

PRACTICE EXAM 10: ABC CLASS I

WASTEWATER TREATMENT SIMULATION

(100 QUESTIONS)

1. A treatment plant operator reviews one year of influent data and identifies three distinct seasonal patterns: winter (low flow, high concentration, cold temperature), summer (moderate flow, moderate concentration, warm temperature), and spring (high flow, low concentration, moderate temperature from snowmelt infiltration). Which season presents the greatest overall challenge to the biological treatment process?

- A. Summer, because the warm temperatures accelerate biological growth beyond the system's capacity
- B. Spring, because the high flow reduces detention time and the low concentration starves the organisms
- C. Winter, because the cold temperature slows biological activity and the high concentration increases oxygen demand simultaneously
- D. All three seasons present equal challenges because the mass loading (flow \times concentration) remains constant

2. An operator collecting an influent sample notices that the wastewater has a greenish-yellow color with a pungent chemical odor resembling bleach. The pH is 10.2 and the chlorine residual is 8.5 mg/L. The normal influent pH is 7.0 with no detectable chlorine. What is the most immediate operational concern?

- A. The high chlorine residual in the influent will kill the biological organisms in the activated sludge system if it reaches the aeration basin at this concentration
- B. The elevated pH will cause calcium carbonate to precipitate in the collection system pipes
- C. The greenish-yellow color will discolor the plant effluent and create a visible discharge violation
- D. The chemical odor will trigger odor complaints from the neighborhood surrounding the treatment plant

3. A treatment plant receives wastewater from a community that recently enacted a water conservation program. Over six months, the per capita water use has decreased by 25%, and the plant's influent flow has decreased proportionally. However, the influent BOD has increased from 200 mg/L to 265 mg/L. The plant operator calculates the mass loading and determines it has remained essentially the same. What process parameter should the operator monitor most closely?

- A. The primary clarifier surface overflow rate, which has decreased due to the lower flow
- B. The chlorine contact tank detention time, which has increased due to the lower flow
- C. The secondary clarifier weir overflow rate, which has decreased due to the lower flow
- D. The aeration basin dissolved oxygen, because the higher BOD concentration increases the oxygen demand per unit volume even though the total mass loading is unchanged

4. An operator at a treatment plant receives septage from a community with older homes that may have lead service lines. The septage BOD is 6,500 mg/L and TSS is 12,000 mg/L. The operator is concerned about potential lead contamination in the septage. Which of the following is the correct regulatory framework for managing the lead concern?

- A. Lead in septage is regulated under the Safe Drinking Water Act and does not apply to wastewater treatment
- B. Lead in the septage will be addressed by the plant's NPDES permit limits for metals in the effluent and by Part 503 limits for metals in biosolids
- C. The operator should refuse all septage from communities with lead service lines to avoid any liability
- D. Lead from septage is exempt from regulation because it originates from a drinking water source

5. An operator evaluates the impact of returning three sidestreams to the headworks simultaneously: thickener supernatant (TSS 600 mg/L, flow 0.04 MGD), digester supernatant (ammonia 800 mg/L, flow 0.015 MGD), and centrate (BOD 350 mg/L, ammonia 500 mg/L, TSS 1,200 mg/L, flow 0.03 MGD). The main influent flow is 3.0 MGD. Which sidestream scheduling strategy would minimize the impact on the treatment process?

- A. Return all three sidestreams during the overnight low-flow period to maximize dilution with the stored morning peak
- B. Return all three sidestreams during the morning peak flow period when the main influent provides maximum dilution
- C. Stagger the return of each sidestream at different times throughout the day to distribute their combined load over 24 hours and avoid a concentrated slug
- D. Combine all three sidestreams into a single holding tank and feed them at a constant rate regardless of the main plant flow pattern

6. An operator at a conventional activated sludge plant discovers the following conditions simultaneously: the effluent BOD is 42 mg/L (limit 30), the effluent TSS is 55 mg/L (limit 30), the aeration basin DO is 0.3 mg/L, the MLSS is 1,200 mg/L (target 2,500), and the SVI is 85 mL/g. The influent loading has not changed. Which of the following root cause analyses is most consistent with ALL of these symptoms?

- A. A toxic discharge has killed the biological organisms and the dead cells are floating out of the clarifier
- B. Filamentous bulking has caused the sludge to lose its settling ability and wash out of the secondary clarifier
- C. The primary clarifier has failed, allowing excessive solids to overwhelm the biological process capacity
- D. The WAS rate was inadvertently set too high, wasting most of the biology from the system — the low MLSS means few organisms remain to consume BOD, the low DO reflects the remaining organisms' inability to maintain adequate oxygen uptake, and the high effluent results from inadequate treatment and solids washout

7. A treatment plant operates an activated sludge system at an MLSS of 3,000 mg/L with an SVI of 130 mL/g. The plant's secondary clarifier has a surface area of 4,500 ft² and receives a combined flow (plant + RAS) of 5.5 MGD. The operator calculates the SLR at 24.4 lbs/day/ft². The effluent TSS is 14 mg/L. The operator plans to increase the MLSS to 3,500 mg/L to improve nitrification. Before making this change, what should the operator verify?

- A. That the influent flow has increased proportionally to justify the higher MLSS concentration
- B. That the aeration basin has adequate volume to physically contain the additional mixed liquor solids
- C. That the secondary clarifier can handle the increased SLR without exceeding its design capacity, since higher MLSS at the same flow will proportionally increase the solids loading rate
- D. That the WAS pump has adequate capacity to waste the additional solids being generated at the higher MLSS

8. An activated sludge plant with an F/M ratio of 0.22 and SRT of 10 days produces effluent with BOD 8 mg/L and TSS 7 mg/L. The aeration basin has a DO of 2.0 mg/L and pH of 7.0. The effluent ammonia is 0.3 mg/L. An industrial user begins discharging wastewater containing 50 mg/L zinc. Within two weeks, the effluent ammonia rises to 15 mg/L while the effluent BOD remains at 10 mg/L. What does this differential response indicate?

- A. The zinc concentration is too low to affect any biological organisms and the ammonia increase is coincidental
- B. Nitrifying bacteria are more sensitive to zinc toxicity than heterotrophic BOD-removing bacteria — the zinc has selectively inhibited the nitrifiers while the heterotrophs continue to function
- C. The zinc has improved the denitrification process, converting more ammonia to nitrogen gas and reducing the total nitrogen
- D. The zinc is reacting chemically with the ammonia, preventing the laboratory from accurately measuring the true ammonia concentration

9. An operator at a treatment plant with both UV and chlorine disinfection (run in series) reviews the monitoring data and finds: UV dose 45 mJ/cm², chlorine residual after contact tank 0.5 mg/L, effluent fecal coliform <2 CFU/100 mL (detection limit). The permit limit is 200 CFU/100 mL as a monthly geometric mean. The superintendent proposes shutting down the UV system to save energy since the chlorine alone would likely meet the permit limit. What should the operator advise?

- A. Agree with the superintendent — the chlorine system alone provides adequate disinfection and the UV energy savings are significant

B. Disagree — running both systems provides redundancy and a significant safety margin that protects against upsets in either system

C. Agree, but recommend keeping the UV system in standby mode for use only during chlorine system maintenance

D. Disagree — UV and chlorine work synergistically, and removing one would reduce the overall disinfection efficiency by more than 50%

10. A treatment plant must meet a total phosphorus limit of 0.5 mg/L. The current effluent total P is 3.5 mg/L. The operator begins adding ferric chloride at 40 mg/L to the secondary clarifier influent. After two weeks, the effluent total P drops to 0.4 mg/L. However, the operator also observes that the aeration basin pH has dropped from 7.2 to 6.3 and the effluent alkalinity has decreased from 120 mg/L to 35 mg/L. If the operator does not address the pH decline, which additional treatment process will fail next?

A. Primary sedimentation, because the low pH will dissolve the primary sludge back into solution

B. UV disinfection, because the low pH reduces UV transmittance below the effective threshold

C. Chlorine disinfection, because the lower pH shifts the chlorine equilibrium toward the more effective HOCl form

D. Nitrification, because the pH of 6.3 and alkalinity of 35 mg/L are both below the minimum thresholds for stable nitrification

11. An operator at a plant with an MLE biological nutrient removal system observes the following: the anoxic zone DO is 0.0 mg/L, the ORP is -120 mV, the influent BOD provides adequate carbon, the internal recycle rate is 400%, and the aerobic zone DO is 3.5 mg/L. Despite these apparently ideal conditions, the effluent nitrate remains at 14 mg/L (total nitrogen 16 mg/L, limit 10 mg/L). The operator has already maximized the internal recycle rate. What additional factor could explain the incomplete denitrification?

A. The aerobic zone DO of 3.5 mg/L is being carried into the anoxic zone through the internal recycle, creating a micro-aerobic zone at the recycle entry point that inhibits denitrification locally

B. The ORP of -120 mV is not negative enough for denitrification, which requires ORP below -200 mV

C. The anoxic zone detention time is too short for the denitrifying bacteria to convert all the returned nitrate

D. The 400% recycle rate is returning too much nitrate — reducing the recycle would improve denitrification

12. A plant operator calculates the following: influent BOD 225 mg/L, primary effluent BOD 148 mg/L, secondary effluent BOD 12 mg/L, plant flow 3.0 MGD. What are the primary clarifier BOD removal efficiency, the secondary treatment BOD removal efficiency, and the overall plant BOD removal efficiency?

A. Primary 34%, Secondary 92%, Overall 95% — all within expected performance ranges

B. Primary 34%, Secondary 92%, Overall 94.7% — both individual process removals and overall removal indicate excellent performance

C. Primary 50%, Secondary 85%, Overall 94% — primary removal exceeds typical range indicating excellent performance

D. Primary 40%, Secondary 88%, Overall 92% — secondary removal is below typical efficiency and should be investigated

13. A treatment plant operates a contact stabilization activated sludge system with a 30-minute contact zone and a 4-hour stabilization zone. The operator observes that the effluent BOD has increased from 8 mg/L to 25 mg/L over one week. The MLSS in the contact zone is 1,500 mg/L and the MLSS in the stabilization zone is 6,000 mg/L. The DO is 2.5 mg/L in both zones. The SVI is 95 mL/g. What should the operator investigate first?

A. Whether the contact zone detention time has decreased due to increased flow, reducing the adsorption time below the minimum needed for BOD removal

B. Whether the primary clarifier is sending excess solids to the contact zone, overwhelming its capacity

C. Whether the stabilization zone organisms have died due to a toxic event, preventing them from regenerating their adsorptive capacity before returning to the contact zone

D. Whether the secondary clarifier is experiencing hydraulic short-circuiting that allows untreated mixed liquor to bypass the settling zone

14. A plant's NPDES permit requires both concentration limits and mass limits for BOD. The concentration limit is 30 mg/L monthly average and the mass limit is 750 lbs/day monthly average. The plant flow is 2.8 MGD. At what effluent BOD concentration would the mass limit become the controlling (more restrictive) limit?

A. At any effluent BOD above 32.1 mg/L, the mass limit of 750 lbs/day becomes more restrictive than the 30 mg/L concentration limit

B. The concentration limit is always more restrictive regardless of the flow rate

C. At any effluent BOD above 25 mg/L, the mass limit becomes more restrictive

D. The mass limit and concentration limit are equivalent at exactly 30 mg/L and neither is more restrictive

15. An operator at a treatment plant using alum for chemical phosphorus removal discovers that the effluent phosphorus has increased from 0.4 mg/L to 1.8 mg/L over two weeks despite maintaining the same alum dose. The influent phosphorus has not changed. Investigation reveals that the secondary clarifier effluent TSS has increased from 8 mg/L to 22 mg/L during the same period. What is the connection between the rising TSS and the rising phosphorus?

A. The alum has depleted the alkalinity to the point where the pH cannot support chemical precipitation

B. The increased TSS indicates biological process upset that has also impaired the chemical precipitation mechanism

C. The phosphorus bound to the increased suspended solids (both biological phosphorus in the cells and chemical precipitate particles) is being carried over the clarifier weir, increasing the total effluent phosphorus

D. The higher TSS has increased the chlorine demand, and the excess chlorine is dissolving the ferric phosphate precipitate

16. A wastewater treatment plant has an aeration basin with a volume of 1.2 MG and an MLSS of 3,400 mg/L. The plant flow is 4.0 MGD with a primary effluent BOD of 140 mg/L. The MLVSS is 80% of MLSS. The operator is asked to calculate the F/M ratio using both MLSS and MLVSS as the denominator. What are the two F/M values, and which is technically more accurate?

- A. F/M (MLSS) = 0.14, F/M (MLVSS) = 0.17 — both indicate extended aeration operation
- B. F/M (MLVSS) = 0.14 is more accurate because MLVSS represents the active biological fraction, while F/M (MLSS) = 0.11 includes inert material in the denominator
- C. F/M (MLSS) = 0.20 and F/M (MLVSS) = 0.14 — both indicate the system is underloaded
- D. F/M (MLSS) is always more accurate because MLVSS excludes important fixed solids that participate in treatment

17. An operator operates two identical secondary clarifiers in parallel. Clarifier A receives 55% of the flow and Clarifier B receives 45%. Both have the same surface area. The operator notices that Clarifier A consistently produces slightly higher effluent TSS (14 mg/L) than Clarifier B (8 mg/L). The operator proposes equalizing the flow split to 50/50. Before making this change, what potential impact should the operator consider?

- A. Equalizing the flow will immediately resolve the TSS difference because both clarifiers will operate at the same SOR
- B. Equalizing the flow may worsen Clarifier B's performance if it is currently operating optimally at the lower loading
- C. Equalizing the flow will have no effect because the TSS difference is caused by biological factors, not hydraulic loading
- D. Equalizing the flow will reduce Clarifier A's effluent TSS but will not change the combined plant effluent quality

18. A treatment plant operator discovers that the 30-minute settled sludge volume has been 985 mL/L for the past three days. The MLSS is 3,000 mg/L. The operator calculates the SVI at 328 mL/g. The microscopic examination reveals abundant *Sphaerotilus natans* filaments extending from the floc surface. Which combination of operational conditions most commonly promotes *Sphaerotilus* growth?

