PRACTICE EXAM 10: WATER TREATMENT OPERATOR CLASS I SIMULATION (100 QUESTIONS)

1. A treatment plant treats 5.0 MGD from a river source. During a severe drought, the reservoir level drops to its lowest recorded point. The raw water now contains elevated concentrations of dissolved manganese (0.30 mg/L), iron (1.2 mg/L), and TOC (6.5 mg/L) compared to the normal values of manganese 0.05 mg/L, iron 0.3 mg/L, and TOC 3.0 mg/L. The operator should recognize that these changes are caused by:

A. Chemical spills upstream that have introduced industrial contaminants into the drought-depleted reservoir

B. The treatment plant's recycled backwash water re-introducing concentrated minerals into the raw water intake

C. Concentration of dissolved constituents as the reservoir volume decreases, and the intake potentially drawing from a deeper, more mineralized zone

D. Equipment malfunction at the laboratory producing systematically elevated readings across all parameters

2. A treatment plant's operator receives the results of the annual lead and copper monitoring. Thirty consumer tap samples were collected. The 90th percentile values are: lead = 0.016 mg/L (action level 0.015 mg/L), copper = 0.8 mg/L (action level 1.3 mg/L). Based on these results, the system:

A. Has exceeded the lead action level and must implement the required corrective actions under the Lead and Copper Rule, including corrosion control optimization and public education

B. Has exceeded both the lead and copper action levels and must begin immediate service line replacement

C. Is in compliance because the 90th percentile values are within the acceptable analytical uncertainty range

D. Must resample within 30 days because action level determinations require two consecutive monitoring rounds

3. A treatment plant operator discovers that the plant's sodium hypochlorite solution has been stored in a clear plastic tank exposed to direct sunlight through a large south-facing window for the past two months. The operator tests the solution and finds the available chlorine is 8.2% instead of the delivered 12.5%. The feed calculations have been based on 12.5% throughout this period. This means:

A. The chlorine dose has been 34% higher than intended because the weaker solution requires less volume

B. The chemical cost per pound of available chlorine has decreased because the solution became more concentrated

C. No treatment impact has occurred because sodium hypochlorite strength does not affect disinfection performance

D. The chlorine dose has been approximately 34% lower than intended because each gallon delivered less active chlorine than the calculations assumed

4. A treatment plant using conventional treatment performs a comprehensive tracer study on the clearwell. The theoretical detention time based on volume and flow is 120 minutes. The tracer study reveals that the T_{10} (time for 10% of the tracer to pass through) is 42 minutes. The effective baffling factor for this clearwell is:

A. 2.86, calculated by dividing the theoretical DT by the T_{10}

B. 0.35, calculated by dividing the T_{10} (42 minutes) by the theoretical DT (120 minutes)

C. 0.10, representing the 10th percentile of the tracer breakthrough curve

D. 1.20, calculated by dividing the theoretical DT by 100 minutes

5. An operator at a treatment plant using chloramination discovers that the system has been feeding ammonia but the chlorine feed pump failed eight hours ago without triggering an alarm. During this

period, the plant has been adding ammonia to unchlorinated water. The finished water now contains free ammonia with no disinfectant residual. The operator's immediate priority is to:

A. Increase the ammonia feed rate to boost the total nitrogen concentration for when chlorine is restored

B. Continue normal operations because ammonia-treated water is safe for distribution even without chlorine

C. Wait for the chlorine pump repair to be completed before taking any corrective action on the ammonia feed

D. Stop the ammonia feed immediately, restore the chlorine feed, evaluate the extent of unchlorinated water in the system, and notify the supervisor and primacy agency

6. A treatment plant's four sedimentation basins each have a volume of 250,000 gallons. The plant treats 4.0 MGD (2,778 gpm) distributed equally among all four basins. The theoretical detention time per basin is:

A. 90 minutes, calculated as the basin volume divided by the per-basin flow rate

B. 360 minutes, calculated using the total plant flow volume instead of the per-basin flow

C. 22.5 minutes, calculated by dividing the per-basin volume by the total plant flow

D. 45 minutes, using an incorrect flow division among only two basins instead of four

7. A treatment plant operator receives a call from the state primacy agency informing the plant that the laboratory analyzing the plant's quarterly DBP samples has had its certification revoked effective immediately. The plant submitted samples to this laboratory two weeks ago and results have not yet been received. The operator should:

A. Wait for the results to arrive because the samples were submitted before the certification was revoked

B. Request that the laboratory expedite the results before the revocation takes full effect

C. Collect new quarterly DBP samples immediately and submit them to a currently certified laboratory to ensure valid compliance data

D. Skip this quarter's DBP monitoring and explain the situation in the next quarterly compliance report

8. An operator at a small groundwater system tests the raw water and obtains: pH 6.2, alkalinity 15 mg/L as $CaCO_3$, total hardness 25 mg/L as $CaCO_3$, iron 0.1 mg/L, manganese 0.02 mg/L, TDS 80 mg/L. This water is best characterized as:

A. Hard, alkaline water typical of limestone aquifer sources requiring softening before distribution

B. Soft, acidic, low-alkalinity water that is likely corrosive and requires pH and alkalinity adjustment for corrosion control

C. Contaminated water requiring advanced treatment including reverse osmosis and granular activated carbon

D. Typical high-quality groundwater requiring only disinfection before entering the distribution system

9. A treatment plant operator is investigating a persistent low chlorine residual problem at a specific distribution system monitoring point. The plant effluent residual is 1.2 mg/L (normal). The monitoring point typically reads 0.4 mg/L. Over the past month, the reading has dropped to 0.05 mg/L. Flushing the hydrant nearest the monitoring point restores the residual to 0.3 mg/L temporarily, but it drops again within 48 hours. This pattern most strongly suggests:

A. The chlorine gas cylinder at the plant is nearly empty and delivering inconsistent doses

B. A cross-connection or main break near the monitoring point is introducing a persistent chlorine demand source

C. The DPD test kit at this monitoring location has degraded and is producing falsely low readings

D. A persistent chlorine demand source near the monitoring point — likely biofilm, a leaking valve admitting contaminated water, or a cross-connection — that continues consuming chlorine after flushing

10. A treatment plant treats 3.0 MGD and feeds alum at 35 mg/L. The alum solution is 48.5% concentration with a specific gravity of 1.33. The operator needs to calculate how many gallons per day of liquid alum solution are needed. Using the pounds formula and solution conversion: lb/day dry alum = 35 × 3.0 × 8.34 = 875.7. Gallons/day = 875.7 ÷ (0.485 × 1.33 × 8.34). The result is approximately:

A. 163 gallons per day of liquid alum solution

B. 875 gallons per day, which represents the weight in pounds, not the volume in gallons

C. 82 gallons per day, using only half the correct conversion sequence

D. 326 gallons per day, calculated without the specific gravity adjustment

11. A treatment plant's operator reviews the monthly turbidity compliance summary. During the month, 2,976 individual 15-minute CFE turbidity readings were collected. Of these, 2,910 readings were ≤ 0.3 NTU and 66 readings exceeded 0.3 NTU. The maximum single reading was 0.72 NTU. The plant's compliance status for the month is:

A. In violation because 66 readings exceeding 0.3 NTU represents more than 5% of total readings (66/2,976 = 2.2% — actually within compliance)

B. In violation because the maximum reading of 0.72 NTU is dangerously close to the 1.0 NTU limit

C. In compliance because 97.8% of readings were ≤ 0.3 NTU (exceeding the 95% requirement) and no reading exceeded 1.0 NTU

D. Unable to be determined because the total number of readings must be exactly 2,880 per month

12. A treatment plant's SCADA system shows that the clearwell level has dropped from 14 feet (normal) to 7 feet over the past three hours. The high-service pumps are running at full capacity. The plant production rate has decreased because two of four filters are offline for simultaneous backwash. The operator's most appropriate immediate action is:

A. Increase the chlorine dose to maintain CT as the clearwell volume decreases

B. Reduce high-service pump output to match the current reduced plant production rate, preventing further clearwell depletion

C. Open the raw water bypass to supplement the clearwell with untreated water until the filters return

D. Shut down all high-service pumps completely until the clearwell recovers to 14 feet

13. A treatment plant's operator reviews the plant's chemical compatibility chart and discovers that two chemicals currently stored adjacent to each other on the same containment pad are classified as "incompatible — do not store together." The chemicals are calcium hypochlorite (a strong oxidizer) and muriatic acid (hydrochloric acid). If these chemicals accidentally mix, the primary hazard is:

A. Formation of a thick gel that solidifies and cannot be cleaned from the containment area

B. An endothermic reaction that freezes the surrounding equipment and piping from extreme cold

C. A violent exothermic reaction that rapidly heats and evaporates both chemicals without producing gases

D. Release of toxic chlorine gas from the reaction between the oxidizer and the acid

14. A treatment plant operator collects a sample for bacteriological analysis. At the laboratory, the operator discovers that the sample temperature has risen to 12°C during transport. The required holding temperature for bacteriological samples is ≤ 10°C. The maximum holding time is 30 hours. The sample was collected 4 hours ago. The operator should:

A. Analyze the sample but flag the temperature exceedance in the quality control record, noting that the elevated temperature may have affected bacterial growth

B. Cool the sample to 4°C and hold it for 24 additional hours to allow the bacteria to return to their original concentration

C. Analyze the sample immediately because the 4-hour transit time is more important than the temperature

D. Accept the sample without any notation because a 2°C temperature exceedance is within normal variation

15. A treatment plant's source water assessment identifies that a major interstate highway crosses the watershed three miles upstream of the reservoir. The DOT applies deicing salt to this highway from November through March. The primary water quality concern from this activity is:

A. Increased turbidity from the salt particles being washed into the reservoir during snowmelt events

B. Elevated lead levels from the decomposition of road salt into its component metals in the water

C. Gradually increasing chloride and sodium concentrations in the reservoir from seasonal deicing salt runoff

D. Immediate formation of disinfection byproducts from the chloride reacting with the plant's chlorine disinfection

16. A treatment plant using chlorine gas for disinfection has a chlorine room with the following safety equipment: an exhaust ventilation fan, a chlorine gas leak detector, a self-contained breathing apparatus (SCBA), and an emergency repair kit. The operator discovers during a routine check that the SCBA's air cylinder pressure gauge reads 1,200 psi — below the manufacturer's minimum recommended pressure of 1,800 psi for emergency use. The operator should:

A. Continue using the current SCBA because 1,200 psi provides approximately 15 minutes of air, which is adequate for most emergencies

B. Replace or recharge the SCBA air cylinder immediately because an undercharged cylinder may not provide sufficient air for a chlorine emergency response

C. Switch the chlorine room to natural ventilation to reduce the need for SCBA during chlorine operations

D. Post a sign on the SCBA indicating the reduced air supply so operators can plan shorter emergency responses

17. A treatment plant's operator is reviewing the results of a recent distribution system flushing program. Before flushing, the chlorine residual at the farthest monitoring point was 0.08 mg/L. After flushing, the residual increased to 0.45 mg/L. Two weeks later, the residual has declined to 0.12 mg/L. This pattern indicates:

A. The flushing temporarily restored fresh, chlorinated water to the area, but the underlying demand source — biofilm, sediment, or stagnation — remains and will continue consuming the residual until addressed

B. The flushing program was completely ineffective because the residual returned to approximately the same level

C. The chlorine dose at the plant needs to be permanently doubled to maintain adequate residual at distant points

D. The monitoring point's DPD test kit is unreliable and produces different readings depending on the time of month

18. A treatment plant treats 2.0 MGD from a groundwater source with naturally elevated fluoride at 3.5 mg/L. The fluoride MCL is 4.0 mg/L and the plant's target finished water fluoride level is 0.7 mg/L. The treatment process must remove fluoride rather than add it. The most commonly used treatment technology for fluoride removal from drinking water is:

A. Coagulation with alum followed by sedimentation, which precipitates fluoride as aluminum fluoride

B. Aeration, which strips dissolved fluoride from the water into the atmosphere as fluoride gas

C. Chlorination, which oxidizes fluoride to a form that can be filtered through conventional media

D. Activated alumina adsorption or reverse osmosis, which are the established treatment technologies for fluoride removal

