

# PRACTICE EXAM 5: ABC CLASS I

## WASTEWATER TREATMENT SIMULATION

### (100 QUESTIONS)

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1. A treatment plant operator reviews the previous week's influent data and notices that every evening between 6:00 PM and 10:00 PM, the influent BOD spikes to 380 mg/L while the daytime average is 175 mg/L. The flow pattern during these evening hours is normal. The spike does not occur on weekends. Which of the following is the most likely source?

- A. Residential cooking and dishwashing activities during the evening meal period
- B. Infiltration from landscape irrigation systems operating on timer-controlled evening schedules
- C. A sewage lift station upstream that stores wastewater during the day and pumps it out each evening
- D. An industrial facility operating an evening shift that discharges high-strength process wastewater after daytime production

2. An operator collects an influent sample during dry weather and measures the following: BOD 225 mg/L, TSS 260 mg/L, pH 7.0, temperature 64°F, and ammonia nitrogen 30 mg/L. All values are within historical norms. The next morning, the operator finds the influent has changed to: BOD 195 mg/L, TSS 420 mg/L, pH 6.8, and ammonia 28 mg/L. The flow has not changed. Which parameter change is most significant and what does it suggest?

- A. The BOD decrease suggests improved pretreatment by an upstream industrial user
- B. The ammonia decrease indicates biological nitrification is occurring in the collection system
- C. The TSS increase to 420 mg/L suggests an unusual solids discharge — possibly construction sediment, grease trap cleanout, or industrial solids
- D. The pH decrease from 7.0 to 6.8 indicates a developing acid condition from an industrial source

3. During a prolonged drought, an operator notices that the influent flow has decreased by 30% while the BOD concentration has increased by 40% compared to the annual average. The total BOD mass loading in pounds per day has remained approximately the same. What is the operational significance of this change for the biological treatment process?

A. The higher BOD concentration at lower flow increases the organic loading per unit volume in the aeration basin, requiring the operator to verify that dissolved oxygen supply is adequate

B. The lower flow automatically compensates for the higher concentration, so no process adjustments are needed

C. The biological process will shut down because the organisms cannot survive at BOD concentrations above 300 mg/L

D. The operator should reduce the MLSS in the aeration basin to match the reduced flow volume

4. An operator receives a telephone call from the city public works department reporting that a tanker truck illegally dumped an unknown liquid into a manhole approximately 2 miles upstream of the treatment plant. The estimated travel time in the sewer is 4 hours. What should the operator do first?

A. Wait for the unknown substance to arrive at the plant and then collect a sample for identification

B. Begin monitoring the influent immediately for pH, color, odor, and other changes, and prepare to protect the biological process if necessary

C. Shut down the influent pumps to prevent the unknown substance from entering the treatment plant

D. Contact the EPA regional office to report the illegal dumping before taking any plant-specific action

5. An operator reviews sidestream data and determines that the centrate from the new dewatering centrifuge contains 1,100 mg/L of ammonia nitrogen at a flow rate of 0.02 MGD. The plant's aerobic zone is designed for a maximum ammonia loading of 1,200 lbs/day. The current main influent ammonia loading is 1,050 lbs/day. Will the centrate return cause the total ammonia loading to exceed the design capacity?

- A. No — the centrate contributes only 18.3 lbs/day, keeping the total well within the 1,200 lbs/day capacity
- B. No — the centrate ammonia is in a non-bioavailable form and does not contribute to the biological nitrogen loading
- C. Yes — the centrate adds approximately 183.5 lbs/day, bringing the total to approximately 1,233.5 lbs/day, which exceeds the design capacity
- D. Yes — the centrate adds approximately 1,100 lbs/day, doubling the total ammonia loading on the plant

6. An operator at a plant with two parallel activated sludge trains notices that Train A consistently produces better effluent (BOD 8 mg/L, TSS 6 mg/L) than Train B (BOD 22 mg/L, TSS 18 mg/L) despite identical equipment and receiving equal flow. Investigation reveals that Train A has an MLSS of 2,600 mg/L with an SVI of 105 mL/g, while Train B has an MLSS of 2,400 mg/L with an SVI of 185 mL/g. Both trains receive the same primary effluent. The DO in both trains is 2.2 mg/L. Which of the following is the most likely explanation for the performance difference?

- A. Train B receives slightly more flow than Train A due to an uneven flow splitting structure
- B. Train A's aeration system is more efficient, delivering more oxygen per unit of energy consumed
- C. The pH in Train B has dropped below 6.0 due to a chemical feed system malfunction on that train
- D. Train B is experiencing filamentous growth (SVI 185 mL/g) that causes poor settling and solids carryover in the clarifier

7. A treatment plant operates a conventional activated sludge process at an F/M ratio of 0.25 and an SRT of 8 days. The plant consistently meets all permit limits. The plant manager proposes switching to extended aeration (F/M of 0.08, SRT of 25 days) to improve effluent quality further. Which of the following is the primary operational trade-off the operator should consider?

- A. Extended aeration produces more excess sludge than conventional activated sludge, increasing disposal costs
- B. Extended aeration requires significantly larger aeration basins and more energy for aeration over the longer detention time

- C. Extended aeration cannot achieve nitrification because the low F/M starves the nitrifying bacteria
- D. Extended aeration produces poorer effluent quality because the organisms consume their own cell mass

8. A circular secondary clarifier has a diameter of 70 feet and a peripheral weir around the entire circumference. The plant flow is 2.8 MGD and the RAS flow is 1.0 MGD. What is the approximate weir overflow rate, and is it within the typical design range?

- A. WOR is approximately 12,740 GPD/ft, which is within the typical range of 10,000 to 20,000 GPD/ft for secondary clarifiers
- B. WOR is approximately 17,280 GPD/ft, which exceeds the typical design range and should be investigated
- C. WOR is approximately 6,370 GPD/ft, which is well below the design minimum and indicates underloading
- D. WOR is approximately 25,500 GPD/ft, which is significantly above the design range and causing solids carryover

9. An operator at an activated sludge plant calculates the following: the aeration basin contains 15,000 lbs of MLSS. The WAS removes 2,500 lbs/day of solids. The effluent carries 200 lbs/day of solids. What is the solids retention time, and what does this value suggest about the plant's ability to nitrify at a wastewater temperature of 12°C?

- A. SRT is 4.2 days, which is adequate for nitrification at any temperature above 5°C
- B. SRT is 6.0 days, which provides a comfortable margin for nitrification at 12°C
- C. SRT is 8.3 days, which is marginal for nitrification at 12°C and may require reducing WAS to extend the SRT
- D. SRT is 5.6 days, which is likely insufficient for nitrification at 12°C because nitrifiers require a longer SRT at cold temperatures

10. A step-feed activated sludge system distributes the influent at multiple points along the length of a plug-flow aeration basin rather than introducing all the flow at the inlet end. What is the primary operational advantage of this configuration during wet-weather events?

- A. Step feeding reduces the energy consumption of the blowers by distributing the air demand more evenly
- B. Step feeding improves nitrification by increasing the contact time between nitrifiers and ammonia
- C. Step feeding distributes the organic load more evenly along the basin and increases the effective volume available for wet-weather flow management
- D. Step feeding eliminates the need for return activated sludge by maintaining organisms throughout the basin

11. A treatment plant that uses gaseous chlorine for disinfection has been directed to switch to sodium hypochlorite to eliminate the risk of a catastrophic chlorine gas release. After the switch, the operator notices that the sodium hypochlorite storage tank has been losing approximately 1.5% of its available chlorine concentration per week in warm weather. What is the operational implication of this degradation?

- A. The operator must test the concentration of each new chemical delivery and reject any shipment below 10%
- B. The operator must account for the decreasing concentration when calculating the daily chemical feed rate, or the actual dose delivered will be lower than intended
- C. The degradation has no operational significance because the feed pump automatically compensates for changes in concentration
- D. The operator should add a stabilizing agent to the storage tank to prevent further concentration loss

12. A plant using UV disinfection followed by no dechlorination has consistently met fecal coliform limits with UV intensities above the minimum setpoint. The state issues a new permit requiring the plant to add chlorination as a backup disinfection system. Why might the state require a redundant disinfection system?

- A. UV disinfection provides no persistent residual and cannot prevent pathogen regrowth if the effluent is recontaminated after leaving the UV system
- B. UV disinfection is ineffective against all viruses and a chemical backup is needed for viral inactivation
- C. UV disinfection consumes excessive energy and chlorine is needed to reduce the electrical demand
- D. UV disinfection produces disinfection byproducts that chlorination can neutralize before discharge

13. An operator at a treatment plant with biological nutrient removal calculates the total nitrogen in the plant effluent as follows: ammonia nitrogen 0.8 mg/L + nitrate nitrogen 6.2 mg/L + organic nitrogen 1.5 mg/L = 8.5 mg/L total nitrogen. The permit limit is 8.0 mg/L. The plant has good nitrification (low ammonia) but the nitrate is keeping the total nitrogen above the limit. Which of the following is the most appropriate process adjustment?

- A. Increase the internal recycle rate from the aerobic zone to the anoxic zone to provide more nitrate for denitrification
- B. Reduce the SRT to decrease nitrification and thereby reduce the nitrate produced in the aerobic zone
- C. Add more dissolved oxygen to the aerobic zone to convert the remaining organic nitrogen to ammonia
- D. Increase the WAS rate to remove more nitrogen from the system through biological solids wasting

14. A treatment plant effluent sample is analyzed and shows a BOD<sub>5</sub> of 26 mg/L and a TSS of 32 mg/L. The NPDES permit limits are 30 mg/L monthly average for BOD and 30 mg/L monthly average for TSS. Based on these single-day results, which of the following is the most accurate compliance assessment?

- A. The plant is in violation of both limits because both parameters are at or above 30 mg/L
- B. The plant is in violation of the BOD limit because 26 mg/L rounds up to 30 mg/L
- C. A single-day result cannot determine monthly average compliance — the results must be evaluated in the context of the full month's data

D. The plant is in compliance because both results are within 10% of the permit limit, which is the acceptable margin

15. An activated sludge plant has been nitrifying reliably for months. Over a two-week period in autumn, the wastewater temperature drops from 20°C to 13°C. The effluent ammonia begins rising from 0.5 mg/L toward 4.0 mg/L. The operator has verified that the DO is 2.5 mg/L, the pH is 7.3, and the alkalinity is 150 mg/L. What is the single most effective process adjustment?

A. Increase the dissolved oxygen in the aeration basin from 2.5 mg/L to 4.0 mg/L to compensate for the colder conditions

B. Add supplemental alkalinity to the aeration basin to provide additional buffering capacity

C. Add a supplemental carbon source to the aeration basin to support the growth of nitrifying organisms

D. Decrease the WAS rate to increase the SRT, giving the slower-growing nitrifiers more time to reproduce at the colder temperature

16. An operator is calculating the chlorine dose for a plant effluent. The chlorine demand is 4.8 mg/L, and the required chlorine residual is 0.5 mg/L. The plant flow is 3.0 MGD. How many pounds per day of chlorine must be fed?

A. 40.0 lbs/day based on the demand alone without including the required residual

B. 132.6 lbs/day based on the total dose of 5.3 mg/L applied to the full plant flow

C. 100.1 lbs/day based on the demand of 4.8 mg/L applied to the full plant flow

D. 12.5 lbs/day based on the residual of 0.5 mg/L applied to the full plant flow

17. A primary clarifier normally achieves 58% TSS removal. After a major rainstorm, the influent flow increases by 150% and the primary clarifier TSS removal drops to 35%. What is the primary reason for the reduced removal efficiency?

- A. The stormwater carries organic solids that are lighter and more difficult to settle than domestic solids
- B. The increased flow reduces the surface overflow rate, allowing more time for solids to settle completely
- C. The storm has introduced chemical contaminants that dissolve the suspended particles into the liquid phase
- D. The increased flow raises the surface overflow rate above the design maximum, reducing the detention time available for particles to settle

18. A treatment plant operator calculates the mass of MLSS in the aeration basin as follows:  $\text{MLSS} = 3,000 \text{ mg/L}$ , basin volume = 0.8 MG. The operator multiplies  $3,000 \times 0.8$  and obtains 2,400. The operator then reports the MLSS mass as 2,400 lbs. What error has the operator made?