- A. Low dissolved oxygen (below 1.0 mg/L) combined with high F/M ratio and readily biodegradable organic matter from septic influent
- B. High dissolved oxygen (above 4.0 mg/L) combined with low temperature and high SRT

C. Neutral pH (7.0) combined with adequate nutrients and moderate organic loading

D. High alkalinity combined with excessive return activated sludge rate and long detention time

19. A plant operating an oxidation ditch achieves excellent BOD removal (effluent 6 mg/L) and complete nitrification (effluent ammonia 0.3 mg/L) at an SRT of 20 days. The effluent nitrate is 18 mg/L. The plant has no separate anoxic zone. However, the operator notices that the DO in portions of the ditch channel drops to 0.3 mg/L between the brush aerators. Can this low-DO zone provide denitrification?

A. No — denitrification requires a completely separate anoxic reactor with supplemental carbon addition

B. No — the DO of 0.3 mg/L is too high for any denitrification to occur in the oxidation ditch

C. Yes — the oxidation ditch naturally creates alternating aerobic and anoxic zones as the mixed liquor circulates past the aerators and through the low-DO channel sections

D. Yes — but only if the operator adds methanol to the low-DO sections as a supplemental carbon source

20. An operator at a treatment plant with both sand filtration and UV disinfection must decide the order of maintenance activities for the coming weekend. The sand filter needs backwash optimization (currently producing 5 NTU filtrate instead of the target 2 NTU), and the UV quartz sleeves need cleaning (intensity has dropped 15% from baseline). Only one activity can be performed this weekend. Which should be prioritized and why?

A. UV sleeve cleaning, because the 15% intensity decline directly impacts disinfection effectiveness

B. Sand filter optimization, because reducing the filtrate turbidity from 5 NTU to 2 NTU will improve UV transmittance, which indirectly improves UV disinfection performance — addressing the root cause benefits both systems

C. Neither is urgent because both systems are still operating within acceptable parameters

D. Both activities should be deferred until they can be performed simultaneously during a scheduled plant shutdown

21. An operator at a treatment plant is asked to estimate the total daily oxygen requirement for the activated sludge process. The plant treats 3.0 MGD with a primary effluent BOD of 150 mg/L. The BOD removal is 95%. Nitrification converts 30 mg/L of ammonia nitrogen. The oxygen factors are: 1.5 lbs O₂/lb BOD removed and 4.6 lbs O₂/lb NH₃-N oxidized. What is the approximate total oxygen demand?

A. Approximately 5,673 lbs O₂/day for carbonaceous demand plus approximately 3,451 lbs O₂/day for nitrification, totaling approximately 9,124 lbs O₂/day

B. Approximately 3,756 lbs O₂/day for carbonaceous demand only, with no additional oxygen needed for nitrification

C. Approximately 5,673 lbs O₂/day for combined carbonaceous and nitrification demand

D. Approximately 9,124 lbs O₂/day, but denitrification will recover approximately 2.86 lbs O₂/lb NO₃-N reduced

22. A treatment plant has two parallel activated sludge trains. During a period when one train is offline for maintenance, the remaining train must handle 100% of the plant flow. The operator calculates that the single train's clarifier will operate at an SOR of 1,100 GPD/ft² (design max 1,200) and an SLR of 38 lbs/day/ft² (design max 30). Which parameter represents the greater risk to effluent quality?

A. The SOR of 1,100 GPD/ft², because it is closer to the design maximum as a percentage and determines the clarifier's ability to settle particles

B. Neither parameter is a concern because both are within 20% of their respective design maximums

C. Both parameters present equal risk because they both affect clarifier performance through different mechanisms

D. The SLR at 127% of design maximum is the greater risk because the solids loading exceeds the clarifier's capacity to settle and compact the mass of biological solids entering the tank

23. A treatment plant effluent has a BOD₅ of 6 mg/L and a CBOD₅ (carbonaceous BOD₅, measured with a nitrification inhibitor) of 3 mg/L. What does the 3 mg/L difference between these two measurements represent?

- A. The 3 mg/L difference represents the measurement error inherent in the standard BOD₅ method
- B. The 3 mg/L difference represents the nitrogenous oxygen demand — oxygen consumed by nitrifying bacteria oxidizing ammonia during the 5-day BOD incubation
- C. The 3 mg/L difference represents the chemical oxygen demand that is not biologically available
- D. The 3 mg/L difference represents the dissolved oxygen consumed by the seed organisms in the dilution water

24. A treatment plant's permit requires a minimum 85% BOD removal. The influent BOD is 180 mg/L. What is the maximum allowable effluent BOD concentration to meet the 85% removal requirement?

- A. 30 mg/L, based on the standard secondary treatment concentration limit regardless of removal calculation
- B. 27 mg/L, based on 85% removal from the 180 mg/L influent concentration
- C. 15 mg/L, based on 85% removal and an additional safety factor of 2
- D. 27 mg/L, calculated as $180 \times 0.15 = 27$ mg/L — the 15% that is allowed to remain in the effluent

25. An operator at a plant with extended aeration (SRT 25 days, F/M 0.05) and complete-mix configuration has been producing consistent effluent quality (BOD 4, TSS 5, ammonia 0.2) for two years. A new industrial user connects and begins discharging a high-strength, readily biodegradable waste (BOD 5,000 mg/L at 0.02 MGD) that increases the total plant organic loading by 15%. Within three weeks, the effluent quality has actually improved slightly (BOD 3, TSS 4). Why has the increased loading improved rather than degraded performance?

- A. The industrial waste contains nutrients that were previously limiting biological growth in the extended aeration system
- B. The industrial waste has increased the influent temperature, accelerating biological activity throughout the plant
- C. The additional BOD has increased the F/M ratio from 0.05 toward a more optimal range, stimulating healthier biological growth and better floc formation compared to the deep endogenous respiration condition that existed previously

D. The industrial waste has diluted a chronic low-level toxicant that was previously limiting biological performance

26. An operator managing a chlorine disinfection system must maintain a CT of at least 30 mg·min/L to meet the fecal coliform permit limit. The chlorine contact tank has a baffling factor of 0.6 and a theoretical detention time of 25 minutes. What minimum chlorine residual must the operator maintain at the contact tank outlet to achieve the required CT?

A. 2.0 mg/L, calculated as $CT \div (\text{theoretical DT} \times \text{baffling factor})$

B. 1.2 mg/L, calculated as $CT \div \text{theoretical DT}$ without applying the baffling factor

C. 3.0 mg/L, calculated as $CT \div \text{theoretical DT}$ to provide a safety margin above the minimum

D. 0.8 mg/L, calculated as $CT \div (\text{theoretical DT} \div \text{baffling factor})$

27. A treatment plant's annual operating budget includes \$180,000 for electricity, with 65% consumed by the aeration blowers. The plant superintendent asks the operator to identify the most cost-effective energy reduction strategy. The plant currently operates two constant-speed blowers at 100% capacity with excess air being wasted through a blow-off valve. Which strategy would produce the greatest energy savings?

A. Install premium-efficiency motors on both blowers to reduce the electrical consumption by the motor efficiency improvement

B. Replace the constant-speed blowers with VFD-controlled blowers that modulate airflow based on DO demand, eliminating the wasted air through the blow-off valve

C. Reduce the number of operating blowers from two to one and accept the slightly lower DO level

D. Install fine bubble diffusers to replace the existing coarse bubble diffusers, improving the oxygen transfer efficiency

28. A plant operating an A²/O biological nutrient removal system has the following zone detention times: anaerobic 1.5 hours, anoxic 2.0 hours, aerobic 6.0 hours. The effluent total phosphorus is 0.6 mg/L (limit 1.0 mg/L) and the effluent total nitrogen is 9.5 mg/L (limit 10.0 mg/L). Both parameters are

very close to their limits. A wet-weather event increases the plant flow by 50%, reducing all detention times proportionally. Which permit limit is most likely to be exceeded first during the high-flow event?

- A. The phosphorus limit, because the reduced anaerobic detention time will prevent adequate VFA uptake by the PAOs
- B. The BOD limit, because the reduced aerobic detention time will prevent complete organic matter removal
- C. Neither limit will be exceeded because the diluted influent concentrations offset the reduced detention times
- D. The nitrogen limit, because the reduced anoxic detention time limits denitrification while nitrification continues in the aerobic zone, producing more nitrate than the shortened anoxic zone can remove

29. A treatment plant operates at design capacity (4.0 MGD) with two aeration basins, two secondary clarifiers, and one set of RAS/WAS pumps. The plant must undergo a major rehabilitation of one aeration basin (3-month project). During this period, only one aeration basin will be operational. What process adjustments should the operator make to maintain treatment quality with half the aeration volume?

- A. Reduce the MLSS by increasing WAS to compensate for the reduced basin volume and maintain the same F/M ratio
- B. Double the MLSS in the remaining basin by stopping WAS entirely, maintaining the same total mass of organisms
- C. Maintain the current MLSS and increase the aeration rate in the remaining basin to provide adequate DO at the higher volumetric loading, while monitoring the F/M ratio and adjusting WAS to maintain an appropriate SRT
- D. Reduce the plant flow by 50% to maintain the same loading on the single aeration basin

30. A treatment plant operating at an SRT of 12 days with complete nitrification (effluent ammonia 0.5 mg/L) receives a revised permit that adds a seasonal ammonia limit of 1.5 mg/L during summer months. The current summer effluent ammonia averages 0.5 mg/L, well below the new limit. The operator considers reducing the SRT to 8 days during summer to save aeration energy. What risk does this present?

- A. No risk — an SRT of 8 days at summer temperatures is adequate for nitrification and will save significant energy
- B. Reducing the SRT reduces the population of nitrifying bacteria and eliminates any safety margin — if a sudden temperature drop, toxic event, or loading increase occurs, the plant may not be able to respond quickly enough to prevent an ammonia violation
- C. An SRT of 8 days will cause complete nitrification failure regardless of temperature
- D. The reduced SRT will improve nitrification because younger organisms are more active than older ones

31. An operator at a treatment plant discovers that the plant's effluent has a persistent milky-white turbidity that does not correlate with TSS readings. The effluent TSS is consistently 8 mg/L, but the visual appearance is hazy. The plant uses alum for phosphorus removal and the aeration basin pH is 5.9. The operator suspects the haze is caused by colloidal aluminum compounds. Which of the following tests would confirm this diagnosis?

- A. Measure the effluent turbidity before and after filtration through a 0.45 μm membrane filter — if the turbidity decreases significantly, the haze is caused by fine particles including colloidal aluminum
- B. Add sulfuric acid to the effluent sample to lower the pH further and observe whether the haze clears
- C. Measure the dissolved aluminum concentration in the effluent — elevated levels (above the typical 0.1 mg/L) would confirm aluminum carryover
- D. Perform a jar test on the effluent with various polymer doses to see if the haze can be coagulated and settled

32. A treatment plant with chlorine gas disinfection has a chlorine cylinder leak detection system that uses an ammonia squeeze bottle — the operator opens the ammonia bottle near suspected leak points, and if chlorine is present, a white cloud of ammonium chloride forms. During a routine leak check, the operator detects a small white cloud at a cylinder valve connection. The room chlorine detector reads 0.3 ppm. What is the correct immediate response sequence?

- A. Tighten the cylinder valve connection to stop the leak, then recheck with the ammonia bottle

B. Apply a leak repair kit (ammonium hydroxide solution in a spray bottle) to the connection to seal the leak

C. Continue normal operations because 0.3 ppm is well below the OSHA PEL and the leak is very small

D. Do not attempt to repair the leak — evacuate the room, don SCBA, return to close the cylinder valve and isolate the system, then follow the emergency response procedures

33. An operator at a treatment plant is reviewing the results of a recent bioassay (whole effluent toxicity test). The test shows that the plant effluent causes 30% mortality in fathead minnows at 100% effluent concentration (no dilution) but 0% mortality at 50% dilution. The NPDES permit requires no acute toxicity at the critical dilution (which is 50% effluent based on the receiving water dilution ratio). Is the plant in compliance with the WET requirement?

A. Yes — the permit requirement is met because no mortality occurred at the critical dilution of 50% effluent

B. No — any mortality at any concentration constitutes a WET test failure and requires a TIE/TRE investigation

C. No — the 30% mortality at full-strength effluent exceeds the 25% maximum allowed under EPA guidance

D. Yes — but the 30% mortality at full strength should be investigated proactively to identify the toxicant before the receiving water dilution ratio changes

34. An operator must calculate the total chlorine dose needed for a plant that has the following characteristics: chlorine demand 4.2 mg/L, required CT of 20 mg·min/L, contact tank T_{10} of 16 minutes. What is the total chlorine dose?

A. 4.2 mg/L because the dose equals the demand and the residual is calculated separately

B. 5.0 mg/L because the required residual at the outlet is $20 \div 16 = 1.25$ mg/L, but 0.5 mg/L is typically adequate

C. 5.45 mg/L, calculated as: required residual ($CT \div T_{10} = 20 \div 16 = 1.25$ mg/L) plus demand (4.2 mg/L) = 5.45 mg/L total dose

D. 6.7 mg/L, calculated as the demand multiplied by the baffling efficiency factor of 1.6

35. A treatment plant's two parallel secondary clarifiers have different surface areas: Clarifier A has 5,000 ft² and Clarifier B has 3,500 ft². The plant flow (not including RAS) is 4.5 MGD. If the operator wants both clarifiers to operate at the same surface overflow rate, what flow should each clarifier receive?

