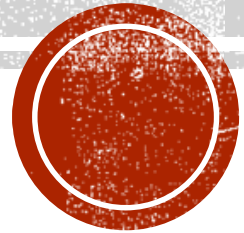
WATER TREATMENT



WATER

- 80% of US population drink publicly supplied water
- Tap water is -
  1. Available
  2. Safe

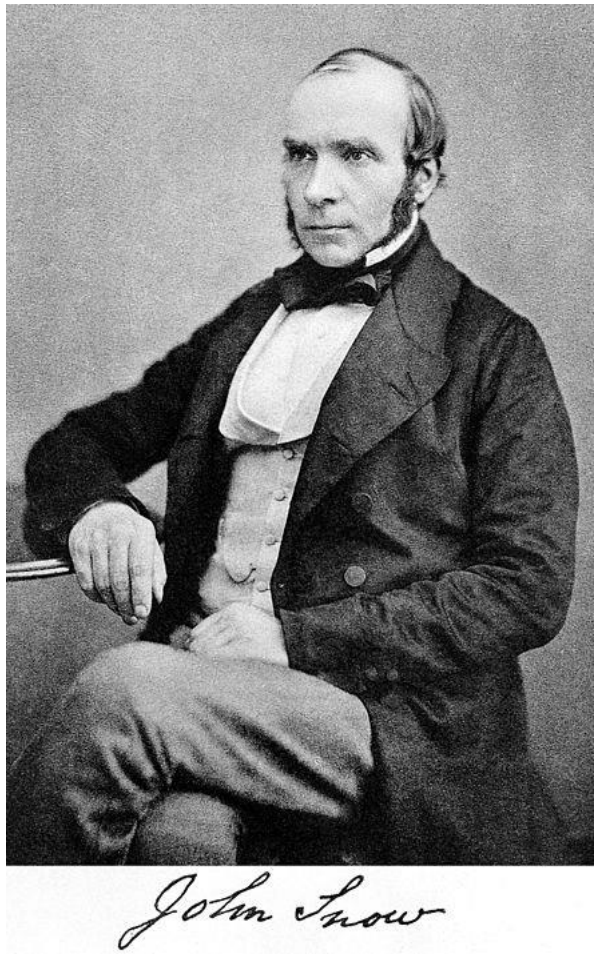
- A child died every 15 seconds due to water borne illness
- 17% do not have access to drinking water

JOHN SNOW

Snow was born on 15 March 1813 in York, England.

His father was a laborer who worked at a local coal yard

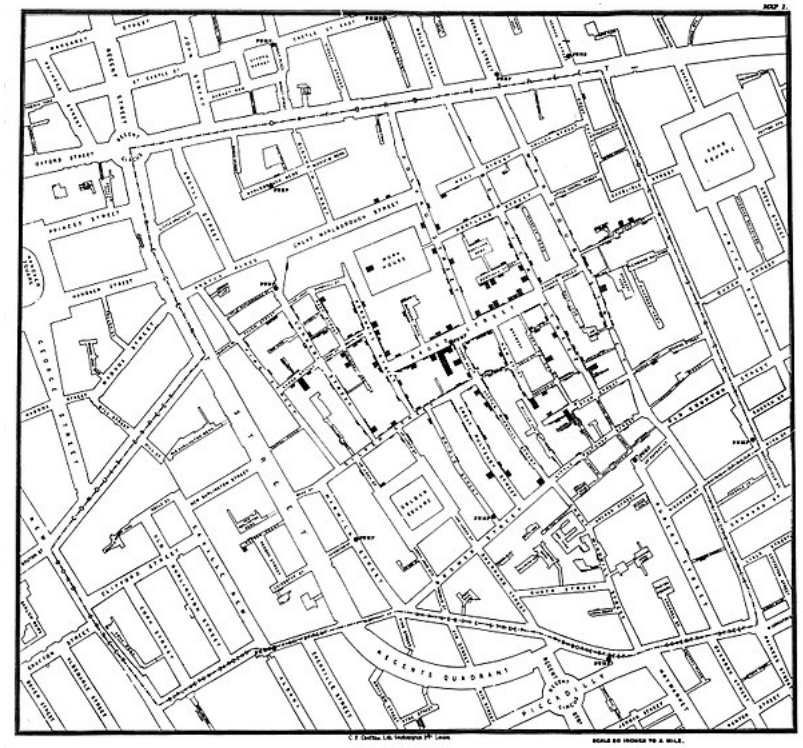
Studied in University of London.

