Wastewater Treatment Lecture 1

Wastewater Engineering – An Overview

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Fall 2025

Course Objectives

By the end of this lecture, students should be able to:

- Define wastewater and explain its sources and importance.
- Describe objectives and significance of wastewater treatment.
- Identify components of wastewater systems.

Definition and Scope of Wastewater Engineering

Wastewater Engineering involves collection, treatment, and reuse/disposal of wastewater.

Objectives:

- Remove contaminants (physical, chemical, biological).

- Protect rivers, lakes, and groundwater.

- Wastewater engineering is a specialized branch of civil and environmental engineering that deals with the **planning, design, construction, and operation** of systems for the **collection, treatment, reuse, and safe disposal** of wastewater generated by domestic, industrial, and institutional activities.
  Its main purpose is to **protect public health** and **preserve the environment**.

The various sources of water can be classified into two categories:

1. Surface sources, such as

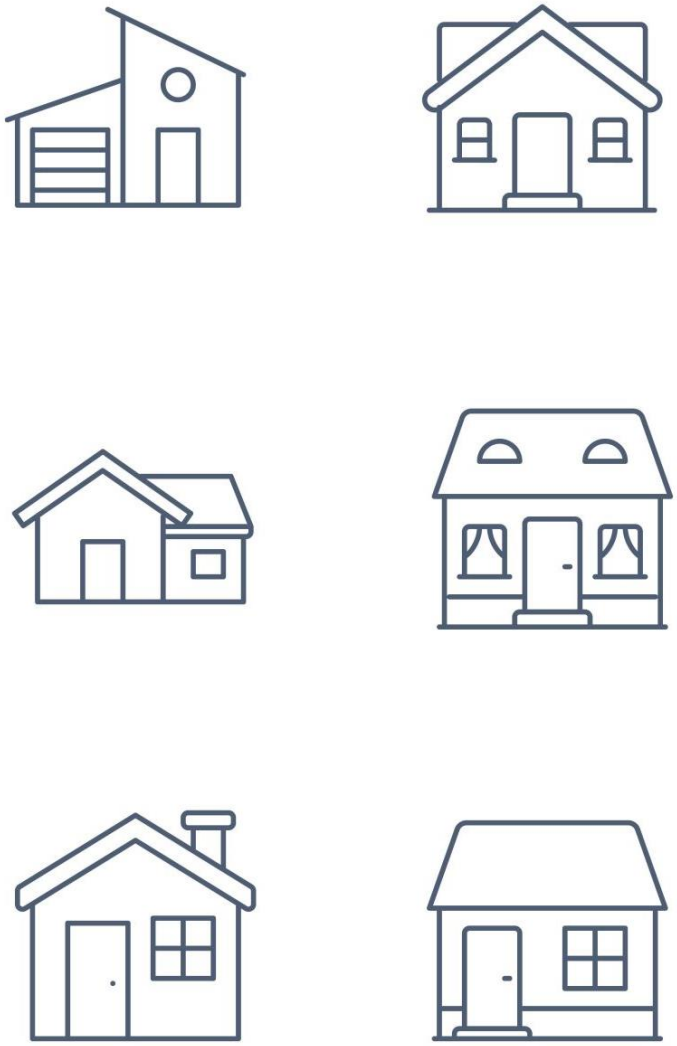
- **a. Ponds and lakes;**
- **b. Streams and rivers;**
- **c. Storage reservoirs; and**
- **d. Oceans, generally not used for water supplies, at present.**

2. Sub-surface sources or underground sources, such as

- **a. Springs;**
- **b. Wells**

Sources and Types of Wastewater

- 1. Domestic: From homes (sinks, toilets, laundry).
- 2. Industrial: Factories and manufacturing processes.
- 3. Institutional: Schools, hospitals, universities.
- 4. Infiltration/Inflow: Groundwater or stormwater entering sewers.



Importance of Wastewater Management:

- Prevents spread of **waterborne diseases** such as cholera and typhoid.
- Protects **surface and groundwater resources** from pollution.
- Enables **sustainable urban development** and safe water reuse.