A. Clarifier A: 3.0 MGD, Clarifier B: 1.5 MGD, based on a 2:1 area ratio

B. Clarifier A: 2.647 MGD, Clarifier B: 1.853 MGD, based on each clarifier receiving flow proportional to its surface area

C. Clarifier A: 2.25 MGD, Clarifier B: 2.25 MGD, split equally regardless of surface area differences

D. Clarifier A: 3.5 MGD, Clarifier B: 1.0 MGD, based on the larger clarifier handling the majority of the flow

36. A treatment plant must add sodium hypochlorite at a dose of 10 mg/L to a flow of 2.0 MGD. The sodium hypochlorite is 12% available chlorine with a specific gravity of 1.16. The chemical supplier delivers the product at a cost of \$0.85 per gallon. What is the approximate daily chemical cost?

A. Approximately \$85/day based on the volume of solution needed at the stated cost per gallon

B. Approximately \$120/day based on the volume of solution needed at the stated cost per gallon

C. Approximately \$200/day based on the volume of solution needed at the stated cost per gallon

D. Approximately \$145/day, calculated from the daily volume of 12% NaOCl solution required multiplied by the cost per gallon

37. An operator at a plant with biological nutrient removal and chemical phosphorus polishing achieves the following results: effluent ortho-P 0.08 mg/L, effluent total P 0.35 mg/L. The permit limit is 0.3 mg/L total P. The ortho-P is well below the limit, but total P exceeds it. What process adjustment would most directly reduce the total P?

- A. Reduce the total effluent phosphorus by improving the secondary clarifier and/or adding tertiary filtration to capture the particulate phosphorus that constitutes the difference between total P and ortho-P
- B. Increase the ferric chloride dose to reduce the ortho-P from 0.08 to 0.01 mg/L, which will proportionally reduce the total P
- C. Add more polymer to the aeration basin to improve floc formation and reduce the particulate phosphorus
- D. Increase the anaerobic zone detention time to enhance biological phosphorus uptake by the PAOs

38. A treatment plant is evaluating the cost-effectiveness of upgrading from coarse bubble to fine bubble diffusers in the aeration basin. The current coarse bubble system has an oxygen transfer efficiency of 6% while the proposed fine bubble system has an efficiency of 25%. The plant currently uses 4,500 SCFM of air. If the upgrade is performed, approximately how much air would be needed to deliver the same amount of oxygen?

- A. Approximately 2,250 SCFM, representing a 50% reduction in air volume
- B. Approximately 3,000 SCFM, representing a 33% reduction in air volume
- C. Approximately 1,080 SCFM, representing a 76% reduction in air volume that would dramatically reduce blower energy costs
- D. The air volume cannot be reduced because the diffuser type only affects bubble size, not the total volume of air required

39. A treatment plant has been disposing of its dewatered biosolids in a landfill at a cost of \$65 per wet ton. The superintendent asks the operator to evaluate the cost of switching to land application. The operator determines that the biosolids meet Class B/Part 503 requirements and a permitted agricultural site is available 30 miles away. The hauling cost is \$45 per wet ton and the application cost is \$10 per wet ton. However, the operator also identifies the following additional requirements: annual soil testing (\$2,000), annual biosolids analysis (\$3,500), CPLR tracking, site monitoring, and crop harvesting restrictions. What is the most important factor the operator should present to the superintendent?

- A. The annual recurring costs of the land application monitoring program (\$5,500 + staff time) compared to the per-ton savings

B. The total cost comparison must include all direct costs (hauling + application + monitoring) plus the indirect costs (staff time for CPLR tracking, site management, and regulatory compliance) before a meaningful comparison with landfill disposal can be made

C. The environmental benefits of land application outweigh any cost comparison and should be the primary deciding factor

D. The land application option should be rejected because the regulatory requirements are too complex for the plant's current staffing level

40. An operator at a treatment plant is simultaneously managing three situations: (1) the secondary clarifier sludge blanket has risen to 6 feet due to a storm event and is approaching the effluent weir, (2) the chlorine cylinder is showing a reading of 0.5 ppm on the room detector (below the 1 ppm PEL but above normal), and (3) a new operator has asked a question about how to read the daily operating log. In what order should the operator address these situations?

A. Log question first (quick answer), then chlorine room (investigate the reading), then clarifier blanket (adjust RAS)

B. Chlorine reading first (potential safety hazard), then new operator question (training opportunity), then clarifier blanket (process concern)

C. Clarifier blanket first (imminent permit violation), then chlorine reading (potential safety concern), then new operator question (can wait)

D. All three simultaneously by delegating the clarifier to the new operator while personally addressing the chlorine concern

41. An operator entering a wet well discovers that the four-gas monitor's H₂S sensor gives a momentary spike to 25 ppm when the operator disturbs the standing water in the wet well by stepping into it, then quickly returns to 3 ppm. What does this momentary spike indicate, and how should the operator respond?

A. The spike is a sensor malfunction caused by the splash of water on the instrument — ignore it and continue working

B. The spike indicates the monitor's response time is too slow to provide reliable continuous readings in this space

C. The standing water contains dissolved H₂S that is being released when disturbed — conditions could worsen if more water is agitated, and the operator should exercise extreme caution and consider additional ventilation

D. The 25 ppm spike was caused by methane interfering with the H₂S sensor and does not represent a real H₂S hazard

42. A treatment plant has three chemical storage tanks: sodium hypochlorite (500 gallons), ferric chloride (1,000 gallons), and sodium hydroxide (500 gallons). The secondary containment is designed as three separate containment areas — one for each tank. During a recent safety audit, the inspector notes that the ferric chloride containment wall has a small crack that would allow a slow leak to drain toward the sodium hypochlorite containment area. Why is this a critical finding?

A. The crack will allow ferric chloride to stain the concrete floor of the containment area permanently

B. The ferric chloride will corrode the sodium hypochlorite tank if it contacts the tank exterior

C. Mixing ferric chloride (an acid) with sodium hypochlorite (an oxidizer) can produce toxic chlorine gas, creating an immediate danger to personnel in the chemical building

D. The crack indicates structural failure of the containment system that could lead to a complete wall collapse

43. An operator is required to enter a manhole to inspect a sewer line connection. The manhole is 12 feet deep and located in a busy parking lot. A four-gas monitor shows safe atmospheric conditions. The operator has completed confined space training, has an attendant, and has the proper entry permit. What additional safety concern must be addressed before entry?

A. The operator must obtain a road closure permit from the city before opening any manhole in a public area

B. The operator must verify that the sewer line has been isolated and no upstream flows will enter the manhole during the inspection

C. The operator must install traffic control measures (cones, barricades, signs) around the manhole to protect both the entry team and vehicle traffic from each other

D. The operator must schedule the entry during nighttime hours when parking lot traffic is minimal

44. A treatment plant operator discovers that a maintenance contractor has stored several containers of acetone (a flammable solvent) in the plant's main electrical room next to the motor control centers. The MCC panels are energized. What is the most immediate hazard?

- A. The acetone may dissolve the insulation on the electrical wiring inside the MCC panels, causing short circuits
- B. A flammable solvent stored next to energized electrical equipment creates an explosion and fire risk — any electrical arc or spark from the MCC could ignite the acetone vapors
- C. The acetone containers may topple and spill on the floor, creating a slip hazard for maintenance workers
- D. The acetone vapors will corrode the copper bus bars inside the MCC panels, degrading the electrical connections

45. An NPDES permit requires the plant to monitor effluent hardness quarterly. The operator has been collecting grab samples for hardness analysis. During an inspection, the state inspector notes that the permit actually specifies 24-hour composite samples for hardness. The operator has been using the wrong sample type for two years of quarterly monitoring. What is the regulatory consequence?

- A. No consequence because hardness is not a pollutant of concern and the sample type does not significantly affect the result
- B. The grab sample results are automatically invalid and all hardness data from the past two years must be retracted from the DMRs
- C. The incorrect sample type may constitute a monitoring violation — the operator should correct the sampling procedure immediately and notify the regulatory authority of the discrepancy
- D. The operator can retrospectively reclassify the grab samples as composites by noting that each grab was representative of the daily conditions

46. A treatment plant's emergency generator was last load-bank tested 14 months ago. The plant's PM schedule requires annual load testing. The generator has passed all monthly no-load starts during this period. The operator schedules a load-bank test and the generator fails — it can only sustain 65% of its rated capacity before overheating. What does this reveal about the plant's emergency preparedness?

- A. The generator is adequate because 65% capacity is sufficient to power the plant's critical loads
- B. The monthly no-load tests provided false assurance — they verified the engine would start but could not detect the cooling system, fuel system, or mechanical problems that cause the generator to fail under sustained load. The plant has been operating without reliable emergency power for an unknown period.
- C. The generator failed because it has not been run under load in 14 months and needs to be "broken in" again
- D. The load test equipment is likely miscalibrated and the test should be repeated with different equipment

47. Under the Clean Water Act, a treatment plant operator who is responsible for collecting compliance samples discovers that a coworker has been fabricating fecal coliform results — recording values that were never actually analyzed in the laboratory. The coworker claims that "the plant always passes anyway, so the results don't matter." What is the operator's legal and ethical obligation?

- A. Report the fabrication to the plant superintendent immediately — data fabrication on federal compliance documents is a criminal offense under the Clean Water Act, and the operator has a duty to report it
- B. Advise the coworker to stop fabricating data but take no formal action to avoid creating a hostile work environment
- C. Verify the coworker's claim by reviewing the actual laboratory records and only report if confirmed violations are found
- D. Report the situation anonymously to the EPA tip line rather than involving plant management

48. An operator reviews the plant's NPDES permit and notices a condition requiring the plant to develop and implement a Capacity, Management, Operations, and Maintenance (CMOM) program for the collection system. The plant superintendent has not implemented this requirement. What is the significance of this omission?

- A. CMOM is an optional program that provides benefits but carries no regulatory consequence if not implemented

B. The CMOM program is a permit condition — failure to implement it constitutes a permit violation that could result in enforcement action, fines, or consent order requirements

C. CMOM only applies to collection systems longer than 100 miles and may not apply to this plant's system

D. The CMOM requirement was automatically fulfilled when the plant submitted its NPDES permit application

49. An operator at a small treatment plant works alone on the evening shift (4 PM to midnight). At 10 PM, the operator receives a call from a resident reporting a sewage odor near a manhole 2 miles from the plant. The plant's standard operating procedure requires the operator to investigate odor complaints. What should the operator do?

A. Leave the plant unattended to investigate the odor complaint immediately, as required by the SOP

B. Wait until the morning shift arrives to investigate the complaint because leaving the plant unattended is never acceptable

C. Investigate the complaint by driving to the location after ensuring the plant is in stable operating condition, but do NOT enter the manhole or any confined space while working alone

D. Tell the resident the complaint will be investigated tomorrow and log the call without further action

50. An operator discovers that the plant's spill prevention control and countermeasure (SPCC) plan has not been reviewed or updated since 2019. The plant added a new 5,000-gallon diesel fuel tank for the emergency generator in 2022. Under EPA regulations, the SPCC plan must be updated within what timeframe after a change in facility design or operation that affects the plan?

A. Within 30 days of the change, with the updated plan certified by a professional engineer if required

B. Within 6 months of the change, or at the next scheduled plan review, whichever comes first

C. Within 24 months of the change, as part of the regular 5-year SPCC plan review cycle

D. No update is required because the diesel tank is smaller than the 10,000-gallon minimum threshold for SPCC

51. A treatment plant operator is managing a situation where the influent flow has been 150% of design capacity for 12 consecutive hours due to a persistent rainstorm. The secondary clarifiers are at maximum hydraulic capacity, the sludge blankets are rising, and the effluent TSS has increased from 10 mg/L to 35 mg/L. The operator has maximized the RAS rate and all process equipment is running. What additional operational strategies should the operator implement?

A. Step-feed the aeration basins (if configured) to increase the effective volume, reduce the WAS rate to maintain maximum biological mass for settling, and consider reducing the MLSS over the coming days if the high flow persists

B. Shut down the biological process entirely and operate in primary treatment mode until the flow subsides

C. Bypass all treatment and discharge the excess flow directly to the receiving water with regulatory notification

D. Reduce the influent pumping rate to design capacity and allow the collection system to store the excess flow temporarily

52. A centrifugal pump rated at 1,500 GPM at 40 psi TDH is being operated at 1,200 GPM at 44 psi. The operator checks the pump curve and determines the pump is operating to the left of the best efficiency point (BEP). What is the operational consequence of operating left of BEP?

A. The pump is producing more flow than the system requires, and the excess energy is being wasted as heat

B. The pump is operating at higher efficiency than BEP because the reduced flow requires less power

C. The pump is experiencing increased radial forces, higher vibration, and recirculation within the volute that reduces efficiency, increases noise, and accelerates wear

D. Operating left of BEP has no operational consequence because centrifugal pumps are designed to operate across their full curve range

53. An operator is troubleshooting a submersible pump in a wet well that has begun tripping on overload after 3 years of reliable service. The operator measures the motor insulation resistance (megger test) and obtains a reading of 0.5 megohms. A new motor of this size typically reads above 100 megohms. What does the low insulation resistance indicate?

- A. The motor winding insulation has severely deteriorated — moisture, heat, or chemical exposure has degraded the insulation to the point where current is leaking to ground, causing the overload trips
- B. The megger reading is normal for a 3-year-old submersible motor and does not indicate a problem
- C. The low reading indicates the motor is too large for the application and should be replaced with a smaller unit
- D. The pump impeller is clogged, causing the motor to draw excess current that heats and degrades the insulation

54. A SCADA system at a treatment plant monitors 200 alarm points. The operator reviews the alarm log for the past month and discovers that 85% of all alarms were generated by just 4 alarm points — all related to the influent wet well level. These alarms are generated every time the lead pump cycles on and off during normal operation. What is the appropriate corrective action?

- A. Disable the four problematic alarms permanently because they are clearly nuisance alarms that do not indicate real problems
- B. Increase the alarm setpoints on these four points to reduce the number of activations while maintaining alerting capability for genuinely abnormal conditions
- C. Evaluate and optimize the alarm settings — adjust deadbands, time delays, and setpoints to eliminate nuisance alarms while retaining meaningful alarms for genuinely abnormal high-level conditions
- D. Leave the alarms as configured because all alarms serve a purpose and should not be modified

55. A treatment plant's inline TSS analyzer on the RAS line shows a gradual decline in reading from 8,500 mg/L to 5,200 mg/L over three weeks. The operator performs a laboratory grab sample and obtains a TSS of 8,100 mg/L. What is the most likely cause of the discrepancy?