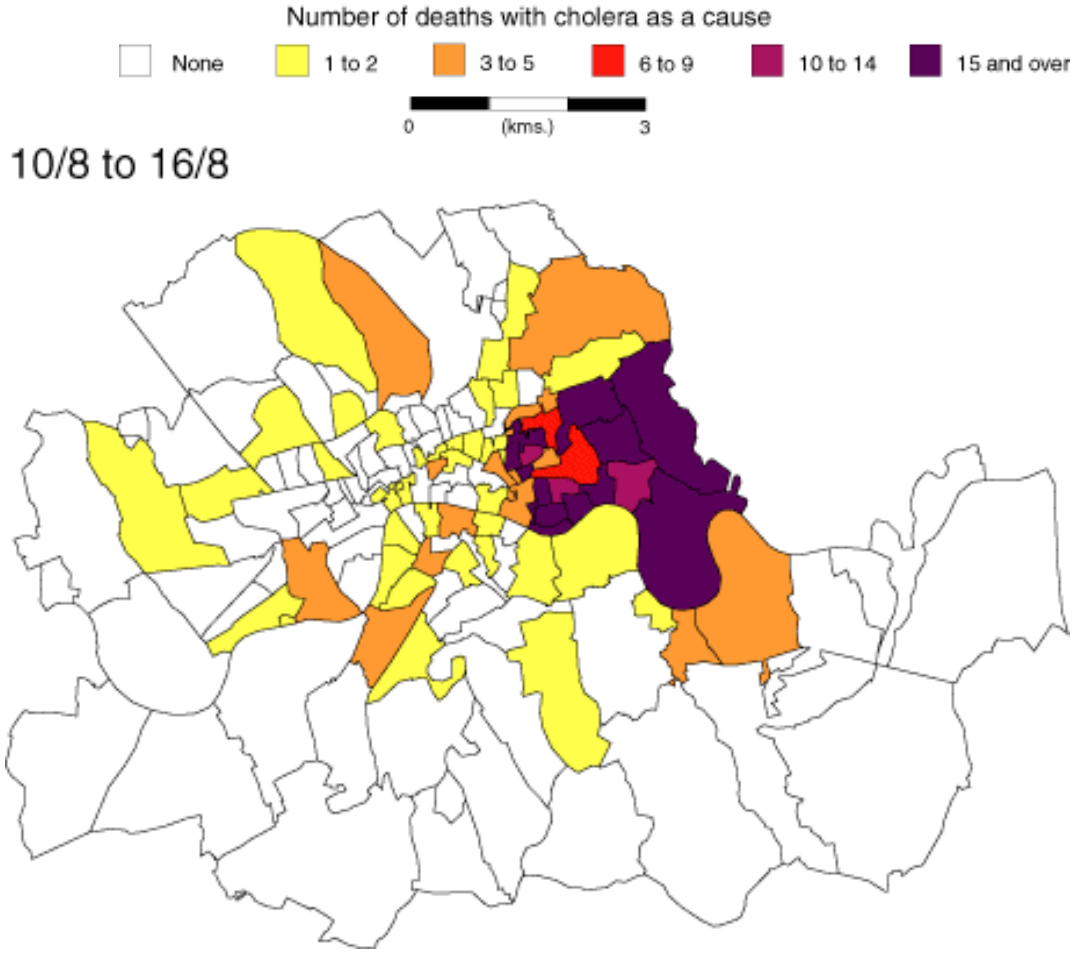


CHOLERA OUTBREAK IN LONDON

Sceptic of the theory that bad air caused diseases

Identified the source of disease by identifying the drinking water source





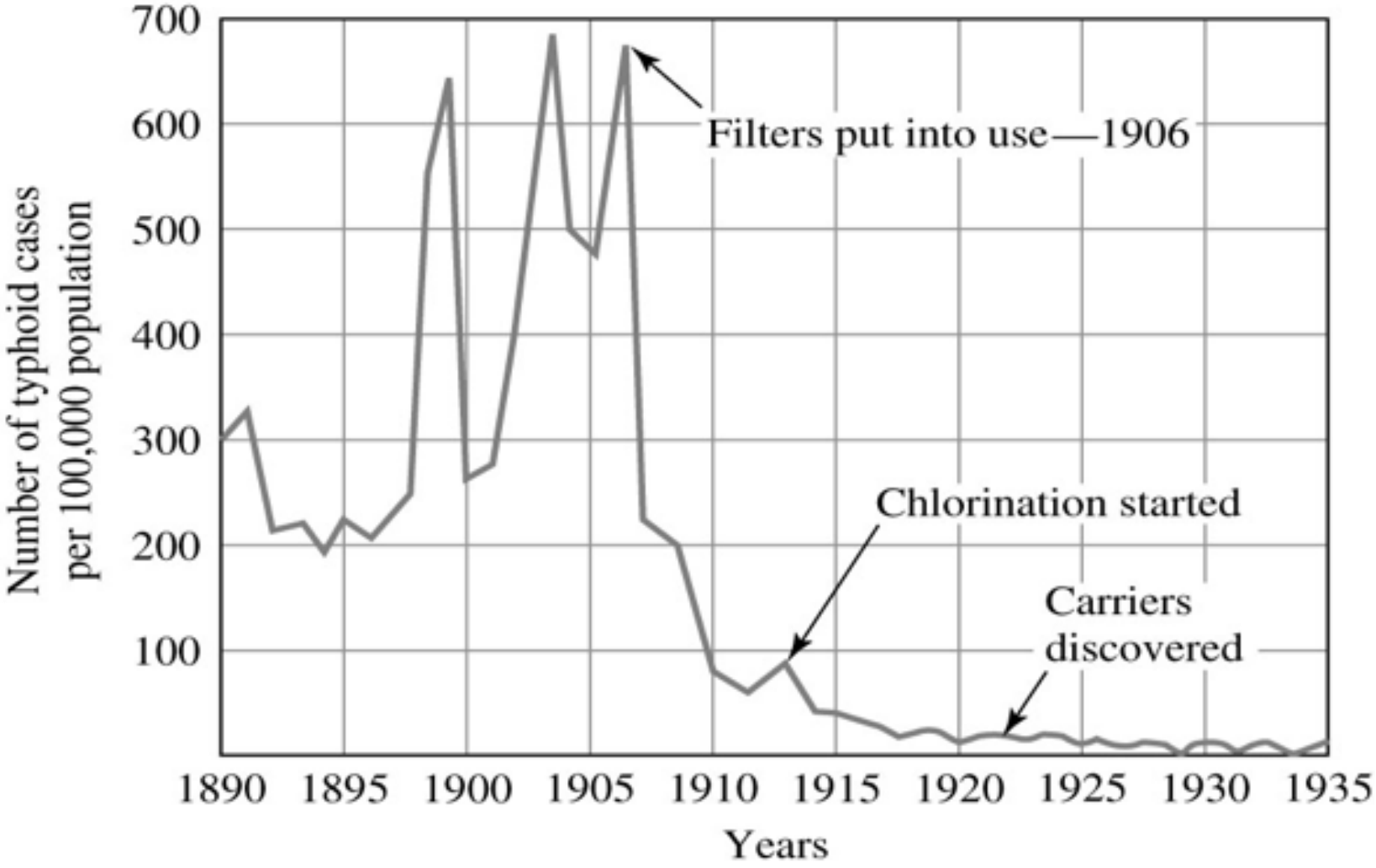


Fig 4-1: Typhoid fever cases per 100,000 population from 1890 to 1935, Philadelphia

DEFINITIONS

- **Public water system** - provides water for human consumption through water distribution network to 15 connections or at least 25 people for at least 60 days a year
  - Community water system (same population year around)
  - Non-transient community water system (schools, factories, offices, hospitals)
  - Transient non-community water system (gas station or campgrounds)
- **Potable water** - Water for consumption
- **Palatable water** - Water that tastes good

CONTAMINATION

- Presence of foreign substances that lower the quality of drinking water or constitute health hazard
- Dissolves pollutants as the surface water travels through different terrains
- Groundwater has more dissolved minerals but sand acts as a natural filter so
- *In general*, surface water is more polluted than groundwater

DRINKING WATER QUALITY

- Four categories
  - Physical - Color, Taste, Odor, Temperature, Clarity
  - Chemical
  - Microbiological
  - Radiological

CHEMICAL

- **Chloride** - Limited to 100 mg/L
- **Fluoride** - Dental caries below optimum level. Fluorosis above optimal level
- **Lead** - Accumulation is cumulative
- **Sodium** - affects people suffering from heart, kidney or circulatory ailments
- **Arsenic** - Known carcinogen. Used in pesticides
- Toxic heavy metals - As, Ba, Cd, Cr, Pb, Hg, Se, Ag
- More than 120 toxic organic compounds

MICROBIAL

- Water must be free of pathogens
- Coliform groups - *E.Coli* and *Aerobacter aerogenes*
- Total coliform test to identify these organisms
- Shows fecal contamination of water
- Survive in water but do not reproduce
- Easy to perform a test in the lab