- A. The operator forgot to multiply by the 8.34 conversion factor — the correct MLSS mass is  $3,000 \times 0.8 \times 8.34 = 20,016 \text{ lbs}$
- B. The operator used the wrong basin volume — 0.8 MG should have been converted to cubic feet before calculating
- C. The operator used the wrong MLSS units — 3,000 mg/L should have been converted to percent solids before calculating
- D. The operator should have divided by 8.34 instead of multiplying to convert from milligrams to pounds

19. An operator is troubleshooting a secondary clarifier that has been producing cloudy effluent for two weeks. The MLSS is 2,800 mg/L, the SVI is 125 mL/g, the sludge blanket depth is 2 feet, and the RAS concentration is 7,200 mg/L. The DO in the aeration basin is 2.3 mg/L. All parameters appear normal, yet the effluent remains turbid. Which of the following should the operator investigate next?

- A. The F/M ratio, which may be too high and producing dispersed growth that passes through the clarifier
- B. The primary clarifier, which may be sending excess fine colloidal solids to the biological process

C. The secondary clarifier effluent weir and launder for algae growth, grease buildup, or structural damage that disrupts flow distribution

D. The aeration system, which may be producing excessively fine bubbles that become entrained in the effluent

20. A rectangular chlorine contact tank is 60 feet long, 8 feet wide, and 6 feet deep. The tank has three passes created by two baffles. The plant flow is 1.5 MGD and the measured chlorine residual is 1.0 mg/L. What is the approximate CT value?

A. CT is approximately 12 mg·min/L, well below the typical target for adequate disinfection

B. CT is approximately 21.4 mg·min/L, which should be compared to the permit-required CT for this plant

C. CT is approximately 42 mg·min/L, which is within the typical range for effective fecal coliform reduction

D. CT is approximately 7.5 mg·min/L, which indicates the contact tank is significantly undersized

21. A plant operating an MLE (Modified Ludzack-Ettinger) biological nutrient removal configuration achieves excellent ammonia removal (effluent  $\text{NH}_3 < 1$  mg/L) but the effluent nitrate is 11 mg/L, resulting in total nitrogen of 13 mg/L against a permit limit of 10 mg/L. The internal recycle is currently set at 200% of influent flow. The anoxic zone DO is 0.0 mg/L and the carbon source (influent BOD) appears adequate. Which of the following adjustments is most likely to reduce the effluent nitrate?

A. Reduce the internal recycle rate to 100% to decrease the amount of dissolved oxygen entering the anoxic zone

B. Increase the dissolved oxygen in the aerobic zone to improve the rate of nitrate production

C. Add supplemental alkalinity to the aerobic zone to increase the pH for better nitrification performance

D. Increase the internal recycle rate to 300–400% to return more nitrate-rich mixed liquor to the anoxic zone for denitrification

22. A plant operator measures the influent BOD at 200 mg/L and the plant effluent BOD at 12 mg/L. The permit requires both a maximum effluent BOD of 30 mg/L and a minimum BOD removal of 85%. Does the plant meet both requirements?

- A. Yes — effluent BOD of 12 mg/L is below 30 mg/L and the removal of 94% exceeds the 85% minimum
- B. No — the removal of 94% exceeds the requirement but the effluent concentration is too low, indicating over-treatment
- C. Yes — the effluent concentration meets the 30 mg/L limit, but the removal percentage cannot be calculated without TSS data
- D. No — the 85% removal requirement applies only to TSS, not to BOD, so only the concentration limit is relevant

23. A plant's effluent consistently meets all permit limits, but the operator notices that the effluent dissolved oxygen has been declining from 7.5 mg/L to 3.2 mg/L over the past month. The NPDES permit requires a minimum effluent DO of 5.0 mg/L. The plant uses cascade aeration at the outfall to increase the effluent DO. Which of the following is the most likely cause of the declining effluent DO?

- A. The aeration basin blowers have been producing less air, resulting in lower DO throughout the plant
- B. The influent BOD has decreased, reducing the biological oxygen demand and the associated oxygen production
- C. The cascade aerator at the outfall has become fouled, scaled, or is operating at reduced capacity, limiting the oxygen transfer to the effluent
- D. The chlorine residual in the contact tank has increased, consuming more dissolved oxygen before discharge

24. A treatment plant with an aerated grit chamber notices that the grit collected over the past month has a strong odor and appears to contain a high proportion of organic material. Laboratory analysis confirms that the grit volatile solids content is 65%, whereas clean grit should have less than 5% volatile solids. What is the most likely cause?

- A. The influent contains an unusual amount of food waste that is being classified as grit incorrectly
- B. The air supply to the grit chamber is set too low, allowing organic solids to settle with the grit instead of remaining in suspension
- C. The grit washer has failed and is not removing organic material from the collected grit
- D. The grit collection mechanism is operating too fast and is scouring organic material from the chamber walls

25. An operator discovers that the plant's effluent total phosphorus has increased from 0.8 mg/L to 2.5 mg/L over two weeks. The plant uses ferric chloride addition to the secondary clarifier influent for phosphorus removal. The ferric chloride feed rate has not changed, and the influent phosphorus loading has not increased. Which of the following is the most likely cause of the rising effluent phosphorus?

- A. The secondary clarifier is operating at a higher SOR and is not capturing the ferric phosphate precipitate effectively
- B. The ferric chloride has chemically reacted with the polymer used for sludge conditioning and lost its effectiveness
- C. The biological phosphorus removal organisms have died due to the presence of ferric chloride in the aeration basin
- D. The ferric chloride solution has degraded in the storage tank, reducing its effective iron concentration below the required dose

26. A wastewater treatment plant is designed for 5.0 MGD average daily flow with a peak capacity of 12.5 MGD. During a major storm, the influent flow reaches 14.0 MGD. The operator must manage the excess 1.5 MGD that exceeds the plant's hydraulic capacity. Under the plant's approved bypass protocol, what is typically the preferred approach?

- A. Discharge the excess flow directly to the receiving water without any treatment as an authorized bypass
- B. Store the excess flow in the collection system by throttling the influent pumps until the storm passes

C. Blend the excess flow with fully treated effluent after the excess receives at least primary treatment and disinfection

D. Divert all 14.0 MGD to a holding pond for storage until the flow returns to normal and then pump it back

27. An activated sludge plant has been steadily increasing its WAS rate over the past month to maintain an MLSS target of 2,500 mg/L. Despite the increased wasting, the MLSS continues to climb and is now at 3,200 mg/L. The influent BOD and flow have not changed. What is the most likely explanation for the rising MLSS despite increased wasting?

A. The higher organic loading from an undetected industrial source is promoting biological growth that exceeds the wasting rate

B. Inorganic solids (grit, chemical precipitates, or industrial inerts) are accumulating in the system and are not being captured by the BOD analysis

C. The WAS pump is not actually delivering the flow rate the operator has set because the pump is worn or the discharge line is partially obstructed

D. The secondary clarifier is thickening the sludge blanket more effectively, concentrating solids that were previously escaping in the effluent

28. An operator at a small package plant using extended aeration and chlorine disinfection reviews the daily monitoring data and finds the following: effluent BOD 7 mg/L, effluent TSS 9 mg/L, effluent pH 7.2, chlorine residual 0.3 mg/L after the contact tank, and fecal coliform 2,400 CFU/100 mL (permit limit 200 CFU/100 mL). All limits except fecal coliform are being met. What is the most likely cause of the high fecal coliform despite the chlorine residual?

A. The chlorine residual of 0.3 mg/L is below the effective disinfection threshold for wastewater effluent

B. The chlorine contact time is insufficient — the flow rate through the contact tank is too fast for the chlorine to inactivate the pathogens

C. The fecal coliform test was performed using the wrong analytical method and the result is invalid

D. The effluent pH of 7.2 is too high for chlorine to be effective as a disinfectant

29. A treatment plant receives a tanker load of septage (liquid waste pumped from septic tanks) at its receiving station. The septage has a BOD of 6,000 mg/L and TSS of 15,000 mg/L. The tanker holds 3,000 gallons. If the operator discharges the entire load into the headworks over a 30-minute period, which of the following impacts is most concerning?

- A. The high TSS will clog the bar screens at the headworks and require immediate manual cleaning
- B. The high pH of the septage will neutralize the plant's alkalinity reserves and cause a pH crash
- C. The chlorine demand of the septage will consume all available chlorine in the disinfection contact tank
- D. The concentrated organic slug will create a shock load on the biological process, potentially depleting dissolved oxygen in the aeration basin

30. An operator determines that the plant must add 45 mg/L of alum to remove phosphorus from a flow of 2.5 MGD. What is the daily alum requirement in pounds per day?

- A. Approximately 938 lbs/day of alum based on the dose, flow, and the 8.34 conversion factor
- B. Approximately 563 lbs/day of alum based on the dose, flow, and the 8.34 conversion factor
- C. Approximately 112.5 lbs/day of alum based on the dose divided by the flow rate
- D. Approximately 1,876 lbs/day of alum based on the dose multiplied by the flow and doubled for safety

31. A plant operating a rotating biological contactor notices that the biofilm on the first-stage discs has become excessively thick — more than 1 inch — and some discs are beginning to show signs of structural stress from the added weight. What operational adjustment is most appropriate?

- A. Reduce the influent flow rate to decrease the organic load and allow the biofilm to thin naturally
- B. Increase the disc rotation speed to create more shear force and strip excess biofilm from the surfaces
- C. Increase the influent flow rate or add recirculation to increase the hydraulic loading and promote biofilm sloughing

D. Apply chlorine solution directly to the disc surfaces during a scheduled shutdown to kill and remove the excess biofilm

32. A new operator asks why the plant's activated sludge process is designed with a tapered aeration configuration — with more air delivered at the inlet end of the aeration basin and less at the outlet end. What is the correct explanation?

- A. Tapered aeration saves energy by reducing total air volume without affecting treatment performance
- B. The organic load and oxygen demand are highest at the inlet end of a plug-flow basin where the primary effluent enters, and decrease along the basin length as the organisms consume the BOD
- C. The dissolved oxygen concentration must be highest at the outlet to ensure adequate oxygen in the secondary clarifier
- D. Tapered aeration prevents the formation of filamentous organisms by maintaining variable oxygen conditions

33. A treatment plant receives a revised NPDES permit that adds a seasonal ammonia limit of 2.0 mg/L (November through March) in addition to the existing year-round BOD and TSS limits. The plant currently operates at an SRT of 7 days and achieves effluent ammonia of 8 mg/L during winter months. To meet the new limit, the operator must take which of the following actions?

- A. Add a post-aeration stage after the secondary clarifier to oxidize the remaining ammonia before discharge
- B. Increase the chlorine dose to chemically oxidize the ammonia in the contact tank effluent
- C. Switch from activated sludge to a trickling filter process, which nitrifies more effectively in cold weather
- D. Significantly extend the SRT by reducing the WAS rate and potentially increase the aeration capacity to maintain adequate DO at the higher MLSS

34. An operator at a plant with fine bubble diffusers in the aeration basin notices that the blower discharge pressure has increased from 7.2 psi to 8.8 psi over the past six months while the airflow rate has remained constant. What is the most likely cause, and what maintenance action is needed?

- A. The fine bubble diffusers are gradually fouling with biological growth and mineral deposits, restricting the air discharge openings, and they need cleaning or replacement
- B. The blower bearings are wearing, creating increased internal friction that manifests as higher discharge pressure
- C. The aeration basin water level has increased by approximately 4 feet, requiring the blower to overcome additional static head
- D. The blower inlet filter is completely plugged, causing the blower to work harder to maintain the set airflow rate

35. An operator is evaluating two possible causes for an increase in secondary clarifier effluent TSS. The 30-minute settling test shows good settling with an SVI of 100 mL/g, and the sludge blanket depth is only 1.5 feet. Despite these normal indicators, the effluent TSS is 28 mg/L (normal: 10 mg/L). Which of the following is the most likely cause?

- A. The secondary clarifier SOR has increased due to a parallel clarifier being taken offline for maintenance
- B. Fine, nonsettleable particles (pin floc or colloidal material) are passing through the clarifier without being captured by the bulk settling process
- C. The RAS concentration has dropped, indicating the clarifier is not thickening the sludge adequately
- D. The WAS pump has failed, causing excessive solids buildup in the secondary clarifier

36. A plant treats 2.0 MGD and uses sodium hypochlorite at a dose of 8.0 mg/L for disinfection. The sodium hypochlorite solution is 12.5% available chlorine with a specific gravity of 1.17. The chemical supplier delivers the solution at full strength, but the operator suspects the current tank inventory has degraded. A titration test shows the actual concentration is now 9.8%. How does this affect the daily volume of solution the operator must feed?