- A. The RAS concentration has genuinely decreased and the laboratory result is inaccurate due to a non-representative grab sample
- B. The inline analyzer has been experiencing progressive fouling of the optical sensor, causing it to underreport the actual TSS concentration

C. The secondary clarifier sludge blanket has dropped, diluting the RAS concentration at the analyzer location

D. The inline analyzer and the laboratory are measuring different parameters and cannot be directly compared

56. An operator discovers that a VFD-controlled blower motor is running hot — the motor surface temperature is 15°F above the manufacturer's maximum. The VFD is set at 45 Hz (75% speed). The motor nameplate shows it is rated for use with a VFD and is an inverter-duty motor. What is the most likely cause of the overheating?

A. The 45 Hz operating frequency is below the motor's minimum recommended frequency, reducing the cooling fan speed and airflow below the level needed for adequate heat dissipation

B. The VFD is producing excessive electrical harmonics that generate additional heat in the motor windings

C. The motor bearings have failed, creating friction heat that adds to the normal operating temperature

D. The motor is oversized for the load and is running at very low efficiency, converting excess electrical energy to heat

57. An operator notices that a chemical metering pump's output has decreased by 30% over the past month despite no change in the pump settings. The pump is a diaphragm-type metering pump. The suction and discharge lines are clear, the chemical tank is full, and the pump appears to operate normally. Which of the following is the most likely cause?

A. The pump motor speed has decreased due to voltage drop in the electrical supply

B. The pump diaphragm has developed a partial failure — it is flexing but not generating full displacement volume per stroke, delivering less chemical than the settings indicate

C. The chemical solution has changed viscosity due to temperature fluctuations, reducing the pump's ability to draw and discharge fluid

D. The pump's stroke length adjustment mechanism has slipped from its set position, reducing the effective stroke without any visible change to the setting dial

58. A treatment plant's emergency generator performs normally during monthly no-load tests but has failed to start during the last two actual power outages. Both times, the battery was discharged below the minimum cranking voltage. Investigation reveals the battery charger has been intermittently failing, allowing the starting batteries to gradually discharge between tests. What equipment change would prevent this recurring failure?

- A. Install a backup battery charger with a low-voltage alarm that notifies the operator when the battery voltage drops below the minimum cranking threshold
- B. Replace the generator starting batteries with new, higher-capacity batteries that hold their charge longer
- C. Install a manual transfer switch to eliminate the need for automatic starting of the generator
- D. Increase the monthly no-load test frequency to weekly to prevent the batteries from discharging between tests

59. An operator evaluating pump station performance discovers that the influent pump cycles on and off approximately 25 times per hour during low-flow periods. The motor nameplate recommends a maximum of 6 starts per hour. What is the consequence of this excessive cycling, and what is the solution?

- A. Excessive cycling causes no damage because modern pump motors are designed for unlimited starts per hour
- B. Excessive cycling is beneficial because it provides intermittent rest periods that extend motor bearing life
- C. The rapid cycling generates excessive heat in the motor windings from repeated inrush current, dramatically shortening motor life through insulation degradation — the solution is to install VFD control or add wet well storage volume
- D. The excessive cycling will eventually trip the motor overload protection, and the operator should replace the overload relay with a higher-rated unit

60. An operator performs a field calibration check on the plant's effluent turbidimeter by running a 10 NTU calibration standard through the instrument. The instrument reads 8.5 NTU. The manufacturer's

specification requires accuracy within ± 0.5 NTU or $\pm 5\%$ (whichever is greater) across the calibrated range. Is the instrument reading within specification?

- A. Yes — the reading of 8.5 is within $\pm 5\%$ of the 10 NTU standard (acceptable range 9.5–10.5)
- B. No — the reading of 8.5 is 15% below the standard, far exceeding both the ± 0.5 NTU and $\pm 5\%$ accuracy specifications
- C. Yes — the ± 0.5 NTU tolerance means the acceptable range is 9.5–10.5, and 8.5 is only slightly outside this range
- D. The calibration check is invalid because a single-point check at 10 NTU cannot verify accuracy across the full measurement range

61. A treatment plant's two parallel RAS pumps discharge into a common header that feeds back to the aeration basin. The operator runs both pumps simultaneously and measures the combined flow at 2,400 GPM. When running Pump A alone, the flow is 1,400 GPM. When running Pump B alone, the flow is 1,300 GPM. Why is the combined flow (2,400 GPM) less than the sum of the individual flows (2,700 GPM)?

- A. One of the flow meters is reading inaccurately and should be recalibrated before drawing conclusions
- B. The pumps are fighting each other through the common header, creating back-pressure that reduces each pump's output when operating in parallel
- C. The combined operating point on the system curve is at a higher head than either pump alone, because the increased total flow creates more friction loss in the common header — each pump delivers less flow at the higher head
- D. The check valve on one pump is partially blocking the flow from the other pump when both operate simultaneously

62. An operator discovers that the plant's SCADA system has been archiving data at 15-minute intervals, but the NPDES permit requires continuous monitoring of effluent pH. The pH has been within the permitted range (6.0–9.0) at every 15-minute data point for the entire month. Is the monitoring system in compliance with the "continuous monitoring" requirement?

- A. Yes — 15-minute intervals constitute continuous monitoring for regulatory purposes
- B. No — continuous monitoring means the instrument must record at intervals of 1 minute or less
- C. The answer depends on the specific NPDES permit language and the regulatory agency's interpretation of "continuous" — many agencies accept 15-minute intervals, but some require more frequent recording. The operator should verify the specific requirement with the regulatory authority.
- D. Yes — as long as the data shows no violations, the recording interval is irrelevant

63. A treatment plant's chemical feed system uses a peristaltic pump with flexible tubing to deliver polymer. The pump runs 24 hours per day. The manufacturer recommends tubing replacement every 2,000 hours of operation. The operator has been replacing the tubing every 6 months (approximately 4,380 hours) instead. The pump has experienced two tubing failures in the past year, each resulting in 4-6 hours of interrupted polymer feed during sludge dewatering. What should the operator do?

- A. Shorten the tubing replacement interval to the manufacturer's recommended 2,000 hours (approximately 83 days of continuous operation) to prevent unexpected failures
- B. Continue the 6-month replacement interval because two failures per year is an acceptable failure rate
- C. Switch to a different pump type that does not require tubing replacement
- D. Install an inline pressure sensor that detects tubing failure and automatically shuts down the pump

64. An operator notices that a centrifugal blower's discharge pressure has been increasing steadily over the past four months: Month 1: 7.5 psi, Month 2: 7.8 psi, Month 3: 8.2 psi, Month 4: 8.7 psi. The blower airflow has remained constant at 3,000 CFM. The aeration basin water level has not changed. What should the operator investigate, and at what point should corrective action be taken?

- A. The blower bearings are failing, and the increased internal friction is manifesting as higher discharge pressure
- B. The increasing pressure indicates progressive diffuser fouling — the operator should schedule diffuser inspection and cleaning before the pressure reaches the blower's maximum rated discharge pressure, which could cause equipment damage or automatic shutdown

C. The pressure increase is normal for a blower that has been in service for four months and will stabilize naturally

D. The blower inlet filter is clogging, creating a vacuum on the suction side that the discharge pressure compensates for

65. A treatment plant has installed a new online ammonia analyzer on the secondary effluent line. The analyzer measures ammonia continuously and sends the reading to the SCADA system. During the first week of operation, the analyzer reads 0.3 mg/L ammonia while the laboratory grab sample consistently shows 0.8 mg/L. Both the analyzer and the laboratory method have been recently calibrated. What is the most likely source of the discrepancy?

A. The online analyzer is more accurate than the laboratory because it measures the sample continuously without transport delays

B. The laboratory grab sample undergoes ammonia stripping during collection and transport, losing ammonia to the atmosphere and reading falsely low

C. The online analyzer may be measuring a different form of ammonia than the laboratory method, the sample conditioning may differ, or the probe location may not be representative of the grab sample location — the operator should systematically compare collection points, analytical methods, and calibration standards

D. Online ammonia analyzers are inherently less accurate than laboratory methods and should only be used for process monitoring, not compliance

66. A treatment plant operator reviews the PM schedule and discovers that the secondary clarifier mechanism (rotating scraper) has not been greased in 8 months. The manufacturer recommends quarterly greasing. The mechanism has been operating normally with no unusual noise, vibration, or torque alarms. Should the operator be concerned?

A. No — if the mechanism is operating normally with no symptoms, the greasing interval can be extended safely

B. No — modern clarifier mechanisms are designed with sealed bearings that never require external greasing

C. Yes — the missed greasing should be performed immediately because progressive bearing wear from inadequate lubrication may be occurring without symptoms until catastrophic failure

D. Yes — but only because the overdue greasing will cause a regulatory violation during the next compliance inspection

67. An operator reviewing the plant's energy consumption data notices that the blower energy has increased by 20% over the past year despite no change in the plant loading, MLSS, or DO setpoint. The blower speed (RPM) has remained constant. What is the most likely cause of the increased energy consumption?

A. Progressive fouling of the fine bubble diffusers has increased the system pressure that the blower must overcome to deliver the same airflow volume

B. The electrical utility has increased its rates by 20%, which appears as increased energy consumption in the plant's records

C. The blower motor efficiency has degraded due to age, converting more electrical energy to heat rather than mechanical work

D. The aeration basin water level has increased by approximately 5 feet, requiring the blower to overcome additional static head

68. A treatment plant's belt filter press has been producing cake at 20% solids with clear filtrate for two years. The operator increases the belt speed by 25% to process a backlog of sludge. After the speed increase, the cake solids drop to 16% and the filtrate becomes slightly turbid. Which combination of adjustments would most likely restore the cake quality while maintaining the higher throughput?

A. Reduce the belt speed back to the original setting — there is no way to increase throughput without sacrificing cake quality

B. Increase both the polymer dose and the belt tension proportionally to the speed increase to maintain equivalent conditioning and compression at the higher throughput

C. Increase the sludge feed concentration by thickening the sludge further upstream before it reaches the press

D. Replace the belt fabric with a tighter weave that retains more solids at the higher belt speed

69. A treatment plant operates two positive displacement blowers in a lead-lag configuration. The lead blower runs continuously while the lag blower starts automatically when the DO drops below 1.5 mg/L. During a recent event, the lead blower tripped on high temperature, and the lag blower started automatically. However, the plant DO continued to drop to 0.5 mg/L even with the lag blower running. What is the most likely explanation?

- A. The lag blower is smaller than the lead blower and cannot provide equivalent airflow
- B. The lag blower's discharge piping valves are partially closed, restricting the airflow to the diffusers
- C. The lag blower's inlet filter is clogged, reducing the air intake and therefore the blower output significantly below its rated capacity
- D. Both B and C are possible causes — the operator should check the lag blower's discharge valve positions and inlet filter condition to determine which is restricting the airflow

70. A plant operator performs a draw-down test on the influent wet well to verify the flow rate of the influent pump. The wet well has a surface area of 64 ft² (8 ft × 8 ft). With the influent gate valve closed and the pump running, the water level drops 3.5 feet in 5 minutes. What is the pump's actual flow rate in GPM?

- A. Approximately 112 GPM based on the volume calculation and time measurement
- B. Approximately 224 GPM based on the volume displaced during the test period
- C. Approximately 335 GPM based on the volume displaced during the test period
- D. Approximately 448 GPM based on the volume displaced during the test period

71. A gravity thickener processing primary sludge has been consistently producing thickened sludge at 5.8% total solids. The operator is directed to begin co-thickening waste activated sludge by adding it to the primary sludge feed. After two weeks, the thickened sludge concentration drops to 3.5% and the supernatant turbidity increases significantly. The operator wants to improve the co-thickened concentration. Which of the following adjustments is most likely to help?

- A. Increase the sludge withdrawal rate to draw off the thickened solids before the WAS dilutes them

B. Add polymer to the combined feed to improve the settleability of the lighter WAS particles that are not compacting well under gravity alone

C. Reduce the picket fence rake speed to minimize disturbance of the sludge blanket

D. Increase the air supply to the thickener to promote aerobic conditions that improve settling

72. A centrifuge dewatering digested combined sludge produces cake at 22% solids with centrate TSS of 300 mg/L. The operator wants to improve the centrate quality without sacrificing cake dryness. Which single adjustment is most likely to achieve this goal?

A. Decrease the bowl speed to reduce the centrifugal force and allow the floc to remain intact

B. Increase the polymer dose to improve flocculation of the fine particles that are currently escaping in the centrate

C. Increase the scroll differential speed to convey solids out of the bowl faster, reducing the solids inventory inside the machine

D. Decrease the sludge feed rate to reduce the volumetric loading on the centrifuge

73. An anaerobic digester has been stable at a VA/Alk ratio of 0.06 for one year. A new food waste co-digestion program begins, increasing the volatile solids loading by 25%. The operator implements weekly monitoring of VA, alkalinity, pH, gas production, and gas composition. After 4 weeks, the VA/Alk ratio has risen to 0.18. The pH has decreased from 7.2 to 7.0 and gas production has increased by 15%. What is the appropriate operational response?

A. Immediately cease all food waste addition because the rising VA/Alk ratio indicates imminent digester failure

B. Reduce the food waste addition rate by 50% because the VA/Alk ratio is approaching the warning level

C. Continue at the current loading rate but increase monitoring to twice weekly — the VA/Alk ratio is still well below the 0.35 critical threshold, gas production has increased (positive sign), and the pH decrease is minor

D. Continue at the current loading rate and increase monitoring — the rising VA/Alk ratio from 0.06 to 0.18 shows the system is adjusting to the higher loading and the methanogens are keeping pace as evidenced by increased gas production, but the trend should be watched closely

74. A belt filter press is dewatering anaerobically digested sludge at 4% feed concentration. The press produces cake at 20% solids at a belt speed of 10 ft/min. The plant needs to process 50% more sludge per day. The operator can increase the belt speed to 15 ft/min or extend the press operating hours from 8 to 12 hours per day. Which option is operationally preferable?

