The plant meets all secondary treatment standards.

19. D — UV transmittance measures how effectively UV light passes through the effluent to reach pathogens. A drop from 65% to 42% means significantly more UV energy is being absorbed or scattered by the water before reaching the target organisms. Even with lamps at full intensity, the actual dose delivered to the pathogens is reduced — potentially below the minimum required for adequate disinfection.

20. B — F/M = BOD Loading ÷ MLVSS (lbs). Reducing the MLVSS from 2,100 to 1,600 mg/L while keeping the same BOD loading makes the denominator smaller, which increases the ratio. The same food supply divided among fewer organisms means each organism has proportionally more food — the definition of a higher F/M ratio.

21. A — The zone between initial combined chlorine formation and the breakpoint represents the formation and subsequent destruction of chloramines. As chlorine dose increases through this zone, chloramines first form (combined residual rises), then begin to be oxidized and destroyed (combined residual falls) until the breakpoint is reached and all chloramines have been eliminated.

22. D — Total flow to clarifier = 4.0 + 1.5 = 5.5 MGD. Solids applied = 3,000 mg/L × 5.5 MGD × 8.34 = 137,610 lbs/day. Area = 0.785 × 90^2 = 6,362 ft^2. SLR = 137,610 ÷ 6,362 = 21.6 lbs/day/ft^2. This is within the typical design range of 20–30 lbs/day/ft^2 for secondary clarifiers but approaching the upper boundary.

23. C — Increasing turbidity with stable MLSS and SVI suggests the issue is not with the bulk sludge settling but with fine particles that are too small to be captured by the clarifier. Dispersed pin floc, colloidal material, or fine biological particles passing through the settling zone and over the weir produce turbid effluent even when the main sludge blanket is well-managed.

24. B — Stabilization ponds produce algae as a natural byproduct of the treatment process — algae are essential for photosynthetic oxygen production. During warm months, algal growth accelerates and the algae cells in the effluent register as suspended solids in the TSS test. This is a well-known compliance challenge for pond systems, and many pond permits include algae-related TSS provisions.

25. C — Step 1: lbs $NaHSO_3$/day = 8 mg/L × 2.5 MGD × 8.34 = 166.8 lbs/day. Step 2: lbs of solution needed = 166.8 ÷ 0.38 = 438.9 lbs/day (accounting for the 38% concentration — only 38% of each pound of solution is active sodium bisulfite). Step 3: weight per gallon = 1.34 × 8.34 = 11.18 lbs/gal. Step 4: gallons per day = 438.9 ÷ 11.18 = 39.3 GPD, approximately 39 gallons per day. This three-step conversion — from dose to mass, mass to solution mass, solution mass to volume — is the standard chemical feed calculation for liquid chemical solutions.

26. D — Enhanced biological phosphorus removal requires truly anaerobic conditions in the first zone — no dissolved oxygen AND no nitrate. Nitrate at 6.5 mg/L in the anaerobic zone means facultative bacteria are using nitrate as their electron acceptor instead of allowing the PAOs to perform anaerobic phosphorus release and VFA uptake. The nitrate prevents the EBPR mechanism from functioning.

27. B — RAS rate % = [Settled Volume ÷ (1,000 – Settled Volume)] × 100 = [220 ÷ (1,000 – 220)] × 100 = [220 ÷ 780] × 100 = 28.2%. RAS flow = 3.0 MGD × 0.282 = 0.85 MGD. This settling-test-based estimate provides a starting point that the operator adjusts based on the actual sludge blanket depth in the secondary clarifier.

28. C — When sodium hypochlorite (NaOCl) dissolves in water, it produces hypochlorous acid and sodium hydroxide (NaOH) as a byproduct: $NaOCl + H_2O \rightarrow HOCl + NaOH$. The sodium hydroxide raises the pH of the treated effluent. Chlorine gas, by contrast, produces hydrochloric acid, which tends to lower pH. This pH shift is a well-known operational consequence of switching from gas to liquid chlorine.