- A. The operator must feed less solution because the degraded solution is more concentrated per unit volume
- B. The operator must feed more solution because the lower strength requires more volume to deliver the target dose
- C. The degradation has no effect on the volume needed because the feed pump compensates automatically
- D. The operator must increase the solution volume by approximately 50% to maintain the required chlorine residual

37. A treatment plant's influent composite sampler collects aliquots at intervals proportional to the influent flow rate. On a day with very low overnight flow and a high morning peak, this flow-proportional composite will differ from a time-proportional composite in which of the following ways?

- A. The flow-proportional composite will contain less total volume because fewer aliquots are collected at night
- B. The time-proportional composite will be more representative of the actual mass loading because it samples equally
- C. The flow-proportional composite will more accurately represent the mass-weighted average concentration because it collects more sample during high-flow periods when more pollutant mass is delivered
- D. There is no practical difference between the two methods for typical domestic wastewater monitoring

38. An activated sludge plant has an aeration basin volume of 1.5 MG, a flow of 5.0 MGD, an MLSS of 3,500 mg/L, and an MLVSS of 2,700 mg/L. The primary effluent BOD is 130 mg/L. What is the F/M ratio, and what does it indicate about the process operating condition?

- A. F/M is approximately 0.16, indicating the system is operating near the boundary between conventional and extended aeration modes
- B. F/M is approximately 0.24, indicating normal conventional activated sludge operation
- C. F/M is approximately 0.38, indicating high-rate operation with potential settling concerns

D. F/M is approximately 0.08, indicating deep extended aeration with risk of pin floc formation

39. A treatment plant operates a tertiary sand filter for effluent polishing. The filter run length (time between backwashes) has decreased from 24 hours to 8 hours over the past month, while the secondary effluent quality has remained stable at 12 mg/L TSS. What is the most likely explanation for the shorter filter runs?

A. The filter media has lost a significant portion of its depth due to washout during previous backwashes

B. The filter is loading faster because the secondary effluent, while still at 12 mg/L TSS, has a higher proportion of fine colloidal particles that penetrate deeper into the media bed and cause faster headloss buildup

C. The filter backwash system is malfunctioning and not fully cleaning the media during each backwash cycle

D. The plant flow rate has decreased, resulting in lower filtration velocity and longer particle capture time

40. An operator needs to enter a wet well to inspect a check valve that is suspected of leaking. The wet well is 16 feet deep, partially filled with wastewater to a depth of 3 feet, and accessed by a fixed ladder through a 30-inch hatch. The operator has completed confined space entry training, has a four-gas monitor, and has an attendant available. Which additional safety concern must the operator address before entering this space?

A. The operator must obtain a medical clearance specifically for work in wet environments from a physician

B. The operator must wait until the wet well is completely drained because entry into standing wastewater is never permitted

C. The operator must address the drowning hazard created by the standing wastewater and ensure appropriate fall protection and water rescue provisions are in place

D. The operator must verify that the electrical panel for the wet well pumps is located at least 50 feet from the hatch opening

41. A maintenance electrician asks an operator to hold a flashlight inside a 480V motor control center while the electrician troubleshoots a circuit. The panel is energized. The operator should respond with which of the following?

- A. Agree to help because holding a flashlight does not involve working on the electrical components directly
- B. Agree to help only if the operator puts on rubber-soled shoes and removes all jewelry before approaching
- C. Agree to help after verifying that the main breaker for the panel has been turned off but not locked out
- D. Decline because assisting with work inside an energized 480V panel exposes the operator to arc flash and electrocution hazards

42. During a routine inspection of the digester area, an operator smells a faint rotten egg odor outside the digester building. The portable H<sub>2</sub>S monitor reads 6 ppm at the building entrance. What is the correct response?

- A. Enter the building to check the digester gas system since 6 ppm is well below the OSHA PEL of 10 ppm
- B. Do not enter the building — notify the supervisor, increase the building ventilation remotely if possible, and investigate the gas source from outside
- C. Enter the building wearing a dust mask to filter the H<sub>2</sub>S gas before it reaches the respiratory system
- D. Ignore the reading because outdoor H<sub>2</sub>S levels below 10 ppm are caused by normal background conditions

43. An operator is performing a lockout/tagout procedure on a chemical metering pump. The pump is electrically powered and fed by a gravity-flow chemical line from an elevated storage tank. The operator locks out the electrical disconnect and tags it. What additional energy source must be isolated?

- A. The gravitational potential energy of the chemical in the elevated supply line, which must be isolated by closing and locking the supply valve
- B. The kinetic energy stored in the pump motor flywheel, which must dissipate before work begins
- C. The thermal energy in the chemical, which must be allowed to cool to ambient temperature before contact
- D. The pneumatic energy in the pump diaphragm, which must be released by disconnecting the air supply

44. A treatment plant's emergency response plan includes a section on chlorine gas emergencies. The plan specifies that all employees must evacuate upwind and uphill when a chlorine alarm sounds. Why is the "uphill" component important?

- A. Chlorine gas rises rapidly and accumulates at the highest point in the facility terrain
- B. Moving uphill positions employees at a safer distance from the facility's stormwater outfall
- C. Chlorine gas is approximately 2.5 times heavier than air and flows downhill like water, collecting in low-lying areas
- D. The uphill direction is specified because the prevailing wind at most treatment plants blows downhill

45. A treatment plant stores 150-lb chlorine gas cylinders. When a cylinder is nearly empty, the operator must replace it with a full cylinder. During the changeover process, which of the following is the most critical safety step?

- A. Weighing the empty cylinder on a platform scale to verify that all chlorine has been completely consumed
- B. Flushing the chlorine supply line with nitrogen gas to purge any residual chlorine before disconnecting
- C. Verifying that the new cylinder's valve is closed before connecting it to the system piping
- D. Closing the cylinder valve on the nearly empty cylinder and verifying that the vacuum system has pulled all remaining gas before disconnecting

46. An operator discovers that a fellow employee has been storing their lunch and personal beverages in the plant laboratory refrigerator alongside wastewater samples preserved with sulfuric acid. Which of the following identifies the primary violation?

A. The acid-preserved samples will degrade faster in a refrigerator that is opened frequently for food retrieval

B. The food storage is contaminating the wastewater samples and invalidating the laboratory results

C. Storing personal food with hazardous chemicals violates general laboratory safety practices, not just the bloodborne pathogens standard

D. Storing food items in areas where potentially infectious materials are handled violates the OSHA Bloodborne Pathogens Standard and poses a direct health risk

47. An operator performs atmospheric monitoring in a gravity thickener vault before entry and obtains the following readings: O<sub>2</sub> 20.8%, H<sub>2</sub>S 3 ppm, CO 5 ppm, LEL 0%. The space is ventilated for 15 minutes and retested with identical results. The operator enters wearing a full-body harness connected to a retrieval tripod, with an attendant stationed at the opening and continuous gas monitoring. Is this entry properly conducted?

A. Yes — all atmospheric readings are within safe limits, ventilation was provided, and proper entry procedures including harness, retrieval, attendant, and continuous monitoring are in place

B. No — the operator should be wearing SCBA because any detectable H<sub>2</sub>S requires supplied-air respiratory protection

C. No — the attendant should also be wearing a harness and retrieval line in case rescue is needed

D. No — the space should have been ventilated for a minimum of 30 minutes, not 15, before retesting

48. Under the Clean Water Act, knowingly submitting false information on a Discharge Monitoring Report can result in which of the following consequences?

A. A written warning from the state regulatory agency with no further penalties for a first offense

- B. A mandatory resampling requirement and a 30-day probationary period for the plant operator
- C. Criminal penalties including fines up to \$10,000 per day of violation and imprisonment up to 2 years
- D. Suspension of the plant's NPDES permit for 90 days while a compliance investigation is conducted

49. An operator at a treatment plant observes that the safety shower in the chemical storage building produces only a weak trickle of water when activated during a weekly test. The manufacturer's specification requires a minimum flow of 20 gallons per minute. What is the correct action?

- A. Document the observation in the daily log and schedule the repair for the next available maintenance window
- B. Take the safety shower out of service, post a sign directing personnel to the nearest alternative shower, and prioritize the repair as an urgent safety issue
- C. The weak flow is acceptable as long as the eyewash station adjacent to the shower is functioning properly
- D. Increase the water supply pressure to the chemical building to boost the shower flow rate temporarily

50. An operator discovers that a treatment plant has been reporting fecal coliform results on DMRs that were analyzed by a laboratory whose state certification expired three months ago. Which of the following correctly describes the regulatory implication?

- A. The results are still valid because the laboratory's analytical methods do not change when the certification lapses
- B. All fecal coliform results analyzed during the period of expired certification may be considered invalid for compliance purposes, and the regulatory authority must be notified
- C. The results are valid as long as the laboratory renews its certification within 6 months of the expiration date
- D. Only the most recent month's results are affected — previous months' results retain their validity

51. A wastewater treatment plant has experienced three effluent BOD exceedances in the past six months. The state regulatory agency has issued a notice of violation and is requiring the plant to submit a corrective action plan. Which of the following elements should the plan include at minimum?

- A. A root cause analysis of each exceedance, specific corrective actions with implementation timelines, preventive measures to avoid recurrence, and an enhanced monitoring program
- B. A request for a permit modification to increase the BOD limit to a level the plant can consistently achieve
- C. A statement that the exceedances were caused by unusual influent conditions beyond the plant's control
- D. A proposal to reduce the plant's monitoring frequency so that fewer potential violations are detected

52. An NPDES permit specifies that the plant must maintain a minimum effluent dissolved oxygen of 5.0 mg/L. The operator measures the DO at 4.2 mg/L at the sampling point. This constitutes which of the following?

- A. A minor deviation that does not need to be reported because DO naturally fluctuates during the day
- B. An observation that should be noted in the daily log but does not qualify as a permit violation
- C. A permit violation that must be documented, investigated, reported to the regulatory authority, and corrected
- D. An acceptable result because the permit limit applies only to the monthly average, not individual measurements

53. The primary purpose of maintaining a complete and accurate daily operating log at a wastewater treatment plant is to accomplish which of the following?

- A. Satisfy the operator certification renewal requirements for continuing education credits
- B. Provide documentation for the annual budget request to justify increased staffing levels

C. Create a publicly available record that residents can review to evaluate the plant's environmental performance

D. Document daily operational conditions, equipment status, process adjustments, and observations to support process control decisions, regulatory compliance, and institutional knowledge

54. An operator is instructed to record all process control data in the plant's daily log using permanent ink. The operator makes an error when recording the aeration basin DO value. What is the correct method for correcting the error?

A. Use correction fluid (white-out) to cover the incorrect entry and write the correct value over it cleanly

B. Draw a single line through the incorrect entry so it remains legible, write the correct value nearby, and initial and date the correction

C. Tear out the page containing the error, rewrite the entire page with the corrected data, and insert it back into the log

D. Erase the incorrect entry using a pencil eraser and rewrite the correct value in the same space

55. A centrifugal pump operating at 1,750 RPM has a nameplate full-load amperage of 18 amps. The operator measures the actual amperage at 22 amps during normal operation. What does this elevated amperage most likely indicate?

A. The pump is operating beyond its design point due to a higher-than-normal system head or a partially restricted condition

B. The pump motor is receiving low voltage from the power supply panel, causing it to draw more current

C. The pump is operating at reduced speed because the VFD has limited the motor output to prevent overload

D. The elevated amperage is normal because pumps always draw more than their nameplate rating during continuous operation

56. An operator is evaluating whether to lubricate or replace the bearings on a blower that has been exhibiting gradually increasing vibration levels. Which of the following diagnostic approaches would provide the most useful information for making this decision?

