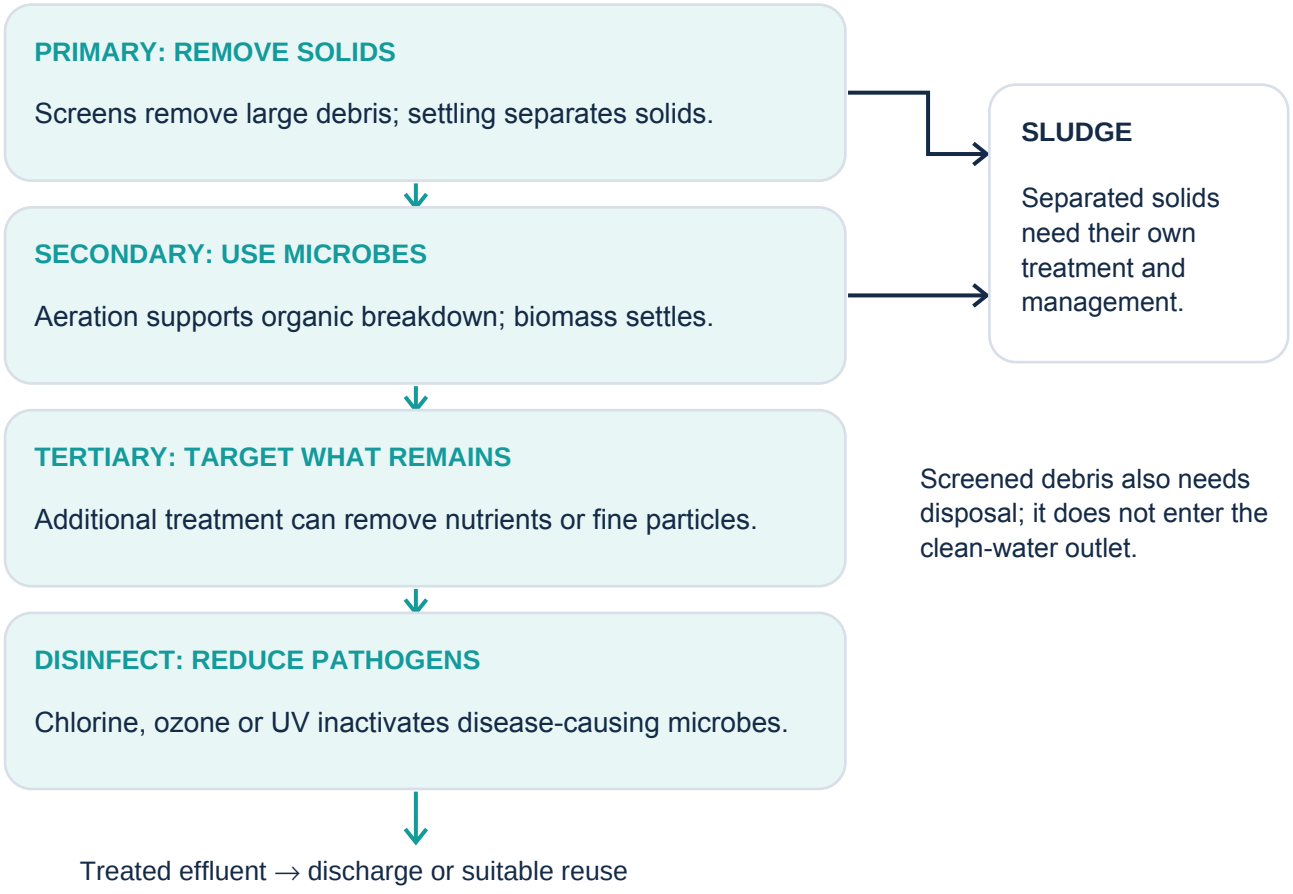
One flow, several different jobs

Sewage carries solids, biodegradable organic matter, nutrients and pathogens. Treatment combines physical, biological and chemical processes before the water is released or reused.

1. FOLLOW THE WATER THROUGH A TREATMENT PLANT

Simplified teaching sequence; actual plant designs vary.



2. MATCH THE PROCESS TO THE POLLUTANT

Settling mainly removes settleable solids, not all dissolved pollutants. Biological treatment lowers the load of biodegradable organic matter. Nutrient removal helps limit eutrophication. Disinfection targets pathogens; it does not prove that all nutrients or chemical contaminants have been removed.

Stage sequence and separation: College Board APES CED, Topic 8.11.
Plant variations and outputs: US EPA, Primer for Municipal Wastewater Treatment Systems.

Scope: College Board AP Environmental Science CED, Topic 8.11, p. 170.