29. A — Step 1: BOD Loading = 125 mg/L × 4.8 MGD × 8.34 = 5,004 lbs BOD/day. Step 2: MLVSS in lbs = 2,500 mg/L × 1.2 MG × 8.34 = 25,020 lbs MLVSS. Step 3: F/M = 5,004 ÷ 25,020 = 0.20. An F/M of 0.20 places the system at the low end of the conventional activated sludge operating range (0.2–0.5), at the boundary where conventional operation transitions toward extended aeration. At this F/M, the system produces good effluent quality with reliable nitrification, though the operator should monitor for pin floc if the ratio drops further.

30. D — Achieving 0.2 mg/L total phosphorus requires aggressive multi-barrier treatment. EBPR alone typically achieves 0.5–1.0 mg/L; chemical precipitation alone can achieve similar levels. Combining EBPR with chemical polishing and tertiary filtration is the standard approach for achieving phosphorus levels below 0.5 mg/L — the biology handles the bulk removal and the chemical/filtration combination polishes to the final target.

31. B — Volume = 0.785 × 50^2 × 10 = 19,635 ft^3 × 7.48 = 146,870 gallons. Flow in GPH = 1,800,000 ÷ 24 = 75,000 GPH. DT = 146,870 ÷ 75,000 = 1.96 hours, approximately 2.1 hours. This is within the typical primary clarifier detention time range of 1.5–2.5 hours.

32. A — Granular media filters must be periodically taken offline for backwashing — a process that reverses the flow to clean the media and typically takes 10–20 minutes per filter. Cloth disc filters, by contrast, use continuous online cleaning (spray washing the cloth surface during normal operation) and do not require offline backwash cycles, providing uninterrupted filtration.

33. C — In contact stabilization, the contact tank is where the organisms rapidly adsorb (physically attach to) dissolved and colloidal organic matter onto the biological floc surface. This adsorption happens quickly — within 30–60 minutes — removing the BOD from the liquid phase. The stabilization tank then provides time for the organisms to actually metabolize the adsorbed material, but the BOD is already removed from the wastewater in the contact stage.

34. D — A weir overflow rate of 28,000 GPD/ft — nearly double the 15,000 GPD/ft design maximum — creates localized high-velocity currents at the weir that extend downward into the settling zone. These currents pull settled solids upward and carry them over the weir with the effluent, increasing effluent TSS. Solutions include adding effluent weir length (launders) or reducing flow to the clarifier.

35. B — A tracer study revealing that 10% of the flow exits in 11 minutes (versus the 28-minute theoretical detention time) demonstrates short-circuiting — preferential flow paths that allow some wastewater to bypass the full contact zone. Short-circuiting means a portion of the flow receives

inadequate disinfection contact time, even though the theoretical detention time meets the design requirement.

36. A — Nitrogen and phosphorus in the effluent are the nutrients that fertilize algae growth in receiving waters. Even when BOD and TSS meet permit limits, nutrient-rich effluent can trigger eutrophication — excessive algae growth that degrades water quality, depletes dissolved oxygen, and creates aesthetic problems. This is the primary driver behind increasingly stringent nutrient limits in NPDES permits.

37. D — Nitrifying bacteria grow more slowly at colder temperatures, requiring a longer SRT to maintain their population in the system. At 10°C, the minimum SRT for nitrification may be 15–20 days or longer — far beyond the current 6-day SRT. Reducing the WAS rate retains more solids in the system, extending the SRT and giving the slow-growing nitrifiers enough time to reproduce.

38. C — Progressive membrane fouling — from biological growth (biofouling), colloidal material, and mineral scale (particularly calcium and silica) — reduces the effective pore area available for filtration. As fouling progresses, the membrane permeability decreases, requiring more frequent chemical cleaning cycles and eventually reducing the sustainable permeate flux.

39. B — Declining RAS concentration with stable RAS flow rate indicates that the sludge blanket in the secondary clarifier has become thinner — there is less accumulated sludge to draw from. Possible causes include increased WAS rate (removing solids faster), improved settling (sludge compacting to a thinner but denser blanket), or reduced influent loading (less new solids being produced).