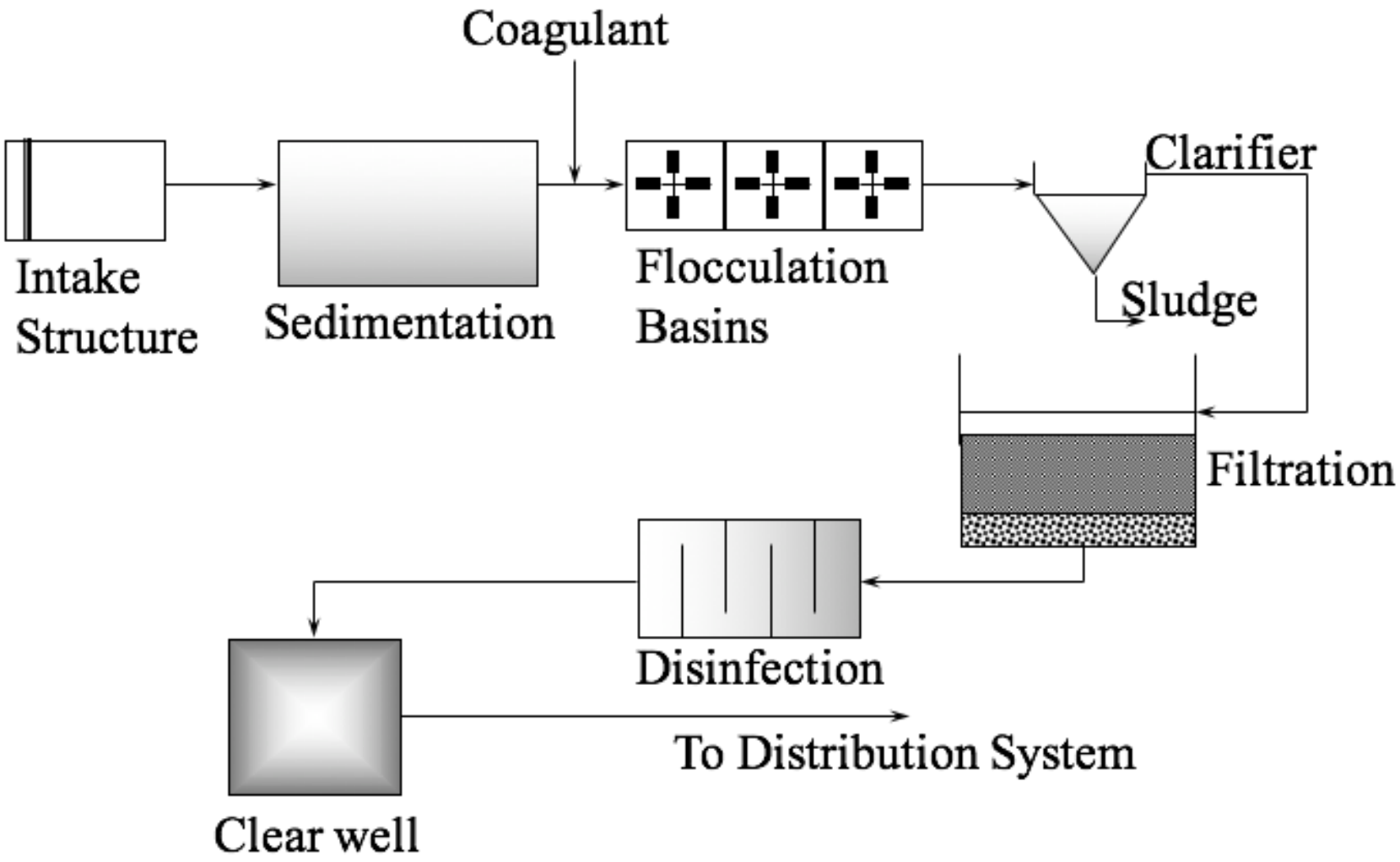
WATER QUALITY STANDARDS

- In 2000, a total of 91 contaminants are regulated by US EPA
- MCL - Maximum Contaminant Level
- MCLG - Maximum Contaminant Level Goals
- MCLG is lower than MCL

