

# Urban Water Management

Within the module:  
Ecology and Water Resources  
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Institut für Wasserwirtschaft,  
Hydrologie und  
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Part 2

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## Overview

### Contents today:

1. **Water distribution**
  - holding tanks
  - network topologies
  
2. **Pipe flow**
  - friction and head loss
  - equations
  - calculations

## **Water distribution**

### **Distribution network and Holding tanks**

#### **Holding tanks for**

- demand fluctuations
  - economic design of facilities
  
- supply pressure
  - pressure balance
  - surges induced by pumps
  
- fire water

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## **Water distribution**

### **Holding tanks**

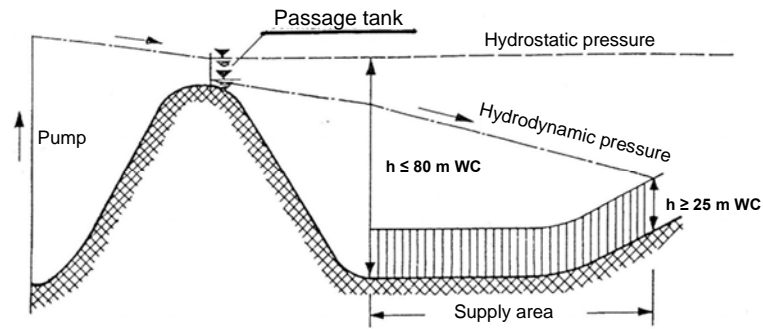
- passage tanks
  
- balance tanks
  
- zone tanks

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## Water distribution

### Holding tanks

- passage tank

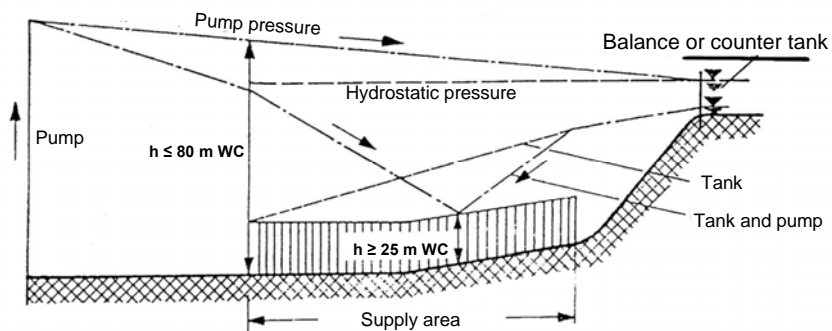


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## Water distribution

### Holding tanks

- balance tank

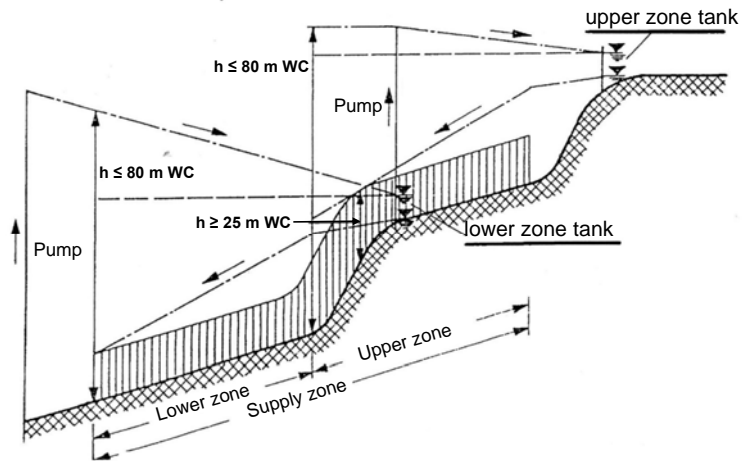


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## Water distribution

### Holding tanks

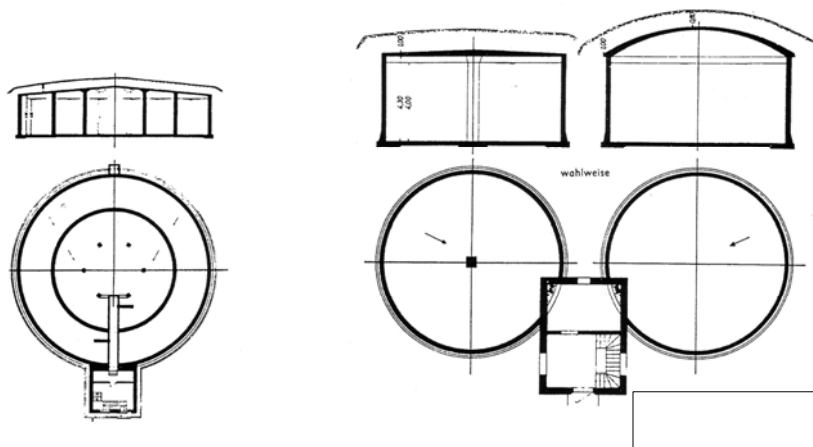
- zone tanks



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## Water distribution

### Tank types



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## Water distribution

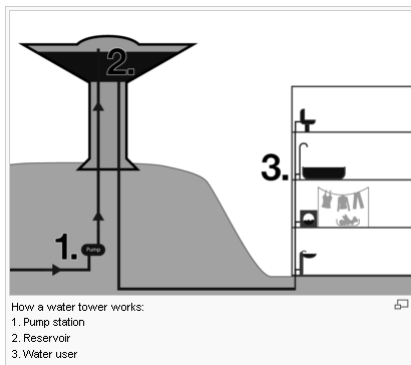
### Water towers



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## Water distribution

### Water towers



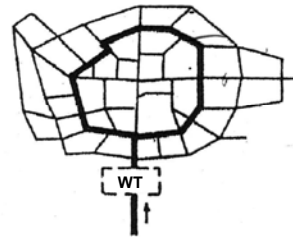
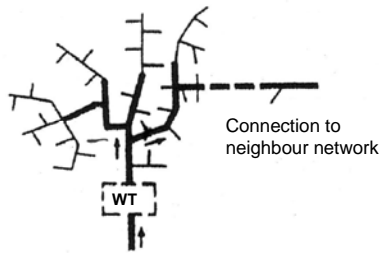