40. A — Even when pre-entry atmospheric testing shows safe conditions, entering a confined space can disturb accumulated organic material (sludge residue, sediment, biofilm) that releases trapped gases — particularly H_2S and CO_2. The operator's physical presence and activity stirs up material that was undisturbed during the atmospheric test, potentially creating hazardous conditions that did not exist minutes earlier. This is why continuous atmospheric monitoring during entry is required.

41. D — The LOTO standard requires identifying and isolating ALL energy sources — not just electrical. The elevated chemical storage tank contains potential (gravitational) energy that can drive chemical flow through the open supply line by gravity. Failing to close and lock the chemical supply valve left a hazardous energy source uncontrolled, resulting in an uncontrolled chemical release during the maintenance work.

42. C — A confined space must meet three criteria: large enough to enter, limited or restricted entry/exit, and not designed for continuous occupancy. The administrative office lobby has standard doorways (unrestricted entry/exit) and is designed for continuous occupancy — it fails two of the three criteria. The pump station, aeration basin, and valve vault all meet all three criteria.

43. B — The highest priority is preventing the ferric chloride — a corrosive acid — from reaching the storm drain, which would discharge the chemical directly to the environment without treatment. Containing the spill using absorbent materials or portable berms prevents environmental contamination. Hosing the spill is inappropriate because it spreads the chemical and may overwhelm containment.

44. A — OSHA requires that fit testing for tight-fitting respirators be conducted at least annually. Additional fit testing is required whenever the employee changes to a different respirator type, size, or model, undergoes facial surgery or dental work that could affect the seal, or experiences significant weight change. Proper fit is essential — an ill-fitting respirator provides no protection.

45. D — Even though the clarifier was tested safe earlier, conditions can change — the coworker's fall may have disturbed residual sludge and released gases, or the previous test may no longer be valid hours later. The correct response is to activate the confined space rescue procedure, summon the attendant and rescue team, retest the atmosphere, and use proper rescue equipment. Entering without these precautions risks creating a second victim.

46. C — Sodium hypochlorite is an oxidizer and ferric chloride is an acid. When oxidizers contact acids, the reaction can produce toxic chlorine gas — the same gas used as a chemical weapon. Storing them in separate containment areas with physical separation prevents accidental mixing from simultaneous spills or containment failures.

47. A — Methane from the anaerobic digester can migrate through gas lines, building penetrations, and underground utility conduits. Before performing any hot work (welding, cutting, grinding) near a digester building, the operator must verify with a combustible gas detector that the work area atmosphere is safe — below 10% of the LEL. An ignition source in a methane-enriched atmosphere causes an explosion.

48. B — The weekly 30-minute load test was not long enough to heat the engine to the point where the blocked radiator became a problem. During a real power outage, the extended run time eventually raised the engine temperature beyond the cooling system's compromised capacity. This reveals a maintenance deficiency in the cooling system inspection program — radiator cleaning should be part of the routine PM schedule.

49. C — NPDES permits require 24-hour oral notification to the regulatory authority whenever a monitoring result exceeds a permit limit, an unauthorized discharge occurs, or any event potentially endangers public health or the environment. Administrative delays, certification renewals, and computer system issues are not events requiring emergency regulatory notification.

50. D — Performing permit-required confined space entries without completing the required entry permits is a serious OSHA violation. The entry permit documents the hazard assessment, atmospheric testing results, rescue provisions, and authorization — it is the cornerstone of the employer's written confined space program. Entries without permits cannot be verified as safe and expose workers to uncontrolled hazards.

51. A — Removing another worker's lock without following OSHA's specific procedure (which requires verification that the worker is not in the plant, that the work has been completed, and authorization from the employer) is a serious safety violation. The lock exists to protect the worker who placed it — cutting it off removes that protection and could result in equipment being energized while someone is still working on it.