- A. Measuring the blower discharge temperature and comparing it to the manufacturer's maximum specification
- B. Checking the blower oil level and color to determine if the oil needs to be changed before further evaluation
- C. Performing a vibration analysis to identify the specific frequency signature and determine whether the vibration pattern indicates a bearing defect, misalignment, or imbalance
- D. Running the blower at reduced speed to see if the vibration decreases proportionally with the speed change

57. A treatment plant has two identical influent pumps. Pump 1 delivers 850 GPM at 32 psi discharge pressure. Pump 2 delivers 850 GPM at 38 psi discharge pressure under the same system conditions. Assuming both pumps are the same age with similar operating hours, what does the higher discharge pressure on Pump 2 most likely indicate?

- A. Pump 2 has a superior impeller design that produces higher pressure at the same flow rate
- B. Pump 2 has a partially restricted discharge line that is forcing the pump to develop higher pressure to maintain the same flow
- C. Pump 2's motor is receiving higher voltage than Pump 1, causing it to spin faster and develop more head
- D. Pump 2's suction line has better conditions (less friction, shorter length) allowing it to develop more discharge pressure

58. A plant operator notices that the automatic transfer switch has been slow to transfer load to the emergency generator during the last two weekly tests — taking 45 seconds instead of the normal 15 seconds. The generator starts normally and builds voltage within the expected time. What should the operator investigate?

- A. The generator fuel system for air locks or contaminated fuel that is slowing the engine acceleration
- B. The generator voltage regulator for improper output voltage that prevents the ATS from recognizing generator readiness
- C. The generator cooling system for overheating conditions that delay the engine from reaching operating speed
- D. The automatic transfer switch's voltage-sensing circuits, time-delay relays, and transfer mechanism for wear or maladjustment

59. A mag meter on the plant effluent line was calibrated six months ago and has been reading consistently. The operator notices that the effluent flow reading is approximately 0.3 MGD higher than the influent flow reading on days with no rain, no sludge hauling, and no water additions to the system. What is the most likely explanation for this discrepancy?

- A. One or both flow meters have drifted from calibration — either the influent meter is reading low or the effluent meter is reading high, and both should be verified
- B. The plant is generating 0.3 MGD of water through biological treatment processes that create water as a metabolic byproduct
- C. The effluent meter is correctly reading higher because the plant water system adds potable water to the process
- D. The mag meter technology is inherently inaccurate for wastewater applications and should be replaced with an ultrasonic meter

60. A clarifier drive mechanism has a torque overload alarm that activates when the rotating mechanism encounters excessive resistance. The alarm has been activating intermittently during the overnight shift but clears by morning. What is the most likely explanation for this pattern?

- A. The overnight operator is accidentally bumping the torque alarm reset button during rounds
- B. Electrical interference from the plant's emergency generator test schedule is causing false alarms
- C. Colder overnight temperatures increase the sludge viscosity, making the settled sludge thicker and harder for the mechanism to push through

D. The torque alarm sensor has a temperature-dependent calibration drift that produces false readings at night

61. An operator is reviewing the specifications for a new chemical metering pump. The pump has a maximum output of 10 GPH at full stroke length and full speed. The required feed rate is 3.5 GPH. At what approximate stroke length setting should the pump be operated if the speed is set at 100%?

- A. The pump should be operated at approximately 25% stroke length to achieve the target feed rate
- B. The pump should be operated at approximately 50% stroke length to achieve the target feed rate
- C. The pump should be operated at approximately 75% stroke length to achieve the target feed rate
- D. The pump should be operated at approximately 35% stroke length to achieve the target feed rate

62. A SCADA system displays a low-level alarm in the sodium hypochlorite storage tank. The tank level indicator shows 8% remaining. The normal delivery schedule is every two weeks, and the next delivery is in 10 days. What should the operator do?

- A. Reduce the chlorine dose to extend the chemical supply until the scheduled delivery date arrives
- B. Contact the chemical supplier to arrange an emergency delivery before the tank runs empty and disinfection is interrupted
- C. Switch to gaseous chlorine from the emergency supply cylinders that are stored in the backup chlorination room
- D. Shut down the disinfection system and notify the regulatory authority that chlorination will be interrupted for 10 days

63. An operator performing daily equipment rounds notices that a progressive cavity sludge pump's stator is leaking sludge from the packing gland at a rate of approximately one drip per second. The pump is otherwise operating normally. What is the correct interpretation and response?

- A. Minor weeping from the packing gland is normal for progressive cavity pumps and indicates that the packing is providing adequate lubrication to the shaft
- B. Any leakage indicates the stator has failed and the pump must be shut down immediately for stator replacement
- C. The packing gland needs adjustment — tightening the packing follower slightly may reduce the leak to an acceptable rate
- D. The pump discharge pressure is too high and is forcing sludge past the packing material against normal flow

64. A treatment plant has a backup generator rated at 750 kW. The critical load inventory shows the following: influent pumps (200 kW), aeration blowers (280 kW), RAS pumps (75 kW), disinfection system (25 kW), SCADA and controls (15 kW), and building lighting/HVAC (60 kW). What is the total critical load, and does the generator have adequate capacity?

- A. The total critical load is 905 kW, which exceeds the generator capacity — non-critical loads must be shed
- B. The total critical load is 655 kW, which is within the generator capacity with adequate margin
- C. The total critical load is 750 kW, which exactly matches the generator rating with no margin for additional loads
- D. The total critical load is 595 kW, which leaves approximately 155 kW of margin for startup surges and additional loads

65. A plant operator notices that the check valve on a RAS pump discharge line is not seating properly — a slight thumping noise is heard each time the pump shuts off, and the operator can feel water pulsing backward through the pump for a few seconds. What is the operational risk if this condition is not corrected?

- A. The backward flow will gradually erode the pump impeller from the reverse-rotation direction
- B. The unseated check valve will cause the pump motor to run in reverse, potentially damaging the electrical winding

C. The water hammer pulses from the backward flow will stress the piping joints and fittings, potentially causing a pipe failure

D. The backward flow will create pressure surges (water hammer) in the piping system that can damage pipes, fittings, and the pump, and will drain the discharge line each time the pump stops

66. An operator inspecting a belt filter press notices that one edge of the belt is consistently tracking to the left, causing uneven sludge distribution and reduced cake capture. What is the most likely cause and the appropriate corrective action?

A. The sludge feed is not distributed evenly across the belt width and the feed distribution box needs adjustment

B. The belt tracking system is malfunctioning or needs adjustment to return the belt to a centered position on the rollers

C. The belt has been installed backward and must be removed, flipped, and reinstalled in the correct orientation

D. The polymer dose is too high on one side of the belt, causing differential drainage that pulls the belt to one side

67. A treatment plant's online pH analyzer in the effluent has been reading 0.3 units lower than the laboratory grab sample analysis for the past three weeks. The laboratory pH meter was recently calibrated with fresh buffer solutions. Which of the following is the most appropriate action?

A. Adjust all reported pH values upward by 0.3 units on the DMR to compensate for the known instrument bias

B. Replace the online pH analyzer with a new instrument from a different manufacturer

C. Recalibrate the online pH analyzer using fresh buffer solutions and verify agreement with the laboratory instrument

D. Report the lower online reading on the DMR because online instruments are considered more representative than grab samples

68. An operator reviewing the plant's preventive maintenance records notices that the emergency generator has not been load-tested in 14 months. The PM schedule requires monthly no-load tests and annual full-load bank tests. The monthly no-load tests have been performed as scheduled. What is the significance of the missed load bank test?

A. The monthly no-load tests verify all critical generator functions, so the annual load test is redundant and can be skipped

B. The missed load bank test means the generator's ability to deliver its rated power output under actual load conditions has not been verified, and it should be tested immediately

C. Load bank tests are only required for generators larger than 1,000 kW and may not apply to this installation

D. The missed test will be caught during the next scheduled OSHA inspection and can be performed at that time

69. A plant operator observes that the mixed liquor in the aeration basin has changed from its normal brown color to a grayish-black color over the past 24 hours. The DO is 0.4 mg/L despite the blowers running at full capacity. The influent flow and BOD have increased significantly. What has most likely occurred?

A. The activated sludge organisms have died from a toxic industrial discharge entering the plant overnight

B. The brown color change to gray-black is normal biological adaptation to higher loading conditions

C. The aeration basin pH has dropped below 5.0, killing the aerobic organisms and allowing anaerobic conditions

D. The aeration system cannot supply enough oxygen to meet the increased demand, and the basin has become oxygen-depleted, creating anaerobic conditions and septic mixed liquor

70. An operator monitoring a belt filter press observes that the polymer-conditioned sludge is draining well in the gravity zone but the cake is tearing apart and falling off the belt in the high-pressure zone. The polymer dose and belt speed are at their normal settings. Which of the following is the most likely cause?

- A. The sludge feed concentration is too low, producing a cake that is too thin to hold together under pressure
- B. The belt tension is set too high for the current sludge characteristics, creating excessive shear that tears the cake
- C. The belt wash system is applying too much water, re-wetting the sludge before it enters the pressure zone
- D. The polymer has degraded in the storage tank and is no longer providing adequate floc strength for the pressure stage

71. A plant's gravity thickener for primary sludge normally produces thickened sludge at 6.5% total solids. Over the past two weeks, the thickened sludge concentration has gradually declined to 4.2% despite no change in the feed rate or sludge characteristics. Which of the following operational adjustments is most appropriate?

- A. Reduce the thickened sludge withdrawal rate to allow the sludge blanket more time to compact in the thickener
- B. Increase the speed of the picket rake mechanism to break up gas pockets and release entrapped water
- C. Increase the thickened sludge withdrawal rate to draw off more concentrated material from the bottom
- D. Add polymer to the thickener feed to improve the settleability of the primary sludge

72. A dewatering centrifuge is producing cake at 24% solids with clear centrate. The operator reduces the polymer dose by 20% to save on chemical costs. The next day, the cake solids remain at 24% but the centrate has become slightly turbid with visible fine solids. What does this observation indicate?

- A. The polymer reduction has had no significant effect and the dose can be reduced further
- B. The centrifuge bowl speed should be increased to compensate for the reduced polymer dose
- C. The lower polymer dose has reduced solids capture efficiency — some fine solids are escaping in the centrate even though the cake quality appears unchanged

D. The sludge feed characteristics have changed independently of the polymer adjustment

73. An anaerobic digester has been operating stably at 97°F for two years. The operator decides to increase the temperature to 100°F to improve volatile solids reduction. Three days after the temperature increase, the volatile acids rise from 250 mg/L to 600 mg/L and gas production drops 15%. What should the operator do?

A. Continue the temperature increase because the initial acid rise is a normal transient response that will stabilize

B. Increase the sludge feed rate to provide more substrate for the stressed methanogens to consume

C. Raise the temperature further to 105°F to push the biology into the thermophilic range more quickly

D. Return the temperature to 97°F immediately — the 3°F increase was too rapid for the temperature-sensitive methanogens, and gradual adjustment of 1°F per week is recommended

74. A plant operating a two-stage anaerobic digestion system reports that the secondary digester supernatant quality has deteriorated — the supernatant TSS has increased from 400 mg/L to 1,800 mg/L over the past month. What is the operational impact of this poor supernatant quality?

A. The high-TSS supernatant improves the biological treatment process by providing seed organisms to the aeration basin

B. The poor supernatant returns excessive solids to the liquid treatment process, increasing the loading on the primary clarifiers and aeration basins

C. The high supernatant TSS indicates the primary digester is performing excellently and producing well-digested sludge

D. The supernatant quality has no effect on plant operations because the supernatant flow is negligible

75. A treatment plant uses sand drying beds for sludge dewatering. The operator applies a 10-inch layer of digested sludge to a bed and checks it after 3 days. The sludge has developed a hard crust on the surface, but the material beneath the crust is still liquid with a strong anaerobic odor. Which of the following is the best corrective action?

- A. Scarify the surface crust with a rake or fork to create cracks that allow moisture vapor to escape and air to penetrate beneath the crust
- B. Add a second layer of sludge on top of the crust to compress the liquid out through the sand below
- C. Flood the bed surface with clean water to dissolve the crust and re-establish gravity drainage
- D. Remove the crusted material and underlying liquid, clean the bed, and reapply a thinner layer

76. An operator is evaluating the volatile solids reduction achieved by the plant's aerobic digester. The raw sludge feed has 74% volatile solids and the digested sludge has 58% volatile solids. Using the Van Kleeck equation, what is the approximate percent volatile solids reduction?