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## Water distribution

### Network topologies

● Branch

● Meshed loop



— Transport and main lines  
 — Supply lines

WT = Water Tank

## Pipe flow

**Velocity:**

$$v = \sqrt{\frac{1}{f} \cdot 2g \cdot D \cdot \frac{\Delta h}{\Delta L}}$$

$f$  = friction factor    $D$  = diameter    $L$  = length  
 $h$  = head (geodetic plus velocity head)  
 $v$  = velocity

**Darcy-Weisbach:**

$$h = f \cdot \frac{L}{D} \cdot \frac{v^2}{2g}$$

**Prandtl-Colebrook:**

$$\frac{1}{\sqrt{f}} = -2 \log_{10} \left( \frac{\varepsilon}{3,71 \cdot D} + \frac{2,51}{\text{Re} \sqrt{f}} \right)$$

$\varepsilon$  = roughness height  
 $\text{Re}$  = Reynolds number  
 $\nu$  = kinematic viscosity

$$\text{Re} = v \cdot \frac{D}{\nu}$$

# Pipe flow

## Practical use

### Roughness height (in m):

Drawn tubing, plastic, glass	0,002 .... 0,005 mm
Smooth Metallic pipes	0,1 .... 0,3 mm
Rusted steel	0,5 .... 1 mm
Incrusted pipes	1 .... 5 mm

### Velocity:

$$v = \frac{Q}{A} = \frac{Q}{\pi \cdot (D/2)^2} = \frac{4 \cdot Q}{\pi \cdot D^2}$$

$v$  should be 1 .. 2 m/s,  
 → dissolve for D with given Q

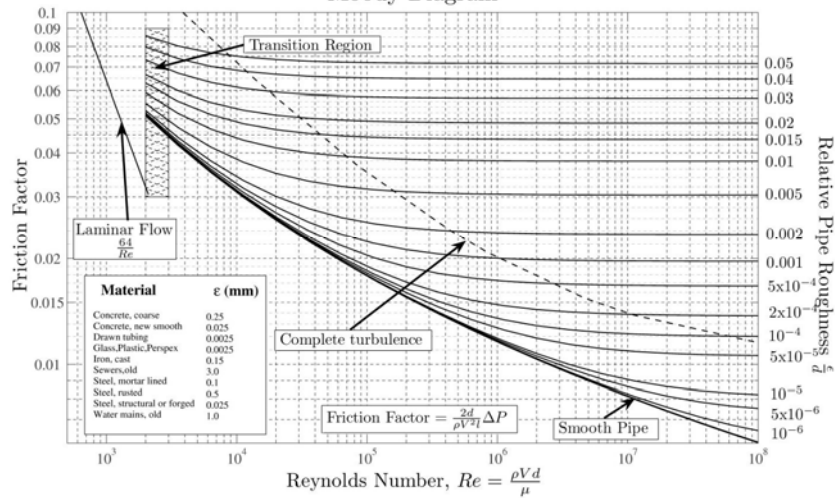
### Compute Reynolds number

Friction factor: ????

# Pipe flow

## Solving the Prandtl-Colebrook equation:

Moody Diagram



## Pipe flow

### Practical use

**Roughness height (in m):**

Smooth Metallic pipes	0,1 .... 0,3 mm
Rivetted pipes	0,5 .... 1 mm
Incrusted pipes	5 .... 10 mm

**Velocity:**

$$v = \frac{Q}{A} = \frac{Q}{\pi \cdot (D/2)^2} = \frac{4 \cdot Q}{\pi \cdot D^2}$$

$v$  should be 1 .. 2 m/s,  
→ dissolve for  $D$  with given  $Q$

**Compute Reynolds number**

**Friction factor: from Moody diagram**

**Compute head loss:**

$$h = f \cdot \frac{L}{D} \cdot \frac{v^2}{2g}$$

## Pipe flow

### Practical use: an example