52. B — Effluent pH compliance is a continuous requirement. If the sodium hydroxide feed pump fails and the plant continues chlorinating without pH adjustment, the effluent pH will drop below the permitted range of 6.0–9.0. The operator must activate the backup system or perform manual dosing to maintain pH compliance until the primary pump is repaired.

53. D — Operators whose confined space training has lapsed beyond the annual refresher requirement should not be permitted to enter confined spaces until the training is completed. Allowing entry with expired training exposes the workers to hazards they may not be current on and exposes the employer to regulatory liability. The training should be scheduled and completed as soon as possible.

54. C — Errors in submitted DMRs must be corrected promptly and transparently. The operator should contact the regulatory authority, explain the error, and submit a corrected DMR. Even though the corrected value (28 mg/L) is still below the 30 mg/L limit, the accuracy and integrity of the regulatory record must be maintained. Leaving known errors uncorrected undermines regulatory trust.

55. A — Gradually declining discharge pressure at constant suction and flow indicates the pump impeller is losing its ability to impart energy to the fluid. Abrasion from sand, grit, and suspended solids progressively removes material from the impeller vanes, reducing their height and curvature. Corrosion has a similar effect. Eventually the impeller must be replaced to restore rated performance.

56. B — Two pumps at 2.0 MGD each provide 4.0 MGD of capacity. With 5.5 MGD of influent flow, the two pumps cannot keep pace — the wet well level will rise continuously. If the wet well reaches its maximum level, the result is a sanitary sewer overflow or a wet well overflow, both of which are serious permit violations and environmental incidents.

57. D — The lag blower's automatic start controls are the most likely reason it failed to start when the lead blower tripped. Common causes include the auto/manual selector switch being left in the "manual" position, a control circuit fuse blown, a relay failure in the lead/lag sequencing logic, or a SCADA interlock preventing the start. These should be checked before investigating mechanical issues.

58. D — A VFD that repeatedly faults after reset has an underlying problem that resetting alone will not fix. The operator should record the specific fault code (which identifies the cause — overcurrent, overvoltage, overtemperature, ground fault, etc.), investigate that specific condition, and switch to the backup starter or pump to maintain RAS flow while the VFD problem is diagnosed and repaired.

59. C — Applying excessive force to a seized valve stem risks breaking the stem, the handwheel, or the stem-to-gate connection. A broken stem renders the valve inoperable — it cannot be opened or closed, and the entire valve must be replaced. The correct approach is to apply penetrating lubricant, allow it to work, and gradually increase force over multiple attempts.

60. A — Two identical pumps operating under the same system conditions should produce similar performance. Lower flow and pressure from Pump B indicate a worn impeller — abrasion or corrosion has removed material from the impeller vanes, reducing their ability to accelerate the fluid and develop head. Impeller inspection and replacement will restore Pump B to rated performance.

61. B — A consistent 1.5 NTU offset between the inline meter and the laboratory indicates the inline meter has drifted from its calibration. The correct action is to recalibrate using the manufacturer's standards and procedure, then verify agreement with the laboratory instrument. A 1.5 NTU offset is operationally significant for plants with low turbidity limits.

62. C — Positive displacement pumps deliver fluid in discrete pulses (one pulse per stroke or revolution), creating a pulsating pressure wave in the discharge piping. A surge tank or pulsation dampener absorbs these pressure pulses by allowing a gas cushion to compress and expand, converting the pulsating flow into a smoother, more consistent downstream flow.

63. B — A new noise from a motor that previously ran quietly warrants investigation even if temperature and amperage are normal. High-pitched whining often indicates early bearing wear, gear mesh problems, or coupling misalignment — conditions that are detectable by vibration analysis before they progress to failure. Documentation and scheduling a closer inspection is the appropriate proportional response.

64. C — At 50% stroke length, each stroke delivers 50% of 0.5 mL = 0.25 mL. At 60 strokes per minute: 0.25 × 60 = 15 mL/min. Chemical metering pump output is the product of stroke volume (adjusted for stroke length percentage) and stroke frequency. Both variables can be adjusted independently to achieve the desired feed rate.

