Treatment of Public Water Supplies

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WQ Parameters Already Discussed

Receiving waters:
- TSS
- BOD
- Nutrients
- Toxics
- "Emerging Contaminants"
- Temperature

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WATER SUPPLY QUALITY (PUBLIC DRINKING WATER)

- Pathogens (disease-causing organisms)
- Turbidity (cloudiness)
- Toxics
- Nuisance components (Fe, Mn, hardness)
- Nutritional additives (fluoride)

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Three Lectures:

Today: Overview of historical and contemporary supply and treatment infrastructure.

- Wednesday: Focus on legal requirements for pathogen removal in public water supplies; disnfection methodologies.
- Next Monday: Engineered solutions to meet federal and state public health standards

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London, 1850s

Much of the developing world today
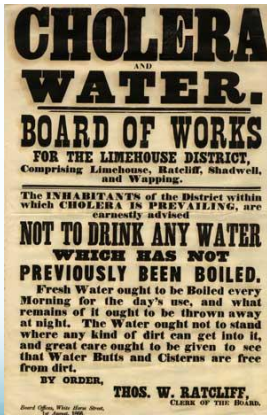
London

Tokyo

World's Largest: Jardine WTP Chicago

Jardine WTP
~ 1 billion gal/day

5 Million Customers

Lake Michigan Intake

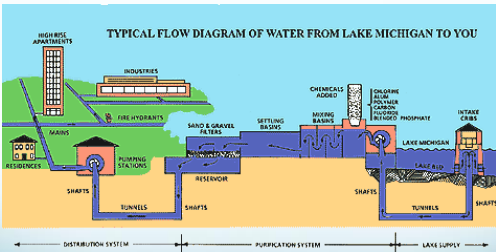

Carter-Harrison and Dever Intake Cribs

Inside The Carter-Harrison Crib

7-hour Treatment Process

A Quick 5000-year Look at Water Supply and Treatment

Nippur, Sumeria 5000 Yrs BP

Wells
Cisterns

Supply culverts
Wastewater drains

archaeologyillustrated.com

India 4000 yrs BP

- Water purification described in Sanskrit Texts
  - Boiling in copper vessels
  - Exposure to sunlight
  - Filtering through charcoal
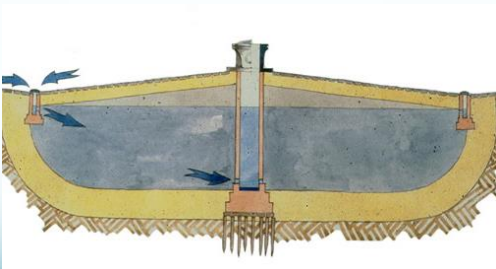
Roman Aqueducts
Still in Use!

Venice, 5th-16th c.:
Rainwater/Well/Filters

Well in Campo S. Maria Formosa

Venetian Plaza
Filtration Well

Municipal Filtered Water

- 1804 Paisley, Scotland
  - Via wagon tanks

- 1807 Glasgow, Scotland
  - Piped in

- 1850s UK, France
  - Modern rapid sand filters
  - Henry Darcy and the fountains of Dijon

Dr. John Snow
Cholera Epidemic
London, 1854

The Broad Street Well

The Modern Era: 20th-21st c.

- Chemical disinfection
  - Chlorination
    - Maidstone, England 1897
    - Jersey City, NJ, 1908

  - Ozonation

- Advanced filtration systems

- Ultraviolet light (UV) disinfection

Safe Drinking Water Act (SDWA, 1974)

- Defines a **public water system (PWS)** as one that serves piped water to
  - at least 25 persons or
  - 15 service connections
  - for at least 60 days each year.

  - There are approximately 161,000 public water systems in the US. ~270,000,000 users.

  - Such systems may be publicly or privately owned.

Pathogens in Water

- Viruses
  - Poliovirus, viral gastroenteritis, hepatitis A

- Bacteria
  - *E. coli, Vibrio cholerae, Shigella spp.*

- Protozoans
  - *Entamoeba histolytica*
  - *Giardia lamblia*
  - *Cryptosporidium parvum* →
    - *Oocysts:*
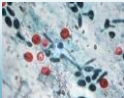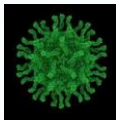
Cryptosporidium Outbreaks

Year	Location	Reported Cases	Reported Deaths
1984	Braun Station, TX	2,000	
1987	Carrollton, GA	13,000	
1989	Thames River area, UK	100,000	
1992	Jackson County, Oregon	15,000	
1993	Milwaukee, Wisconsin	403,000	100
1994	Las Vegas, NV	78	16

Chlorine Residual

A powerful safety measure to have disinfecting capability *in* the system

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Dateline News: Pineville, LA.
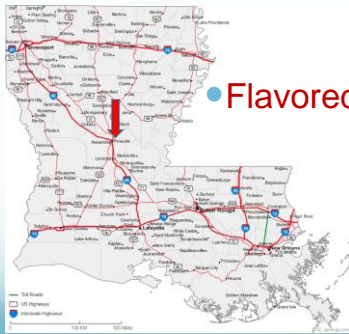
- Flavored water??

But residual chlorine

does not ALWAYS work

CDC Warns Of Swimming Pool Parasite Cryptosporidium

- Cryptosporidium can survive for 10 days or more in chlorine-treated water

Dateline: Portland, OR

Parasite in Pool Infects 51 People at Summer Party

An outbreak of cryptosporidiosis in Sellwood continues to affect a number of children and adults

Oregonian

Friday, September 25, 1998

Highlights of the SDWA

Authorizes EPA to set enforceable health standards for contaminants

- MCL = Maximum contaminant level
- MCLG = Maximum contaminant level GOAL
- TT = Specified Treatment Technology

Examples of Pathogen Regs

- Coliforms: MCLG = 0
  - MCL = <5% "+" tests/month for *total* coliforms
  - Advanced test for *fecal* coliforms = 0

- Giardia & Cryptosporidium: MCLG = 0
  - TT: Filtration or UV to achieve log-3 removal (99.9%)

Other Highlights of the SDWA

- Requires public notification of water system violations & annual reports to consumers
- Establishes federal-state partnership for regulation, enforcement

Highlights of the SDWA

- Provisions specifically designed to protect underground sources of drinking water

- Requires disinfection *and* filtration of surface water supplies…
  - Except those with pristine, protected sources (hello Portland)

- Establishes a multi-billion-dollar state revolving loan fund for water system upgrades

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Bottom Line for US Designers

- *Must* chlorinate water

- *Must* reduce pathogens by 99.9% ("log-3 removal")

- For *surface water sources m*ust have technology to remove or destroy certain protozoa pathogens. Typically means filtration. UV is the alternative (e.g., Seattle)

-- OR—

- Must have a specially protected supply watershed

- Post-treatment storage reservoirs must be covered

Flowchart:
- Water Samples: Test for *E. Coli*
  - System with Filtration
    - Low coliforms → Basic disinfection (chlorination only)
    - High coliforms → Crypto analysis
  - Unfiltered System → Crypto analysis
    - Crypto analysis → Low Crypto count
    - Crypto analysis → High Crypto count → Design/implement additional treatment