WATER OPERATOR MATH BY ALTITUDE WATER LLC

SENIOR-OPERATOR EXAM PREP · ZERO MATH DRILLS

Class B & A Water Treatment Comprehensive Study Guide

For WPI/ABC & Colorado CWP Water Treatment Class B and A (WPI Class III–IV). Advanced treatment processes, process control, membranes, advanced disinfection, instrumentation and SCADA, pumps, plant optimization, process safety, and senior-level troubleshooting — explained the way the exam tests them.

- 12 senior-level chapters · Class B/A depth
- 60-question non-math mastery check
- "Exam Trap Alert" callouts
- Multi-factor troubleshooting matrices
- Class B vs Class A scope in every chapter
- Offline interactive study companion

Official Sources · Verified as of November 2026. Public pages only, cited for reference; confirm current details at the official source.

Source: Water Professionals International (WPI), *Standardized Water Treatment Operator Exams — Need-to-Know Criteria and Formula/Conversion Table* (as of November 2026). https://gowpi.org/services/abc-testing/standardized-exams/standardized-water-treatment-operator-exams/

Source: Water Professionals International (WPI), *Formula/Conversion Table — Water Treatment, Distribution & Water Laboratory Exams* (2024 edition, as of November 2026). https://gowpi.org/services/abc-testing/formula-conversion-tables/

Source: Water Professionals International (WPI), *Historical Need-to-Know Criteria (2019 standardized water treatment and distribution exams)* (as of November 2026). https://gowpi.org/services/abc-testing/need-to-know-criteria/

Source: Colorado CCWP Office, *CCWP – Need to know criteria and study resources* (as of November 2026). https://cdphe.colorado.gov/ccwp-need-to-know-criteria-and-study-resources

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CHAPTER 1 OF 12 · SOURCE WATER MANAGEMENT

Advanced Source Water Management, Watershed Protection, Eutrophication, HABs/Cyanotoxins & Source Blending

LEARNING OBJECTIVES

- Explain reservoir thermal stratification, turnover, and how each stage changes raw water quality at different intake depths.
- Describe the eutrophication cycle and how nutrients, light, and temperature drive algal and cyanobacterial blooms.
- Recognize the operational impacts of harmful algal blooms (HABs) — cell lysis, intracellular vs extracellular toxins, and taste-and-odor compounds.
- Choose treatment strategies that remove intact cells without releasing toxins, and strategies that destroy dissolved toxins.
- Use selective withdrawal, reservoir management tools, and source blending to deliver the most treatable water to the plant.
- Describe watershed protection practices and the treatment impacts of wildfire, runoff events, and upstream discharges.

CLASS B VS CLASS A SCOPE

Class B (WPI Class III)
Explain stratification and turnover, recognize HAB and taste-and-odor events, and select basic responses (intake level changes, PAC, oxidant adjustments). Know why pre-oxidation of a bloom can be harmful.

Class A (WPI Class IV)
Lead the source-water strategy: integrate monitoring data, reservoir management, selective withdrawal, blending, and treatment changes into one plan; anticipate seasonal events; manage toxin risk, DBP precursors, and Mn release together.

1.1 Reservoir Limnology for Senior Operators

A reservoir is not a tank of uniform water — it is a layered, living system, and the layer you draw from controls your treatment problems. In summer, the sun warms the surface, creating a warm, light, well-mixed upper layer called the **epilimnion**, a zone of rapid temperature change called the **thermocline** (metalimnion), and a cold, dense bottom layer called the **hypolimnion**. Because the layers have different densities, they do not mix, and the hypolimnion is cut off from the atmosphere.

Bacteria decomposing settled organic matter consume the dissolved oxygen in the hypolimnion. Once it goes **anoxic**, the chemistry at the sediment surface changes: **iron and manganese** are reduced to soluble forms and diffuse into the water, **hydrogen sulfide** and **ammonia** accumulate, and phosphorus is released from the sediments — fuel for the next bloom. In fall, the surface cools until the whole column reaches the same density; wind then mixes it completely (**fall turnover**). Spring turnover occurs after ice-off in cold climates. During turnover, the anoxic bottom water — with its Mn, Fe, sulfide, color, and odor — is suddenly distributed through the whole reservoir.

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Geosmin and 2-methylisoborneol (MIB) are detectable by many people at **single-digit nanograms per liter** and are **not removed by conventional coagulation or by chlorine**. The main tools are **powdered activated carbon (PAC)**, **granular activated carbon (GAC)**, **ozone**, and advanced oxidation. MIB is harder to adsorb than geosmin and usually needs more PAC. PAC must be added early with enough contact time, and away from points where chlorine or permanganate would occupy its adsorption sites or be consumed by it.

EXAM TRAP ALERT

Adding more chlorine to 'burn out' an earthy-musty odor does **not** work — geosmin and MIB are resistant to chlorine, and extra chlorine adds chlorinous odor and DBPs. The correct answers involve **activated carbon or ozone**, and source control.

Reservoir management tools

- **Aeration / destratification** — mixes the column, suppresses cyanobacteria that rely on calm, stratified water, and limits anoxia.
- **Hypolimnetic oxygenation** — adds oxygen to the bottom layer without breaking stratification, keeping Mn, Fe, sulfide, and phosphorus in the sediments while preserving cold water.
- **Algaecides** (copper-based or peroxide-based) — applied only under the reservoir's approved plan and before a bloom peaks. Treating a heavy cyanobacteria bloom can **lyse cells and release toxins and odor compounds** into the water at once.
- **Nutrient control** in the watershed and in-lake phosphorus inactivation (e.g., aluminum sulfate or lanthanum-modified clay treatments).
- **Selective withdrawal** using multi-level intakes.

1.3 Harmful Algal Blooms & Cyanotoxins

Some cyanobacteria (e.g., *Microcystis*, *Dolichospermum*, *Planktothrix*, *Aphanizomenon*, *Raphidiopsis/Cylindrospermopsis*) produce toxins. The key operational distinction is **where the toxin is**: in many blooms most microcystin is **intracellular** (inside intact cells), while cylindrospermopsin is often largely **extracellular** (dissolved). The treatment strategy follows from that.

Cyanotoxins at a Glance

Toxin	Type of effect	Where it usually is	Treatment notes
Microcystins	Liver toxin (hepatotoxin)	Mostly **intracellular** in healthy blooms	Remove intact cells by coagulation/DAF/filtration; dissolved fraction readily oxidized by chlorine (pH-dependent), ozone, permanganate; PAC/GAC adsorb
Cylindrospermopsin	Liver and kidney toxin	Often **extracellular**	Free chlorine and ozone are effective; permanganate is poor; GAC/PAC moderate
Anatoxin-a	Nerve toxin (neurotoxin)	Mixed	Ozone and permanganate effective; **free chlorine is poor**; PAC/GAC adsorb
Saxitoxins	Nerve toxin	Mixed	Chlorine effectiveness increases with pH; PAC/GAC adsorb

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