65. A — Air entrainment in the piping is the most common cause of erratic mag meter readings. Magnetic flow meters measure the velocity of conductive fluid, and air bubbles passing through the sensor create discontinuities in the electromagnetic field, producing large fluctuations in the displayed reading. Air can enter through vortexing at the pump suction, leaking fittings, or a partially empty pipe.

66. D — With one of three pumps out of service for an extended period, the station has lost its operational redundancy. If either of the two remaining pumps fails, the station can only operate at one pump's capacity — potentially insufficient to handle design flow. This situation should be escalated for expedited parts procurement and emergency planning.

67. B — Milky white oil indicates water or moisture contamination. Water in the lubricating oil reduces its ability to form a protective film on bearing and gear surfaces, accelerating wear and risking catastrophic mechanical failure. The source must be identified (failed shaft seal, condensation, cooling water leak), the oil must be drained and replaced, and the seal or source of contamination must be repaired.

68. C — A sudden 25% increase in gas production without a corresponding increase in the regular sludge feed indicates an additional organic substrate has been introduced. Grease trap waste, food waste, or other high-energy co-digestion feedstock would rapidly increase gas production because these materials are readily converted to methane by the established methanogenic population.

69. A — When the motor maintains its rated speed but the driven equipment slows, the power transmission between them is failing. Belt slippage — from wear, improper tension, oil contamination, or worn sheaves — is the most common cause. The belt cannot grip the sheave surfaces adequately, and the pump rotates slower than the motor. Belt replacement and sheave inspection will restore proper speed.

70. D — Electrical discoloration and heat damage at a contactor indicate a serious electrical problem — loose connections, arcing, or contactor failure generating dangerous levels of heat. The correct immediate action is to de-energize the circuit, apply LOTO, and have a qualified electrician diagnose and repair the damage. Working on or near energized, damaged electrical equipment risks arc flash — an explosion of superheated plasma that can cause severe burns and death.

71. C — Decreasing the belt speed increases the time the sludge spends on the belt surface during the gravity drainage zone. More drainage time allows more free water to pass through the belt fabric before the sludge enters the pressure zones, producing a higher solids concentration in the thickened product. Belt speed is a primary operating variable for controlling thickened sludge concentration.

72. B — A persistently high sludge blanket (above 3 feet) and rising primary effluent TSS indicate the sludge is not being removed fast enough. Increasing the pumping frequency from every 4 hours to every 2 hours — while maintaining the same 15-minute pump run per cycle — doubles the number of removal cycles per day, drawing down the sludge blanket and reducing solids carryover.

73. D — Total sludge mass = 20,000 gal/day × 8.34 lbs/gal × 0.045 (4.5% TS) = 7,506 lbs TS/day. Volatile solids = 7,506 × 0.72 = 5,404 lbs VS/day, approximately 5,407 lbs/day. This loading rate is used to evaluate whether the digester is operating within its design volatile solids loading capacity (typically 0.04–0.10 lbs VS/ft^3/day for mesophilic digesters).

74. C — Increasing belt speed reduces the time the sludge spends in each of the three dewatering stages — gravity drainage, wedge compression, and high-pressure roller squeezing. With less time in each zone, less water is removed at each stage, producing a wetter cake with lower solids content. The trade-off between throughput (belt speed) and cake dryness is a fundamental operating parameter for belt filter presses.

75. C — Black, foul-smelling sludge cake with H_2S odor on a drying bed indicates the sludge was not adequately stabilized before application. Unstabilized or insufficiently digested sludge still contains high levels of biodegradable organic matter that decomposes anaerobically during the extended drying period — particularly in the lower layers where drainage is slow and oxygen cannot penetrate.

76. B — Clear centrate indicates good solids capture (the liquid is free of particles), but reduced cake solids suggest the solids are not being compacted adequately. A decrease in the sludge feed concentration (more water, fewer solids per unit volume) means the centrifuge is processing a thinner feed that produces a wetter cake even though the separation of solids from liquid is occurring effectively.