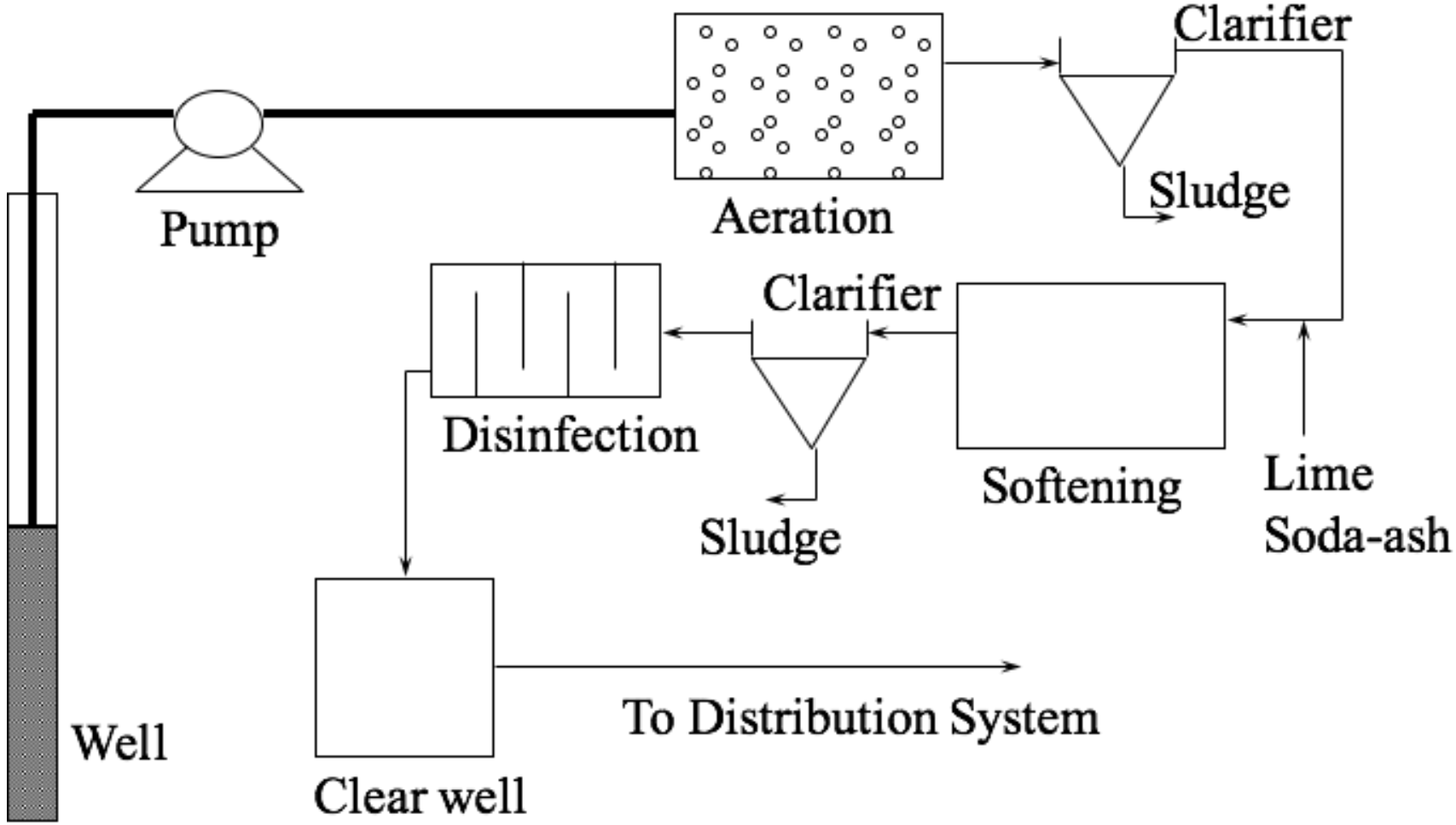
WATER TREATMENT

- Surface water and groundwater under direct influence of surface water should undergo specific treatment technique - filtration and/or disinfection
- Turbidity - 0.3 NTU for 95% of samples (clarity)
- Disinfection - 99.99% removal of viruses
- Total Coliform - 5% positive samples in 40 samples per month

Surface Water Treatment Plant



Ground Water Treatment Plant



WASTEWATER TREATMENT

WHAT IS WASTEWATER

DOMESTIC WASTEWATER

GREYWATER

BLACKWATER

WHAT IS WASTEWATER

INDUSTRIAL WASTEWATER

Textile Industry

Chemicals

Some of the industries that also contribute include:

Food processing, metal industry, automobile industry, pharmaceutical industry etc.,

Industries are regulated for the type of chemicals they are allowed to dispose into surface water (Clean Water Act)