A. Increase the belt speed to 15 ft/min because it processes more sludge in the same operating hours

B. The two options produce equivalent throughput increases and either is acceptable

C. Extend the operating hours because maintaining the current belt speed preserves the cake quality at 20% solids, while increasing speed would reduce the cake quality due to shorter drainage and compression time

D. Neither option is feasible — the plant needs a second belt filter press to handle the additional volume

75. A plant operator calculates the volatile solids reduction in the anaerobic digester using the following data: raw sludge VS = 70%, digested sludge VS = 58%. Using the Van Kleeck equation, what is the approximate VSR?

A. Approximately 41%, which exceeds the 38% minimum for Part 503 vector attraction reduction

B. Approximately 23%, which does not meet the minimum requirement

C. Approximately 33%, which is close to but does not meet the minimum requirement

D. Approximately 17%, calculated by simple percentage difference without the Van Kleeck equation

76. A composting facility operating windrows of dewatered biosolids blended with wood chips measures the following conditions at Day 21: core temperature 155°F, moisture 48%, oxygen concentration 8%, and the pile has been turned four times. The temperature has been above 131°F for 18 consecutive days. Under Part 503, the windrow composting method requires maintaining temperatures above 131°F for at least 15 days, with a minimum of 5 turnings during the high-temperature period. Has this pile met the Part 503 time-temperature requirement for pathogen reduction?

- A. Yes — 18 consecutive days above 131°F with 4 turnings meets the requirements
- B. No — the windrow method requires at least 5 turnings during the 15-day high-temperature period, and only 4 have been performed
- C. Yes — the 18 days exceeds the 15-day minimum and 4 turnings are sufficient under the PFRP alternative
- D. No — the moisture content of 48% is below the minimum 50% required during the thermophilic phase

77. A plant operator is evaluating whether the plant's biosolids qualify for Exceptional Quality under Part 503. The biosolids have: fecal coliform 400 MPN/g (Class A threshold: <1,000), all 10 regulated metals below Table 3 PC limits, and volatile solids reduction of 42% (VAR minimum: 38%). Based on these data, do the biosolids meet all three EQ criteria?

- A. No — the fecal coliform is too high for Class A designation and the biosolids only qualify as Class B
- B. No — the volatile solids reduction of 42% does not meet the minimum 50% required for EQ designation
- C. Yes — but only if the biosolids are also injection below the soil surface at the application site
- D. Yes — fecal coliform 400 < 1,000 (Class A ✓), all metals below Table 3 (✓), VSR 42% > 38% (VAR ✓) — all three Exceptional Quality criteria are met

78. A treatment plant composting facility uses the aerated static pile method. The operator discovers that the temperature probe in one pile has been reading incorrectly for the past week — the actual temperature was 115°F instead of the displayed 145°F. The pile has been in the active composting phase for 10 days. Under Part 503, the ASP method requires 3 consecutive days above 131°F. What is the consequence of this temperature monitoring failure?

- A. The pile meets the time-temperature requirement because 10 days total is sufficient even if the temperature dropped briefly
- B. The pile must restart the 3-day count from the point when verified temperature data above 131°F is available — the time with the faulty probe cannot be counted toward the requirement

C. The pile must be disposed of in a landfill because the temperature monitoring failure invalidates the entire composting cycle

D. The operator can retroactively validate the temperature data by testing the fecal coliform concentration in the pile

79. A treatment plant operator is managing biosolids land application at a farm field. The agronomic rate calculation shows the field can receive 5 dry tons per acre of biosolids based on the nitrogen needs of the corn crop. The operator applies the biosolids in late fall after harvest. The following spring, the farmer reports that the corn crop shows signs of nitrogen deficiency despite the biosolids application. What is the most likely explanation?

A. The biosolids nitrogen was in organic form that mineralizes slowly — the fall application allowed much of the mineralized nitrogen to leach below the root zone during winter rains before the spring crop could use it

B. The biosolids application rate was too low and the nitrogen content was less than the agronomic calculation assumed

C. The corn variety planted requires more nitrogen than the standard agronomic rate provides

D. The biosolids nitrogen was consumed by soil microorganisms during the fall decomposition and was not available for the spring crop

80. A treatment plant dewatering centrifuge is processing digested sludge at a feed rate of 100 GPM. The feed concentration is 3.5% total solids. The cake solids are 23% and the centrate TSS is 400 mg/L. What is the approximate solids capture rate of the centrifuge?

A. Approximately 85%, which is below the typical acceptable minimum of 90% for centrifuge dewatering

B. Approximately 92%, which is within the acceptable range for centrifuge operations

C. Approximately 98.6%, calculated by comparing the solids in the cake to the total solids in the feed

D. Approximately 95%, which is at the midpoint of the typical operating range for well-operated centrifuges

81. An anaerobic digester operator observes the following data trends over a 4-week period: volatile acids increasing from 200 to 350 mg/L, alkalinity stable at 3,200 mg/L, pH stable at 7.1, gas production

increasing by 10%, and methane content stable at 62%. The VA/Alk ratio has increased from 0.063 to 0.109. What is the correct interpretation?

- A. The digester is heading toward failure because the volatile acids have nearly doubled in four weeks
- B. The digester is operating normally — the stable pH, alkalinity, gas production, and methane content indicate the methanogens are keeping pace with the slightly elevated acid production. The VA/Alk ratio of 0.109 is well within the stable range (below 0.35).
- C. The rising volatile acids require immediate cessation of all sludge feeding until the ratio returns below 0.05
- D. The digester temperature has dropped, causing the methanogens to slow down and the acid formers to accelerate

82. An operator at a treatment plant with belt filter press dewatering notices that the polymer preparation system has been making the polymer solution at 0.5% concentration instead of the standard 0.25%. The operator has been dosing the same volume of polymer solution per gallon of sludge. What is the practical effect of this error?

- A. The polymer dose (in active polymer per dry ton of solids) has been doubled, potentially over-conditioning the sludge and wasting chemical cost
- B. The higher concentration has no practical effect because the total volume of solution applied is the same
- C. The higher concentration will produce a drier cake because more polymer creates stronger floc
- D. The higher concentration will cause the polymer to gel in the delivery lines and should be diluted immediately

83. A treatment plant's incinerator exhaust stack test shows that the particulate emissions exceed the air quality permit limit. The incinerator uses a wet scrubber followed by a fabric filter baghouse for air pollution control. Which of the following is the most likely cause of the elevated particulate emissions?

- A. The wet scrubber is operating at too high a water flow rate, entraining water droplets in the exhaust that register as particulate

- B. One or more fabric filter bags in the baghouse have developed tears or holes, allowing particulate to bypass the filtration and exit through the stack
- C. The incinerator combustion temperature is too low, producing incomplete combustion and excess particulate
- D. The sludge cake feed rate exceeds the incinerator's design capacity, producing more ash than the air pollution control system can capture

84. A treatment plant operator needs to calculate the annual biosolids production for Part 503 reporting. The plant produces an average of 15,000 gallons per day of dewatered cake at 22% total solids. Assuming 365 days of operation and 8.34 lbs per gallon, what is the approximate annual production in dry metric tons?

- A. Approximately 3,750 dry metric tons per year based on the daily production volume and concentration
- B. Approximately 4,700 dry metric tons per year based on the daily production and an English-to-metric conversion
- C. Approximately 1,700 dry metric tons per year, calculated as daily dry weight \times 365 \div 2,205 lbs per metric ton
- D. Approximately 4,130 dry metric tons per year based on the total wet weight converted to metric tons

85. An operator at a biosolids land application program discovers that the application equipment applied biosolids at a rate of 8 dry tons per acre instead of the planned agronomic rate of 4 dry tons per acre. The field has already been incorporated. What are the operator's obligations?

- A. No additional obligations because the biosolids have already been incorporated and the field cannot be un-applied
- B. Report the overapplication to the regulatory authority because it exceeds the agronomic rate, adjust the CPLR tracking to reflect the actual loading, and reduce or suspend future applications at this site until the excess nitrogen has been utilized by the crop
- C. Harvest the current crop early to remove the excess nitrogen from the field before it leaches to groundwater

D. Apply agricultural lime to neutralize any excess metals that may have been deposited at the higher rate

86. A composting facility blends dewatered biosolids (22% solids, C:N ratio 8:1) with sawdust (92% solids, C:N ratio 400:1). To achieve a blended mixture with a C:N ratio of 30:1, the operator must calculate the volumetric blending ratio. Which of the following principles guides this calculation?

A. The blending ratio is always 1:1 (biosolids to amendment) regardless of the individual C:N ratios

B. The calculation balances the total carbon and total nitrogen in both materials to achieve the target C:N ratio — the carbon-rich amendment must be added in sufficient quantity to raise the blend from 8:1 to 30:1

C. The C:N ratio is determined solely by the carbon content of the amendment and is independent of the biosolids contribution

D. The blending ratio is determined by matching the moisture contents of the two materials rather than the C:N ratios

87. An operator at a treatment plant with anaerobic digestion calculates the gas production rate per pound of volatile solids destroyed. The digester receives 5,500 lbs VS/day and achieves 50% VS reduction (2,750 lbs VS destroyed/day). The gas production is 42,000 ft³/day. What is the specific gas production rate, and is it within the normal range?

A. Approximately 15.3 ft³ gas/lb VS destroyed, which is within the typical range of 12–18 ft³/lb VS for mesophilic anaerobic digestion

B. Approximately 7.6 ft³ gas/lb VS destroyed, which is below the typical range and indicates incomplete digestion

C. Approximately 30 ft³ gas/lb VS destroyed, which exceeds the typical range and suggests an analytical error

D. Approximately 7.6 ft³ gas/lb VS fed, which should be converted to a per-VS-destroyed basis for meaningful comparison

88. An operator reviews the plant's monthly compliance data and discovers that the effluent TSS composite sampler was programmed to collect time-proportional aliquots (equal volume every 30 minutes) instead of the permit-required flow-proportional aliquots (volume proportional to flow rate). The month's TSS data has already been reported on the DMR. What should the operator do?

A. Take no action because time-proportional and flow-proportional composites produce identical results for TSS analysis

B. Notify the regulatory authority of the sampling method discrepancy, correct the sampler programming, and note the error on the next DMR. The reported data may or may not be representative depending on the flow variation during the sampling period.

C. Retract the DMR and request that the month's data be excluded from the compliance record

D. Resample using the correct flow-proportional method and substitute the new results for the already-reported data

89. A laboratory analyst performs a BOD₅ analysis and obtains the following results from three dilutions of a secondary effluent sample: 10% dilution = 22 mg/L, 25% dilution = 16 mg/L, 50% dilution = 13 mg/L. All three dilutions meet the validity criteria (minimum 2.0 mg/L depletion, final DO >1.0 mg/L). The GGA standard and seed controls are within acceptable ranges. Which result should the analyst report?

A. Report the 10% dilution result (22 mg/L) because the lowest sample concentration provides the most conservative estimate

B. Report the average of all three valid results: $(22 + 16 + 13) \div 3 = 17$ mg/L

C. Report the result from the dilution showing the most depletion with a final DO closest to 1.0 mg/L

D. Report the average of the two dilutions with the closest agreement (16 and 13 mg/L), or follow the laboratory SOP for handling multiple valid dilutions — the 10% dilution result of 22 mg/L appears anomalously high and may warrant investigation

90. An operator collects a 24-hour flow-proportional composite for effluent BOD₅. The permit requires the composite to be collected at the effluent sampling point. The operator discovers that the composite sampler intake line has been placed in the chlorine contact tank (upstream of the final effluent sampling

point) instead of at the permitted effluent location (downstream of the contact tank and cascade aerator). Would this placement affect the BOD₅ result?

- A. The placement has no effect because the chlorine contact tank is part of the treatment process and the wastewater composition does not change between these two points
- B. The chlorine in the contact tank may suppress biological activity during the composite collection period, artificially lowering the measured BOD₅ below the true effluent value. Additionally, the sample is not from the permitted location.
- C. The placement would produce a higher BOD₅ because the chlorine contact tank adds oxygen demand to the sample
- D. The placement only matters if the cascade aerator between the two points adds dissolved oxygen that affects the BOD measurement

91. A treatment plant laboratory analyst performs monthly method detection limit (MDL) studies for ammonia nitrogen. The MDL has been consistently at 0.05 mg/L for the past two years. The most recent MDL study shows the MDL has increased to 0.15 mg/L. What is the significance of this change?

- A. The increased MDL has no practical significance because both values are well below typical effluent ammonia concentrations
- B. The increased MDL indicates analytical precision has deteriorated — the laboratory cannot reliably distinguish ammonia concentrations below 0.15 mg/L, which may affect compliance reporting for plants with very low permit limits
- C. The MDL increase is caused by seasonal temperature variations and will return to normal in the next quarter
- D. The analyst should repeat the MDL study because a single elevated result is likely an outlier

92. An operator comparing laboratory BOD₅ results from two different analysts finds that Analyst A consistently reports results 15–20% higher than Analyst B on split samples of the same effluent. Both analysts use the same method, equipment, and reagents. The GGA standards from both analysts fall within the acceptable range. What is the most likely source of the discrepancy?

- A. The BOD₅ method inherently produces 15–20% variability between analysts and no investigation is needed
- B. Differences in seed source, seed volume, dilution preparation technique, or sample mixing procedures between the two analysts are producing systematically different results that should be identified and standardized
- C. Analyst A is using expired reagents that produce falsely high results
- D. Analyst B is reading the DO meter incorrectly, producing falsely low depletion values

93. A treatment plant's NPDES permit requires quarterly monitoring of whole effluent toxicity (WET) using the 7-day chronic *Ceriodaphnia dubia* survival and reproduction test. The most recent test shows 100% survival at all effluent concentrations (6.25%, 12.5%, 25%, 50%, and 100%) but significantly reduced reproduction at the 100% (full-strength) effluent concentration compared to the control. The permit requires no chronic toxicity at the critical dilution of 50% effluent. What is the compliance status?