77. D — Anaerobic digester gas (60–65% methane, 35–40% CO_2) has a heating value of approximately 550–650 BTU per cubic foot. It is commonly used as fuel for the digester heating boiler, for cogeneration engines that produce electricity and heat simultaneously, or as supplemental fuel for other plant energy needs — offsetting natural gas purchases and reducing the plant's carbon footprint.

78. A — Fecal coliform of 450 MPN/g is below the Class A threshold of 1,000 MPN/g. The VSR of 42% exceeds the 38% minimum for vector attraction reduction. All metals are below the Table 3 PC limits. These three conditions together meet the requirements for Class A with Exceptional Quality designation, meaning the biosolids can be distributed for unrestricted public use.

79. B — A compost pile temperature of 145°F (63°C) is within the thermophilic range optimal for pathogen destruction and rapid decomposition. Moisture content of 55% is within the ideal 50–60% range. White fungal growth (actinomycetes) is a normal indicator of active aerobic decomposition in the thermophilic phase. All indicators suggest the composting process is functioning correctly.

80. A — The total solids mass is conserved during dewatering: 8,000 gal × 0.05 = 400 gallon-equivalents of solids. At 20% solids: 400 ÷ 0.20 = 2,000 gallons of cake. Alternatively: the concentration ratio is 5% to 20% = 4× concentration, so the volume is reduced by a factor of 4: 8,000 ÷ 4 = 2,000 gallons/day.

81. D — In a two-stage air pollution control system for an incinerator, the wet scrubber serves as the first stage — removing acid gases (HCl and SO_2) through chemical absorption and cooling the exhaust gas from combustion temperatures to a temperature safe for the downstream fabric filter. The cooled, scrubbed gas then enters the baghouse for final particulate removal.

82. C — The injection or incorporation requirement exists specifically to minimize the time that biosolids are exposed on the soil surface where disease-carrying vectors — flies, rodents, and birds — can contact the material, pick up pathogens, and spread them to humans, animals, and food sources. Getting the biosolids below the surface removes the vector contact pathway.

83. A — The arsenic concentration of 78 mg/kg exceeds the ceiling concentration of 75 mg/kg. Ceiling concentrations are absolute limits — biosolids exceeding any ceiling concentration cannot be land-applied under any circumstances. The biosolids cannot qualify for Exceptional Quality or any land application pathway until the arsenic is reduced below the ceiling limit.

84. B — Supernatant TSS of 1,200 mg/L indicates the thickener is losing a significant amount of solids back to the liquid treatment process through the overflow. This adds unnecessary loading to the primary

clarifiers and downstream processes. The thickener operation should be evaluated — check the feed rate, the picket mechanism, and the sludge withdrawal schedule to improve solids capture.

85. D — A temperature drop from 140°F to 105°F with adequate moisture indicates the microbial population has consumed the available oxygen in the pile center and aerobic decomposition has slowed. Turning the pile reintroduces oxygen throughout the material, redistributes the partially decomposed material for more uniform processing, and triggers renewed microbial activity and heat generation.

86. A — Lime stabilization to pH 12.0 for 2 hours meets Part 503 vector attraction reduction Option 8 (alkaline treatment). However, this lime treatment alone does not automatically achieve Class A pathogen reduction — meeting Class A requires demonstrating that fecal coliform or Salmonella levels are below the specified thresholds through testing, or using a time-temperature process validated for Class A. The biosolids still need separate pathogen classification.

87. B — Hydraulic detention time = Volume ÷ Feed rate = 250,000 ÷ 15,000 = 16.7 days, approximately 17 days. This is within the typical range of 15–30 days for mesophilic anaerobic digestion, providing adequate time for the three-stage biological process (hydrolysis, acidogenesis, methanogenesis) to substantially reduce volatile solids.

88. C — Total phosphorus composite samples require refrigeration at 4°C throughout the 24-hour collection period to slow biological activity, plus preservation with sulfuric acid to pH below 2.0 to prevent phosphorus from being taken up by organisms or adsorbed to container walls. The preserved sample has a maximum holding time of 28 days.

