People Caring About Water

2019 Northeast Onsite Wastewater Short Course

April 2-4, 2019
Mystic Marriott Hotel
Groton, Connecticut

A to Z Wastewater Characteristics

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NOWRA
National Onsite Wastewater Recycling Association

Objectives

- Understand the sources and flows of wastewater in a home = Quantity
- Understand the different constituents in wastewater = Quality
- Understand treatment of wastewater from a physical and biological perspective
- Be able to apply this knowledge in the field

Typical Water Use

- Regulations say 100 - 150 gallons per day per bedroom
  - Assumes 2 people per bedroom
- 50-75 gallons/person/day
- Annual estimates of use
  - Per person per year = 28,000 gal = 76 gpd
  - Typical home ~ 3 persons = 84,000 gal/yr

Residential Wastewater Flows

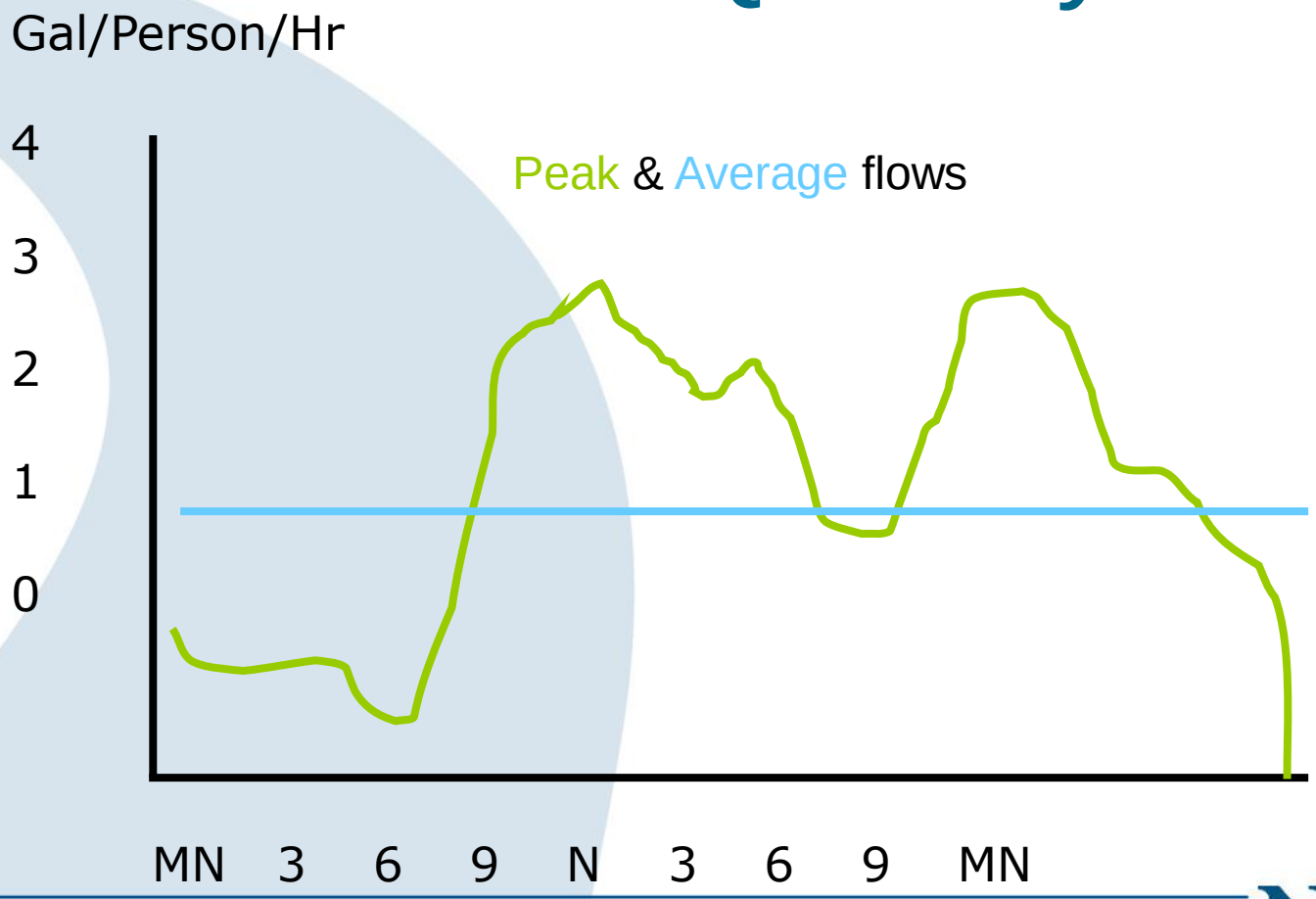
Study (gal/pers/day)	No. Residences	Duration (months)	Average (gal/pers/day)	Range
Brown & Caldwell (1984)	210		66.2 [a]	57.3 – 73.0
Anderson & Siegrist (1989)	90	3	70.8	65.9 – 75.6
Anderson, et al. (1983)	25	2	50.7	26.1 – 85.2
Mayer et al. (1999)	1188	1[b]	69.3	57.1 – 83.5
Weighted Ave.	153		68.6	