- A. Approximately 49% volatile solids reduction, exceeding the 38% minimum for Part 503 vector attraction reduction
- B. Approximately 38% volatile solids reduction, exactly meeting the minimum threshold
- C. Approximately 22% volatile solids reduction, which fails to meet the 38% minimum
- D. Approximately 55% volatile solids reduction, well above the Part 503 requirement

77. An anaerobic digester produces 8,500 cubic feet of gas per day. The gas has a methane content of 62% and a heating value of approximately 600 BTU per cubic foot of methane. What is the approximate daily energy value of the methane produced?

- A. 5,100,000 BTU/day, which can offset a small portion of the plant's daily natural gas consumption
- B. 8,500,000 BTU/day, based on the total gas volume regardless of the methane percentage
- C. 2,550,000 BTU/day, based on half the total gas volume at the stated heating value
- D. 3,162,000 BTU/day, based on the methane fraction of the total gas multiplied by the heating value per cubic foot

78. A treatment plant is evaluating whether its biosolids qualify for land application under Part 503. The laboratory reports the following metal concentrations in the biosolids (mg/kg dry weight): arsenic 32, cadmium 15, copper 850, lead 180, mercury 8, nickel 210, selenium 28, zinc 1,400. All values are below the ceiling concentrations. Are all values also below the Table 3 pollutant concentration limits for Exceptional Quality designation?

- A. Yes — all reported metals are below both ceiling and Table 3 limits for Exceptional Quality biosolids
- B. No — while most metals are below Table 3 limits, at least one metal exceeds the EQ threshold when compared to the Table 3 pollutant concentration limits
- C. The Table 3 limits cannot be determined without knowing the annual biosolids production volume
- D. The metal concentrations are irrelevant for EQ designation — only the pathogen reduction class matters

79. A treatment plant operator discovers that one of the plant's sludge holding tanks has developed a significant crack in the concrete wall, and sludge is slowly leaking onto the surrounding ground. The tank holds 50,000 gallons of thickened sludge at 5% solids. What is the primary environmental concern?

- A. The leaking sludge will contaminate the plant's air quality monitoring equipment located nearby
- B. The sludge contains metals that will immediately volatilize and create an air quality emergency
- C. The leaking sludge may contaminate soil and potentially reach groundwater or surface water, creating a regulatory violation and environmental hazard
- D. The primary concern is the structural integrity of adjacent tanks that share common walls with the cracked tank

80. A belt filter press is dewatering digested sludge and producing cake at 18% solids. The plant needs to increase the cake solids to 22% to meet the landfill's acceptance requirements. Which of the following adjustments is most likely to increase the cake solids?

- A. Increase the polymer dose to create stronger, more water-releasing floc particles

- B. Increase the belt speed to process the sludge more quickly through the pressure zone
- C. Increase the belt tension and roller pressure to squeeze more water from the sludge during the high-pressure stage
- D. Decrease the sludge feed rate to apply a thinner layer of sludge on the belt for more complete drainage

81. A composting operation receives dewatered biosolids at 22% solids and blends them with wood chips at a volumetric ratio of 1:2 (biosolids to wood chips). The purpose of this blending ratio is to achieve which target condition?

- A. A carbon-to-nitrogen ratio of approximately 10:1 to maximize the rate of ammonia volatilization
- B. A moisture content of 10–20% to promote rapid thermophilic decomposition in the compost pile
- C. A pH of 12.0 or higher to meet Part 503 lime stabilization requirements for pathogen reduction
- D. A moisture content of 50–60%, adequate porosity for oxygen penetration, and a carbon-to-nitrogen ratio of approximately 25–30:1

82. An operator at a treatment plant with anaerobic digestion notices that the pressure relief valve on the digester gas dome has been venting gas intermittently for the past 48 hours. The digester gas pressure is at the high end of the normal range. Which of the following should the operator investigate first?

- A. The sludge feed pump for a malfunction that is overfeeding the digester and causing excess gas production
- B. The digester gas utilization equipment (boiler, engine, or flare) for a shutdown or restriction that is preventing normal gas consumption
- C. The digester mixing system for a failure that has caused stratification and released a pocket of trapped gas
- D. The digester heating system for overheating that is accelerating the methanogenic bacteria beyond their normal gas production rate

83. An operator comparing the dewatering performance of two belt filter presses processing identical sludge finds that Press A produces cake at 21% solids while Press B produces cake at only 16% solids. Both presses receive the same polymer dose and operate at the same belt speed. What should the operator check first on Press B?

- A. The belt tension and roller pressure settings, which may be lower on Press B than on Press A
- B. The sludge feed rate, which may be higher on Press B, overloading the belt capacity
- C. The belt fabric, which may be worn, stretched, or of a different weave that reduces dewatering effectiveness
- D. The belt wash water temperature, which may be lower on Press B and reducing the effectiveness of the cleaning cycle

84. An operator calculates that the plant's anaerobic digester achieves 44% volatile solids reduction. The digested biosolids have a fecal coliform concentration of 800 MPN/g. All regulated metals are below the Table 3 pollutant concentration limits. What Part 503 classification do these biosolids achieve?

- A. Class B with cumulative pollutant loading tracking required for each land application site
- B. Class B with Exceptional Quality designation based on the metal concentrations alone
- C. Class A with Exceptional Quality designation because fecal coliform is below 1,000 MPN/g, metals meet Table 3 limits, and VSR exceeds 38% for vector attraction reduction
- D. Class A but not Exceptional Quality because the volatile solids reduction of 44% does not meet the 50% minimum for EQ

85. A treatment plant incineration system uses a multiple hearth furnace with a capacity of 5 dry tons per day. The plant produces 7 dry tons per day of dewatered biosolids. How should the operator manage the excess production?

- A. Reduce the plant's sludge production by decreasing the WAS rate and allowing higher MLSS in the aeration basin

- B. Increase the furnace temperature to process the additional 2 tons within the existing operating period
- C. Store the excess biosolids and run the incinerator on extended shifts, or arrange alternative disposal for the excess
- D. Blend the excess biosolids with the incinerator ash to reduce the total volume requiring management

86. Biosolids that have been treated by lime stabilization to pH 12 for 2 hours meet which of the following Part 503 requirements?

- A. One of the vector attraction reduction options (Option 8 — alkaline treatment) but not automatic Class A pathogen reduction
- B. Both Class A pathogen reduction and Exceptional Quality designation simultaneously
- C. Class B pathogen reduction and one vector attraction reduction option simultaneously
- D. Only the heavy metal reduction requirements because lime binds with metals and reduces their bioavailability

87. A plant operator is comparing the solids capture rates of two gravity belt thickeners processing WAS. Thickener A captures 96% of the feed solids in the thickened product, while Thickener B captures only 82%. What is the primary operational consequence of Thickener B's lower capture rate?

- A. Thickener B produces a drier thickened sludge because the lost solids are primarily water-retaining biological particles
- B. Thickener B sends significantly more solids back to the liquid treatment process through its filtrate, increasing the recycle load
- C. Thickener B's lower capture rate has no operational consequence because the lost solids are biologically inactive
- D. Thickener B produces thickened sludge with a higher volatile solids content because only the inorganic fraction is lost

88. An operator collects samples for NPDES compliance monitoring and discovers that the automatic sampler has been malfunctioning — the ice in the refrigeration compartment melted 12 hours into the 24-hour composite collection, and the sample temperature rose from 4°C to 15°C for the remaining 12 hours. The composite is for BOD<sub>5</sub> analysis. How should the operator handle this situation?

- A. Analyze the composite as collected because BOD<sub>5</sub> is not significantly affected by temperature excursions during collection
- B. Adjust the final BOD result mathematically to compensate for the accelerated biological activity during the warm period
- C. Flag the sample as potentially compromised due to the preservation failure, document the equipment malfunction, and recollect a new composite if the holding time permits
- D. Discard only the warm portion of the composite and analyze the first 12 hours of properly refrigerated sample

89. An operator is reviewing monthly laboratory QC data and notices that the dissolved oxygen probe calibration check has been consistently reading 0.3 mg/L higher than the Winkler titration verification for the past four months. The operator has been reporting the probe readings on the daily operating log. What is the appropriate action?

- A. Continue using the probe readings because 0.3 mg/L is within the acceptable precision of DO measurement
- B. Switch all DO reporting to Winkler titration values until the probe is repaired or replaced
- C. Average the probe and Winkler readings and report the average on all process control records
- D. Recalibrate the DO probe, investigate the cause of the persistent bias, and note the discrepancy in the QC records for the affected four-month period

90. A laboratory analyst collects a grab sample for pH analysis at 8:00 AM. Due to a workload delay, the sample is not analyzed until 10:30 AM — 2.5 hours after collection. The sample has been sitting on the laboratory bench at room temperature uncovered. The pH result is 6.8. Is this result reliable for process control purposes?

- A. The result is unreliable because pH should be measured within 15 minutes of collection — the 2.5-hour delay allows CO<sub>2</sub> exchange, temperature equilibration, and biological activity to alter the true pH
- B. The result is reliable because pH is a stable parameter that does not change significantly over a 2.5-hour period
- C. The result is reliable only if the sample was refrigerated during the 2.5-hour holding period
- D. The result is reliable because the pH of 6.8 falls within the normal range for wastewater and is therefore valid

91. An operator collects a 24-hour flow-proportional composite sample for TSS analysis. The composite container is properly refrigerated and the sample is delivered to the laboratory within 6 hours of the end of the collection period. The laboratory technician begins the TSS analysis 5 days after receipt. Is the analysis within the allowable holding time?

- A. No — the holding time is measured from sample collection, and 5 days plus 6 hours of transport exceeds the 24-hour holding time for TSS
- B. Yes — the maximum holding time for TSS is 7 days from the time of collection, and approximately 5.25 days have elapsed
- C. No — the maximum holding time for refrigerated TSS samples is 48 hours, the same as for BOD<sub>5</sub>
- D. Yes — TSS samples preserved with sulfuric acid have a 28-day holding time regardless of refrigeration

92. An operator reviewing laboratory data notices that the plant's effluent fecal coliform results show the following pattern: the results are consistently below the permit limit of 200 CFU/100 mL from Monday through Friday, but the weekend results (collected by the weekend operator) frequently exceed 400 CFU/100 mL. The chlorine residual and contact time are consistent throughout the week. What should the operator investigate?

- A. The weekend flow rates, which may be lower and causing the chlorine dose to be excessive
- B. The weekend influent BOD, which may be lower and reducing the chlorine demand of the effluent

C. The weekend sampling technique, sample handling, and laboratory procedures, which may differ from the weekday analyst's methods

D. The weekend weather conditions, which may affect UV disinfection system performance

93. An operator determines that a wastewater sample has an initial DO of 8.0 mg/L and a final DO of 2.5 mg/L after 5 days of BOD incubation. The sample was diluted by placing 30 mL of sample in a 300 mL BOD bottle (10% dilution, or dilution factor of 10). What is the BOD<sub>5</sub> result?

A. 5.5 mg/L, calculated by subtracting the final DO from the initial DO

B. 550 mg/L, calculated by dividing the DO depletion by the dilution factor

C. 0.55 mg/L, calculated by multiplying the DO depletion by the sample volume

D. 55 mg/L, calculated by multiplying the DO depletion by the dilution factor

94. A treatment plant submits monthly DMRs electronically through the state's online reporting system. The system requires the operator to enter monitoring results for each parameter, calculate the appropriate statistical measures (monthly average, weekly average, daily maximum), and certify the report with an electronic signature. If the operator discovers an error in a previously submitted DMR, what is the correct procedure?

A. Submit a corrected DMR through the same electronic system, with a narrative explanation of the error, the corrected values, and the reason for the correction

B. Submit the correction in the following month's DMR by adjusting that month's values to offset the error

C. Contact the regulatory agency by telephone and provide the corrected values verbally

D. No correction is possible once a DMR has been electronically submitted and certified

95. A laboratory performs a TSS analysis and obtains a filter weight of 1.5280 g (clean) and a filter-plus-residue weight of 1.5315 g after drying. The sample volume was 400 mL. What is the TSS concentration?