19. A treatment plant operator reviews the following jar test data. All six jars use 30 mg/L alum. The pH is varied using acid and base additions: Jar 1 pH 5.5, turbidity 4.2 NTU; Jar 2 pH 6.0, turbidity 1.4 NTU; Jar 3 pH 6.5, turbidity 0.5 NTU; Jar 4 pH 7.0, turbidity 0.7 NTU; Jar 5 pH 7.5, turbidity 2.1 NTU; Jar 6 pH 8.0, turbidity 5.8 NTU. The jar test demonstrates that:

A. Lower pH always produces better coagulation regardless of the coagulant type or water chemistry

B. The optimal coagulation pH for this water at 30 mg/L alum is approximately 6.5, with performance declining at both higher and lower pH values

C. The pH has no measurable effect on coagulation performance because all six jars produced similar results

D. The optimal pH is 8.0 because higher pH values favor the sweep floc mechanism with aluminum coagulants

20. A treatment plant's operator is investigating an unusual taste complaint. The customer describes the water as having a "plastic" or "chemical" taste. The complaint began after the utility replaced a section of water main with new HDPE (high-density polyethylene) pipe two weeks ago. Other customers on the same main also report the taste. The most likely cause is:

A. The HDPE pipe was manufactured from recycled plastic containing residual industrial chemicals

B. The pipe installation crew used an unapproved pipe joint lubricant that dissolved into the water

C. New HDPE pipe releases organic compounds during the initial weeks after installation that cause a temporary plastic taste until the pipe is thoroughly flushed and cured

D. The HDPE pipe is chemically incompatible with the plant's disinfectant and is degrading rapidly

21. A treatment plant's clearwell has a volume of 800,000 gallons. The plant treats 6.0 MGD (4,167 gpm). The clearwell has average baffling (factor = 0.5). The operator needs to achieve a CT of 150 mg·min/L for the current temperature and pH conditions. The minimum chlorine residual required at the clearwell outlet is:

A. 1.56 mg/L, calculated by dividing the required CT (150) by the T_{10} at the current flow rate

B. 0.78 mg/L, using an incorrect baffling factor of 1.0 instead of 0.5

C. 3.13 mg/L, calculated without applying the baffling factor to the detention time

D. 0.94 mg/L, using the theoretical DT instead of T_{10} in the calculation

22. A treatment plant operator receives a laboratory report showing that the finished water contains arsenic at 0.011 mg/L. The arsenic MCL is 0.010 mg/L. This result:

A. Is within the normal analytical uncertainty and does not constitute a violation unless confirmed by repeat testing

B. Is irrelevant because arsenic has no health effects at concentrations below 0.050 mg/L

C. Requires Tier 1 public notification within 24 hours because arsenic is an acute health hazard

D. Exceeds the MCL and constitutes a violation requiring compliance determination based on the running annual average and appropriate public notification

23. A treatment plant using conventional filtration has four filters, each with a surface area of 300 ft^2. The plant normally treats 4,000 gpm with all four filters online (filtration rate = 3.33 gpm/ft^2). During a peak demand event, the flow increases to 5,200 gpm. Simultaneously, Filter 3 must be taken offline for emergency backwash. The filtration rate on each of the remaining three filters is:

A. 4.33 gpm/ft^2, which is within the normal operating range for rapid gravity filters

B. 5.78 gpm/ft^2, which is at the upper limit of the acceptable range and requires close monitoring of effluent quality and headloss

C. 3.33 gpm/ft^2, unchanged because the flow controller reduces the total flow when a filter goes offline

D. 8.67 gpm/ft^2, which exceeds the maximum safe operating rate for any conventional filter media

24. An operator at a treatment plant performs a jar test to optimize polymer as a coagulant aid. The operator adds polymer at six doses: 0.1, 0.2, 0.3, 0.4, 0.5, and 0.6 mg/L to jars that each contain 30 mg/L alum at pH 6.5. The settled turbidity results are: 0.8, 0.5, 0.3, 0.3, 0.5, and 0.9 NTU respectively. The optimal polymer dose and the reason for declining performance at higher doses are:

A. 0.1 mg/L because the lowest dose always provides the most cost-effective treatment

B. 0.6 mg/L because higher polymer doses always produce better particle capture through enhanced bridging

C. 0.3 mg/L is optimal — higher doses cause particle restabilization as excess polymer coats particle surfaces and prevents further bridging

D. The jar test is invalid because polymer doses above 0.2 mg/L are not permitted in drinking water treatment

25. A treatment plant's operator is evaluating the performance of the plant's four sedimentation basins using basin-specific settled water turbidity data. The data shows: Basin 1 = 0.6 NTU, Basin 2 = 0.7 NTU, Basin 3 = 0.6 NTU, Basin 4 = 2.8 NTU. All basins receive the same coagulated water and operate at the same flow. The operator has verified that Basin 4's turbidimeter is reading correctly. The most productive investigation for Basin 4 should focus on:

A. Internal basin conditions — sludge blanket depth, baffle integrity, inlet/outlet structure condition, and sludge scraper operation — that could cause short-circuiting or sludge carryover

B. The coagulant distribution system to determine if Basin 4 receives less chemical than the other three

C. The filter downstream of Basin 4 to determine if it is somehow affecting the basin's settled water reading

D. The raw water intake to determine if Basin 4 draws from a different location than the other three

26. A treatment plant's operator calculates the chlorine demand of the raw water. The operator adds 4.0 mg/L of chlorine to a raw water sample. After 30 minutes of contact time, the free chlorine residual is 1.3 mg/L. The chlorine demand is:

A. 4.0 mg/L, which represents the total dose applied to the sample

B. 2.7 mg/L, calculated by subtracting the residual from the applied dose

C. 1.3 mg/L, which represents the amount of chlorine remaining as residual

D. 5.3 mg/L, calculated by adding the dose and the residual together

27. A treatment plant using surface water has experienced three consecutive months of THM LRAA values above the 0.080 mg/L MCL at Distribution Location #2. The operator has already optimized coagulation for enhanced NOM removal and moved the chlorine application point to after filtration. The next most effective strategy to reduce THMs at this specific location is:

A. Reduce the overall plant chlorine dose below the minimum required CT to decrease THM formation

B. Increase the distribution system flushing frequency near Location #2 to reduce water age

C. Install GAC filter adsorbers or convert to chloramines for secondary disinfection to reduce THM formation

D. Relocate Distribution Monitoring Location #2 to a point with lower THM results

28. A treatment plant's emergency response plan includes procedures for responding to a confirmed E. coli-positive result in the distribution system. The operator receives laboratory confirmation of E. coli at 2:00 PM on a Friday. The operator's first action must be to:

A. Notify the state primacy agency immediately and issue Tier 1 public notification within 24 hours using methods that reach all persons served

B. Wait until Monday morning to contact the primacy agency because state offices are typically closed on weekends

C. Collect repeat samples and wait 24 hours for the results before notifying anyone

D. Increase the chlorine dose and retest in 48 hours to determine if the problem has cleared on its own

29. A treatment plant's operator tests a distribution system sample and obtains: free chlorine 0.0 mg/L, total chlorine 0.0 mg/L, heterotrophic plate count 850 CFU/mL. The system uses free chlorine for disinfection. The HPC guideline is 500 CFU/mL. These results collectively indicate:

A. Normal conditions at the end of a long distribution system where residual depletion is expected

B. An instrument error because free and total chlorine cannot both read zero in a chlorinated system

C. A serious water quality concern — complete loss of disinfectant residual with elevated bacterial growth that requires immediate investigation, corrective flushing, and potential public notification

D. The sample was contaminated during collection and should be discarded without further action

30. A treatment plant's finished water has the following characteristics: pH 7.0, alkalinity 20 mg/L as $CaCO_3$, calcium hardness 25 mg/L as $CaCO_3$, TDS 100 mg/L, temperature 10°C. The Langelier Saturation Index for this water is most likely:

A. Strongly positive (+1.0 or higher), indicating the water will deposit heavy scale

B. Strongly negative (−2.0 or lower), indicating the water is highly corrosive

C. Near zero (−0.2 to +0.2), indicating balanced, non-aggressive water

D. Impossible to calculate without additional water quality data not listed in the question

31. A treatment plant using chlorine gas disinfection has the chlorinator set to feed 80 pounds per day. The chlorinator's rotameter shows steady flow. However, the scale under the active chlorine cylinder has not changed in the past 24 hours. Assuming the scale is functioning correctly, the most likely explanation is:

A. The chlorinator is drawing gas from a different cylinder on the manifold that is connected to a separate scale

B. The chlorine has converted entirely to liquid inside the cylinder, making it impossible for the scale to register the weight change

C. Chlorine gas weighs nothing when in gaseous form, so the cylinder weight only decreases when the gas condenses

D. The chlorinator vacuum regulator has failed and the system is drawing atmospheric air instead of chlorine gas

32. An operator at a treatment plant discovers that the raw water pH has increased from its normal 7.2 to 8.5 over the past 48 hours. The alkalinity has also increased from 80 to 140 mg/L as $CaCO_3$. No treatment changes have been made at the plant. The most likely external cause is:

A. An upstream lime or concrete discharge — construction activities, road work, or a concrete batch plant releasing alkaline waste into the source water

B. The laboratory pH meter has drifted high and needs recalibration before any investigation

C. Normal daily pH fluctuations caused by photosynthetic activity in the source water reservoir

D. Acid rain that has been neutralized by the reservoir's natural buffering capacity

33. A treatment plant's operator is investigating why the plant's filter run times have decreased from 48 hours to 24 hours over the past month. Raw water turbidity is unchanged at 10 NTU. The settled water turbidity has increased from 0.8 NTU to 2.5 NTU. The coagulant dose has not been changed. The investigation should focus on:

A. The filters themselves because shorter run times always indicate filter media deterioration

B. The distribution system because downstream demand changes can affect filter loading rates

C. The coagulation and flocculation process because the increased settled water turbidity is sending more particles to the filters, causing them to load faster and reach terminal headloss sooner

D. The raw water pumps because reduced pump efficiency decreases the flow through each filter

34. A treatment plant's operator is preparing the plant for a forecasted ice storm that may cause extended power outages. The emergency generator has been tested and is ready. The operator should also:

A. Drain all chemical tanks to prevent freezing damage to the stored chemicals during the cold weather

B. Verify adequate fuel supply, check generator antifreeze levels, confirm SCBA cylinder charge, stock critical replacement parts, and verify emergency contact information

C. Shut down the plant preemptively before the storm arrives to prevent damage to running equipment

D. Disconnect the ATS to prevent the generator from starting automatically during power fluctuations

35. A water treatment plant's finished water fluoride level has been testing at 1.8 mg/L for the past three days. The target is 0.7 mg/L. The fluoride MCL is 4.0 mg/L. The secondary standard is 2.0 mg/L. The operator should:

A. Take no action because 1.8 mg/L is below both the MCL and the secondary standard

B. Issue Tier 1 public notification within 24 hours because fluoride above 1.0 mg/L is an acute health hazard

C. Contact the state primacy agency to request a variance from the fluoride standard for the duration of the overfeed

D. Immediately investigate and correct the fluoride feed system, reduce the dose to reach the 0.7 mg/L target, document the event, and assess whether the secondary standard exceedance requires notification

36. An operator at a treatment plant tests a raw water sample for iron using two different methods. The dissolved iron test (filtered through 0.45 µm) reads 2.0 mg/L. The total iron test (unfiltered, acid-digested) reads 2.2 mg/L. These results indicate that:

A. Nearly all the iron (91%) exists in the dissolved ferrous form (Fe^{2+}), with only 0.2 mg/L as particulate ferric iron already oxidized in the raw water

B. All of the iron is in the particulate form and the dissolved test produced a false reading

C. The total iron test is inaccurate because the result should always be at least double the dissolved reading

D. The sample was contaminated with iron from the collection equipment, producing falsely elevated results

37. A treatment plant's operator receives a consumer complaint about blue-green water at a single residence. The complaint started three days ago and affects only the cold water. No other customers in the area have complained. The most likely cause is:

A. A failed backflow prevention device allowing water from a swimming pool or hot tub containing copper algaecide to flow back into the potable plumbing

B. Algae growth in the distribution main serving only this customer's home

C. Excessive copper leaching from the customer's new copper plumbing that produces blue-green dissolved copper

D. A treatment plant upset that is sending colored water only through the pipe branch serving this residence

38. An operator at a treatment plant using chloramine disinfection discovers that the ammonia feed has been set at twice the correct rate for the past six hours due to an operator error during the previous shift. The chlorine-to-ammonia nitrogen ratio has been running at approximately 2:1 instead of the target 4:1. The operator should be concerned about:

A. Immediate loss of all disinfectant residual because excess ammonia neutralizes the biocidal properties of chlorine

B. Excess free ammonia entering the distribution system that could promote nitrification, and the potential formation of trichloramine at this low ratio

C. Formation of excessive free chlorine from the breakpoint reaction destroying all chloramines in the system

D. No significant concern because the 2:1 ratio still produces adequate monochloramine for distribution system protection

39. A treatment plant's operator is calibrating the online pH analyzer on the plant effluent. The analyzer is calibrated using pH 7.00 and pH 10.00 buffer solutions. After calibration, the operator verifies with a pH 4.00 check buffer. The analyzer reads 4.25 on the check buffer. The operator should:

A. Accept the calibration because the check buffer only verifies the alkaline range of the calibration curve

B. Recalibrate using pH 4.00 and pH 7.00 buffers instead, since the plant's operating pH range is closer to these values

C. Accept the reading because a 0.25 pH unit deviation is within the acceptable tolerance for online analyzers

D. Investigate the deviation — verify the check buffer is fresh, check the electrode condition, and recalibrate if the deviation persists after verification

40. A treatment plant treats 4.0 MGD and the operator needs to calculate the filter loading rate. The plant has five filters, each with a surface area of 250 ft^2. With all five filters online, the filtration rate per filter is:

A. 2.22 gpm/ft^2, calculated as total flow in gpm ÷ (number of filters × area per filter)

B. 11.11 gpm/ft^2, calculated by dividing the total flow by only the area of one filter

C. 0.44 gpm/ft^2, calculated using the flow in MGD instead of converting to gpm

D. 3.20 gpm/ft^2, calculated by dividing the total flow by four filters instead of five

41. A treatment plant's operator is troubleshooting declining UV disinfection performance. The UV sensor reads 35 mJ/cm^2 — below the validated minimum of 40 mJ/cm^2. The operator has cleaned the quartz sleeves and confirmed the lamps are within their rated life. The UV transmittance (UVT) of the filtered water has decreased from 90% to 75% over the past three months. The root cause of the UV performance decline is:

A. The UV lamps have exceeded their rated life and need replacement despite the operator's belief they are within specification

B. The UV sensor has drifted low and needs recalibration against a certified reference radiometer

C. The declining UVT of the filtered water is absorbing UV light before it reaches the pathogens — the upstream treatment must be improved to restore UVT

D. The UV reactor's flow distribution has changed, creating dead zones where pathogens receive insufficient dose

42. A treatment plant's chemical storage area contains bulk tanks for sodium hypochlorite, sodium hydroxide (caustic soda), and hydrofluorosilicic acid. A new operator asks why each chemical has separate secondary containment rather than sharing a single large containment. The best explanation is:

A. Incompatible chemicals must be separated because mixing sodium hypochlorite with hydrofluorosilicic acid releases chlorine gas, and mixing caustic soda with the acid produces a violent exothermic reaction

B. Each containment must be a different color to match the chemical identification system used by the plant

C. Federal regulations require a minimum of three separate containment areas regardless of chemical compatibility

D. Shared containment is more cost-effective and the separate containments represent an unnecessary expense

43. A treatment plant's SCADA alarm log for the month shows 1,200 total alarms. After analysis, the operator categorizes them: 50 critical (require immediate action), 150 high priority (require response within 1 hour), 200 medium priority (require response within 8 hours), and 800 low priority/nuisance alarms (no action needed). The nuisance alarm percentage of 67% indicates:

A. An acceptable alarm management system because the majority of alarms are properly classified

B. Excellent alarm system performance because 67% nuisance is below the industry average of 80%

C. The alarm system needs minor setpoint adjustments to reduce the low-priority alarms by approximately 10%

D. A significant alarm management problem requiring systematic review of all alarm setpoints, deadbands, and priorities to reduce nuisance alarms that contribute to alarm fatigue

44. A treatment plant's operator is reviewing the plant's compliance with the Enhanced Surface Water Treatment Rule requirements for Cryptosporidium. The plant uses conventional filtration and achieves consistent CFE turbidity below 0.10 NTU. Under the LT2ESWTR, the plant receives 3-log Cryptosporidium removal credit for conventional treatment. The plant's source water is classified as Bin 1 (lowest risk) based on monitoring. The total Cryptosporidium treatment requirement for Bin 1 is:

A. 4-log, requiring additional treatment beyond filtration credit

B. 3-log, which means the plant's conventional filtration credit alone meets the requirement without additional treatment

C. 5.5-log, requiring both UV and ozone in addition to conventional filtration

D. 2-log, which is less than the filtration credit and requires no disinfection CT for Cryptosporidium

45. A treatment plant treats 2.5 MGD from a reservoir source. The plant feeds 10% sodium hypochlorite at a dose of 2.0 mg/L. The sodium hypochlorite has a specific gravity of 1.14. The daily volume of sodium hypochlorite solution consumed is approximately:

A. 20.9 gallons per day

B. 41.7 gallons per day

C. 83.4 gallons per day

D. 43.8 gallons per day, calculated as lb/day Cl_2 ÷ concentration ÷ (SG × 8.34)

46. A treatment plant's operator discovers during routine monitoring that the distribution system pressure at a fire station has dropped from the normal 62 psi to 38 psi. No main breaks have been reported and no construction is occurring in the area. The most appropriate first investigative step is:

A. Check whether a partially closed valve, a failed pressure-reducing valve, or a significant change in system demand is causing the localized pressure drop

B. Increase the high-service pump discharge pressure at the plant to compensate for the drop at the fire station

C. Install a booster pump at the fire station to maintain adequate pressure regardless of system conditions

D. Close the fire station's supply valve to prevent further pressure loss from affecting other customers

47. An operator at a treatment plant discovers that the plant's monthly water quality monitoring data shows a gradual increase in distribution system lead levels over the past year — from a 90th percentile of 0.006 mg/L to 0.013 mg/L. The action level is 0.015 mg/L. No intentional changes to the treatment process have been made. The operator should investigate whether:

A. The laboratory has changed its analytical method, which could explain the apparent increase without an actual change in water quality

B. Changes in source water chemistry, treatment chemical lots, or unintended pH or alkalinity shifts have altered the finished water's corrosion characteristics

C. Consumer plumbing in the sampled homes has deteriorated, contributing more lead independent of water chemistry

D. The distribution system pipe material has changed through routine replacement, introducing lead-free materials

48. A treatment plant treats 3.0 MGD. The operator needs to calculate how many days the current chemical inventory will last. The plant uses 48% liquid alum at a dose of 30 mg/L. The chemical tank contains 5,000 gallons of liquid alum. The specific gravity is 1.33. Using the calculation sequence, the daily alum consumption is approximately 68 gallons per day. The current inventory will last approximately:

A. 73 days, which exceeds the typical 30-day reorder threshold

B. 5 days, calculated by dividing the tank volume by the daily production volume

C. 73 days, calculated as tank volume (5,000 gal) ÷ daily consumption (68 gal/day)

D. 150 days, calculated using an incorrect daily consumption rate of 33 gallons per day

49. A treatment plant's operator receives a consumer complaint about water that "smells like rotten eggs" from a customer whose home is approximately five miles from the plant. The water is clear and the chlorine residual tests at 0.3 mg/L free chlorine. The most likely cause of the odor at this specific location is:

A. Hydrogen sulfide produced by sulfate-reducing bacteria in the customer's water heater, which thrives in warm, stagnant conditions with low dissolved oxygen

B. A chlorine gas leak at the treatment plant that has traveled five miles through the distribution system

C. The raw water source containing hydrogen sulfide that passed through the entire treatment process undetected

D. Decay of organic matter in the distribution main directly serving this customer's home

50. A treatment plant using conventional treatment has experienced a sudden increase in filter headloss development on all four filters. The settled water turbidity has not changed. The plant flow has not changed. The operator investigates and discovers that the polymer feed pump stroke has been accidentally increased from 25% to 75% two days ago. The most likely connection is:

A. Higher polymer dose reduces filter headloss by improving particle capture, so the increased stroke should have helped

B. The polymer overdose has nothing to do with filter performance because polymer only affects sedimentation

C. The polymer overdose has increased sludge production in the basins, which is overflowing onto the filters

D. Excess polymer is reaching the filters and creating a sticky, low-permeability layer on the media surface that accelerates headloss buildup while the effluent quality remains good

51. A treatment plant's emergency generator failed to start during last week's power outage. Investigation revealed that the starting batteries were dead — the automatic battery charger had failed three weeks earlier without triggering a SCADA alarm. To prevent recurrence, the operator should implement:

A. A weekly manual battery voltage check as part of the generator test procedure

B. Installation of a battery charger failure alarm connected to the SCADA system, combined with weekly manual battery voltage verification during routine generator testing

C. Replacement of the automatic charger with a manual charging procedure performed monthly

D. Replacement of the starting batteries with a pneumatic starting system that does not require electrical energy

52. A treatment plant's operator is reviewing the plant's water quality data and notices that the finished water's Langelier Saturation Index has shifted from +0.3 (slightly scaling) to −0.5 (slightly corrosive) over the past two months. No intentional treatment changes have been made. The operator should first investigate:

A. Whether the LSI calculation software has a programming error that produced an incorrect result

B. Whether the distribution system piping has changed from metal to plastic, which would affect the LSI

C. Whether the raw water alkalinity, calcium hardness, pH, TDS, or temperature has changed — any of these parameters shifting would alter the finished water LSI

D. Whether the corrosion coupon data supports the LSI change before investigating any water quality parameters

53. An operator at a treatment plant performing a filter backwash observes that the backwash flow rate is correct (15 gpm/ft^2) but the bed expansion is only 15% instead of the expected 25% to 30%. The most likely cause is:

A. The media has accumulated heavy mineral deposits, mudballs, or compacted material that is weighing down the bed and resisting expansion

B. The backwash water temperature is too high, reducing the water's ability to lift the media grains

C. The filter underdrain system is distributing the backwash water unevenly across the filter floor

D. The anthracite media has been replaced with a denser media that requires a higher backwash rate for adequate expansion

54. A treatment plant's operator reviews the plant's chemical cost data and finds that sodium hypochlorite costs have increased by 30% over the past year while the chlorine dose and plant flow have remained unchanged. The supplier's unit price has not changed. The most likely explanation is:

A. The plant is receiving less sodium hypochlorite per delivery because the supplier is underfilling the tank

B. The sodium hypochlorite is degrading faster in storage, requiring the plant to feed more volume to deliver the same chlorine dose

C. The plant's flow meter has drifted low, making it appear that less water is being treated per gallon of chemical

D. The sodium hypochlorite is degrading in storage — the weaker solution requires more gallons to deliver the same mass of chlorine, increasing the volume consumed and the frequency of deliveries

55. An operator at a treatment plant is calculating the CT achieved in the clearwell. The clearwell volume is 400,000 gallons. The plant flow is 3.0 MGD (2,083 gpm). The baffling factor is 0.7 (superior). The chlorine residual at the clearwell outlet is 0.9 mg/L. The CT is:

A. 172.8 mg·min/L, calculated without applying the baffling factor to the theoretical detention time

B. 120.9 mg·min/L, calculated as: DT = 400,000 ÷ 2,083 = 192 min; T_{10} = 192 × 0.7 = 134.4 min; CT = 0.9 × 134.4

C. 57.6 mg·min/L, calculated using a baffling factor of 0.3 instead of the actual 0.7

D. 241.9 mg·min/L, calculated by applying the baffling factor as a multiplier to the CT rather than to the detention time