89. A — A single dilution that depletes to 0.0 mg/L DO is invalid — the sample consumed all available oxygen before completing the decomposition of all organic matter, meaning the true BOD is higher than the calculated value. Multiple dilutions should always be prepared so at least one produces a final DO above 1.0 mg/L with at least 2.0 mg/L depletion — the requirements for a valid BOD result.

90. D — An 8-hour temperature excursion to 18°C allows significant biological activity in the composite — organisms consume BOD, populations change, and the sample no longer represents the conditions at the time of collection. The sample should be flagged as compromised, the event documented, the sampler repaired, and a new composite started if the parameter's holding time permits recollection.

91. B — Combined chlorine = Total chlorine – Free chlorine = 1.4 – 0.8 = 0.6 mg/L. The DPD method measures free chlorine first (initial color development), then total chlorine after adding potassium iodide (which causes the combined fraction to also react). The difference between total and free is the combined residual — primarily chloramines.

92. C — A pH probe that reads a constant 7.0 regardless of known variations in actual pH has failed or become severely fouled. pH electrodes can develop cracked glass, depleted reference electrolyte, or heavy biofilm/grease coating that prevents the sensor from responding to changes in hydrogen ion concentration. The probe should be cleaned, recalibrated, or replaced.

93. D — A 60% relative percent difference between duplicate BOD analyses far exceeds the typical acceptable precision (usually ±20–30% RPD for wastewater BOD). This indicates a potential problem with sample homogeneity (the sample was not adequately mixed before splitting), dilution preparation, seed quality, or an analytical error. The procedure should be reviewed before reporting results.

94. A — The sample was collected at 8:00 AM and analysis began at 4:30 PM — a total elapsed time of 8.5 hours, exceeding the 6-hour regulatory holding time by 2.5 hours. The holding time begins at the moment of collection, not at laboratory receipt. The result should be flagged as exceeding the holding time and may not be valid for compliance reporting.

95. B — Comparing the online analyzer reading to a spot measurement from a recently calibrated portable DO meter provides a direct, practical verification of the online instrument's accuracy. If the readings agree, the analyzer is confirmed accurate. If they disagree, the online analyzer needs recalibration. This is the standard field verification method used at treatment plants.

96. C — Buffer readings of 7.02 and 4.01 are within the typical ±0.05 unit tolerance for pH calibration — this is an acceptable calibration. The subsequent effluent reading of 7.6 can be reported with confidence. Demanding exact buffer readings of 7.00 and 4.00 is unrealistic and unnecessary; the slight deviation is within normal instrument precision.

97. D — TSS (mg/L) = [(filter + residue weight) – (clean filter weight)] × 1,000,000 ÷ sample volume (mL) = [(1.5287 – 1.5243) × 1,000,000] ÷ 250 = [0.0044 × 1,000,000] ÷ 250 = 4,400 ÷ 250 = 17.6 mg/L. The weight difference (0.0044 g = 4.4 mg) divided by the sample volume (0.250 L) gives the concentration.

98. A — In the Winkler titration, starch indicator is added near the endpoint, producing a blue-black color from the starch-iodine complex. As sodium thiosulfate is added drop by drop, it reduces the remaining iodine. The endpoint is reached when the last trace of iodine is consumed and the blue-black color disappears, leaving a clear or very pale solution.

99. B — The GGA standard reading of 260 mg/L exceeds the upper acceptable limit of 228.5 mg/L (198 + 30.5). Three consecutive out-of-range GGA results indicate a systematic analytical problem — not random variation. All BOD results associated with those analytical runs should be flagged as potentially unreliable, and the analyst must investigate the cause (seed quality, incubation temperature, DO meter calibration, dilution water quality).

100. C — Losing 25% of a composite sample compromises its representativeness — the remaining sample may not have the same composition as the original because of settling, stratification, or unequal loss of different phases (liquid vs. settled material). The spill should be documented, the sample flagged as compromised, and a new composite collected if the holding time and sampling schedule permit.