- A. 3.5 mg/L, based on the weight difference and sample volume
- B. 7.0 mg/L, based on the weight difference and sample volume
- C. 8.75 mg/L, based on the weight difference of 0.0035 g converted to milligrams and divided by the sample volume in liters
- D. 14.0 mg/L, based on the weight difference multiplied by the 8.34 conversion factor

96. An operator performing quality control on the BOD<sub>5</sub> analysis discovers that the seed control (a blank dilution water sample with seed but no wastewater sample) has consumed 1.8 mg/L of dissolved oxygen during the 5-day incubation period. What does this indicate?

- A. The seed organisms are dead and a new seed source must be prepared before any additional BOD analyses
- B. The seed organisms are active and consuming oxygen from organic matter in the seed material itself — this is normal and the seed correction must be subtracted from the sample BOD results
- C. The dilution water has been contaminated with organic matter and must be discarded and remade
- D. The incubation temperature has exceeded 20°C, causing excessive oxygen consumption by the seed organisms

97. An operator measures the chlorine residual in the contact tank effluent using the DPD method and obtains a free chlorine residual of 0.0 mg/L and a total chlorine residual of 0.8 mg/L. What does this result indicate about the disinfection conditions?

- A. No chlorine of any type is present and the disinfection system has completely failed
- B. The chlorine is entirely in the combined form (chloramines) with no free chlorine present
- C. The DPD reagent has expired and is not reacting properly with the chlorine in the sample
- D. All of the chlorine is present as free chlorine, and the total reading confirms the measurement

98. An operator reviews trend data for the aeration basin MLSS over a 30-day period and observes that the MLSS has been steadily increasing from 2,400 mg/L to 3,800 mg/L despite no change in the WAS pump settings. The WAS pump is a progressive cavity pump. What is the most likely explanation?

- A. The influent BOD has increased, stimulating more biological growth than the WAS pump can remove
- B. The aeration basin is accumulating inorganic solids from grit that passed through the grit removal system
- C. The WAS pump stator has worn, reducing the pump's actual output below the indicated setting, so fewer solids are being wasted than intended
- D. The secondary clarifier is returning a more concentrated RAS stream that is adding solids to the aeration basin

99. An operator needs to verify that a batch of sodium hypochlorite solution received from the supplier matches the labeled concentration of 12.5%. The operator performs a titration test and determines the actual available chlorine is 10.2%. What adjustment must the operator make to the chemical feed rate?

- A. Increase the feed rate by approximately 22.5% to compensate for the lower-than-labeled concentration and deliver the same mass of chlorine per day
- B. Decrease the feed rate by 18% because the lower concentration reduces the chemical's reactivity
- C. Make no adjustment because the 2.3% difference is within the acceptable manufacturing tolerance
- D. Dilute the solution with water to exactly 10.0% concentration for easier feed rate calculation

100. A treatment plant operator is preparing to submit the monthly DMR. The permit requires a monthly average for effluent BOD based on weekly composite samples. Four weekly results were collected: 18, 24, 35, and 22 mg/L. The monthly average limit is 30 mg/L and the weekly average limit is 45 mg/L. What is the compliance status?

- A. In violation of the monthly average because one individual weekly result (35 mg/L) exceeds 30 mg/L

B. In compliance for both limits — the monthly average is 24.75 mg/L (below 30) and no weekly result exceeds 45 mg/L

C. In violation of the weekly average because the 35 mg/L result exceeds 30 mg/L

D. In compliance for the weekly limit but in violation of the monthly average based on the four-week data

## Practice Exam 5: Answer Key and Explanations

1. D — A recurring weekday-only BOD spike during evening hours is the classic pattern of an industrial facility operating an evening production shift. Residential cooking activities produce modest BOD increases, not spikes to 380 mg/L. The weekday-only pattern eliminates residential sources (which occur seven days per week) and points to a commercial or industrial operation that does not run on weekends.

2. C — A TSS spike from 260 to 420 mg/L with stable BOD, pH, and ammonia indicates a solids-specific event rather than a general wastewater quality change. Construction sediment, grease trap cleanout waste, or an industrial solids discharge would dramatically increase TSS without proportionally affecting the organic or nitrogen parameters. This warrants investigation of upstream sources.

3. A — When flow decreases but BOD concentration increases proportionally, the total mass loading ( $\text{lbs/day} = \text{mg/L} \times \text{MGD} \times 8.34$ ) may remain similar — but the concentration per unit volume in the aeration basin increases. The operator must verify that the aeration system can supply enough dissolved oxygen to meet the higher concentration-driven demand in the same basin volume.

4. B — With 4 hours before the unknown substance arrives, the operator should immediately begin enhanced influent monitoring (pH, color, odor, DO) to detect the substance as early as possible and prepare contingency plans to protect the biological process. Shutting down influent pumps risks upstream overflows. Waiting passively wastes the advance warning time. Monitoring first, then acting based on what is detected, is the correct approach.

5. C — Centrate ammonia load =  $1,100 \text{ mg/L} \times 0.02 \text{ MGD} \times 8.34 = 183.5 \text{ lbs/day}$ . Total =  $1,050 + 183.5 = 1,233.5 \text{ lbs/day}$ , which exceeds the 1,200 lbs/day design capacity by approximately 33.5 lbs/day. This demonstrates why sidestream contributions must be calculated and included in the total plant loading evaluation — a small high-concentration flow can push the total beyond design.

6. D — Train B's SVI of 185 mL/g (compared to Train A's 105 mL/g) indicates filamentous organisms are causing the sludge to settle poorly in Train B's secondary clarifier. Poor settling allows biological solids to wash over the effluent weir, directly increasing effluent BOD and TSS. Since both trains have identical equipment, flow, and DO, the biological condition (filamentous growth) is the differentiating factor.

7. B — Extended aeration requires detention times of 18–36 hours (compared to 4–8 hours for conventional), meaning significantly larger aeration basins and continuous aeration over the longer detention period. The energy cost for running blowers 24 hours a day through a much larger basin volume is substantially higher. This increased infrastructure and energy cost is the primary trade-off for the improved effluent quality.

8. A — Weir length =  $\pi \times D = 3.14 \times 70 = 219.8$  ft. WOR = Plant flow  $\div$  Weir length = 2,800,000 GPD  $\div$  219.8 = 12,740 GPD/ft. Note: only the plant flow (not RAS) is used for WOR because the RAS does not flow over the weir. The result of 12,740 GPD/ft is within the typical design range of 10,000–20,000 GPD/ft.

9. D — SRT = System solids  $\div$  Total solids removed = 15,000  $\div$  (2,500 + 200) = 15,000  $\div$  2,700 = 5.6 days. At 12°C, nitrifying bacteria require a minimum SRT of approximately 12–15 days because their growth rate slows dramatically in cold water. An SRT of 5.6 days is far too short for nitrification at this temperature — the nitrifiers are being wasted faster than they can reproduce.

10. C — Step feeding distributes the influent at multiple points along the basin, which spreads the organic load more evenly and effectively increases the basin volume available for flow management during wet-weather events. Instead of concentrating all the load at the inlet (which causes oxygen depletion), the load is shared across the basin, improving both treatment performance and hydraulic flexibility.

11. B — The operator must account for the declining concentration when setting the feed rate. If the pump delivers the same volume as when the solution was 12%, but the actual concentration is now 10.5%, the chlorine mass delivered is 16% less than intended. The operator must either increase the pump output proportionally or recalculate the feed rate based on the current measured concentration.

12. A — UV disinfection provides no persistent residual — it damages pathogen DNA during exposure but leaves nothing in the effluent to prevent regrowth if the effluent is recontaminated (by cross-connections, contaminated stormwater in outfall structures, or bird droppings in open channels). A chlorine backup provides a residual that maintains disinfecting power after the UV exposure.

13. A — The plant is nitrifying well (0.8 mg/L ammonia) but not denitrifying adequately (6.2 mg/L nitrate). Increasing the internal recycle rate returns more nitrate-rich mixed liquor to the anoxic zone, providing more substrate for denitrifying bacteria to convert to nitrogen gas. With adequate carbon source already available, a higher recycle rate directly increases nitrate removal.

14. C — Monthly average compliance is determined by calculating the arithmetic mean of all sample results collected during the calendar month. A single-day result of 26 mg/L (BOD) or 32 mg/L (TSS) does not constitute a monthly average violation — it is one data point that will be averaged with all other results from the month. The full month's dataset is needed before compliance can be assessed.

15. D — With DO, pH, and alkalinity all adequate, the only remaining factor limiting nitrification is the growth rate of the nitrifying bacteria at the colder temperature. Reducing the WAS rate increases the SRT, giving the slower-growing nitrifiers enough residence time to reproduce and maintain their population at 13°C. This is the most direct and effective single adjustment.

16. B — Total dose = Demand + Residual = 4.8 + 0.5 = 5.3 mg/L. lbs/day = 5.3 × 3.0 × 8.34 = 132.6 lbs/day. The pounds formula converts the concentration-based dose into the mass of chlorine that must be fed daily. The complete dose must include both the demand (chlorine consumed) and the desired residual (chlorine remaining for disinfection).

17. D — A 150% flow increase dramatically raises the surface overflow rate — the upward velocity of water in the clarifier exceeds the settling velocity of many particles. The detention time is simultaneously reduced, giving particles less time to settle. Both effects combine to reduce TSS removal efficiency from the normal 58% to 35%.

18. A — The operator forgot the 8.34 conversion factor. The correct calculation is: lbs = mg/L × MG × 8.34 = 3,000 × 0.8 × 8.34 = 20,016 lbs. The product of mg/L and million gallons must be multiplied by 8.34 (the weight of one gallon of water in pounds) to convert to pounds. This is the most common mathematical error on the ABC exam.

19. C — With all standard process parameters appearing normal (MLSS, SVI, blanket depth, RAS, DO), the problem is likely mechanical rather than biological. The secondary clarifier effluent weir should be inspected for algae growth, grease buildup, uneven leveling, or physical damage that disrupts the uniform flow distribution over the weir and creates localized currents that pull solids into the effluent.

20. B — Volume =  $60 \times 8 \times 6 = 2,880 \text{ ft}^3 \times 7.48 = 21,542 \text{ gal}$ . Flow in GPM =  $1,500,000 \div 1,440 = 1,041.7 \text{ GPM}$ . DT =  $21,542 \div 1,041.7 = 20.7 \text{ minutes}$ . CT =  $1.0 \text{ mg/L} \times 20.7 \text{ min} = 20.7 \text{ mg}\cdot\text{min/L}$ , approximately  $21.4 \text{ mg}\cdot\text{min/L}$ . This should be compared to the permit-required CT value to determine adequacy.

21. D — The problem is that insufficient nitrate is being returned to the anoxic zone for denitrification. At 200% internal recycle, a significant fraction of the nitrate produced in the aerobic zone passes directly to the clarifier and exits in the effluent. Increasing the recycle to 300–400% returns more nitrate to the anoxic zone where it can be converted to nitrogen gas, reducing the effluent nitrate.

22. A — BOD removal =  $[(200 - 12) \div 200] \times 100 = 94\%$ . The effluent BOD of 12 mg/L is well below the 30 mg/L concentration limit, and the 94% removal far exceeds the 85% minimum removal requirement. Both permit conditions are met. There is no such thing as "over-treatment" from a compliance perspective.

23. C — A cascade aerator relies on physical splashing and turbulence to transfer atmospheric oxygen into the effluent. If the cascade structure has become fouled with algae, mineral scale, or debris, or if the flow distribution across the cascade weirs has been disrupted, the oxygen transfer efficiency decreases and the effluent DO drops below the permit minimum.

24. B — The air supply rate in an aerated grit chamber controls the intensity of the spiral rolling pattern that keeps organic solids in suspension while allowing dense grit to settle. If the air rate is too low, the rolling velocity is insufficient to keep organic material suspended, and it settles along with the grit — producing "dirty" grit with high volatile solids content.

25. D — Since the ferric chloride dose and influent phosphorus haven't changed, the most likely cause of rising effluent phosphorus is degradation of the chemical solution. Ferric chloride can degrade through hydrolysis, precipitation, or dilution in storage. If the effective iron concentration has decreased, the same volume of solution delivers less iron, and less phosphorus is precipitated.

26. C — When flow exceeds the plant's hydraulic capacity, the approved approach at many plants is to provide primary treatment and disinfection to the excess flow, then blend it with fully treated effluent before discharge. This provides at least partial treatment to all flow rather than allowing raw sewage to be discharged or risking upstream overflows from flow restriction.