Let microbes do the organic work

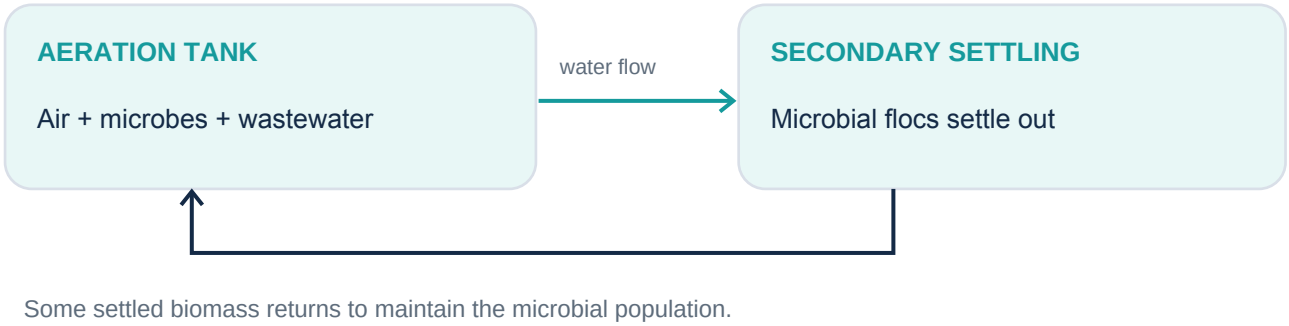
Primary treatment separates materials physically. Secondary treatment uses living microorganisms to transform biodegradable organic matter and then separates the resulting solids.

1. PRIMARY: SCREEN, SLOW, SETTLE

Screens and grates trap large objects; grit removal protects equipment. Water slows in a settling tank so settleable particles collect as primary sludge. Floating fats and scum can be skimmed off. Many dissolved substances and small suspended particles remain, so clear-looking water is not necessarily fully treated.

2. SECONDARY: AERATE, THEN SEPARATE

An activated-sludge example (supporting detail): aerobic microbes use organic matter and oxygen, releasing carbon dioxide and producing new biomass.



Some settled biomass returns to maintain the microbial population.

3. WHY LOWER BOD PROTECTS A RIVER

Biochemical oxygen demand (BOD) describes oxygen used by microorganisms while breaking down organic matter under specified conditions. High BOD can draw down dissolved oxygen (DO), leaving less for fish and other aquatic organisms. Removing organic matter before discharge reduces this downstream oxygen demand.

Keep the distinction clear: BOD is oxygen demand; DO is oxygen present. Aeration supplies oxygen in the treatment tank, while organic-waste removal reduces demand in the receiving water.

Primary treatment and activated sludge: US EPA, Municipal Wastewater Treatment Primer.
BOD and dissolved oxygen: USGS Water Science School.

Scope: College Board AP Environmental Science CED, Topic 8.11, p. 170.

Finish treatment; manage residues

Clean-looking effluent can still contain nutrients, microorganisms or dissolved pollutants. Choose additional processes for the water quality needed and check performance with appropriate measurements.

1. TERTIARY: TARGET RESIDUAL POLLUTANTS

Advanced treatment can add filtration, chemical removal or ecological/biological processes. For example, phosphorus can be removed using chemicals that form solids for separation; nitrogen can be removed through biological treatment. Nutrient removal limits algal growth and subsequent oxygen depletion. No single finishing step removes every possible contaminant.

2. DISINFECTION: THREE METHODS, ONE MAIN TARGET

Chlorine	Chemical disinfectant; residual chlorine may require removal before discharge to protect aquatic life.
Ozone	Strong oxidant made on site; equipment, energy and safe gas handling are needed.
UV light	Damages microbial genetic material. Cloudiness or suspended particles can shield organisms from exposure.

Effective disinfection needs sufficient dose or exposure. It reduces infection risk, but does not automatically make effluent drinking water.

3. SLUDGE: A SEPARATE MANAGEMENT TASK

Supporting detail: primary solids and excess microbial biomass contain water, organic and inorganic material, and potentially contaminants. Stabilization and dewatering prepare sludge for appropriate use or disposal. Suitable treated biosolids may be used on land, but this requires quality controls; untreated sludge is not automatically safe fertilizer.

4. CHECK THE RIGHT MEASURE

Illustrative BOD readings: 200 mg/L entering, 20 mg/L leaving.
Reduction = (200 - 20) / 200 × 100 = 90%.
This is a BOD concentration reduction, not proof of 90% pathogen removal.

Finishing stages: College Board APES CED, Topic 8.11.
Disinfection trade-offs: US EPA, Disinfection for Small Systems.
Residuals: US EPA, Basic Information about Sewage Sludge and Biosolids.

Scope: College Board AP Environmental Science CED, Topic 8.11, p. 170.