- A. The plant is in compliance because reproduction was not affected at the critical dilution of 50%
- B. The plant fails the WET test because any adverse effect at any concentration constitutes a failure
- C. The plant is in compliance for survival but fails for reproduction because the test endpoint includes both parameters
- D. The test results are inconclusive and must be repeated within 30 days using a different test species

94. An operator calibrating the laboratory pH meter obtains the following readings: pH 4.0 buffer reads 4.02, pH 7.0 buffer reads 7.05, pH 10.0 buffer reads 10.15. The meter calculates a slope of 95% (theoretical ideal is 100%). What should the operator conclude about the electrode condition?

- A. The electrode is functioning normally — a slope of 95% is excellent and all three buffer readings are within acceptable tolerance
- B. The electrode slope of 95% indicates mild aging — the electrode is still usable but should be monitored, and the increasing error at pH 10 suggests the reference junction may be partially blocked

C. The electrode is producing acceptable results at pH 4 and 7 but the 0.15 unit error at pH 10 disqualifies the electrode for any measurements above pH 9.0

D. The electrode must be replaced immediately because the slope is below the 98% minimum for compliance-grade measurements

95. A treatment plant submits monthly DMRs for BOD, TSS, ammonia, fecal coliform, pH, DO, and flow. The operator discovers that the January DMR was submitted with the December data accidentally copied into the January fields. The February DMR was submitted correctly with February data. The error is discovered in March during an internal audit. What is the correct procedure?

A. Submit a corrected January DMR with the actual January data, notify the regulatory authority of the error, and document the correction and the internal QC measures implemented to prevent recurrence

B. Average the December and January data and submit the average as a corrected January DMR

C. Take no action because the February DMR was correct and the January error will be averaged out over the annual summary

D. Wait until the annual report submission to correct the January data as part of the annual reconciliation process

96. A laboratory analyst is performing a total suspended solids analysis. The analyst filters 250 mL of secondary effluent through a pre-weighed glass fiber filter, dries the filter at 103°C for one hour, cools in a desiccator for 30 minutes, and weighs. The filter weight gain is 2.5 mg. The analyst then returns the filter to the oven for an additional 30 minutes, cools, and reweighs. The weight gain is now 2.3 mg. What should the analyst do next?

A. Report the TSS as $2.3 \text{ mg} \div 0.25 \text{ L} = 9.2 \text{ mg/L}$ because the second weighing is closer to constant weight

B. Return the filter to the oven for another 30 minutes, cool, and reweigh — the 0.2 mg difference between the first and second weighings indicates the sample has not yet reached constant weight (the difference exceeds the 0.5 mg threshold... actually 0.2 mg is less than 0.5 mg). The sample has reached constant weight. Report as $2.3 \div 0.25 = 9.2 \text{ mg/L}$.

C. The difference of 0.2 mg between the two weighings may or may not meet the constant weight criterion depending on the laboratory's SOP — typically, drying is continued until consecutive weighings agree within ± 0.5 mg, and 0.2 mg is within this tolerance

D. Average the two weighings: $(2.5 + 2.3) \div 2 = 2.4$ mg, and report TSS as $2.4 \div 0.25 = 9.6$ mg/L

97. An operator at a treatment plant performs a jar test to determine the optimal alum dose for phosphorus removal. The test results show: 10 mg/L alum \rightarrow TP 3.2 mg/L, 20 mg/L \rightarrow TP 1.8 mg/L, 30 mg/L \rightarrow TP 0.8 mg/L, 40 mg/L \rightarrow TP 0.5 mg/L, 50 mg/L \rightarrow TP 0.4 mg/L. The permit limit is 1.0 mg/L TP. The operator must select the optimal dose that meets the permit while minimizing chemical cost and pH impact. Which dose should the operator select?

A. 50 mg/L because it produces the lowest phosphorus concentration and provides maximum compliance margin

B. 20 mg/L because it is the lowest dose that approaches the permit limit

C. 40 mg/L because it achieves the permit limit with acceptable margin while avoiding the diminishing returns of the 50 mg/L dose

D. 30 mg/L because it achieves 0.8 mg/L (below the 1.0 mg/L limit) at the lowest effective dose — doubling to 40 mg/L only reduces TP by an additional 0.3 mg/L while increasing chemical cost and alkalinity consumption by 33%

98. An operator reviewing the plant's 12-month compliance record for the annual report identifies the following pattern: January through September, the effluent BOD monthly average ranged from 14 to 22 mg/L (limit 30). In October, the monthly average was 28 mg/L. In November, it was 32 mg/L (a violation). In December, it was 26 mg/L. What does this seasonal pattern most likely indicate, and what should the operator recommend?

A. The fall/winter increase is random variation and does not indicate a systematic problem

B. The October-November deterioration coincides with colder wastewater temperatures that slow biological treatment, and the plant may need to increase the SRT or make other winter-preparation adjustments to prevent future November violations

C. The November violation was caused by a single high daily result that skewed the monthly average upward

D. The pattern indicates the plant's permit limits should be adjusted to include seasonal variation allowances

99. A plant operator is asked to certify on the DMR that the information submitted is "true, accurate, and complete to the best of my knowledge and belief." The operator has verified all the analytical data and process measurements, but is aware that the laboratory's pH meter was out of calibration for 3 days during the month. The pH data during those 3 days may be unreliable but the pH was always well within the 6.0-9.0 permit range based on the (possibly inaccurate) readings. Can the operator sign the DMR certification?

A. Yes — the operator should sign the certification, note the pH meter calibration issue in the DMR remarks section, and ensure the data quality concern is documented

B. No — the operator cannot certify the data as "true and accurate" because some pH data may be unreliable

C. Yes — the pH data is acceptable because the readings were within the permit range regardless of calibration status

D. No — the operator must exclude all pH data from the month and report "no data available" for pH

100. This is the final question of the final practice exam. An operator who has completed all ten practice exams (1,000 total questions) and is preparing for the actual ABC Class I Wastewater Treatment certification exam should focus their final review on which of the following strategies?

A. Memorizing as many specific numerical values (exact detention times, exact chemical doses, exact loading rates) as possible in the remaining study time

B. Reviewing any domains that consistently scored below 70% across multiple practice exams, focusing on understanding WHY the correct answers are correct rather than memorizing specific facts, and practicing the mathematical calculations that appear most frequently

C. Reading the entire study guide from beginning to end one more time to ensure comprehensive coverage

D. Focusing exclusively on the mathematical calculations because they represent the highest-value questions on the exam

Practice Exam 10: Answer Key and Explanations

1. C — Winter presents the greatest combined challenge: cold temperatures directly slow biological metabolism (reducing treatment efficiency), while the concentrated influent (higher BOD per unit volume due to lower flow) increases the oxygen demand in the aeration basin. The operator must simultaneously compensate for slower biology and higher volumetric loading — requiring extended SRT and potentially increased aeration.
2. A — Chlorine residual of 8.5 mg/L in the influent is acutely toxic to the biological organisms in the activated sludge system. Even a brief exposure at this concentration can kill a significant portion of the biological population, causing treatment failure that takes days or weeks to recover. The operator must immediately divert the chlorinated flow, notify the pretreatment coordinator, and protect the biology.
3. D — Although the total BOD mass loading hasn't changed, the higher concentration (265 mg/L vs. 200 mg/L) means each gallon of wastewater entering the aeration basin carries more organic matter. The aeration system must supply more oxygen per unit volume of mixed liquor to maintain the same DO setpoint. If the blowers were already near capacity, the higher concentration could cause DO to drop.
4. B — Lead from septage enters the wastewater treatment process and partitions between the liquid phase (regulated by the NPDES permit's effluent metals limits) and the solids phase (regulated by Part 503 ceiling concentrations and pollutant concentration limits for biosolids). Both regulatory frameworks address metals from all sources, including septage.
5. A — Staggering the return of each sidestream at different times prevents simultaneous peak loading from all three sources. If all three are returned at once, the combined ammonia load (thickener + digester + centrate) could create a brief but intense nitrogen spike that overwhelms the nitrification capacity. Distributed return spreads the load evenly across 24 hours.
6. D — The low MLSS (1,200 vs. target 2,500) with a normal SVI (85 mL/g — the remaining organisms settle well) points to excessive solids removal, not toxicity (which would show poor settling) or filamentous bulking (which would show high SVI). The WAS pump running at an excessive rate explains all symptoms: fewer organisms → lower DO uptake → insufficient treatment → high effluent BOD and TSS.
7. C — Increasing the MLSS from 3,000 to 3,500 mg/L increases the mass of solids entering the secondary clarifier at the same flow rate. The SLR will increase proportionally — from 24.4 to

approximately 28.5 lbs/day/ft². If this exceeds the clarifier's design capacity (typically 20–30 lbs/day/ft²), the clarifier may not be able to settle and compact the additional solids, causing effluent TSS to increase.

8. B — Nitrifying bacteria are significantly more sensitive to heavy metal toxicity than heterotrophic BOD-removing bacteria. Zinc at 50 mg/L selectively inhibits *Nitrosomonas* and *Nitrobacter* while the more robust heterotrophs continue to metabolize organic matter. This differential sensitivity is a fundamental principle of wastewater microbiology and a common exam topic.

9. A — The operator should disagree but also acknowledge the superintendent's energy concern. Running both UV and chlorine provides critical redundancy — if either system fails (lamp burnout, chemical supply interruption, power fluctuation), the other maintains continuous disinfection. The energy savings from shutting down UV are modest compared to the compliance risk of a single-point-of-failure disinfection system.

10. D — Nitrification requires a minimum pH of approximately 6.5 and minimum alkalinity of approximately 50–80 mg/L as CaCO₃ for stable operation. At pH 6.3 and alkalinity 35 mg/L, both are below their minimums. Nitrification will slow progressively and may cease entirely, causing effluent ammonia to exceed the permit limit. The operator must add supplemental alkalinity before nitrification fails.

11. D — At 400% internal recycle, the theoretical maximum denitrification is 80% of the nitrate produced ($4 \div 5 = 80\%$). However, DO carried from the aerobic zone (at 3.5 mg/L) through the internal recycle partially inhibits denitrification at the entry point, AND the anoxic zone detention time may be insufficient for the denitrifiers to fully convert all the returned nitrate before the flow exits to the aerobic zone.

12. B — Primary removal: $[(225 - 148) \div 225] \times 100 = 34.2\%$. Secondary removal: $[(148 - 12) \div 148] \times 100 = 91.9\%$. Overall: $[(225 - 12) \div 225] \times 100 = 94.7\%$. All three values are within expected performance ranges — primary at 25–40%, secondary above 85%, and overall above 85%.

13. C — In contact stabilization, the organisms adsorb BOD in the contact zone and metabolize it in the stabilization zone. If the stabilization zone organisms are damaged (toxicity, equipment failure, inadequate DO), they cannot fully regenerate their adsorptive capacity. When they return to the contact zone, they cannot adsorb as much BOD as healthy organisms, and the effluent BOD increases.

14. A — At 2.8 MGD, the mass loading at the 30 mg/L concentration limit = $30 \times 2.8 \times 8.34 = 700.6$ lbs/day, which is below the 750 lbs/day mass limit. The concentration limit of 30 mg/L becomes the controlling limit. The mass limit of 750 lbs/day would control only if the effluent BOD exceeds $750 \div (2.8 \times 8.34) = 32.1$ mg/L. Above 32.1 mg/L, the mass limit is more restrictive.

15. C — The phosphorus increase directly correlates with the TSS increase because phosphorus is bound to the suspended particles in two forms: biologically incorporated phosphorus within the cell mass, and chemically precipitated ferric phosphate particles. When more particles escape over the clarifier weir (higher TSS), they carry their bound phosphorus with them, increasing the effluent total phosphorus.

16. B — BOD Loading = $140 \times 4.0 \times 8.34 = 4,670$ lbs/day. MLSS (lbs) = $3,400 \times 1.2 \times 8.34 = 34,027$ lbs. F/M (MLSS) = $4,670 \div 34,027 = 0.137$. MLVSS = $3,400 \times 0.80 = 2,720$ mg/L. MLVSS (lbs) = $2,720 \times 1.2 \times 8.34 = 27,221$ lbs. F/M (MLVSS) = $4,670 \div 27,221 = 0.171$. The MLVSS-based F/M is technically more accurate because it excludes inert material from the denominator.

17. C — Equalizing the flow split from 55/45 to 50/50 increases the flow to Clarifier B by approximately 11%. If Clarifier B is currently operating at its optimal loading, the increased flow may push it beyond its capacity. The operator should evaluate whether Clarifier B can handle the increased loading before making the change, rather than assuming equal flow automatically improves overall performance.

18. A — *Sphaerotilus natans* is a classic low-DO filamentous organism that proliferates when dissolved oxygen drops below 1.0 mg/L — particularly in combination with high F/M ratios and readily biodegradable organic matter (such as from septic influent or food processing waste). The organism extends filaments from the floc surface to reach oxygen and nutrients, creating the characteristic bulking condition.

19. D — Oxidation ditches naturally create alternating aerobic zones (near the brush aerators where vigorous aeration occurs) and anoxic zones (in the channel sections between aerators where DO is consumed by the organisms faster than it is replenished). This creates a built-in denitrification capability without a separate anoxic reactor. Many oxidation ditches achieve 50–70% nitrogen removal through this mechanism.

20. B — The sand filter's elevated turbidity (5 NTU) reduces the UV transmittance of the secondary effluent entering the UV system. Fixing the filter (reducing turbidity from 5 to 2 NTU) will improve the UV transmittance, which directly increases the UV dose delivered to the pathogens. This single fix addresses both the filtration problem AND the UV performance issue — addressing the root cause benefits both systems.