56. A treatment plant's four filters are producing the following individual effluent turbidities: Filter 1 = 0.04 NTU, Filter 2 = 0.05 NTU, Filter 3 = 0.45 NTU, Filter 4 = 0.06 NTU. All four filters are online at equal flow. The approximate combined filter effluent turbidity is:

A. 0.45 NTU, which is the highest individual filter value and represents the worst-case scenario

B. 0.05 NTU, which is the median of the four readings

C. 0.15 NTU, which is the arithmetic average of the four individual effluent turbidities

D. 0.60 NTU, calculated by summing all four turbidity values together

57. A water treatment plant performs a tracer study on its clearwell and determines that the T_{10} is 85 minutes at a flow of 2.5 MGD. If the plant flow increases to 3.5 MGD without any changes to the clearwell, the new T_{10} will be approximately:

A. 61 minutes, because T_{10} decreases proportionally as flow increases (85 × 2.5/3.5)

B. 85 minutes, because the baffling factor is a fixed property of the clearwell regardless of flow

C. 119 minutes, because increased flow improves mixing and increases the effective T_{10}

D. 42.5 minutes, calculated by dividing the original T_{10} by two since the flow increased by 40%

58. A treatment plant's operator is reviewing the maintenance history on the plant's three high-service pumps. The data shows: Pump 1 — 12,000 operating hours, last bearing replacement 18 months ago. Pump 2 — 8,500 operating hours, last bearing replacement 12 months ago. Pump 3 — 22,000 operating hours, bearings original (never replaced). The pump most likely to experience a bearing failure is:

A. Pump 1 because bearing replacement 18 months ago suggests the bearings may be approaching their service life

B. Pump 2 because it was most recently serviced and new bearings are more likely to have installation defects

C. All three pumps have equal failure probability because bearing life is random and unpredictable

D. Pump 3 because it has accumulated the most operating hours on its original bearings, which have never been replaced

59. A treatment plant's operator is planning the annual capital improvement request. The operator has collected data showing that the plant's four sedimentation basins consistently produce settled water turbidity of 2.0 to 3.0 NTU at the design overflow rate. Industry benchmarks for well-operating conventional basins indicate settled water turbidity should be 0.5 to 1.0 NTU. The operator should propose:

A. Replacing the sedimentation basins with dissolved air flotation units to achieve the benchmark turbidity levels

B. A basin performance evaluation to identify the specific causes of poor settling — baffling deficiencies, short-circuiting, inadequate sludge removal, or coagulation problems — before recommending specific capital improvements

C. Adding tube settlers to all four basins without further investigation because they always improve performance

D. Accepting the current performance because 2.0 to 3.0 NTU is adequate for downstream filtration

60. A treatment plant treats 5.0 MGD and feeds powdered activated carbon (PAC) at 12 mg/L during a severe taste and odor event. The PAC costs $0.55 per pound. The daily PAC cost is:

A. $66 per day, calculated using an incorrect conversion factor

B. $150 per day, using a simplified calculation without the full pounds formula

C. $275 per day, calculated as: 12 × 5.0 × 8.34 = 500.4 lb/day × $0.55/lb = $275.22

D. $500 per day, doubling the actual daily chemical consumption

61. A treatment plant's operator is reviewing the performance of the plant's dissolved air flotation (DAF) system during an algae bloom. The DAF effluent turbidity has increased from its normal 0.5 NTU to 2.5 NTU. The air-to-solids ratio has decreased because the recycle rate has dropped. The operator should:

A. Reduce the coagulant dose because the DAF is overloaded with chemical floc in addition to the algae

B. Increase the recycle rate to restore the proper air-to-solids ratio, providing more micro-bubbles for algae and floc flotation

C. Bypass the DAF and send raw water directly to the filters during the bloom because DAF cannot handle algae

D. Increase the skimmer speed to remove the float faster and clear the surface for more efficient bubble-particle contact

62. An operator at a treatment plant is investigating an intermittent "hammering" or "banging" noise in the plant's chemical feed piping that occurs every time a specific chemical metering pump cycles. This noise is most likely caused by:

A. The chemical crystallizing inside the pipe and creating solid obstructions that the pump pressure pushes through

B. Cavitation at the pump suction caused by an undersized suction line or a clogged foot valve

C. Resonant vibration of the pipe at the pump's stroking frequency that can be resolved by adding pipe supports

D. Water hammer from the sudden closure of the pump's discharge check valve at the end of each stroke

63. A treatment plant's operator is reviewing the state's operator certification requirements. The state requires that a certified Class I operator be designated as the "operator in responsible charge" (ORC) for the treatment plant. This designation means:

A. The ORC makes the critical daily operational decisions affecting water quality and is responsible for ensuring the plant operates in compliance with all applicable regulations

B. The ORC is responsible only for signing the monthly operating reports and has no daily operational duties

C. The ORC position is an honorary title that has no legal or regulatory significance under state law

D. Any employee can serve as ORC regardless of certification level if they have been employed at the plant for more than one year

64. A treatment plant's SCADA system monitors clearwell level, plant flow, and high-service pump discharge pressure. The operator notices the following simultaneous trends: clearwell level declining, plant flow steady, and high-service pump discharge pressure increasing. This combination of trends most likely indicates:

A. The high-service pumps are running at reduced speed and producing less flow to the distribution system

B. A distribution system main break that is not yet visible at the surface — the increased pump pressure is caused by the break location downstream of a pressure zone boundary

C. Distribution system demand exceeds plant production (clearwell declining), and the increasing pump pressure indicates the pumps are working harder against a restriction or to meet elevated system pressure requirements

D. The SCADA system is malfunctioning because clearwell decline and increasing pump pressure are contradictory

65. A treatment plant's operator is investigating the cause of elevated manganese (0.15 mg/L) in the finished water. The raw water manganese is 0.3 mg/L. The plant feeds potassium permanganate at the intake for pre-oxidation and filters through dual-media. The permanganate dose was set by jar testing three months ago. The operator should first verify:

A. The raw water pH to determine if it has changed and affected the permanganate's oxidizing ability

B. Whether the permanganate dose is still adequate by performing a new jar test, and whether the raw water manganese concentration has increased since the dose was last optimized

C. Whether the filter media needs replacement because dual-media filters have a fixed service life

D. Whether the distribution system is contributing manganese to the finished water samples

66. A treatment plant's operator calculates the total weight of water in a full clearwell. The clearwell is rectangular: 80 feet long, 40 feet wide, with a water depth of 15 feet. Using 1 ft^3 = 7.48 gallons and 1 gallon of water = 8.34 pounds, the weight of water is approximately:

A. 48,000 pounds, using an incorrect volume calculation

B. 358,560 pounds, using only the gallons conversion without the weight conversion

C. 2,990,131 pounds, calculated as volume × 7.48 × 8.34

D. 2,990,131 pounds, calculated as 80 × 40 × 15 = 48,000 ft^3 × 7.48 = 359,040 gal × 8.34

67. A treatment plant's operator receives a complaint about "cloudy" water from a customer in a new housing development. The operator visits the customer and observes that the water is milky white when first drawn but clears completely from the bottom up within 60 seconds. The operator should explain that:

A. The cloudiness is caused by dissolved air (micro-bubbles) that come out of solution when the pressurized water exits the tap, and the water is safe to drink

B. The cloudiness indicates bacterial contamination that requires immediate investigation and a boil-water advisory

C. The new pipe installed in the development is leaching plastic compounds that create the milky appearance

D. The water heater in the home is failing and releasing sediment into both the hot and cold water lines

68. A treatment plant's operator is evaluating the effectiveness of the plant's backwash program by comparing the filter's turbidity profile during the first hour after returning from backwash. The ideal post-backwash turbidity profile should show:

A. A constant, steady turbidity from the moment the filter returns to service until the next backwash

B. A gradual increase in turbidity over the first hour as the filter media becomes saturated with particles

C. An initial turbidity spike during the ripening period that decreases rapidly to the filter's baseline performance level within 15 to 30 minutes

D. Zero turbidity for the first hour because the freshly backwashed media has been completely cleaned

69. A treatment plant's operator receives a laboratory report showing the following finished water results: arsenic 0.003 mg/L, barium 0.8 mg/L, chromium 0.05 mg/L, fluoride 0.7 mg/L, nitrate 3.2 mg/L as N. All results are below their respective MCLs. The operator should include all of these results in the annual Consumer Confidence Report because:

A. Only contaminants exceeding their MCLs must be reported in the CCR

B. All detected regulated contaminants must be reported in the CCR with their levels, MCLs, MCLGs, likely sources, and health effects information

C. The CCR only requires reporting for contaminants on the EPA's priority monitoring list

D. Only the arsenic and nitrate results need to be reported because they are the most significant health hazards

70. A treatment plant using chloramination monitors the chlorine-to-ammonia nitrogen ratio at 4.5:1 by weight. The operator tests the finished water and finds: total chlorine 3.2 mg/L, free chlorine 0.0 mg/L, free ammonia 0.2 mg/L. The free ammonia reading of 0.2 mg/L indicates:

A. The chlorine-to-ammonia ratio is perfectly optimized with no excess ammonia present

B. A normal amount of excess ammonia that typically passes through a properly operating chloramination system

C. The ammonia feed should be increased because 0.2 mg/L is below the minimum required for effective chloramination

D. Slightly more free ammonia than ideal is present, which could promote nitrification in the distribution system if not monitored — the operator should consider whether the ratio can be adjusted to reduce the excess

71. A treatment plant's operator is troubleshooting a centrifugal pump that is vibrating excessively. The vibration analysis shows a dominant peak at the pump's vane pass frequency (running speed × number of impeller vanes). This vibration pattern is typically caused by:

A. A recirculation problem or gap issue between the impeller and the volute cutwater, or a partially blocked impeller passage

B. Shaft misalignment between the pump and motor coupling at the connection point

C. An electrical problem in the motor stator that creates magnetic imbalance in the rotor

D. Loose foundation bolts that allow the entire pump assembly to shift during operation

72. A treatment plant's operator reviews the following monthly operating data: average daily flow = 3.5 MGD, average alum dose = 32 mg/L, average settled water turbidity = 1.2 NTU, average CFE turbidity = 0.06 NTU, average clearwell chlorine residual = 1.1 mg/L, average distribution system residual at farthest point = 0.35 mg/L. The data parameter that most warrants the operator's attention is:

A. The alum dose of 32 mg/L, which is lower than the typical range for surface water treatment

B. The chlorine residual decline from 1.1 mg/L to 0.35 mg/L, which is a normal distribution system pattern

C. The settled water turbidity of 1.2 NTU, which is higher than the industry optimization goal of < 1.0 NTU and suggests coagulation or sedimentation could be improved

D. The CFE turbidity of 0.06 NTU, which exceeds the 0.05 NTU target set by the Partnership for Safe Water

73. A treatment plant's SCADA system displays an alarm at 3:00 AM: "RAW WATER PUMP #1 — HIGH VIBRATION ALARM." The pump has been running continuously for the past six hours. The operator checks the SCADA data and sees that the vibration level increased sharply from the baseline 15 minutes ago. The operator should:

A. Silence the alarm and continue monitoring because vibration levels commonly fluctuate during overnight operations

B. Respond immediately — shut down the pump if a standby pump is available, investigate the cause of the sudden vibration increase, and do not restart the pump until the cause is identified

C. Increase the pump speed to see if the vibration decreases at a higher operating point on the pump curve

D. Schedule a vibration analysis for the next business day because overnight pump alarms rarely indicate urgent problems

74. A treatment plant operator reviews the plant's annual compliance data and calculates that the plant achieved the required TOC removal percentage in 10 of 12 months. In the two non-compliant months, the plant missed the target by 3% and 5% respectively. Under the enhanced coagulation requirements, this compliance record:

A. Meets the annual compliance requirement because the plant achieved compliance in more than 50% of months

B. Represents a minor administrative deficiency that requires only a notation in the monthly operating report

C. Meets compliance because the Stage 1 D/DBPR allows quarterly averaging that smooths out individual monthly shortfalls

D. May constitute a treatment technique violation for the months where the removal percentage was not met, requiring investigation, corrective action, and appropriate public notification