27. A — If the WAS pump is delivering the set flow rate and the MLSS continues to rise, the actual solids production is exceeding the wasting rate. An undetected increase in organic loading — such as a new industrial discharge that elevates BOD without being immediately apparent in routine monitoring — would promote biological growth that outpaces the current wasting rate.

28. B — A chlorine residual of 0.3 mg/L combined with a fecal coliform count of 2,400 CFU/100 mL (12 times the permit limit) indicates that while chlorine is present, the contact time is insufficient for the chlorine to inactivate the organisms. The CT value (chlorine residual  $\times$  contact time) is below the minimum needed for adequate disinfection, most likely because the flow moves through the contact tank too quickly.

29. D — Septage at 6,000 mg/L BOD discharged rapidly into the headworks creates a massive organic shock load that dramatically increases the oxygen demand in the aeration basin. If the aeration system cannot increase oxygen supply fast enough to match the surge, the DO crashes, biological treatment is impaired, and the activated sludge may take days to recover.

30. A —  $\text{lbs/day} = 45 \text{ mg/L} \times 2.5 \text{ MGD} \times 8.34 = 938.3 \text{ lbs/day}$ . This is a straightforward application of the pounds formula. The result tells the operator how many pounds of alum chemical must be delivered to the process each day to maintain the target phosphorus removal.

31. C — Excessive biofilm thickness on RBC discs is corrected by increasing the hydraulic loading — either through higher influent flow or recirculation of treated effluent. The increased water flow over the disc surface creates more shear force, stripping the excess biofilm from the discs and reducing the weight that threatens the structural integrity of the disc assemblies.

32. B — In a plug-flow aeration basin, the organic load and corresponding oxygen demand are highest at the inlet where the primary effluent (with full BOD concentration) enters and mixes with the return sludge. As the wastewater progresses along the basin, the organisms progressively consume the BOD, and the oxygen demand decreases. Tapered aeration matches the air supply to this decreasing demand profile.

33. D — An SRT of 7 days is far too short for nitrification at winter temperatures, resulting in 8 mg/L effluent ammonia. Meeting a 2.0 mg/L winter ammonia limit requires extending the SRT to 15–20+ days by significantly reducing the WAS rate. The resulting higher MLSS will increase oxygen demand, likely requiring increased aeration capacity to maintain adequate DO.

34. A — Gradually increasing blower discharge pressure at constant airflow is the signature of progressively fouling diffusers. Fine bubble diffusers accumulate biological growth, mineral scale (calcium carbonate), and silt deposits that partially block the tiny air discharge openings. The blower must develop more pressure to push the same volume of air through the increasingly restricted openings.

35. B — With normal SVI (100 mL/g), normal blanket depth (1.5 ft), and normal MLSS, the bulk sludge is settling properly — the problem is not with the main sludge mass. The elevated effluent TSS is caused by fine, nonsettleable particles (pin floc, colloidal material, or dispersed biological solids) that pass through the settling zone because they are too small to be captured by gravity settling.

36. D — The original dose calculation was based on 12.5% available chlorine. At 9.8%, the solution is 21.6% weaker than labeled ( $(12.5 - 9.8) \div 12.5 = 0.216$ ). The operator must feed approximately 27% more volume ( $12.5 \div 9.8 = 1.276$ ) to deliver the same mass of chlorine. This represents a roughly 27% increase, closer to a 25-30% increase than a 50% increase.

37. C — Flow-proportional compositing collects more sample volume during high-flow periods (when more pollutant mass is being delivered) and less during low-flow periods. This produces a composite whose concentration more accurately reflects the mass-weighted average concentration over the sampling period — which is what NPDES compliance is based on. Time-proportional compositing gives equal weight to all periods regardless of flow.

38. A — BOD Loading =  $130 \times 5.0 \times 8.34 = 5,421$  lbs/day. MLVSS (lbs) =  $2,700 \times 1.5 \times 8.34 = 33,777$  lbs. F/M =  $5,421 \div 33,777 = 0.16$ . An F/M of 0.16 places the system at the boundary between conventional activated sludge (0.2–0.5) and extended aeration (0.05–0.15), suggesting the system is moderately underloaded.

39. B — The secondary effluent TSS hasn't changed (still 12 mg/L), but the filter runs are much shorter. This indicates the filter is loading faster per unit of solids — the particle characteristics have changed even though the total mass concentration is stable. A higher proportion of fine colloidal particles penetrate deeper into the media bed and cause faster headloss buildup than larger particles that are captured near the surface.

40. C — Standing wastewater at 3 feet depth in a confined space creates a drowning hazard in addition to the atmospheric and access hazards inherent in the confined space. The operator must address fall protection (preventing a fall from the ladder into the water), water rescue provisions (life ring, throw line), and PPE appropriate for working in or near wastewater before entry.

41. D — An energized 480V motor control center presents extreme arc flash and electrocution hazards. Even holding a flashlight inside the panel puts the operator within the arc flash boundary — if a short circuit occurs, the resulting arc flash can produce temperatures exceeding 35,000°F and a blast wave that causes severe burns and trauma. Only qualified electrical workers with appropriate arc flash PPE should work inside energized panels.

42. B — H<sub>2</sub>S at 6 ppm is below the 10 ppm PEL but indicates a gas leak or abnormal condition — H<sub>2</sub>S should not be detectable at 6 ppm outside a building under normal operating conditions. The operator should not enter the building without investigating the source remotely. Increasing ventilation remotely (if controls are accessible from outside) and notifying the supervisor are the correct initial responses.

43. A — The elevated chemical storage tank contains potential (gravitational) energy. Even with the pump electrically de-energized, gravity will drive chemical through an open supply line to the disconnected point. The supply valve must be closed and locked to isolate this gravity-flow energy source — failing to do so was the specific LOTO deficiency that caused the chemical release in the Exam 4 scenario.

44. C — Chlorine gas is approximately 2.5 times heavier than air (molecular weight 71 vs. air at 29). When released, it sinks and flows downhill like a dense liquid, accumulating in low-lying areas, depressions, and valleys. Moving uphill ensures personnel travel against the gas flow direction, away from the zone where chlorine concentrates to potentially lethal levels.

45. D — Before disconnecting a nearly empty chlorine cylinder, the operator must close the cylinder valve and verify that the vacuum system has pulled all remaining gas from the connection and piping. This prevents a release of residual chlorine gas when the connection is broken. If the vacuum system is not functioning or gas remains under pressure in the connection, a dangerous release can occur during disconnection.

46. D — The OSHA Bloodborne Pathogens Standard (29 CFR 1910.1030) explicitly prohibits eating, drinking, smoking, applying cosmetics, and handling contact lenses in work areas where there is a reasonable likelihood of exposure to blood or other potentially infectious materials. Wastewater samples contain OPIM, and storing food alongside them creates a direct ingestion exposure pathway.

47. A — All atmospheric readings are within safe limits (O<sub>2</sub> 20.8% > 19.5%, H<sub>2</sub>S 3 ppm < 10 ppm PEL, CO 5 ppm < 35 ppm PEL, LEL 0% < 10%). The space was ventilated and retested. The entry team includes a harnessed entrant with retrieval system, an attendant at the opening, and continuous gas monitoring. All elements of a proper permit-required confined space entry are in place.

48. C — Section 309(c)(4) of the Clean Water Act provides criminal penalties for knowingly making false statements, representations, or certifications in any record, report, or document required under the CWA. Penalties include fines of up to \$10,000 per day of violation and imprisonment of up to 2 years. This applies to DMRs, laboratory records, and any other compliance documentation.

49. B — A safety shower that cannot deliver the minimum 20 GPM flow specified by ANSI Z358.1 is non-functional for emergency decontamination. The shower must be taken out of service, clearly marked as non-functional, and an alternative shower location must be posted. Repair should be prioritized as an urgent safety issue because personnel in the chemical storage area have no emergency decontamination capability until it is fixed.

50. B — Laboratory results produced by a laboratory whose state certification has lapsed may not be accepted for NPDES compliance purposes. State certification programs verify that laboratories maintain quality control standards, employ qualified analysts, and use approved methods. When the certification expires, the regulatory assurance of data quality is lost, and all results during the lapsed period are potentially invalid.

51. A — A corrective action plan should demonstrate that the plant has identified why each violation occurred (root cause analysis), implemented specific measures to correct the identified causes (corrective actions with timelines), established procedures to prevent recurrence (preventive measures), and enhanced its monitoring program to detect developing problems earlier. This demonstrates good faith and operational competence.

52. C — An effluent DO of 4.2 mg/L below a permit minimum of 5.0 mg/L is a permit violation regardless of natural variability. Instantaneous limits (like DO and pH) apply to every measurement — there is no averaging. The violation must be documented, the cause investigated (check cascade aerator, check aeration system), corrective action taken, and the regulatory authority notified within 24 hours.

53. D — The daily operating log serves as the plant's comprehensive operational record — documenting conditions, equipment status, process adjustments, observations, and events that support daily process control decisions, demonstrate compliance to regulators during inspections, provide institutional knowledge for future operators, and serve as evidence of proper operation and maintenance.

54. B — The correct method for correcting an error in a permanent record is to draw a single line through the incorrect entry (leaving it legible), write the correct value nearby, and initial and date the correction. This transparent method preserves the record's integrity — anyone reviewing the log can see both the original entry and the correction, preventing any appearance of data falsification.

55. A — Motor amperage that exceeds the nameplate full-load rating indicates the motor is working harder than designed. The most common causes are a clogged impeller (increased friction), a partially closed discharge valve (increased head), or the pump operating far from its best efficiency point on the performance curve. The condition should be investigated before the sustained overload damages the motor windings.

56. C — Vibration analysis identifies the specific frequency components of the vibration signal, which correspond to different mechanical faults. Bearing defects produce characteristic high-frequency patterns, misalignment produces specific 1× and 2× running speed patterns, and imbalance produces a dominant 1× running speed signal. The frequency signature tells the analyst exactly what type of problem exists.

57. B — Identical pumps under identical system conditions should produce identical performance. Pump 2 developing 38 psi versus Pump 1's 32 psi to deliver the same 850 GPM indicates Pump 2 is fighting more downstream resistance. A partially restricted discharge line (scale buildup, partially closed valve, or obstruction) forces the pump to develop higher pressure to push the same volume through the restriction.

58. D — The generator starts and builds voltage normally, indicating the engine and generator are functioning. The delay is specifically in the transfer process — the ATS is taking 45 seconds instead of 15 to recognize the generator output and transfer the load. This points to the ATS's voltage-sensing circuits, time-delay relays, or the mechanical transfer mechanism as the most likely components needing inspection.

59. A — In a closed system with no external water additions, the effluent flow should equal the influent flow (minus minor losses to evaporation and sludge removal). A consistent 0.3 MGD discrepancy indicates one or both meters have drifted from calibration. Both should be verified against a known reference — draw-down test, bucket test, or comparison to a calibrated portable meter.

60. C — Overnight temperatures cause the wastewater and sludge in the clarifier to cool, increasing the viscosity of the water and the density/stiffness of the settled sludge blanket. The sludge collection mechanism must push through this thicker, more viscous material, which requires more torque. As the day warms, the sludge becomes less viscous and the torque alarm clears. This is a common seasonal pattern.

61. D — At 100% speed, the pump delivers 10 GPH at full stroke. The target is 3.5 GPH. Stroke percentage =  $3.5 \div 10 \times 100 = 35\%$ . Setting the stroke length to 35% at full speed delivers the target 3.5

GPH. Chemical metering pump output is the product of stroke volume (proportional to stroke length setting) and stroke frequency (speed setting).

62. B — With only 8% remaining and 10 days until the scheduled delivery, the plant will likely run out of sodium hypochlorite before the delivery arrives — causing an interruption in disinfection that would constitute a permit violation. The operator should arrange an emergency delivery to prevent the tank from running empty. Reducing the chlorine dose would compromise disinfection effectiveness.

63. A — Minor weeping (approximately one drip per second) from a progressive cavity pump packing gland is generally considered normal and indicates the packing is properly lubricated. The packing on a sludge pump needs some lubrication from the pumped fluid to prevent overheating and premature wear. Excessive leakage would warrant tightening, but a slow drip is typically acceptable.