SOURCES OF WASTEWATER

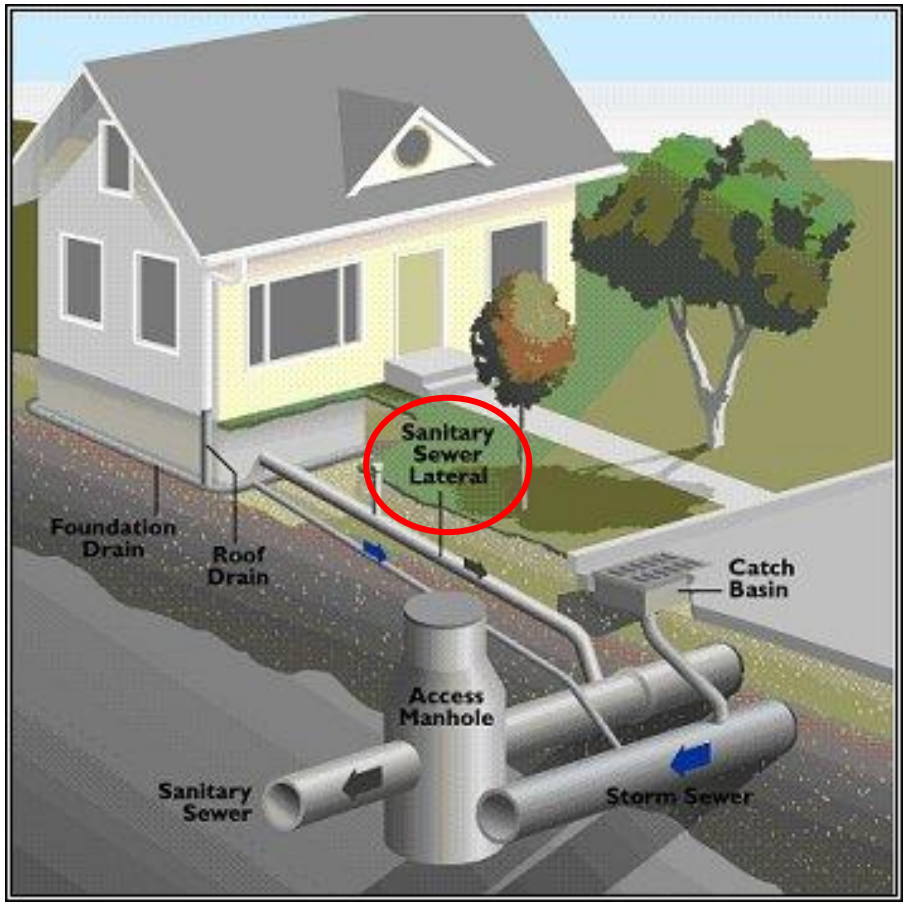
Domestic

Industrial/Commerical

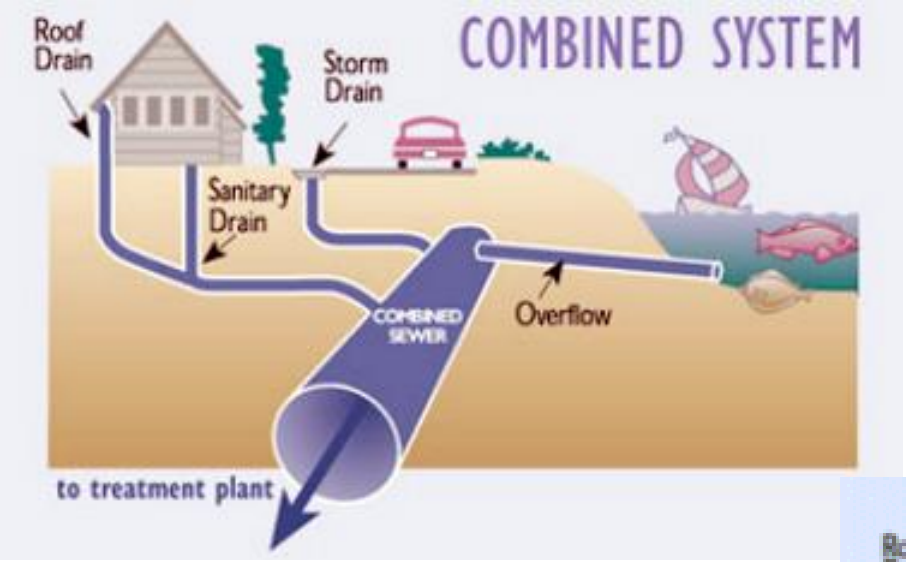
Stormwater runoff

WASTEWATER COLLECTION

- On-site collection (septic tanks)
- Municipal sewage collection
  - Separate sewer
  - Combined sewer
  - Partially combined

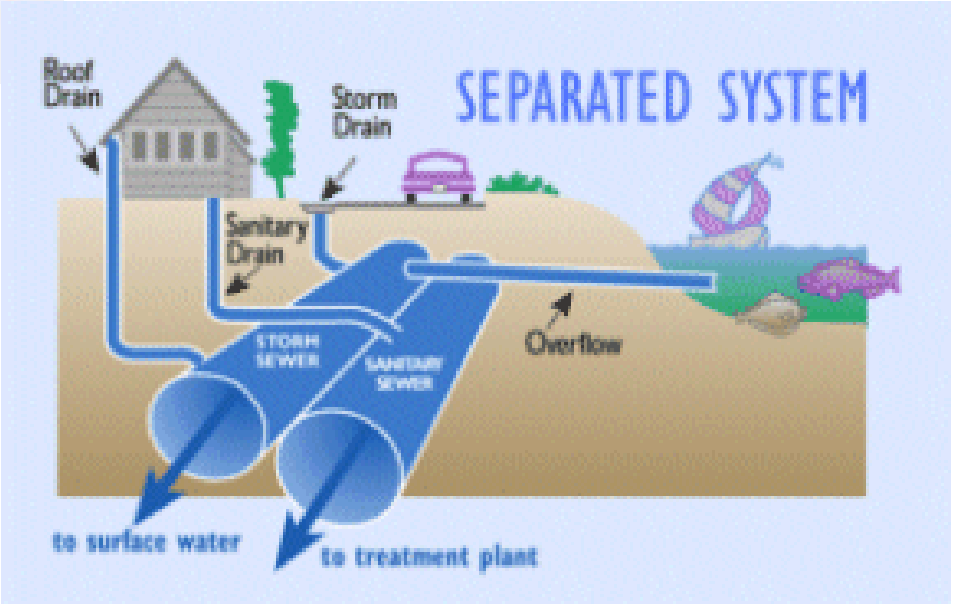


WASTEWATER COLLECTION



Stormwater & Wastewater are connected to the same system.

Stormwater & Wastewater are separate. Storm water drains to surface water and wastewater goes to the treatment plant

