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## Pond Design and Construction

**Course Number:** CE-02-304

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## Module 1: Introduction

### Learning Objectives

By the end of this section, you will be able to:

- **Identify** the primary functional differences between embankment and excavated ponds.
- **Evaluate** site conditions to determine the appropriate pond type based on topography and water requirements.
- **Identify** the specific height and hazard classification constraints applicable to the design criteria in this manual.

*Executive Summary:* Ponds are versatile engineering solutions for water storage. Selecting between an embankment or excavated design depends primarily on local topography and the volume of water required. Designers must adhere to strict height and safety limits to ensure project viability and public safety.

### Pond Classification and Use

The demand for reliable and economical water sources has expanded the use of ponds beyond traditional livestock and irrigation needs. Modern applications include fish production, fire protection, energy conservation, wildlife habitat, and erosion control.

### Pond Types and Selection Criteria

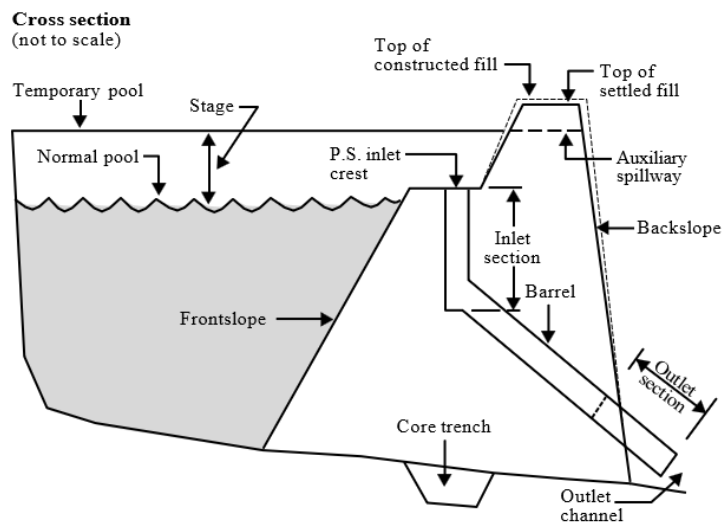
- **Embankment Ponds:** Constructed by building a dam across a stream or watercourse where the valley provides enough depression to store **5 feet or more** of water. These are suitable for terrain ranging from gentle to steep slopes.
- **Excavated Ponds:** Created by digging a pit or "dugout" in nearly level areas. These are typically used when water requirements are relatively small, as the capacity is derived almost entirely from the volume of the excavation.
- **Hybrid Designs:** In moderately sloping areas, capacity can be achieved through a combination of excavation and embankment construction.

### Design Fundamentals and Safety Limits

The engineering criteria and recommendations provided in this course are subject to specific safety and scale limitations.

⚠ **Safety Constraint:** The guidelines provided herein are strictly for dams that meet the following criteria:

- **Height:** Less than **35 feet** high.
- **Hazard Classification:** Locations where structure failure will **not** result in:
  - Loss of life.
  - Damage to homes, commercial, or industrial buildings.
  - Damage to main highways or railroads.
  - Interruption of public utilities.



**Figure 1:** Typical embankment and reservoir

### Component Fundamentals

When designing an embankment pond, several key structural elements must be integrated to manage water levels and ensure stability:

- **Normal Pool:** The water level maintained under standard conditions, typically controlled by the principal spillway (P.S.) inlet crest.
- **Temporary Pool:** The additional storage capacity used during high-flow events before water is discharged through the auxiliary spillway.
- **Core Trench:** An excavated trench backfilled with impervious material to prevent seepage under the dam.
- **Settled vs. Constructed Fill:** Designers must account for the difference between the initial height of the fill during construction and the final elevation after natural settlement occurs.



**Design Tip:** Local site-specific data is critical for successful pond development. Engineers are encouraged to collaborate with local conservation specialists and land users to verify soil suitability and hydrological data before final design.

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### *Checkpoint Quiz*

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- 1. A project site consists of nearly level terrain and requires a small, reliable water supply for local fire protection. Which pond type is most appropriate?**
- a) Embankment pond
  - b) Excavated pond
  - c) Multi-stage reservoir
  - d) High-head dam

**Answer:** (b). Excavated ponds are specifically recommended for nearly level areas where capacity is obtained by digging and water needs are smaller.

- 2. Under the scope of this technical manual, what is the maximum allowable height for a dam structure?**
- a) 15 feet
  - b) 25 feet
  - c) 35 feet
  - d) 50 feet

**Answer:** (c). The criteria in this manual are strictly for structures less than 35 feet high with low hazard potential.

- 3. Which component is specifically designed to prevent water from seeping through the foundation of an embankment?**
- a) Auxiliary spillway
  - b) Principal spillway barrel
  - c) Core trench
  - d) Backslope

**Answer:** (c). The core trench is a critical sub-surface feature used to control seepage beneath the embankment.

## Module 2: Water Needs

### Learning Objectives

By the end of this section, you will be able to:

- **Estimate** total pond storage capacity based on diverse water use requirements, including livestock, irrigation, and fire protection.
- **Determine** the compatibility of multiple-use pond objectives to ensure functional design.
- **Evaluate** structural and equipment requirements for specific pond utilities, such as dry hydrants and spray tank conveyance.

*Executive Summary:* Designing an effective pond requires a holistic assessment of all intended water uses. The capacity must account for both the volume of consumption and unavoidable losses (seepage and evaporation) while ensuring that multi-purpose goals do not conflict during peak demand seasons.

### Livestock Water Requirements

Properly distributed watering places are essential for uniform grazing. Inadequate water distribution leads to overgrazing near water sources and underutilization of distant forage, potentially causing livestock loss and soil erosion.



**Figure 2:** This pond supplies water to a stockwater trough used by cattle in nearby grazing area

## Irrigation and Agricultural Spraying

Irrigation demands the highest volume of water compared to other uses. Storage capacity must be sufficient for the entire growing season, factoring in application efficiency and rainfall.

- **Irrigation Thresholds:** Generally limited to high-value crops on small acreages (less than 50 acres).
- **Calculation Benchmark:** A 3-inch application on 1 acre requires **81,462 gallons**.
- **Field Spraying:** Requires approx. **100 gallons per acre** per application.
- **Orchard Spraying:** May require **1,000 gallons or more per acre** per application.

💡 **Design Tip:** To fill spray tanks from an embankment pond, utilize a pipe through the dam with a flexible hose at the downstream end to allow for gravity filling. Excavated ponds require a small pump for this task.



**Figure 3:** Water is pumped out of this pond for irrigation



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