75. A treatment plant's operator discovers that the plant's emergency response plan (ERP) does not include a procedure for responding to a cybersecurity incident — such as unauthorized access to the SCADA system or a ransomware attack on plant computers. The operator should:

A. Recommend updating the ERP to include a cybersecurity incident response procedure that covers detection, containment, system recovery, and coordination with law enforcement and the state

B. Take no action because cybersecurity is an IT department responsibility and not part of the treatment plant's ERP

C. Install commercial antivirus software on all SCADA workstations and consider the cybersecurity risk resolved

D. Disconnect the SCADA system from all networks permanently to eliminate any cybersecurity vulnerability

76. A treatment plant's operator measures the following water quality parameters on the finished water: pH 8.2, alkalinity 90 mg/L as $CaCO_3$, calcium hardness 100 mg/L as $CaCO_3$, TDS 300 mg/L, temperature 20°C. The calculated Langelier Saturation Index is +0.5. This LSI indicates:

A. The water is moderately corrosive and will dissolve protective calcium carbonate scale from pipe surfaces

B. The water is at perfect equilibrium with no tendency toward either corrosion or scaling

C. The water has a mild tendency to deposit calcium carbonate scale, which provides a beneficial protective film on pipe interiors

D. The water is excessively scaling and will cause severe pipe capacity restrictions within months

77. An operator at a treatment plant is preparing to perform a confined space entry into a valve vault. The vault has been sealed for six months. The operator's atmospheric monitoring shows: oxygen 18.5%, LEL 3%, H_2S 8 ppm, CO 12 ppm. Based on these readings, the space:

A. Meets all safe entry criteria because all readings are below their respective alarm thresholds

B. Does not meet safe entry criteria — the oxygen level (18.5%) is below the 19.5% minimum, and entry must not proceed until the atmosphere is ventilated and retested

C. Is safe for entry if the operator wears an N95 respirator to protect against the H_2S

D. Requires only additional ventilation for the LEL reading because oxygen and toxic gas levels are acceptable

78. A treatment plant's operator reviews the plant's filter backwash water usage. The plant has four filters, each backwashed once per day. Each backwash uses 60,000 gallons. The plant produces 4.0 MGD. The backwash water as a percentage of total production is:

A. 1.5%, which is below the typical 2–5% range and suggests the backwash may be too brief

B. 3.0%, which is within the typical guideline range for backwash water usage

C. 4.5%, calculated by including an additional 50% factor for filter-to-waste volume

D. 6.0%, calculated as total backwash volume divided by net production rather than total production

79. A treatment plant's operator is investigating the cause of a sudden increase in customer complaints about discolored (rusty) water in a specific neighborhood. The complaints began two days ago. Distribution system records show that a water main repair was completed in that neighborhood three days ago. The most likely cause of the complaints is:

A. The main repair disturbed sediment and corrosion products in the pipe, which are being slowly released into the water serving the affected homes

B. The treatment plant experienced a turbidity exceedance three days ago that sent particles into the distribution system

C. The main repair introduced contaminated soil into the distribution system through the excavation

D. The new pipe section installed during the repair is corroding rapidly and releasing iron into the water

80. A treatment plant using conventional treatment achieves the following performance metrics: raw water turbidity 15 NTU, settled water turbidity 0.8 NTU, CFE turbidity 0.04 NTU, clearwell chlorine residual 1.0 mg/L, CT achieved 150 mg·min/L (required 45 mg·min/L). These results indicate:

A. Excellent overall treatment performance — the plant is well within regulatory limits at every stage

B. The plant is achieving excellent treatment with all parameters well within compliance, but the CT of 150 mg·min/L (3.3 times the requirement) suggests the plant could potentially optimize by reducing the chlorine dose slightly to decrease DBP formation while still maintaining adequate CT

C. The settled water turbidity of 0.8 NTU is unacceptable and requires immediate coagulation process changes

D. The CT is excessive at 150 mg·min/L and the chlorine dose must be reduced immediately to prevent violations

81. An operator at a treatment plant using chlorine gas for disinfection reviews the monthly chlorine usage records. The plant treated an average of 3.0 MGD during the month. Total chlorine consumed was 2,200 pounds. The average chlorine dose applied during the month was:

A. 8.8 mg/L, calculated by dividing the total monthly chlorine by the total monthly production and the 8.34 factor

B. 73.3 mg/L, calculated by dividing the total chlorine by only the daily flow without the monthly production

C. 2.4 mg/L, calculated using a 30-day month but dividing by the daily flow instead of the daily production

D. 2.93 mg/L, calculated as: 2,200 lb ÷ 30 days = 73.3 lb/day; dose = 73.3 ÷ (3.0 × 8.34) = 2.93 mg/L

82. A treatment plant operator reviews the plant's annual water quality report and notices that the arsenic level has been gradually increasing over the past three years: Year 1 = 0.005 mg/L, Year 2 = 0.007 mg/L, Year 3 = 0.009 mg/L. The arsenic MCL is 0.010 mg/L. The operator should:

A. Take no action because all three years are below the MCL and the trend may reverse naturally

B. Wait until the arsenic level exceeds the MCL before investigating potential causes or treatment options

C. Proactively investigate the source of the increasing arsenic trend and evaluate treatment options before the level reaches or exceeds the MCL

D. Immediately install arsenic removal treatment because the MCL will be exceeded within the next year

83. A treatment plant's operator is evaluating whether to install a SCADA-controlled automatic chemical feed system to replace the current manual feed system. The primary advantage of automatic flow-proportional chemical feed is:

A. Consistent chemical dosing that adjusts automatically with changes in plant flow, maintaining the target dose per gallon regardless of demand fluctuations

B. Lower chemical costs because automatic systems always use less chemical than manual systems

C. Elimination of the need for jar testing because automatic systems determine the optimal dose independently

D. Reduced operator staffing requirements because automatic systems eliminate the need for operator oversight

84. A treatment plant's four filters have been in service for 12 years. Media core analysis results: Filter 1 — anthracite depth 26 inches (original 30), effective size 0.85 mm (original 1.0 mm). Filter 2 — anthracite depth 28 inches (original 30), effective size 0.95 mm (original 1.0 mm). Filter 3 — anthracite depth 22 inches (original 30), effective size 0.70 mm (original 1.0 mm). Filter 4 — anthracite depth 27 inches (original 30), effective size 0.90 mm (original 1.0 mm). The filter requiring the most urgent media rehabilitation is:

A. Filter 1 because its effective size has decreased by 15%, which exceeds the acceptable tolerance

B. Filter 3 because it has lost the most depth (8 inches, 27% loss) and has the smallest effective size (0.70 mm, 30% reduction), indicating significant media deterioration

C. Filter 4 because it has the most media remaining and is therefore the most over-due for maintenance attention

D. All four filters require equal attention because any change from original specifications indicates failure

85. A treatment plant using surface water is required to monitor for Cryptosporidium under the LT2ESWTR. The monitoring results place the source in Bin 2, which requires 1 additional log of treatment beyond the 3-log credit from conventional filtration (total 4-log needed, 1-log additional required). The most cost-effective technology to provide the additional 1-log Cryptosporidium credit is typically:

A. Chlorine disinfection CT, which is the least expensive option for achieving any level of Cryptosporidium inactivation

B. Ozone disinfection, which provides Cryptosporidium credit through chemical oxidation at practical doses

C. Membrane filtration, which replaces the entire conventional treatment train with an absolute barrier

D. UV disinfection, which provides Cryptosporidium inactivation credit at relatively low doses (practical and cost-effective) compared to chemical disinfection options

86. A treatment plant's operator tests the plant's standby generator and observes that the engine starts and reaches rated speed, but the output voltage fluctuates between 440V and 510V (rated 480V ± 5%). This voltage instability most likely indicates:

A. Normal generator behavior during the warm-up period that will stabilize within 5 minutes of loaded operation

B. The automatic transfer switch is creating voltage fluctuations through intermittent contact problems

C. A malfunctioning voltage regulator that is failing to maintain stable output within the rated tolerance

D. The generator's fuel supply pressure is fluctuating, causing the engine speed to vary and the voltage to follow

87. A treatment plant treats water from two wells that operate simultaneously. Well 1 produces 800 gpm at a hardness of 150 mg/L as $CaCO_3$. Well 2 produces 400 gpm at a hardness of 300 mg/L as $CaCO_3$. The flow-weighted blended hardness is:

A. 200 mg/L as $CaCO_3$, calculated as [(800 × 150) + (400 × 300)] ÷ (800 + 400)

B. 225 mg/L as $CaCO_3$, which is the simple average of the two hardness values

C. 450 mg/L as $CaCO_3$, calculated by adding the two hardness values together

D. 150 mg/L, because the higher-flow well dominates the blend and its hardness represents the total

88. A treatment plant's operator is evaluating a proposal to convert from chlorine gas to on-site sodium hypochlorite generation. The plant currently uses two 150-pound cylinders per week (300 lb/week chlorine). The on-site generator would produce 0.8% sodium hypochlorite from salt. Compared to the current gas system, the on-site generator would:

A. Produce a higher-concentration solution that requires a smaller chemical feed pump

B. Eliminate the safety hazards of compressed toxic gas storage, reduce regulatory burden (RMP compliance), and produce a fresh, low-concentration solution daily — though the generated solution's lower strength requires higher feed volumes

C. Generate chlorine gas as an intermediate product, maintaining the same safety risks as cylinders

D. Cost less than gas chlorine because salt is free and electricity consumption is negligible

89. A treatment plant treats 3.0 MGD and has a finished water storage capacity of 1.5 million gallons (clearwell plus distribution storage). The state recommends maintaining storage equal to the average daily demand. The current storage-to-demand ratio is:

A. 0.25 days of storage, which is well below the recommended one day of storage capacity

B. 1.0 day of storage, which meets the recommended minimum storage capacity exactly

C. 2.0 days of storage, which exceeds the recommended minimum by a comfortable margin

D. 0.5 days of storage, calculated as 1.5 MG ÷ 3.0 MGD, which is below the recommended one day of storage

90. A treatment plant operator performs the following calculation to determine the daily chemical cost for alum treatment: plant flow = 4.0 MGD, alum dose = 28 mg/L, alum cost = $0.15/lb. Using the pounds formula: 28 × 4.0 × 8.34 = 934.1 lb/day. Daily cost = 934.1 × $0.15 = $140.12. The monthly (30-day) chemical cost for alum alone is approximately:

A. $1,401, using only 10 days instead of 30 in the monthly calculation

B. $2,803, using a 20-day month instead of 30 for the calculation

C. $4,204, calculated as $140.12/day × 30 days

D. $8,407, doubling the correct monthly cost due to a calculation error

91. A treatment plant's operator is reviewing the plant's performance data and notices that the specific UV absorbance (SUVA) of the raw water has increased from 2.5 L/mg·m to 4.5 L/mg·m over the past three months. This increase in SUVA indicates:

A. The raw water NOM has become more hydrophobic and aromatic, which means it is more amenable to removal by coagulation — but it also has higher DBP formation potential

B. The raw water has become less treatable by coagulation because higher SUVA indicates dissolved minerals

C. The raw water turbidity has increased proportionally to the SUVA value

D. The treatment plant's UV disinfection system needs to increase its dose because SUVA directly measures UV resistance

92. A treatment plant's operator receives a complaint from a customer about very low water pressure (15 psi) at their home. The system's minimum pressure standard is 20 psi. The operator checks the nearest distribution system pressure monitor and reads 55 psi. The most likely cause of the customer's low pressure is:

A. A system-wide pressure problem that the distribution monitor has failed to detect due to instrument error

B. A problem between the distribution main and the customer's tap — a partially closed curb stop, a corroded or restricted service line, a faulty pressure-reducing valve at the home, or excessive internal plumbing friction

C. The treatment plant's high-service pumps operating below rated capacity during the peak demand period

D. A distribution main break between the pressure monitor and the customer's home that has not been reported

93. A treatment plant using conventional treatment is experiencing a period of extremely cold raw water (2°C). The operator has increased the alum dose based on jar testing and added polymer as a flocculation aid. Despite these adjustments, the settled water turbidity remains elevated at 2.5 NTU compared to the normal 0.8 NTU. The next operational adjustment the operator should consider is:

A. Reducing the flow rate through the plant to increase flocculation detention time and sedimentation detention time, compensating for the reduced settling velocity caused by cold water's higher viscosity

B. Switching from alum to a non-chemical treatment method that is not affected by water temperature

C. Increasing the backwash frequency to prevent cold water from damaging the filter media

D. Increasing the plant flow rate to create more turbulence that improves particle collisions in cold water

94. A treatment plant's operator is reviewing the results of a vulnerability assessment. The assessment identifies that the plant's chemical delivery receiving area allows delivery trucks to access the plant property through an unmanned, unlocked gate. Chemical deliveries are scheduled in advance, but the gate remains unlocked 24 hours a day. The recommended corrective action is:

A. Remove the gate entirely because it creates a bottleneck during deliveries that delays the driver

B. Install a surveillance camera at the gate as the sole security improvement needed

C. Secure the gate with a lock, provide keys or access codes only to authorized delivery drivers and plant personnel, and verify driver identity before allowing access to the chemical storage area

D. Relocate the chemical storage area inside the treatment plant building to eliminate the need for truck access

95. A treatment plant operator is reviewing the state's continuing education requirements for operator certification renewal. The operator holds a Class I Water Treatment certification. The state requires 30 hours of approved continuing education every 3 years. The operator has completed 22 hours with 6 months remaining before the renewal deadline. The operator should:

A. Enroll in approved training courses immediately to complete the remaining 8 hours before the deadline, prioritizing courses relevant to the operator's certification level and job responsibilities

B. Request a waiver from the state because 22 of 30 hours (73%) constitutes substantial compliance

C. Allow the certification to lapse and apply for reinstatement after completing the remaining hours

D. Transfer unused CE hours from a colleague who has excess hours beyond their own renewal requirement

96. A treatment plant's operator tests the total hardness of the raw water at 240 mg/L as $CaCO_3$ and the alkalinity at 180 mg/L as $CaCO_3$. The operator needs to determine the carbonate hardness and non-carbonate hardness. The correct values are:

A. Carbonate hardness = 240 mg/L, non-carbonate hardness = 0 mg/L

B. Carbonate hardness = 180 mg/L, non-carbonate hardness = 60 mg/L

C. Carbonate hardness = 60 mg/L, non-carbonate hardness = 180 mg/L

D. Carbonate hardness = 120 mg/L, non-carbonate hardness = 120 mg/L

97. A treatment plant's finished water has a free chlorine residual of 1.0 mg/L at pH 7.0 and temperature 15°C. The operator uses the EPA CT tables and determines that the CT required for 0.5-log Giardia inactivation is 25 mg·min/L. The clearwell T_{10} is 30 minutes. The CT achieved is 30 mg·min/L. The safety factor (achieved CT ÷ required CT) is:

A. 0.83, which means the plant is not meeting the CT requirement and must increase the residual or T_{10}

B. 25.0, which represents the required CT value itself rather than the safety factor

C. 1.0, which means the plant is exactly meeting the requirement with no safety margin

D. 1.2, meaning the plant achieves 20% more CT than required — an adequate but modest safety factor

98. A treatment plant's operator is preparing for the winter season. The plant treats surface water from a reservoir. Based on experience, the operator should anticipate the following winter operational challenges:

A. Reduced chlorine demand because cold water reacts more slowly with organic matter

B. Improved coagulation performance because cold water increases particle collision frequency

C. Cold water challenges including increased water viscosity, slower coagulation kinetics, reduced settling velocity, potential ice formation at the intake, and possibly increased manganese from reservoir turnover

D. No operational changes because conventional treatment processes perform identically regardless of temperature

99. A treatment plant's operator discovers that the plant's four parallel sedimentation basins have been receiving unequal flow — Basins 1 and 2 each receive 35% of the total flow, while Basins 3 and 4 each receive only 15%. The operator adjusts the basin inlet valves to equalize flow at 25% per basin. After equalization, the operator should expect:

A. Improved overall settled water quality because the previously overloaded Basins 1 and 2 will now have longer detention times and lower overflow rates, producing better settling performance

B. No change in settled water quality because flow distribution has no effect on sedimentation performance

C. Degraded overall performance because Basins 3 and 4 are now receiving more flow than they have historically handled

D. Improved performance only in Basins 1 and 2, with degraded performance in Basins 3 and 4

100. A treatment plant has been in operation for 25 years. The operator reviews the plant's historical performance data and identifies a long-term trend: the average coagulant dose has increased from 20 mg/L (Year 1) to 38 mg/L (Year 25) while the raw water turbidity has remained relatively stable at 10 to 15 NTU throughout this period. This 90% increase in coagulant demand over 25 years most likely reflects:

A. A gradual decline in the quality of commercially available alum products over this time period

B. Long-term changes in the source water's organic content, mineral composition, or alkalinity that have progressively increased coagulant demand beyond what turbidity measurements alone can detect

C. Systematic operator error in jar test procedures that has gradually biased the optimal dose upward

D. Normal aging of the treatment plant's basins and filters that requires increasingly higher chemical doses to compensate

Practice Exam 10: Answer Key and Explanations

1. C — During drought, the reservoir volume shrinks while the total dissolved mineral load remains relatively constant, concentrating all dissolved constituents. Additionally, the lowered water level may cause the fixed-depth intake to draw from a deeper zone closer to the sediment, where anaerobic conditions have allowed manganese, iron, and organic decomposition products to accumulate.

2. A — The 90th percentile lead level of 0.016 mg/L exceeds the 0.015 mg/L action level. Under the Lead and Copper Rule, the system must optimize corrosion control treatment, implement public education about lead in drinking water, and evaluate the need for lead service line replacement. The copper result (0.8 mg/L) is below the 1.3 mg/L action level and does not trigger additional requirements.

3. D — The solution degraded from 12.5% to 8.2% — a 34% reduction in available chlorine. Since the feed calculations assumed 12.5%, each gallon pumped delivered 34% less active chlorine than intended. The plant has been under-dosing chlorine for the entire storage period, potentially compromising disinfection and CT compliance.

4. B — Baffling factor = T_{10} ÷ Theoretical DT = 42 ÷ 120 = 0.35. This indicates poor to average baffling — only 35% of the theoretical detention time provides effective contact. Improving baffling through internal walls, serpentine channels, or curtain walls would increase the T_{10} and the resulting CT from the same clearwell volume.

5. D — Eight hours of ammonia addition without chlorine means unchlorinated water with free ammonia has entered the distribution system. The operator must immediately stop the ammonia feed, restore chlorine disinfection, evaluate how much of the distribution system received unchlorinated water, and notify the supervisor and state primacy agency of the potential public health threat.

6. A — Basin detention time = Basin volume ÷ Flow per basin. With 4 basins in parallel: flow per basin = 2,778 ÷ 4 = 694 gpm. DT = 250,000 ÷ 694 = 360 minutes per basin. (Note: Candidates should carefully determine whether a question asks for per-basin or total system detention time, as using the total plant flow with a single basin volume is a common exam error.)

7. C — Samples analyzed by a laboratory whose certification has been revoked are not valid for regulatory compliance. The operator must collect new quarterly DBP samples immediately and submit them to a currently certified laboratory. Waiting for results from the revoked laboratory or skipping the monitoring period would create a compliance gap.

8. B — pH 6.2, alkalinity 15 mg/L, and hardness 25 mg/L describe soft, acidic, poorly buffered water with very low mineral content. This water profile produces a strongly negative Langelier Saturation Index and is aggressive toward pipe materials. Corrosion control through pH and alkalinity adjustment is the primary treatment need beyond disinfection.

9. D — A chlorine residual that temporarily recovers after flushing but drops again within 48 hours indicates a persistent, ongoing demand source near the monitoring point. The flushing temporarily introduces fresh chlorinated water, but the source — biofilm, a leaking valve admitting contaminated water, or a cross-connection — continues consuming chlorine until the root cause is identified and eliminated.

10. A — lb/day dry alum = 35 × 3.0 × 8.34 = 875.7 lb. Solution gal/day = 875.7 ÷ (0.485 × 1.33 × 8.34) = 875.7 ÷ 5.38 = 162.8 ≈ 163 gallons/day. This three-step calculation converts from dose to dry chemical weight to liquid solution volume, accounting for both concentration and specific gravity.

11. C — Of 2,976 readings, 66 exceeded 0.3 NTU: 66 ÷ 2,976 = 2.2%. Since 97.8% of readings were ≤ 0.3 NTU (well above the 95% minimum) and no single reading exceeded 1.0 NTU (the highest was 0.72 NTU), the plant meets both turbidity compliance criteria for the month.

12. B — When the clearwell is draining because demand exceeds production, the immediate corrective action is to reduce the outflow (high-service pump output) to match or fall below the current reduced

production rate. This stops the clearwell from draining further while the plant works to return the offline filters to service and restore full production capacity.

13. D — Calcium hypochlorite is a strong oxidizer. When mixed with hydrochloric acid (muriatic acid), the acid reacts with the hypochlorite to release toxic chlorine gas — the same deadly gas that chlorine gas detection systems and SCBA equipment are designed to protect against. These chemicals must be stored in physically separated containment areas.

14. A — A sample temperature of 12°C exceeds the ≤ 10°C holding temperature requirement. Elevated temperature can promote bacterial growth during transport, potentially altering the sample's microbiological characteristics. The operator should analyze the sample but flag the temperature exceedance in the QC record because the results may not accurately represent conditions at the time of collection.

15. C — Road salt (sodium chloride) applied during winter dissolves into snowmelt and storm runoff, carrying dissolved chloride and sodium into the reservoir. Over years of seasonal application, these dissolved ions accumulate in the reservoir, gradually increasing chloride and sodium concentrations — potentially approaching secondary drinking water standards.

16. B — An SCBA with 1,200 psi (below the 1,800 psi minimum) may not provide enough breathing air for an emergency response — particularly a chlorine gas release that could require 20 to 30 minutes of SCBA use. The cylinder must be recharged or replaced immediately to ensure adequate emergency respiratory protection is available at all times.

17. A — The flushing temporarily displaced the chlorine-depleted water with fresh, chlorinated water from the transmission main, restoring the residual. However, the underlying cause — biofilm, sediment, stagnation, or a persistent demand source — was not eliminated by the flushing alone. The chlorine demand continues consuming the residual until the root cause is addressed.

18. D — Fluoride removal requires specific treatment technologies — activated alumina adsorption or reverse osmosis are the most commonly used methods. Conventional coagulation, aeration, and chlorination are not effective for fluoride removal. The high natural fluoride (3.5 mg/L) must be reduced to the 0.7 mg/L target through one of these specialized processes.

19. B — The jar test data shows a classic U-shaped turbidity response with pH as the variable: minimum turbidity at pH 6.5 (0.5 NTU) with increasing turbidity at both lower and higher pH values. This

demonstrates that alum coagulation has an optimal pH range — approximately 6.0 to 7.0 for this water — outside of which performance degrades significantly.

20. C — New HDPE pipe can release volatile organic compounds and other leachable substances during the initial weeks after installation. These compounds produce a temporary "plastic" or "chemical" taste that affects all customers served by the new pipe section. Thorough flushing and curing time (typically 2 to 4 weeks) usually resolves the issue.

21. A — DT = 800,000 ÷ 4,167 = 192 min. T_{10} = 192 × 0.5 = 96 min. Required C = CT ÷ T_{10} = 150 ÷ 96 = 1.5625 ≈ 1.56 mg/L. The operator must maintain at least 1.56 mg/L at the clearwell outlet to achieve the required 150 mg·min/L CT at the current flow and baffling conditions.

22. D — Arsenic at 0.011 mg/L exceeds the 0.010 mg/L MCL. Unlike the Lead and Copper Rule's action level system, arsenic compliance is determined through MCL comparison. The system must determine compliance based on the running annual average and provide appropriate public notification as directed by the state primacy agency.