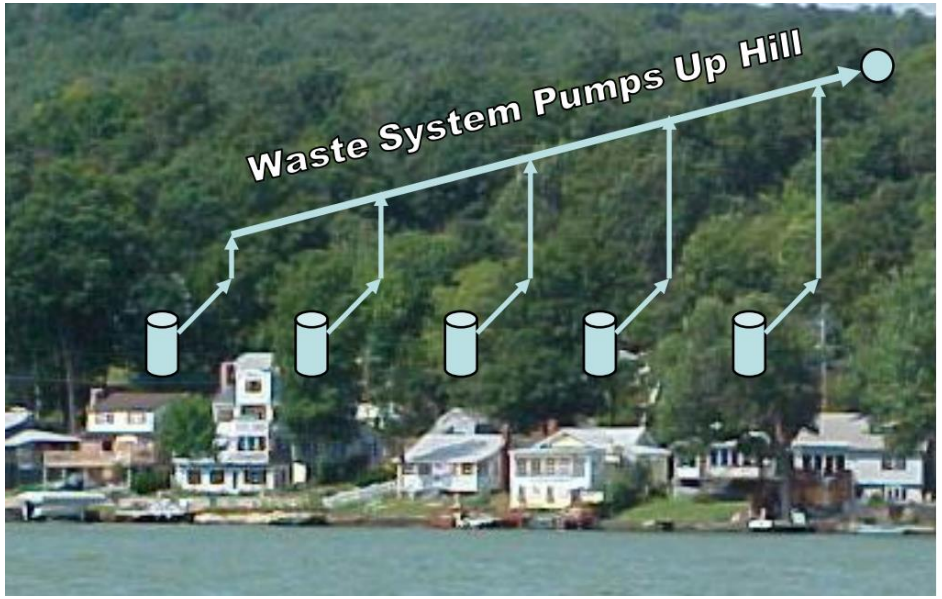


TYPES OF SEWERS

- Gravity – Water moves through the pipes by gravity (most commonly used)

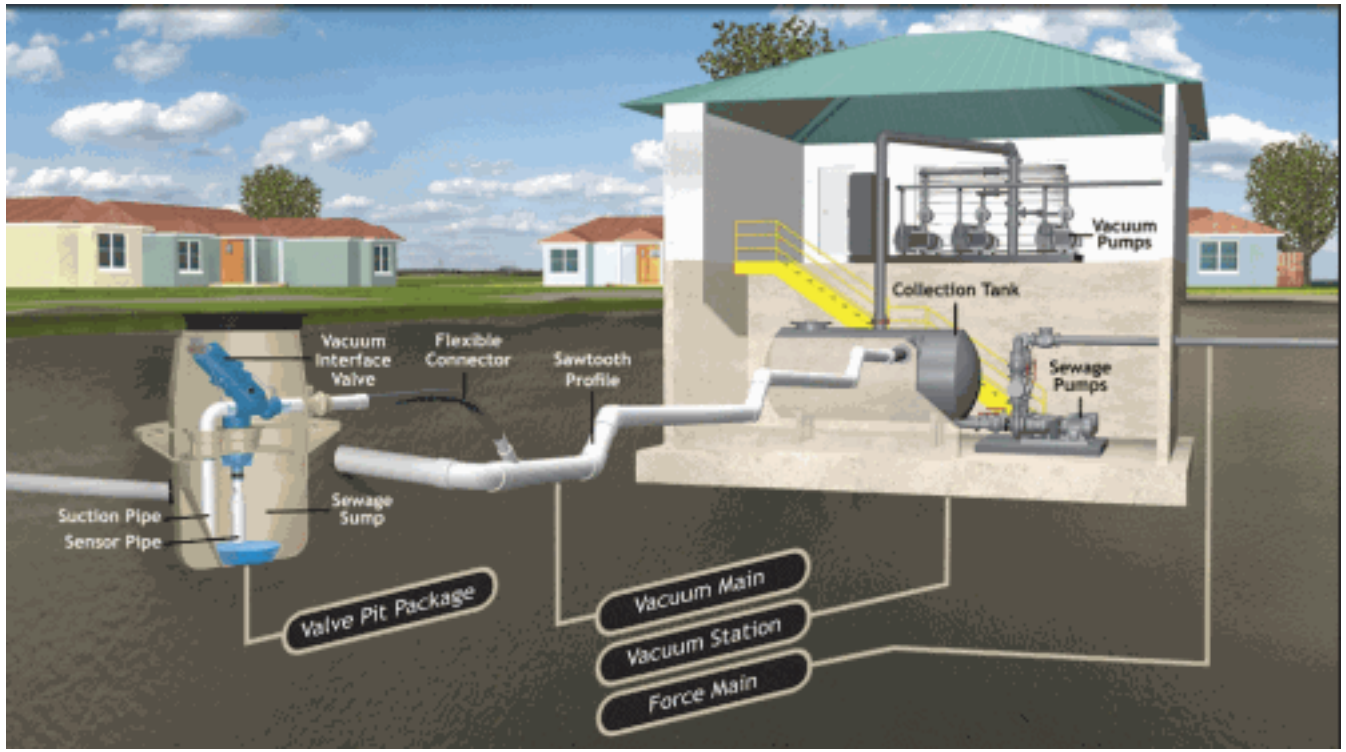
- Low pressure – Useful where gravity sewers may be impractical.
  - Wastewater is grinded to slurry before moving
  - Does not require big pipes to move water