Overview of the Treatment Process

- Wastewater treatment is a multi-stage process that removes contaminants and produces safe effluent.
  Main stages:
- 1. Collection of wastewater
- 2. Preliminary treatment
- 3. Primary treatment
- 4. Secondary (biological) treatment
- 5. Tertiary (advanced) treatment
- 6. Sludge processing
- 7. Effluent discharge or reuse

Collection of Wastewater

- Wastewater flows through **underground pipes (sewers)** by gravity.
- In low-slope areas, **pumping stations** help lift flows.
- Proper collection prevents leakage and groundwater pollution.
- Design depends on pipe material, diameter, slope, and expected flow.

Preliminary Treatment

- Purpose: to remove large and coarse materials that could damage equipment.
  Processes:
- **Screening:** removes rags and plastics.
- **Grit removal:** eliminates sand and stones.
- **Comminutors:** grind solid particles.
  Outcome: protects pumps and ensures smooth flow to primary treatment.

Primary Treatment

- Physical clarification using **sedimentation tanks**.
- Solids settle to the bottom; oil and grease float to the top.
- Removes ≈ 60 % of suspended solids and 30 % of BOD.
- Prepares wastewater for biological treatment steps.

- **Secondary (Biological) Treatment**

Removes dissolved organic matter through microbial action.

- **Tertiary (Advanced) Treatment**

Provides additional purification beyond secondary treatment.

Processes include filtration, adsorption, ion exchange and chemical disinfection (chlorine, ozone)

- **Sludge Processing**

Sludge contains organic and inorganic solids from all treatment stages.

- **Effluent Discharge and Reuse**

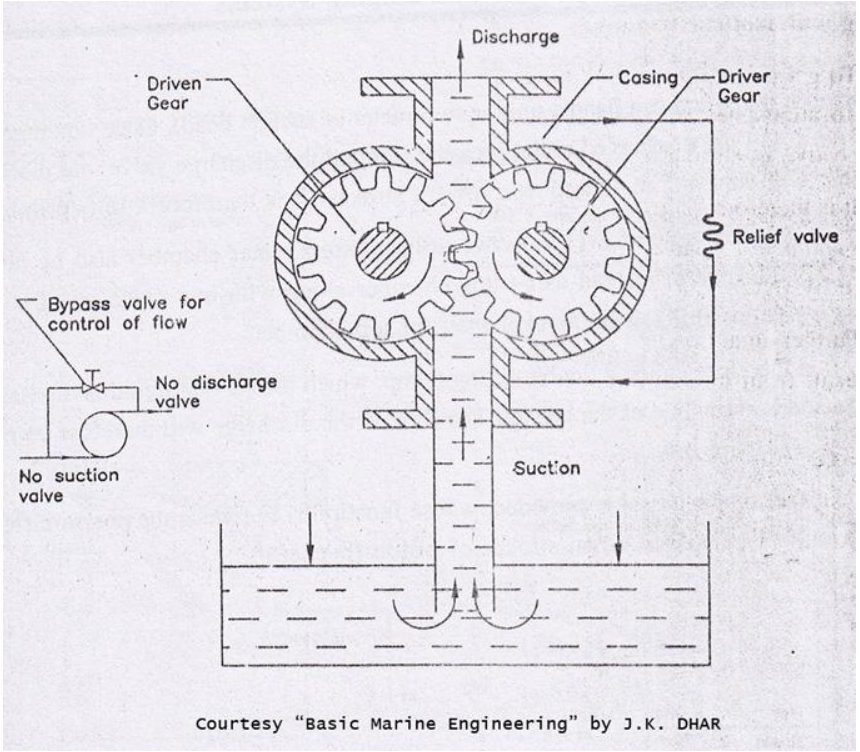
The final product of wastewater treatment is **effluent water** that meets quality standards.