23. B — Flow per filter = 5,200 ÷ 3 = 1,733 gpm. Rate = 1,733 ÷ 300 = 5.78 gpm/ft^2. This rate is at the upper limit of the acceptable range for rapid gravity filters (typically 2 to 6 gpm/ft^2). The operator must closely monitor individual filter effluent turbidity and headloss development because performance may degrade at this elevated loading rate.

24. C — The jar test shows optimal performance at 0.3 to 0.4 mg/L polymer, with turbidity increasing at both 0.5 and 0.6 mg/L. The performance decline at higher doses is caused by particle restabilization — excess polymer coats particle surfaces completely, saturating the available bridging sites and preventing further aggregation between particles.

25. A — With three basins at 0.6–0.7 NTU and Basin 4 at 2.8 NTU (confirmed by instrument verification), the problem is clearly basin-specific. The investigation should focus on internal conditions unique to Basin 4 — sludge blanket depth, baffle integrity, short-circuiting, sludge scraper operation, and inlet/outlet structure condition.

26. B — Chlorine demand = Applied dose − Residual = 4.0 − 1.3 = 2.7 mg/L. This represents the amount of chlorine consumed by reactions with NOM, ammonia, iron, manganese, and other chlorine-demanding substances during the 30-minute contact period. The operator uses this value to set the plant dose: demand plus desired residual.

27. D — After optimizing coagulation and moving the chlorine application point, the remaining strategies involve either removing more NOM precursor (GAC adsorbers) or switching to a secondary disinfectant that produces fewer DBPs (chloramines instead of free chlorine). Both approaches directly address THM formation at Location #2. Relocating the monitoring point is not an acceptable compliance strategy.

28. A — E. coli confirmation in the distribution system is a Tier 1 public health emergency. The operator must notify the state primacy agency immediately — regardless of the day or time — and issue Tier 1 public notification within 24 hours. Waiting until Monday, waiting for repeat results, or attempting to resolve the issue without notification are all violations.

29. C — Zero disinfectant residual combined with HPC exceeding 500 CFU/mL represents a serious water quality failure at this monitoring point. The complete loss of disinfectant protection and elevated bacterial counts require immediate investigation (flushing, pressure testing, cross-connection survey) and potential public notification.

30. B — Low pH (7.0), very low alkalinity (20 mg/L), very low calcium (25 mg/L), and low TDS (100 mg/L) at cool temperature (10°C) collectively produce a strongly negative LSI — indicating highly corrosive water that will aggressively dissolve calcium carbonate and metals from pipe surfaces. This water requires significant corrosion control treatment.

31. D — If the scale on the active cylinder hasn't changed in 24 hours despite the chlorinator operating, the chlorinator may be drawing gas from a different cylinder on the manifold, or the system may have lost vacuum and is not actually delivering chlorine despite the rotameter showing flow. The operator should verify residual at the application point and check the manifold valve configuration.

32. A — A simultaneous increase in both pH (7.2 to 8.5) and alkalinity (80 to 140 mg/L) over 48 hours strongly suggests an alkaline discharge into the source water. Concrete batch plant waste, lime runoff from construction, cement truck washout, or road stabilization activities release calcium hydroxide that dramatically raises both pH and alkalinity in receiving waters.

33. C — The settled water turbidity increase from 0.8 to 2.5 NTU (with unchanged raw water and coagulant dose) indicates the coagulation/flocculation process has deteriorated. This sends more particles to the filters, causing faster headloss development and shorter runs. The operator should perform a fresh jar test, verify the chemical feed system, and investigate whether raw water chemistry has changed.

34. B — Comprehensive storm preparation includes verifying fuel supply (adequate for extended outage), checking generator antifreeze and coolant levels, confirming SCBA cylinder charge, stocking critical spare parts and emergency chemicals, verifying emergency contact information, and testing communication systems. Proactive preparation prevents cascading failures during the event.

35. D — At 1.8 mg/L, fluoride exceeds the 2.0 mg/L secondary standard... actually 1.8 is below 2.0. But at 1.8 mg/L, the level is more than 2.5 times the 0.7 mg/L target, indicating a significant fluoride feed system malfunction. The operator should immediately investigate and correct the feed system, reduce the dose to target, document the event, and evaluate whether notification is appropriate for the prolonged overfeed.

36. A — Dissolved iron (2.0 mg/L) represents the ferrous (Fe^{2+}) fraction that is invisible and passes through a 0.45 µm filter. Total iron (2.2 mg/L) includes both dissolved and particulate forms. The small difference (0.2 mg/L) indicates that 91% of the iron exists in the dissolved form, with only a small fraction already oxidized to particulate ferric iron in the raw water.

37. C — Blue-green water affecting only cold water at a single residence — with no other complaints in the area — points to copper leaching from the customer's plumbing. Aggressive water (low pH, low alkalinity) dissolves copper from new copper pipes, producing blue-green dissolved copper at concentrations that can discolor the water and stain fixtures.

38. B — A 2:1 chlorine-to-ammonia ratio (half the target 4:1) means significant excess ammonia is entering the distribution system. This excess ammonia provides a nutrient source for nitrifying bacteria, promoting nitrification. At very low ratios, dichloramine and trichloramine may also form, producing objectionable taste and odor.

39. D — A pH 4.00 buffer reading of 4.25 (6.25% error) after calibration with pH 7.00 and 10.00 buffers indicates either the check buffer has degraded or the electrode slope is not linear across the full pH range. The operator should verify the buffer is fresh, then recalibrate if the deviation persists. If the electrode cannot hold calibration across the range, replacement is needed.

40. A — Total flow = 4.0 MGD = 2,778 gpm. Flow per filter = 2,778 ÷ 5 = 555.6 gpm. Rate = 555.6 ÷ 250 = 2.22 gpm/ft^2. This rate is within the typical design range of 2–6 gpm/ft^2 for rapid gravity filters, indicating adequate filter capacity at the current flow.

41. C — After eliminating lamp life and sleeve cleanliness as causes, the declining UVT (75%, down from 90%) is the root cause. The water itself is absorbing more UV light before it can reach the pathogens — likely from increased NOM, color, or dissolved metals in the filtered water. Improving upstream treatment to restore UVT is the correct long-term solution.

42. A — Sodium hypochlorite mixed with hydrofluorosilicic acid releases toxic chlorine gas. Sodium hydroxide mixed with hydrofluorosilicic acid produces a violent exothermic reaction. Each incompatible pair must be physically separated in independent containment to prevent dangerous reactions if tank failures occur simultaneously.

43. D — A 67% nuisance alarm rate means two-thirds of all alarms require no operator action — contributing significantly to alarm fatigue. While better than the worst-case scenarios, this rate still poses a serious risk that operators will become desensitized and miss or delay response to genuine critical alarms. Systematic alarm rationalization is needed.

44. B — Under the LT2ESWTR, Bin 1 (lowest risk, based on source water Cryptosporidium monitoring) requires 3-log total treatment. Conventional filtration already receives 3-log Cryptosporidium removal credit. Therefore, no additional treatment beyond conventional filtration is required for Bin 1 sources.

45. D — lb/day Cl_2 = 2.0 × 2.5 × 8.34 = 41.7 lb. Solution lb/day = 41.7 ÷ 0.10 = 417 lb. Gal/day = 417 ÷ (1.14 × 8.34) = 417 ÷ 9.51 = 43.8 gallons/day. This three-step calculation converts chlorine dose to dry weight to solution weight to volume.

46. A — A localized pressure drop at a single monitoring point with no reported breaks warrants systematic investigation. The most likely causes are a partially closed valve (inadvertently left closed after maintenance), a failed pressure-reducing valve, or a significant increase in localized demand. Each can be verified through field investigation.

47. B — A steady increase in lead 90th percentile values over time with no intentional treatment changes suggests the finished water's corrosion characteristics have shifted. Changes in source water chemistry, treatment chemical lots, or unintended pH or alkalinity drifts can alter the water's aggressiveness toward lead-bearing plumbing without the operator's awareness.

48. C — Daily consumption ≈ 68 gallons. Days of inventory = 5,000 ÷ 68 = 73.5 days. This exceeds the typical 30-day reorder threshold, providing comfortable inventory coverage. The operator should still verify the reorder point accounts for delivery lead time and potential delays.

49. A — A rotten egg smell at a single residence with adequate chlorine residual (0.3 mg/L) in the distribution water points to the customer's water heater. Sulfate-reducing bacteria thrive in warm, low-oxygen conditions inside water heaters — particularly those set below 60°C or with sacrificial magnesium anodes that create reducing conditions favorable for H_2S production.

50. D — Excess polymer reaching the filters creates a sticky, low-permeability coating on the media surface. This organic film traps particles at the surface rather than allowing depth penetration, causing rapid surface blinding and accelerated headloss. The effluent quality may remain good initially because the film effectively captures particles — but the dramatically shortened filter runs confirm the operational problem.

51. B — The root cause was a failed battery charger that went undetected for three weeks. Prevention requires both an automated alarm (battery charger failure alarm connected to SCADA) and a manual backup verification (weekly battery voltage check during routine generator testing). Either measure alone is insufficient — the combination provides redundant detection.

52. C — The LSI shift from +0.3 to −0.5 without intentional treatment changes indicates one or more of the underlying water quality parameters (alkalinity, calcium hardness, pH, TDS, temperature) has changed. The operator should compare current raw and finished water data against historical values to identify which parameter shifted and why.

53. A — Correct backwash flow rate with inadequate bed expansion indicates the media is heavier or more resistant to fluidization than expected. Heavy mineral deposits (calcium carbonate, iron oxide), mudballs, or compacted material weigh down the media grains, preventing them from achieving full expansion despite adequate hydraulic force from the backwash flow.

54. D — When the chlorine dose and plant flow are unchanged but sodium hypochlorite consumption increases 30%, the solution has degraded — each gallon now contains less available chlorine. The metering pump delivers the same volume per stroke, but the weaker solution delivers less chlorine per gallon. More gallons must be pumped to achieve the same dose, increasing both volume consumed and delivery frequency.

55. B — DT = 400,000 ÷ 2,083 = 192 minutes. T_{10} = 192 × 0.7 = 134.4 minutes. CT = 0.9 × 134.4 = 120.96 ≈ 121 mg·min/L. The superior baffling factor (0.7) retains 70% of the theoretical detention time as effective contact time — a significant advantage that generates substantially more CT from the same clearwell volume compared to average (0.5) or poor (0.3) baffling.

56. C — Combined effluent turbidity = (0.04 + 0.05 + 0.45 + 0.06) ÷ 4 = 0.60 ÷ 4 = 0.15 NTU (when all filters operate at equal flow). This demonstrates how one poorly performing filter (0.45 NTU on Filter 3) elevates the combined reading from the 0.04–0.06 NTU range to 0.15 NTU — highlighting the importance of individual filter monitoring.

57. A — T_{10} is inversely proportional to flow (at constant clearwell volume and baffling). New T_{10} = Original T_{10} × (Original flow ÷ New flow) = 85 × (2.5 ÷ 3.5) = 85 × 0.714 = 60.7 ≈ 61 minutes. The 40% flow increase reduces the T_{10} by approximately 28%, which directly reduces the available CT.

58. D — Pump 3, with 22,000 operating hours on original, never-replaced bearings, has accumulated by far the most wear. Bearing life is finite and cumulative — even high-quality bearings have a design life measured in operating hours. At 22,000 hours without replacement, Pump 3 is statistically the most likely to experience bearing failure.

59. B — Before recommending expensive capital improvements, the operator should identify the specific causes of poor settling. A basin performance evaluation — including tracer testing, flow distribution analysis, sludge blanket measurements, baffle inspection, and coagulation optimization — may reveal correctable problems (baffling deficiencies, short-circuiting, sludge buildup) that do not require major capital expenditure.

60. C — Feed rate = 12 × 5.0 × 8.34 = 500.4 lb/day. Daily cost = 500.4 × $0.55 = $275.22 per day. During a severe taste and odor event lasting several weeks, PAC costs can represent a significant portion of the plant's chemical budget — one reason permanent GAC installation may be more cost-effective for plants with frequent seasonal events.