  - Can be used in areas with shallow water tables, hilly terrain etc

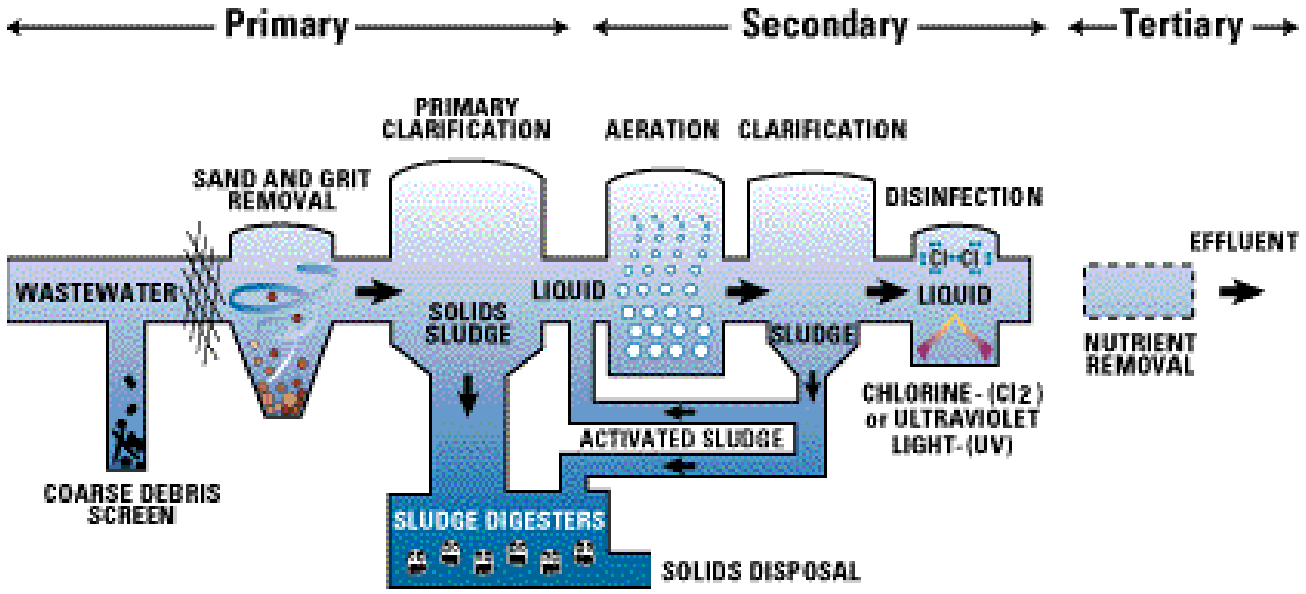


VACUUM SEWERS

- Useful to convert on-site sewage collection to central collection with minimal disruption
- Less water required to transport
- Expensive and expert design is required
- High energy required to create permanent vacuum



WASTEWATER TREATMENT



- Primary Treatment – Removal of solids
- Secondary Treatment – Removal of organics
- Tertiary – Removal of nutrients

SECONDARY TREATMENT

- Biological processes to remove organic material (hydrocarbons)
- Bacteria uses oxygen to consume the suspended organic waste in the water
- Water is aerated to provide bacteria with sufficient oxygen to continue feeding on the bacteria
- Organic waste is represented as biological oxygen demand (BOD)

WATER QUALITY VS WASTEWATER

Water Treatment

- Treating surface water or groundwater for drinking
- Water quality focuses on removal of suspended solids for surface water
- Removal of hardness in groundwater
- Secondary parameters include
  - Turbidity
  - Color
  - Dissolved oxygen
  - pH

Wastewater Treatment

- Focus is on the removal of organic material (also called BOD)
- Wastewater quality also focuses on nutrient concentration such Nitrate and Phosphate in effluent
- Effluent is typically discharged into surface water

THINGS TO REMEMBER!!

- What is in your wastewater depends on the source
- Collection method depends on the topography and economics
- Energy is required for collection and treatment
- Moving wastewater farther requires more energy
- Increasing energy means increasing cost
- Access to clean water impacts the health and well-being of the people in the community

LOW COST WASTEWATER TREATMENT

- To make wastewater treatment accessible to underdeveloped communities

  - What are some of the strategies?
    - Reduce energy in collection
    - Reduce energy in treatment
    - A lot of energy is expended in providing oxygen for the bacteria

  - Examples of low cost treatment methods
    - Water Stabilization Ponds
    - Constructed Wetlands

WASTE STABILIZATION PONDS

- Three different interconnected ponds
- First pond settles the solids to the bottom
- Second pond digests the organic material using the oxygen from algae
- Third pond for stabilization and removal of pathogens using heat

WASTE STABILIZATION PONDS

Advantages

- Resistant to organic and hydraulic shock loads
- High reduction of solids, BOD and pathogens
- High nutrient removal if combined with aquaculture
- Low operating cost
- No electrical energy required
- Can be built and repaired with locally available materials
- Effluent can be reused in aquaculture or for irrigation in agriculture

WASTE STABILIZATION PONDS

Disadvantages

- Requires large land area
- High capital cost depending on the price of land
- Requires expert design and construction
- Cleaning the pond (normally every few years)
- Mosquito control required
- If the effluent is reused, salinity needs to be monitored
- Not always appropriate for colder climates

CONSTRUCTED WETLANDS

- Widely accepted as an accepted method of treating wastewater
- Cheaper than conventional wastewater treatment plants
- Useful in developing nations in tropics due to the high rate of plant growth

CONSTRUCTED WETLANDS

Advantages

- Construction can provide jobs
- Utilizes natural processes
- Electricity is only required for pumps

Disadvantages

- Consumes a lot of space
- Moderate capital cost depending on price of land
- Not useful in cold climates

SAN DIEGO: WASTEWATER TREATMENT