Discharged to natural water bodies or reused for:

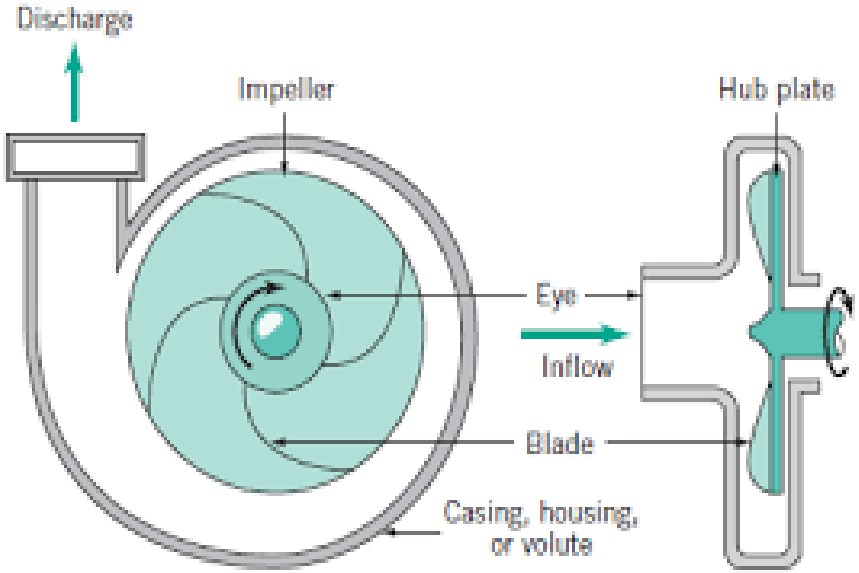
  - **Irrigation** (agricultural or landscape)
  - **Industrial process water**
  - **Groundwater recharge** (after filtration)

Types of Pumps

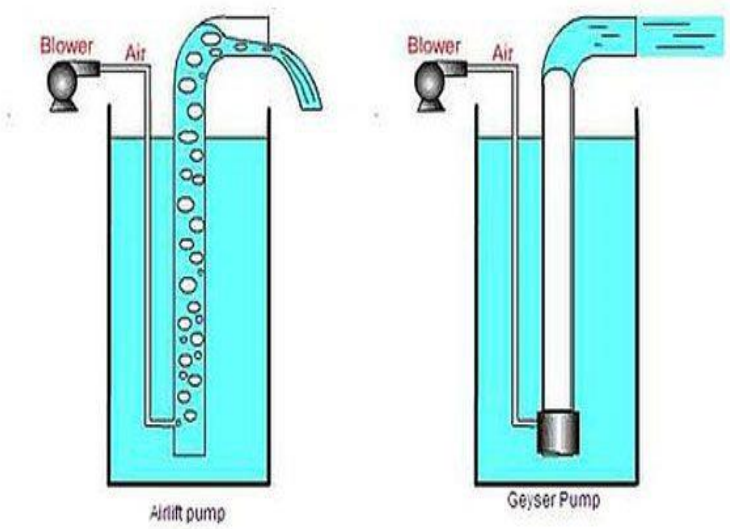
1. Displacement pumps (reciprocating, rotary)



2. Velocity pumps (centrifugal, turbine and jet pumps)



3. Buoyancy pumps (air lift pumps)



Work done by the pump

Power:

$$P_{provided} = Q \cdot \gamma \cdot H$$

$$P_{required} = \frac{2 \cdot \pi \cdot \omega \cdot T}{60}$$

- Where,
- P = power, ft-lb/sec
- Q = discharge from the pump, ft^3/sec
- γ = specific weight of the water, lb/ft^3
- H = head delivered by the pump, ft
- ω = speed of the shaft supplying power to the impeller of the pump, rpm
- T = torque provided by the shaft, ft-lb.

Data Analysis Cont'd

Efficiency : Power Provided / Power Required by the pump.

$$\eta = \frac{P_{provided}}{P_{required}}$$

where,

η = Efficiency

$P_{provided}$ = Power Provided or Water horsepower (WHP), ft-lb/sec (hp)

$P_{required}$ = Braking horsepower (BHP), ft-lb/sec (hp)

Thank you