61. B — The DAF effluent deterioration coincides with a decreased air-to-solids ratio from reduced recycle flow. DAF effectiveness depends on having sufficient micro-bubbles to attach to and float the floc and algae particles. Increasing the recycle rate restores the proper bubble-to-particle ratio, improving particle capture and reducing effluent turbidity.

62. D — Water hammer occurs when the discharge check valve slams shut at the end of each pump stroke, creating a pressure shock wave in the piping. The sudden stoppage of flow momentum produces

the characteristic hammering noise. Installing a pulsation dampener on the discharge line absorbs the pressure surges and eliminates the noise.

63. A — The ORC makes the critical daily operational decisions that directly affect water quality — chemical dosing, process adjustments, monitoring, and compliance. The ORC is legally responsible for ensuring the plant operates within all applicable regulations and bears professional accountability for the water quality delivered to consumers.

64. C — Clearwell declining means demand exceeds production. Increasing pump discharge pressure simultaneously indicates the pumps are working harder — possibly because a partially closed valve downstream or increasing system elevation requires more head, or because the pumps are accelerating to meet rising demand. The combined pattern reflects a demand-exceeds-supply condition with the pumps compensating.

65. B — A permanganate dose set three months ago may no longer be optimal if the raw water manganese concentration has increased or the water chemistry has changed. The operator should perform a new jar test to verify the current optimal dose and check whether the raw water manganese level has risen since the original dose was established.

66. D — Volume = 80 × 40 × 15 = 48,000 ft^3. Gallons = 48,000 × 7.48 = 359,040 gallons. Weight = 359,040 × 8.34 = 2,994,394 ≈ 2,990,131 pounds. This calculation demonstrates the enormous weight of water in treatment structures — important for structural engineering and for understanding the forces involved in basin draining and filling.

67. A — Milky water that clears from bottom to top within 60 seconds is the classic presentation of dissolved air — micro-bubbles entrained in pressurized distribution water that come out of solution when the water exits the tap at atmospheric pressure. The bubbles rise and dissipate rapidly. This is an aesthetic phenomenon with no health significance.

68. C — The ideal post-backwash turbidity profile shows an initial spike during the ripening period as the filter re-establishes its particle-capturing capability, followed by a rapid decline to the filter's baseline performance. The ripening spike is normal and expected — its magnitude and duration indicate the backwash's effectiveness and the filter's overall condition.

69. B — The CCR must include all detected regulated contaminants — not just those exceeding MCLs. Every detected parameter must be reported with its concentration, the applicable MCL, the MCLG, the

likely source, and health effects information. This transparency allows consumers to make informed decisions about their drinking water quality.

70. D — Free ammonia of 0.2 mg/L indicates more ammonia is passing through than is being consumed by the chlorine — slightly more than ideal. While some excess is typical, 0.2 mg/L provides a nutrient source for nitrifying bacteria in the distribution system. The operator should evaluate whether a slight ratio adjustment (increasing toward 5:1) could reduce the free ammonia without compromising the chloramine residual.

71. A — Vibration at the vane pass frequency (running speed × number of vanes) is characteristic of a flow interaction between the impeller and the volute cutwater — either the gap is too small, a vane passage is partially blocked, or recirculation is occurring. This frequency-specific signature distinguishes the problem from imbalance (1×) or misalignment (2×).

72. C — Settled water turbidity of 1.2 NTU is above the industry optimization target of < 1.0 NTU established by the Partnership for Safe Water. While compliant, improving settled water quality reduces the load on downstream filters, extends filter runs, and provides a larger safety margin against turbidity exceedances. Coagulation optimization through jar testing is the appropriate response.

73. B — A sudden vibration increase (sharp change from baseline within 15 minutes) on a pump running continuously indicates an acute mechanical problem — a failed bearing, a broken impeller vane, a foreign object entering the pump, or a sudden shaft misalignment. The operator should shut down the pump to prevent catastrophic damage and switch to the standby pump while investigating.

74. D — Each month where the TOC removal percentage falls below the required value may constitute a treatment technique violation under the Stage 1 D/DBPR. The plant must investigate the cause of the shortfall, implement corrective action, and provide appropriate public notification for each month of non-compliance.

75. A — A cybersecurity incident — unauthorized SCADA access, ransomware, or data manipulation — can compromise treatment process controls as severely as a physical emergency. The ERP should include procedures for detecting the intrusion, containing the damage, restoring systems from known-good backups, and coordinating with law enforcement and the state.

76. C — An LSI of +0.5 indicates the water is slightly supersaturated with calcium carbonate and will deposit a thin protective scale layer on pipe interiors. This thin $CaCO_3$ film acts as a barrier between the

water and the pipe material, reducing corrosion. A slightly positive LSI (+0.0 to +0.5) is generally considered optimal for corrosion control.

77. B — Oxygen at 18.5% is below the safe minimum of 19.5%. Entry must not proceed until the atmosphere is ventilated to bring all parameters within safe ranges. The low oxygen indicates a displacement or consumption process (microbial activity, oxidation of organic material) that has reduced the oxygen content below the safe threshold.

78. D — Total daily backwash = 4 filters × 60,000 gal = 240,000 gal. Percentage = 240,000 ÷ 4,000,000 × 100 = 6.0%. This exceeds the typical 2–5% guideline and warrants evaluation — the backwash duration, flow rate, or frequency may be excessive, or the filters may be loading too quickly due to upstream treatment issues.

79. A — Distribution main repairs disturb the sediment and corrosion products that have accumulated inside the pipe over years of service. The repair process — cutting, draining, and refilling the main — mobilizes this material, which then flows to nearby homes as discolored water. The condition typically resolves within days to weeks as the disturbed material is flushed through normal water use.

80. B — All parameters are well within compliance, but the CT of 150 mg·min/L (3.3× the required 45) suggests an opportunity to reduce the chlorine dose. A modest reduction would decrease DBP formation potential while still maintaining adequate CT — optimizing the balance between disinfection effectiveness and DBP compliance.

81. D — Daily chlorine = 2,200 lb ÷ 30 days = 73.3 lb/day. Dose = 73.3 ÷ (3.0 × 8.34) = 73.3 ÷ 25.02 = 2.93 mg/L. This reverse calculation allows the operator to verify the actual applied dose from chemical consumption records — useful for confirming feed system accuracy and tracking treatment costs.

82. C — A three-year upward trend approaching the MCL is a clear warning signal requiring proactive investigation. The operator should identify the source (geological, seasonal, treatment-related), evaluate treatment options (coagulation optimization, activated alumina, RO), and develop a compliance strategy before the level crosses the 0.010 mg/L threshold.

83. A — Automatic flow-proportional chemical feed maintains a consistent dose per gallon regardless of plant flow fluctuations. When demand increases and flow rises, the system automatically increases the chemical feed rate proportionally. When demand drops, the system reduces the feed. This eliminates the dosing errors inherent in manual systems where operators must constantly adjust feed rates.

84. B — Filter 3 has the most significant deterioration: 8 inches of depth loss (27% reduction) and the smallest effective size (0.70 mm, 30% reduction from original). Both parameters indicate severe media attrition that compromises filtration capacity, shortens filter runs, and increases the risk of turbidity breakthrough. Filter 3 needs urgent media replacement.

85. D — UV disinfection provides effective Cryptosporidium inactivation at relatively low doses — typically 12 mJ/cm² for 2-log and 22 mJ/cm² for 3-log credit. These doses are practical and cost-effective compared to the thousands of mg·min/L of chlorine CT or the capital cost of ozone or membrane systems required to achieve equivalent Cryptosporidium credit.

86. C — Voltage fluctuating between 440V and 510V (±6–7% variation) when the rated tolerance is ±5% indicates the automatic voltage regulator (AVR) is failing to maintain stable output. The AVR senses the output voltage and adjusts the excitation current to the generator's field windings. A malfunctioning AVR produces the characteristic voltage hunting or oscillation pattern.

87. A — Flow-weighted hardness = [(800 × 150) + (400 × 300)] ÷ (800 + 400) = (120,000 + 120,000) ÷ 1,200 = 240,000 ÷ 1,200 = 200 mg/L as $CaCO_3$. The flow-weighted average accounts for each well's proportional contribution based on both its hardness concentration and its flow rate.

88. B — On-site generation eliminates the safety hazards of storing compressed toxic chlorine gas (no RMP requirements, no SCBA needs, no leak detection systems for gas). The generated 0.8% solution is far less hazardous than 12.5% bulk hypochlorite and is produced fresh daily, avoiding degradation. The tradeoff is lower concentration requiring higher feed volumes.

89. D — Storage-to-demand ratio = 1.5 MG ÷ 3.0 MGD = 0.5 days. This is half the recommended one day of storage, indicating the system may be vulnerable during extended peak demand periods, emergency events, or plant shutdowns. Additional storage capacity or demand management strategies should be evaluated.

90. C — Daily cost = 934.1 lb × $0.15/lb = $140.12/day. Monthly cost = $140.12 × 30 = $4,203.45 ≈ $4,204. Chemical cost calculations are essential for budgeting, cost tracking, and evaluating treatment optimization opportunities. Operators should perform these calculations regularly and compare actual costs against budgeted amounts.

91. A — SUVA (Specific UV Absorbance = UV_{254} ÷ DOC) measures the aromaticity and hydrophobicity of NOM. Higher SUVA (4.5 vs. 2.5) indicates the NOM has become more aromatic and

hydrophobic — these compounds are more amenable to removal by coagulation but also have higher reactivity with chlorine, producing more DBPs if not adequately removed.

92. B — A single customer at 15 psi while the nearest system monitor reads 55 psi indicates the pressure loss occurs between the main and the tap. The most likely causes are a partially closed curb stop, a corroded or restricted service line, excessive internal plumbing friction, or a malfunctioning customer-side pressure-reducing valve. The system-wide pressure is adequate.

93. D — After maximizing coagulant dose and adding polymer with inadequate results, reducing the plant flow rate is the next logical adjustment. Lower flow increases detention time in both the flocculation basins (more time for particle collisions) and sedimentation basins (more time for settling), compensating for the reduced kinetic energy and higher viscosity of cold water.

94. C — An unlocked, unmanned gate providing 24-hour access to the chemical storage area is a significant security vulnerability. The gate should be locked and access controlled through keys or codes provided only to authorized personnel. Driver identity should be verified against expected delivery schedules before granting access.

95. A — With 8 hours remaining and 6 months to complete them, the operator should enroll immediately in approved courses. Certification lapses create regulatory violations because most states require a certified operator in responsible charge at all times. Proactive scheduling ensures the requirement is met well before the deadline.

96. B — When total hardness (240) exceeds alkalinity (180), carbonate hardness equals the alkalinity (180 mg/L) and non-carbonate hardness equals the excess: $240 - 180 = 60$ mg/L as $CaCO_3$. The carbonate portion is associated with bicarbonate ions and is removable by boiling; the non-carbonate portion requires chemical softening or ion exchange.

97. D — CT achieved = $1.0 \times 30 = 30$ mg·min/L. Required CT = 25 mg·min/L. Safety factor = $30 \div 25 = 1.2$. A safety factor of 1.2 means the plant achieves 20% more CT than required — providing a modest buffer against flow increases, residual fluctuations, or temperature changes that could reduce the achieved CT.

98. C — Winter operations present multiple challenges: increased water viscosity slows settling and filtration, cold temperatures reduce chemical reaction rates and coagulation effectiveness, ice formation

can obstruct intakes, and fall/winter reservoir turnover can introduce dissolved manganese and iron. Operators must anticipate and prepare for all these seasonal impacts.

99. A — Equalizing flow from 35/35/15/15 to 25/25/25/25 dramatically improves conditions in the previously overloaded Basins 1 and 2. Their overflow rates decrease by approximately 29% (from 35% to 25% of total flow), significantly improving detention time and settling performance. Basins 3 and 4 receive more flow but are still within design capacity.

100. B — A 90% increase in coagulant demand over 25 years with stable turbidity strongly suggests long-term changes in the source water's chemistry that turbidity measurements cannot detect. Gradually increasing NOM (from watershed development or climate changes), declining alkalinity (from acid deposition), or shifting mineral composition all increase coagulant demand independent of turbidity.