Table 3-1 pg, 3-3 in US EPA Manual, 2002

[a]Based on indoor water use monitoring and not wastewater flow monitoring

[b]Based on two weeks of continuous monitoring in each of two seasons at each home

WW Quantity



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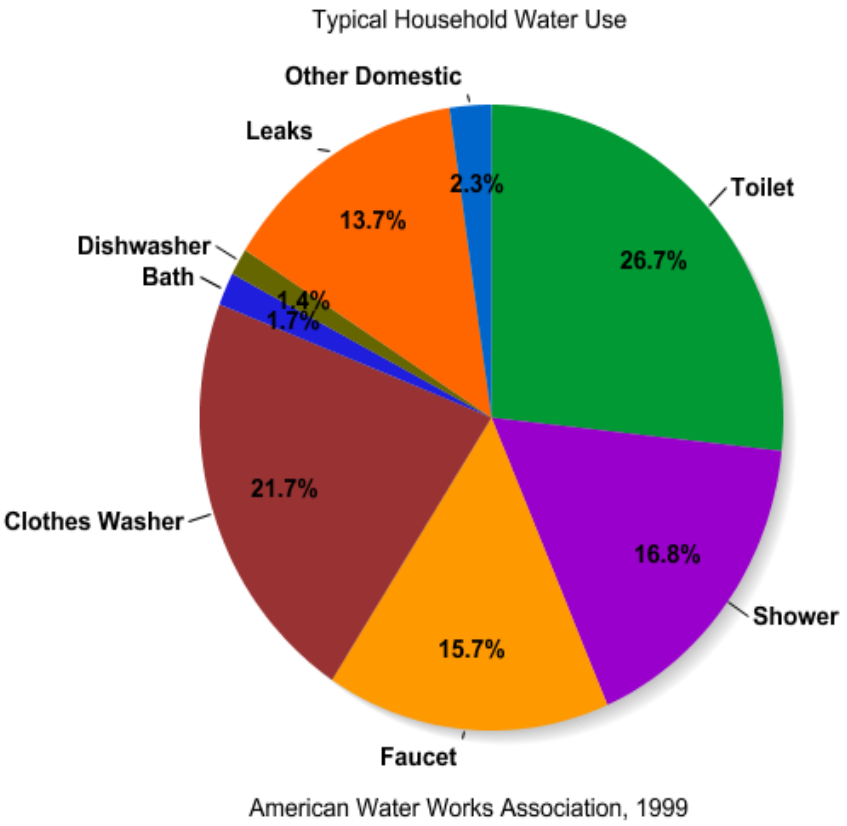
Wastewater

- Quantity or flow rate
  - Design for peak flows
    - EPA estimates 70 gal/person/day
    - EPA has charts for businesses
  - Measure if possible
    - Failures often due to hydraulic overload
    - Install water meter or pump meter

Where Does it Come From?

- Water use:
  - Bathroom ~ 64%
    - Toilet = 27%
    - Bathing = 19%
    - Faucets = 8%
  - Laundry = 22%
  - Kitchen = 10%
  - Leaks = 14%



Bathroom 64%

- Only urine, feces, soap, toilet paper and limited amounts of cleaner should be going down drain
- No wipes, feminine products, prophylactics, cigarette butts, etc
- No every flush toilet bowl sanitizers or every shower cleaner

Bathroom Continued

- Old used 5 gallons per flush
- Almost all new toilets are 1.6 gallons per flush or less
- Newest toilets have choice of flush for #1 (half flush) or #2 (full flush)
- Overall water usage may not have changed a lot as people bathe and wash hands more