21. A — Carbonaceous $O_2 = 150 \times 3.0 \times 8.34 \times 0.95 \times 1.5 = 5,673$ lbs/day. Nitrification $O_2 = 30 \times 3.0 \times 8.34 \times 4.6 = 3,451$ lbs/day. Total = 9,124 lbs O_2 /day. The nitrification demand (38% of total) is substantial and must be accounted for when sizing the aeration system. Many plants underestimate the oxygen requirement by forgetting to include the nitrogenous demand.

22. A — The SOR at 1,100 GPD/ft² is 92% of the design maximum (1,200) — a 50 GPD/ft² margin. The SLR at 38 lbs/day/ft² is 127% of the design maximum (30) — exceeding the limit by 8 lbs/day/ft². The SLR violation represents the greater risk because exceeding the clarifier's ability to settle and compact the solids mass directly causes solids to wash over the effluent weir.

23. B — The difference between BOD_5 (6 mg/L, measured without a nitrification inhibitor) and $CBOD_5$ (3 mg/L, measured with a nitrification inhibitor) is the nitrogenous oxygen demand — the oxygen consumed by nitrifying bacteria oxidizing ammonia to nitrate during the 5-day incubation. The inhibitor suppresses nitrification, isolating the carbonaceous demand.

24. D — Maximum effluent BOD = Influent $\times (1 - \text{Required removal}) = 180 \times (1 - 0.85) = 180 \times 0.15 = 27$ mg/L. If the effluent exceeds 27 mg/L, the percent removal drops below 85%. Note that the concentration limit (30 mg/L) and the removal-based limit (27 mg/L) are independently enforceable — the plant must meet whichever is more restrictive.

25. C — The extended aeration system was operating in deep endogenous respiration (F/M 0.05, SRT 25 days) where the organisms consume their own cell mass, producing tiny, dense pin floc. The 15% increase in organic loading raised the F/M from 0.05 toward a healthier 0.06, providing more external food and stimulating larger, better-structured floc formation — actually improving the settling and effluent quality.

26. A — Effective contact time = Theoretical DT \times Baffling factor = $25 \times 0.6 = 15$ minutes. Required residual = $CT \div T_{10} = 30 \div 15 = 2.0$ mg/L. The operator must maintain a minimum outlet chlorine residual of 2.0 mg/L to achieve the required CT of 30 mg·min/L at the effective (baffled) contact time of 15 minutes.

27. B — The plant is currently wasting 35% of its blower energy through the blow-off valve — air that is compressed, heated, and then dumped rather than used for treatment. VFD-controlled blowers modulate their speed based on actual DO demand, delivering only the air needed and eliminating the wasted energy. This typically reduces aeration energy by 25–40%, the single largest savings opportunity.

28. D — A 50% flow increase reduces all detention times proportionally: anaerobic from 1.5 to 1.0 hours, anoxic from 2.0 to 1.33 hours, aerobic from 6.0 to 4.0 hours. The shortened anoxic zone provides less time for denitrification, while the aerobic zone (though shortened) still provides adequate time for nitrification at the current SRT. The result is continued nitrate production but reduced nitrate removal.

29. C — With one basin offline, the remaining basin receives 100% of the loading at half the volume — doubling the volumetric loading and halving the HRT. The operator should maintain the current MLSS (to preserve the biological population) and increase the aeration rate proportionally to supply adequate DO at the higher volumetric oxygen demand. The F/M will increase, but monitoring ensures treatment quality is maintained.

30. B — Reducing the SRT from 12 to 8 days eliminates the safety margin that protects against unexpected events. A sudden temperature drop, a brief toxic event, or a weekend loading spike could push nitrification performance beyond the reduced population's capacity. The 4-day margin (12 vs. minimum ~6 at summer temperatures) provides resilience; reducing to 8 days leaves only a 2-day buffer.

31. C — Measuring the dissolved aluminum concentration directly quantifies how much aluminum is passing through the treatment process in dissolved or colloidal form. Normal effluent dissolved aluminum is below 0.1 mg/L. Elevated dissolved aluminum at pH 5.9 confirms that the low pH is causing aluminum to remain in solution rather than precipitating as insoluble aluminum hydroxide floc.

32. D — A confirmed chlorine gas leak — even a small one at 0.3 ppm — requires following the emergency response procedure: do not attempt repairs in the contaminated atmosphere, evacuate, don SCBA for full respiratory protection, then return to close the cylinder valve and stop the gas at its source. The 0.3 ppm level can rapidly increase to dangerous concentrations if the leak worsens.

33. A — The permit specifies the critical dilution at 50% effluent based on the receiving water dilution ratio. At this critical dilution, no mortality was observed. The 30% mortality at full-strength effluent does not constitute a permit violation because the permit requirement applies specifically at the critical dilution. However, proactive investigation of the full-strength toxicity is recommended.

34. C — Required residual = $CT \div T_{10} = 20 \div 16 = 1.25$ mg/L. Total dose = Demand + Required residual = $4.2 + 1.25 = 5.45$ mg/L. The dose must be sufficient to satisfy the chlorine demand (4.2 mg/L consumed by reactions with organic matter and ammonia) AND produce the required residual (1.25 mg/L) at the outlet to achieve the target CT.

35. B — To equalize the SOR, each clarifier receives flow proportional to its surface area. Total area = $5,000 + 3,500 = 8,500$ ft². Clarifier A share = $5,000 \div 8,500 = 58.8\% \times 4.5 = 2.647$ MGD. Clarifier B share = $3,500 \div 8,500 = 41.2\% \times 4.5 = 1.853$ MGD. Both operate at the same SOR of 529 GPD/ft².

36. D — lbs Cl₂/day = $10 \times 2.0 \times 8.34 = 166.8$ lbs/day. lbs solution = $166.8 \div 0.12 = 1,390$ lbs/day. Weight per gallon = $1.16 \times 8.34 = 9.67$ lbs/gal. Volume = $1,390 \div 9.67 = 143.7$ GPD. Daily cost = $143.7 \times \$0.85 = \122.15 , approximately \$120–145/day depending on rounding.

37. A — The ortho-P of 0.08 mg/L shows the dissolved phosphorus is well-controlled. The total P of 0.35 mg/L includes an additional 0.27 mg/L in particulate form — phosphorus bound to suspended solids escaping the clarifier. Improving clarifier performance or adding tertiary filtration captures these particles, reducing total P to approach the ortho-P level.

38. C — The oxygen transfer efficiency ratio is $25\% \div 6\% = 4.17$. To deliver the same mass of oxygen, the fine bubble system needs only $1/4.17$ of the air volume: $4,500 \div 4.17 = 1,079$ CFM, approximately 1,080 SCFM. This 76% reduction in air volume translates directly to reduced blower energy — the primary economic justification for the diffuser upgrade.

39. B — The total cost comparison must include all costs: per-ton savings (\$65 landfill vs. \$55 hauling+application = \$10/ton savings), annual monitoring costs (\$5,500), staff time for program management, liability insurance, and regulatory compliance burden. A complete financial analysis may show that the per-ton savings are offset by the program management costs, or may confirm net savings.

40. D — The clarifier blanket approaching the weir is the most time-critical issue — solids can wash over the weir within minutes, causing an immediate permit violation. The operator should immediately increase the RAS rate. The chlorine reading of 0.5 ppm, while below the PEL, warrants investigation next — it may indicate a developing leak that could worsen. The training question can wait until both operational concerns are addressed.

41. D — The attendant should immediately activate the retrieval system — at 17.5% oxygen and dropping, the entrant is at imminent risk of losing consciousness. The momentary spike to 25 ppm H₂S confirms that the standing water contains dissolved H₂S at dangerous concentrations. The oxygen depletion may be caused by biological activity consuming oxygen, or by gas displacement from disturbed water releasing dissolved gases.

42. A — If ferric chloride (an acid with pH ~2) and sodium hydroxide (a base with pH ~14) leaked simultaneously into a shared containment, the exothermic neutralization reaction would generate extreme heat (potentially exceeding 200°F), violent boiling, and dangerous splashing of both corrosive chemicals. Separate containment prevents this life-threatening chemical reaction.

43. C — Sodium hypochlorite (oxidizer) mixing with ferric chloride (acid) can produce toxic chlorine gas. If the crack allows ferric chloride to drain into the sodium hypochlorite containment during a simultaneous leak, personnel in the building would be exposed to chlorine gas in an enclosed space — a potentially fatal scenario. The crack must be repaired immediately and separate containment integrity verified.

44. B — Acetone is a highly flammable solvent (flash point -4°F) that produces heavier-than-air vapors. Storing it next to energized motor control centers creates an immediate explosion and fire hazard — any electrical arc, spark from a contactor, or fault in the MCC could ignite the acetone vapors. The containers must be removed from the electrical room immediately.

45. D — The NPDES permit specifies the sample type for each parameter. Using grab samples instead of the required composites constitutes a monitoring violation because the two sample types may produce different results — composites capture time-weighted or flow-weighted averages while grabs represent only a single moment. The operator must correct the procedure and notify the regulatory authority.

46. A — The monthly no-load tests provided false confidence by demonstrating the engine would start and the generator would produce voltage. However, the critical capability — sustaining rated power output under load — was never tested. The generator could have been unable to power the plant's critical loads during an actual power outage for the entire 14 months. Annual load testing would have detected this deficiency 2 months after it developed.

47. C — Data fabrication on federal compliance documents (DMRs) is a criminal offense under Section 309(c)(4) of the Clean Water Act, carrying penalties of up to \$10,000 per day and imprisonment up to 2 years. The operator has both a legal obligation (as someone who handles compliance data) and an ethical duty to report the fabrication to the plant superintendent immediately.

48. B — CMOM is a permit condition, not a suggestion. Failure to implement a permit condition constitutes a permit violation subject to the same enforcement authority as any other noncompliance — including notices of violation, administrative penalties, consent orders, and potential civil or criminal enforcement. The superintendent must be advised to implement the CMOM program promptly.

49. A — The operator should investigate the complaint as required by the SOP, but with critical safety limitations: never enter a manhole or confined space while working alone, verify the plant is stable before leaving, and maintain communication with the plant control system remotely if possible. The investigation should be limited to a surface-level assessment — visual inspection, odor assessment, and documentation.

50. C — Under 40 CFR 112, SPCC plans must be reviewed and amended within six months of any change in facility design, construction, operation, or maintenance that materially affects the plan's spill potential. Adding a 5,000-gallon diesel tank in 2022 was a material change that should have triggered a plan amendment within 6 months. The plan is now 3+ years overdue for this amendment.

51. A — Step-feeding (if available) distributes the incoming flow at multiple points along the aeration basin, effectively increasing the usable volume and distributing the organic load. Reducing WAS retains maximum biological mass for improved settling. These combined strategies maximize the plant's treatment and clarification capacity during the extended high-flow event.

52. B — Operating left of BEP means the pump is producing less flow than its design point at higher head. This creates radial thrust imbalance on the impeller, internal recirculation in the volute (wasted energy), increased vibration, higher noise levels, and accelerated wear on bearings and seals. Sustained operation far left of BEP significantly shortens pump life.

53. A — A megger reading of 0.5 megohms (versus >100 megohms for a new motor) indicates severe insulation degradation. Moisture infiltration is the most common cause in submersible pumps — seals degrade over time, allowing water to contact the windings. The degraded insulation allows current to leak to ground, triggering the overload protection. The motor should be pulled and rewound or replaced.

54. C — The 4 nuisance alarms generating 85% of all alarms create "alarm fatigue" — operators become desensitized to alarms and may ignore or slow-respond to genuine critical alarms buried in the flood of routine notifications. Optimizing these 4 alarm points (adjusting deadbands, adding time delays, resetting setpoints) dramatically reduces the alarm volume while preserving meaningful alerting.

55. D — A gradual decline in the inline TSS reading from 8,500 to 5,200 mg/L — contradicted by a laboratory grab showing 8,100 mg/L — indicates the inline optical sensor is progressively fouling. Biological growth, grease, or mineral deposits on the sensor windows reduce the transmitted or reflected signal, causing the analyzer to underreport the actual solids concentration.

56. B — At 75% speed (45 Hz), the motor's internal cooling fan also operates at 75% speed, providing significantly less cooling airflow. VFD-operated motors generate additional heat from harmonic currents in the windings. The combination of reduced cooling and additional harmonic heating causes the motor temperature to exceed its rating at reduced speed — a common issue that may require an auxiliary cooling fan.

57. B — A diaphragm-type metering pump with gradually declining output and no visible external problems most likely has a partially failing diaphragm. The diaphragm develops fatigue cracks, small tears, or permanent deformation that reduce its effective displacement volume per stroke. The pump appears to stroke normally, but each stroke delivers less volume than the setting indicates.

58. C — After each weighing cycle, the analyst checks whether constant weight has been achieved. The difference between the first (2.5 mg) and second (2.3 mg) weighings is 0.2 mg. Most standard methods define constant weight as consecutive weighings agreeing within ± 0.5 mg. Since $0.2 \text{ mg} < 0.5 \text{ mg}$, constant weight has been achieved, and the TSS should be reported as $2.3 \text{ mg} \div 0.25 \text{ L} = 9.2 \text{ mg/L}$.

59. D — Excessive pump cycling (25 starts/hour vs. 6 maximum) subjects the motor windings to repeated inrush current — typically 5–7 times the running current — each start. This creates enormous heat generation in the windings that the motor cannot dissipate between starts. The cumulative thermal damage destroys the winding insulation, leading to premature motor failure.

60. B — The reading of 8.5 NTU versus the 10 NTU standard represents a 15% error. The $\pm 5\%$ specification at 10 NTU means the acceptable range is 9.5–10.5 NTU. The ± 0.5 NTU specification also gives a range of 9.5–10.5 NTU. At 8.5 NTU, the reading is 1.5 NTU below the standard — far outside either specification. The instrument requires recalibration.

61. D — When two centrifugal pumps operate in parallel into a common header, the combined flow creates more friction loss in the downstream piping than either pump alone. This moves the operating point on the system curve to a higher head, and each pump delivers less flow at the higher head. The combined flow is always less than the sum of individual flows — this is a fundamental characteristic of parallel pump operation.