64. C — Total critical load =  $200 + 280 + 75 + 25 + 15 + 60 = 655$  kW. The 750 kW generator can handle this load with 95 kW of margin (12.7%). However, the building HVAC (60 kW) might be classified as non-critical and could be shed if needed, providing additional margin. The generator has adequate capacity for the identified critical loads.

65. D — A leaking check valve allows reverse flow each time the pump stops, creating pressure surges (water hammer) that stress the piping system. Additionally, the discharge line drains back through the pump between cycles, requiring the pump to re-prime and refill the line at each start. The repeated hammering and drain-back cycle damages pipes, fittings, and the pump over time.

66. B — Belt tracking is controlled by a tracking system (guide rollers, pneumatic correction mechanisms, or manual adjustment screws) that keeps the belt centered on the rollers during operation. If the tracking system is out of adjustment or has malfunctioned, the belt drifts to one side, causing uneven sludge distribution and reduced cake capture along the misaligned edge.

67. C — A consistent 0.3-unit offset between the online and laboratory instruments indicates the online analyzer has drifted from its calibration point. Since the laboratory meter was recently calibrated with fresh buffers (the reference standard), the online analyzer should be recalibrated to bring it into agreement with the laboratory. Any compliance data from the online instrument should reference the laboratory verification.

68. A — Monthly no-load tests verify that the engine starts, runs, and the generator produces voltage — but they do not verify that the generator can actually deliver its full rated power under load. Only a load

bank test (running the generator at its rated kW output for an extended period) confirms this critical capability. Without the annual load test, the generator's ability to power the plant during an actual outage is unverified.

69. D — Gray-black mixed liquor with a DO of 0.4 mg/L despite full blower output indicates the aeration system cannot meet the oxygen demand — likely from a significant increase in organic loading. The basin has become oxygen-depleted, and anaerobic conditions are developing (evidenced by the color change to gray-black from the formation of metal sulfides under anaerobic conditions).

70. B — Sludge that drains well in the gravity zone (indicating adequate polymer conditioning) but tears apart in the high-pressure zone suggests the belt tension or roller pressure is too high for the sludge's physical characteristics. Excessive pressure shears the conditioned floc apart rather than squeezing water from it, causing the cake to break and fall through the belt gaps.

71. A — Declining thickened sludge concentration at constant feed rate suggests the sludge blanket is not compacting as well as it should. Reducing the withdrawal rate allows the sludge blanket more time to consolidate under gravity, producing a more concentrated underflow. The withdrawal rate should be reduced gradually while monitoring the blanket depth to prevent it from rising too high.

72. C — Clear centrate but unchanged cake solids after a 20% polymer reduction is deceptive — the polymer reduction has actually reduced the solids capture efficiency. Fine particles that were previously bound into the floc by the higher polymer dose are now escaping in the centrate. While the cake appears similar, the total solids recovery has decreased, sending more solids back to the liquid process.

73. D — Methane-forming bacteria are extremely sensitive to temperature changes — even a 3°F increase applied suddenly can stress them. The volatile acid rise and gas production drop indicate the methanogens are struggling. The temperature should be returned to 97°F immediately. Future temperature adjustments should be made gradually — no more than 1°F per week — to allow the biology to acclimate.

74. B — Poor supernatant quality (1,800 mg/L TSS vs. normal 400 mg/L) means the secondary digester is returning a heavy solids load back to the liquid treatment process when the supernatant is decanted to the headworks. This increases the loading on the primary clarifiers and aeration basins, potentially affecting treatment performance and increasing sludge production — a negative feedback loop.

75. A — Scarifying (scoring or cracking) the surface crust is the standard technique for improving drying on beds where a hard crust has formed over liquid sludge. The cracks allow moisture vapor to escape from beneath the crust and permit air to penetrate into the wet underlying material, promoting both evaporation and aerobic decomposition that further reduces moisture content.

76. A — Using the Van Kleeck equation:  $VS_{in} = 0.74$ ,  $VS_{out} = 0.58$ .  $VSR = [(0.74 - 0.58) \div (0.74 - (0.74 \times 0.58))] \times 100 = [0.16 \div (0.74 - 0.429)] \times 100 = [0.16 \div 0.311] \times 100 = 51.4\%$ , approximately 49–51% depending on rounding. This exceeds the 38% minimum for Part 503 vector attraction reduction.

77. D — Methane volume =  $8,500 \text{ ft}^3 \times 0.62 = 5,270 \text{ ft}^3$  of methane per day. Energy =  $5,270 \text{ ft}^3 \times 600 \text{ BTU/ft}^3 = 3,162,000 \text{ BTU/day}$ . This energy can be used to heat the digester, power a cogeneration engine, or offset natural gas purchases — a significant economic and environmental benefit of anaerobic digestion.

78. B — While all reported values are below the ceiling concentrations, comparison to the Table 3 pollutant concentration limits reveals that at least one metal exceeds the EQ threshold. For example, the Table 3 limit for copper is 1,500 mg/kg (the reported 850 is OK), but checking all metals against their specific Table 3 limits will identify which metal(s) prevent EQ designation.

79. C — Leaking sludge containing pathogens, nutrients, organic matter, and potentially regulated metals can contaminate the soil immediately surrounding the tank and, depending on the volume and duration, migrate to groundwater or reach surface water through runoff. This creates both an environmental hazard and a regulatory violation requiring immediate containment, cleanup, and notification.

80. C — Increasing the belt tension and roller pressure in the high-pressure zone squeezes more water from the sludge, producing a drier cake. The trade-off is that excessive pressure can cause the cake to crack, tear, or extrude through the belt weave. The operator should increase pressure incrementally and monitor cake quality to find the optimal setting that achieves 22% without structural problems.

81. D — The blending ratio is designed to achieve three simultaneous objectives: reduce the moisture content to the optimal 50–60% range (dewatered biosolids at 22% are too wet for composting alone), create adequate porosity for oxygen circulation through the pile, and balance the carbon-to-nitrogen ratio to approximately 25–30:1 (the optimal range for aerobic composting microorganisms).

82. B — If the gas utilization equipment (boiler, engine-generator, or flare) has shut down or is operating at reduced capacity, the gas produced by the digester has nowhere to go. The gas accumulates in the dome, pressure rises, and the pressure relief valve vents the excess. The operator should check all gas-consuming equipment for shutdowns, restrictions, or malfunctions.

83. A — Identical sludge, identical polymer, and identical speed should produce identical results. The most common cause of performance differences between presses under these conditions is the belt tension and roller pressure settings. If Press B's tension or pressure settings are lower than Press A's, the sludge receives less compression in the high-pressure zone and retains more water.

84. C — Fecal coliform of 800 MPN/g is below the 1,000 MPN/g Class A threshold. Volatile solids reduction of 44% exceeds the 38% minimum for vector attraction reduction. All metals are below Table 3 limits. These three conditions — Class A pathogen reduction, Table 3 metals compliance, and VAR achievement — together qualify the biosolids as Exceptional Quality.

85. D — With production exceeding incinerator capacity by 2 dry tons per day, the excess must be managed through alternative means. Options include running the incinerator on extended shifts (if operationally feasible), storing the excess in a temporary holding area, or arranging alternative disposal (landfilling or land application) for the volume exceeding incinerator capacity.

86. A — Lime stabilization to pH 12 for 2 hours meets Part 503 vector attraction reduction Option 8 (alkaline treatment) — but it does not automatically achieve Class A pathogen reduction. Class A requires demonstrated fecal coliform below 1,000 MPN/g or Salmonella below 3 MPN/4g through testing, or an approved alternative process that includes specific time-temperature criteria beyond simple pH elevation.

87. B — If Thickener B captures only 82% of the solids, the remaining 18% exits in the filtrate and is returned to the liquid treatment process. This represents a significant recycle load that increases the solids and BOD loading on the primary clarifiers and aeration basins. Higher capture rates (>95%) minimize this recycle impact and improve overall plant efficiency.

88. C — A 12-hour temperature excursion from 4°C to 15°C allows significant biological activity in the BOD composite — organisms consume organic matter, changing the sample's BOD from what it was at the time of collection. The sample no longer accurately represents the plant's actual conditions and should be flagged as compromised. Recollecting with properly functioning refrigeration is the correct approach.

89. D — A persistent 0.3 mg/L positive bias in the DO probe compared to the Winkler reference method over four months indicates a systematic calibration drift or instrument problem — not random measurement variation. The probe should be recalibrated, the cause of the bias investigated (membrane condition, electrolyte level, reference standard accuracy), and the four months of affected data noted in the QC records.

90. A — pH changes rapidly after collection due to CO<sub>2</sub> exchange with the atmosphere (CO<sub>2</sub> loss raises pH), temperature equilibration (pH is temperature-dependent), and biological activity that produces or consumes acids. A 2.5-hour delay with the sample uncovered at room temperature means the measured pH of 6.8 likely does not reflect the actual pH at the time of collection.

91. B — TSS samples have a maximum holding time of 7 days from the time of collection when refrigerated at 4°C. The composite collection ended approximately 5.25 days before analysis began (6 hours transport + 5 days in the lab), which is within the 7-day limit. The analysis is properly within the allowable holding time.

92. C — Consistent weekday compliance with weekend violations — when the treatment process itself is operating identically — strongly suggests a difference in the sampling or analytical procedures between the weekday and weekend analysts. The weekend operator's sampling technique, sample handling, container preparation, preservation, holding time compliance, and laboratory procedures should all be reviewed and compared to the weekday analyst's practices.

93. D — DO depletion =  $8.0 - 2.5 = 5.5$  mg/L. Dilution factor =  $300 \text{ mL} \div 30 \text{ mL} = 10$ . BOD<sub>5</sub> = Depletion  $\times$  Dilution Factor =  $5.5 \times 10 = 55$  mg/L. The dilution factor corrects for the fact that only a fraction of the BOD bottle was actual sample — the rest was dilution water. The depletion is valid (2.0+ mg/L depletion with final DO above 1.0 mg/L).

94. A — Errors in submitted DMRs must be corrected by submitting a corrected report through the same reporting system, with a clear narrative explaining what was wrong, what the correct values are, and why the error occurred. This maintains the integrity of the regulatory record. Offsetting errors in future reports or verbal corrections are not acceptable regulatory documentation practices.

95. C — Weight difference =  $1.5315 - 1.5280 = 0.0035$  g = 3.5 mg. TSS =  $3.5 \text{ mg} \div 0.400 \text{ L} = 8.75$  mg/L. The calculation converts the weight gain on the filter (in milligrams) divided by the sample volume (in liters) to produce the concentration in mg/L. This result is within the typical range for well-treated secondary effluent.

96. B — The seed control measures the oxygen demand contributed by the seed organisms themselves — not by the wastewater sample. A depletion of 1.8 mg/L in the seed control is normal and expected because the seed material (settled wastewater or commercial seed) contains some organic matter. This value is subtracted from the sample BOD results to correct for the seed's contribution.

97. D — Free chlorine residual of 0.0 mg/L with total chlorine of 0.8 mg/L means all of the chlorine present is in the combined form — chloramines (monochloramine, dichloramine). No free chlorine ( $\text{HOCl}$  or  $\text{OCl}^-$ ) is present. Combined chlorine is a weaker disinfectant than free chlorine, typically 25–100 times less effective, which means longer contact times or higher residuals are needed.

98. C — A progressive cavity pump's output decreases as the stator wears because the worn elastomer can no longer maintain the sealed cavities that move the fluid. The pump appears to be running at the set speed and output, but the actual volume delivered is lower than the setting indicates. The steadily rising MLSS confirms less sludge is being wasted than the operator intends.

99. A — The labeled concentration is 12.5% but the actual is 10.2%. To deliver the same chlorine mass:  $\text{new volume} = \text{old volume} \times (12.5 \div 10.2) = \text{old volume} \times 1.225$ . This represents a 22.5% increase in the feed rate. Without this adjustment, the plant would underdose chlorine by approximately 18%, potentially causing a disinfection failure and fecal coliform permit violation.

100. B — Monthly average =  $(18 + 24 + 35 + 22) \div 4 = 24.75$  mg/L, which is below the 30 mg/L monthly average limit. The highest individual weekly result (35 mg/L) is below the 45 mg/L weekly average limit. The plant is in compliance with both limits. Note that a single weekly result exceeding 30 mg/L does not constitute a monthly average violation — only the calculated average of all results matters.