62. C — The definition of "continuous monitoring" varies by regulatory jurisdiction. Some states accept 15-minute intervals as continuous, while others require 1-minute or even 1-second intervals. The operator should review the specific permit language and consult with the regulatory authority to confirm the acceptable recording interval before assuming compliance.

63. A — Two tubing failures in a year — each causing 4–6 hours of interrupted chemical feed — represent preventable process disruptions. The manufacturer's 2,000-hour recommendation is based on testing of the tubing material's fatigue life. Operating at more than double the recommended interval (4,380 hours) virtually guarantees periodic in-service failures. Replacing at 2,000 hours prevents these disruptions.

64. B — The steady 4-month pressure increase (7.5 → 8.7 psi) at constant airflow is the signature of progressive diffuser fouling. Each month adds more biological growth and mineral scale to the diffuser openings, requiring the blower to develop more pressure to push the same air volume through the increasingly restricted diffuser orifices. Cleaning should be scheduled before the pressure reaches the blower's maximum rated discharge.

65. D — An analyzer reading 0.3 mg/L while the lab shows 0.8 mg/L (or vice versa) could be caused by many factors: different sample locations, different analytical methods, sample conditioning differences, or calibration discrepancies. The operator should not assume either instrument is correct until a systematic comparison eliminates each potential source of error.

66. A — The overdue greasing of the clarifier mechanism bearings creates a real risk of bearing failure that could damage the expensive mechanism drive, rake arms, or the concrete tank itself. Grease provides both lubrication (preventing metal-to-metal contact) and corrosion protection. After 8 months without greasing, the grease may have degraded, and the bearings may be operating with inadequate protection.

67. A — Progressive diffuser fouling increases the system pressure (backpressure) that the blower must overcome. PD blowers maintain constant volume output, so when the discharge pressure increases, the blower consumes more power (pressure × volume = power). A 20% increase in discharge pressure produces approximately 20% more energy consumption — explaining the entire increase.

68. B — Increasing the belt speed by 25% means the sludge spends 25% less time in each dewatering zone. To compensate, both the polymer dose (to maintain adequate floc strength at the faster speed) and the belt tension (to maintain adequate compression in the shorter pressure zone time) should be increased proportionally. This restores the original performance parameters at the higher throughput.

69. D — Both restricted discharge piping (partially closed valves) and a clogged inlet filter would reduce the lag blower's actual air output below its rated capacity. Either condition alone could explain the problem, and both should be checked. The operator should verify that all discharge piping valves are fully open and that the inlet filter is clean before concluding the blower itself has failed.

70. C — Volume = $64 \text{ ft}^2 \times 3.5 \text{ ft} = 224 \text{ ft}^3 \times 7.48 \text{ gal/ft}^3 = 1,675.5$ gallons in 5 minutes = 335 GPM. This draw-down test provides a direct, practical measurement of actual pump output that can be compared to the flow meter reading or pump curve performance data.

71. A — Waste activated sludge is significantly harder to gravity-thicken than primary sludge because biological floc particles are light, fluffy, and hydrophilic. Adding polymer to the combined feed helps the lighter WAS particles aggregate and settle more effectively, improving both the thickened sludge concentration and the supernatant clarity.

72. B — The centrate quality problem (300 mg/L TSS escaping) indicates fine particles are not being captured. Increasing the polymer dose improves flocculation of these fine particles, binding them into larger aggregates that the centrifugal force can capture. Since the cake solids are already good (22%), this targeted adjustment addresses the centrate problem without affecting the cake quality.

73. D — The VA/Alk ratio has increased from 0.06 to 0.18 — a significant rise but still well below the 0.35 critical threshold. The gas production increase (15%) is a positive indicator that the methanogens are responding to the additional substrate. The minor pH decrease (7.2 → 7.0) is not alarming. The operator should continue at the current loading with increased monitoring to ensure the trend stabilizes.

74. C — Extending the operating hours preserves the proven belt speed (10 ft/min) that produces 20% cake solids. Increasing the speed to 15 ft/min would reduce the drainage and compression time by 33%, likely producing a wetter cake (below 20%). The 50% throughput increase is achieved with 12 hours at the same quality rather than 8 hours at reduced quality.

75. A — The Van Kleeck equation: $VSR = [(VS_{in} - VS_{out}) \div (VS_{in} - (VS_{in} \times VS_{out}))] \times 100$. Substituting: numerator = $0.70 - 0.58 = 0.12$. Denominator = $0.70 - (0.70 \times 0.58) = 0.70 - 0.406 = 0.294$. $VSR = 0.12 \div 0.294 \times 100 = 40.8\%$, approximately 41%. This exceeds the 38% minimum required for Part 503 vector attraction reduction. The Van Kleeck equation accounts for the fact that volatile solids destruction reduces the total mass, which artificially concentrates the remaining volatile fraction — a simple percentage difference ($70\% - 58\% = 12\%$, or $12 \div 70 = 17\%$) significantly underestimates the true volatile solids destruction. 76. B — The Part 503 windrow composting method (Alternative 1 under 503.32(a)(3)) requires maintaining temperatures above 131°F (55°C) for at least 15 days, during which the windrow must be turned at least 5 times. With only 4 turnings in 18 days, the minimum 5-turning requirement has not been met. The operator must perform at least one more turning while maintaining the temperature above 131°F.

77. D — All three Exceptional Quality criteria are met: (1) fecal coliform 400 MPN/g is below the Class A threshold of 1,000 MPN/g; (2) all 10 regulated metals are below the Table 3 pollutant concentration limits; (3) volatile solids reduction of 42% exceeds the 38% minimum for vector attraction reduction. These three conditions together qualify the biosolids for unrestricted public distribution.

78. C — The ASP/in-vessel method requires temperatures above 131°F for at least 3 consecutive days. If the temperature probe was faulty for the past week and the actual temperature was only 115°F, the 3-day count cannot include any days with unverified or failed temperature data. The count must restart from the first day when verified temperature monitoring confirms the 131°F threshold is exceeded.

79. A — Fall-applied biosolids release nitrogen through mineralization over the winter months. During this period, no crop is growing to absorb the nitrogen, and winter rainfall leaches the mobile nitrate below the root zone. By spring planting, much of the available nitrogen has moved beyond the crop's reach. This is why spring application (just before the crop's peak nitrogen demand) is generally more efficient.

80. C — Step 1: Feed solids rate = $100 \text{ GPM} \times 8.34 \text{ lbs/gal} \times 0.035 = 29.19 \text{ lbs/min}$. Step 2: Centrate solids loss rate = $100 \text{ GPM} \times 8.34 \text{ lbs/gal} \times (400 \div 1,000,000) = 0.334 \text{ lbs/min}$ (using the approximation that centrate flow \approx feed flow since the cake volume is small). Step 3: Capture rate = $(29.19 - 0.334) \div 29.19 \times 100 = 98.9\%$, approximately 98.6%. This excellent capture rate indicates the centrifuge is effectively separating solids from liquid — only about 1.1% of the incoming solids mass is escaping in the centrate. Well-operated centrifuges typically achieve capture rates above 95%, and rates above 98% indicate optimal polymer conditioning and machine settings.

81. D — Despite the volatile acids doubling (200 \rightarrow 350), the alkalinity remains stable (3,200), pH is steady (7.1), gas production is increasing (positive indicator), and methane content is unchanged (62%). The VA/Alk ratio of 0.109 is well below the 0.35 warning threshold. The system is adjusting to a change (possibly higher loading or seasonal variation) but all indicators confirm the methanogens are keeping pace.

82. A — At 0.5% concentration instead of 0.25%, each gallon of polymer solution contains twice the active polymer. Since the operator is feeding the same volume per gallon of sludge, the actual active polymer dose (lbs polymer per dry ton of solids) has been doubled. This wastes chemical cost and may over-condition the sludge, potentially causing charge reversal and re-dispersion of the floc.

83. C — Elevated particulate emissions with a scrubber and baghouse in the control system most likely indicate a compromised fabric filter. Torn, burned, or poorly sealed bags allow particulate to bypass the

filtration and exit through the stack. The scrubber removes acid gases and cools the exhaust but is not designed for fine particulate removal — that is the baghouse's function.

84. B — Daily dry solids = $15,000 \text{ GPD} \times 8.34 \times 0.22 = 27,522 \text{ lbs/day}$. Annual = $27,522 \times 365 = 10,045,530 \text{ lbs/year}$. Convert to metric tons: $10,045,530 \div 2,205 = 4,556 \text{ dry metric tons}$. Depending on rounding: approximately 4,130–4,700 dry metric tons per year. This number is required for Part 503 annual reporting and determines the monitoring frequency.

85. D — The overapplication exceeds the agronomic nitrogen rate, creating the potential for nitrate to leach to groundwater or run off to surface water. The operator must report the overapplication to the regulatory authority (it constitutes a deviation from the approved application plan), adjust the CPLR tracking to reflect the actual loading, and reduce or suspend future applications at this site.

86. C — To achieve a target C:N ratio from two materials with vastly different ratios, the calculation must balance the total carbon and nitrogen in the blended mixture. The biosolids contribute mostly nitrogen (C:N 8:1) while the sawdust contributes mostly carbon (C:N 400:1). Enough sawdust must be added to raise the blend from 8:1 to the target 30:1.

87. A — Specific gas production = $42,000 \text{ ft}^3/\text{day} \div 2,750 \text{ lbs VS destroyed/day} = 15.3 \text{ ft}^3 \text{ gas/lb VS destroyed}$. This falls within the typical range of 12–18 $\text{ft}^3/\text{lb VS destroyed}$ for mesophilic anaerobic digestion, confirming the digester is performing normally and converting volatile solids to gas at the expected rate.

88. B — Time-proportional compositing gives equal weight to all sampling periods regardless of flow, while flow-proportional compositing weights each aliquot volume according to the flow rate at the time of collection. For parameters like TSS where concentration varies with flow, the two methods can produce different results. The regulatory authority should be notified and the programming corrected.

89. D — Three valid dilutions showing results of 22, 16, and 13 mg/L exhibit a pattern where the most dilute sample (10%) produces a noticeably higher result. This can indicate interference, insufficient depletion correction, or analytical artifact at the low dilution. The two dilutions with closest agreement (16 and 13 mg/L) are generally most reliable, and their average (14.5 mg/L) is typically reported.

90. C — The chlorine contact tank contains active chlorine residual that suppresses biological activity in the composite during collection. This artificial suppression means the BOD₅ measured from the contact tank sample may be lower than the true effluent BOD at the permitted location downstream.

Additionally, collecting from the wrong location is itself a monitoring violation regardless of the analytical effect.

91. A — An MDL increase from 0.05 to 0.15 mg/L means the laboratory can no longer reliably detect or quantify ammonia concentrations below 0.15 mg/L. For plants with ammonia limits near or below 0.15 mg/L, this could affect compliance reporting. The increased MDL indicates deteriorating analytical precision that should be investigated — causes include degraded reagents, instrument drift, or contaminated labware.

92. B — Both analysts produce acceptable GGA results (within the quality control range), eliminating major method errors. The consistent 15–20% difference on split samples points to subtle but systematic differences in technique — seed preparation, seed volume, dilution technique, sample mixing, or pipetting practices. Standardizing these procedural details between analysts should reduce the discrepancy.

93. D — The permit requires no chronic toxicity at the 50% dilution. Survival was 100% at all concentrations (passing the survival endpoint). However, reproduction was significantly reduced at 100% effluent. The permit's critical dilution is 50%, and reproduction at 50% was not affected — the plant passes the chronic WET test. The 100% effluent toxicity warrants voluntary investigation but is not a violation.

94. C — A slope of 95% indicates the electrode is beginning to age — the glass membrane is losing sensitivity. The buffer readings at pH 4 and 7 are acceptable (± 0.05 units). However, the 0.15-unit error at pH 10 is larger than at the lower buffers, suggesting the reference junction may be partially blocked (affecting high-pH accuracy more than low-pH). The electrode is usable but should be monitored for further degradation.

95. A — The operator should submit a corrected January DMR with the actual January data, notify the regulatory authority that the January submission contained December data entered in error, and implement internal QC procedures (such as data review checklists or supervisor verification) to prevent recurrence. Leaving known errors uncorrected is itself a violation.

96. B — The 0.2 mg difference between consecutive weighings (2.5 and 2.3 mg) is within the ± 0.5 mg constant weight criterion used by most laboratories following Standard Methods. The sample has reached constant weight, and the second weighing (2.3 mg) should be used: $TSS = 2.3 \div 0.25 \text{ L} = 9.2 \text{ mg/L}$.

97. D — The jar test shows: from 30 to 40 mg/L, the phosphorus drops from 0.8 to 0.5 mg/L (0.3 mg/L improvement for 10 mg/L additional alum). From 40 to 50 mg/L, the improvement is only 0.1 mg/L. The 30 mg/L dose achieves 0.8 mg/L — below the 1.0 mg/L limit with 0.2 mg/L margin — at the lowest effective cost while minimizing pH depression and alkalinity consumption.

98. C — The seasonal pattern — excellent performance spring through summer, declining in fall, violation in November — correlates with declining wastewater temperature. Cold water slows biological metabolism, reducing BOD removal efficiency. The plant should implement winter preparation procedures: extend the SRT starting in October, increase aeration to compensate for the higher MLSS, and monitor the process more closely through the cold months.

99. A — The operator can sign the certification by noting the pH meter calibration issue in the DMR remarks section. The certification requires data to be "true, accurate, and complete to the best of my knowledge and belief." Full disclosure of the known data quality concern (3-day calibration gap) in the remarks satisfies this standard — the operator is being transparent about a known limitation rather than concealing it.

100. B — Effective final preparation focuses on understanding principles rather than memorizing isolated facts. Reviewing persistently weak domains builds competence where it is most needed. Understanding WHY answers are correct (rather than memorizing which letter is correct) enables the test-taker to apply knowledge to novel scenarios. Practicing calculations builds confidence and speed for the exam's quantitative questions.