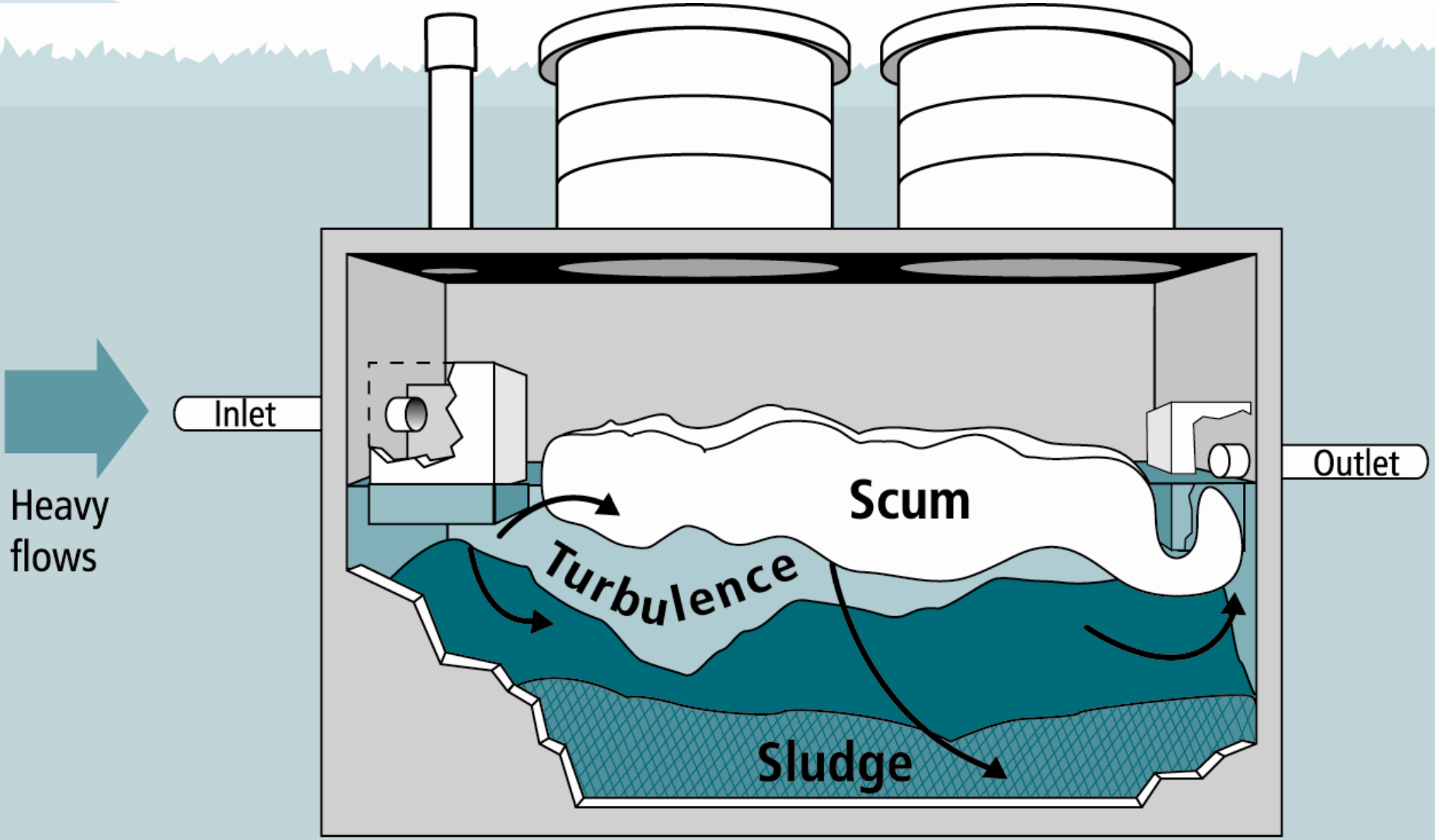
No Flow Toilets

- Composting, electric/incinerating, chemical toilets
- Different management of black water
  - Majority of nitrogen removed
- Grey water system can be reduced in size

Laundry 22%

- Consider adding a lint filter
- Loads should be spread out

TURBULENCE FROM HEAVY USAGE



Detergents and Bleaches

- Use high quality
- More is not better
- Powdered
  - Careful of cheap products:
    - Inorganic materials and clay as fillers
    - Add fine particles
- Liquid
  - Filler is typically water
- Do NOT use liquid fabric softeners

Kitchen 10%

- A full dishwasher uses less water than washing dishes by hand
- Some dishwashers have garbage disposals built in
- Fat, oils and grease should poured down drain

Garbage Disposal

- Adds more solids
- Undigested food chopped into small pieces increases the load on a system
- More water use
- Increases the need for maintenance and care of the system.
- Recommendation:
  - Don’t install one
  - Don’t use it if you have one

Estimating Water Use

- Bedrooms
- Unfinished space
- High water using devices
- Multi-generation families
- Home based business

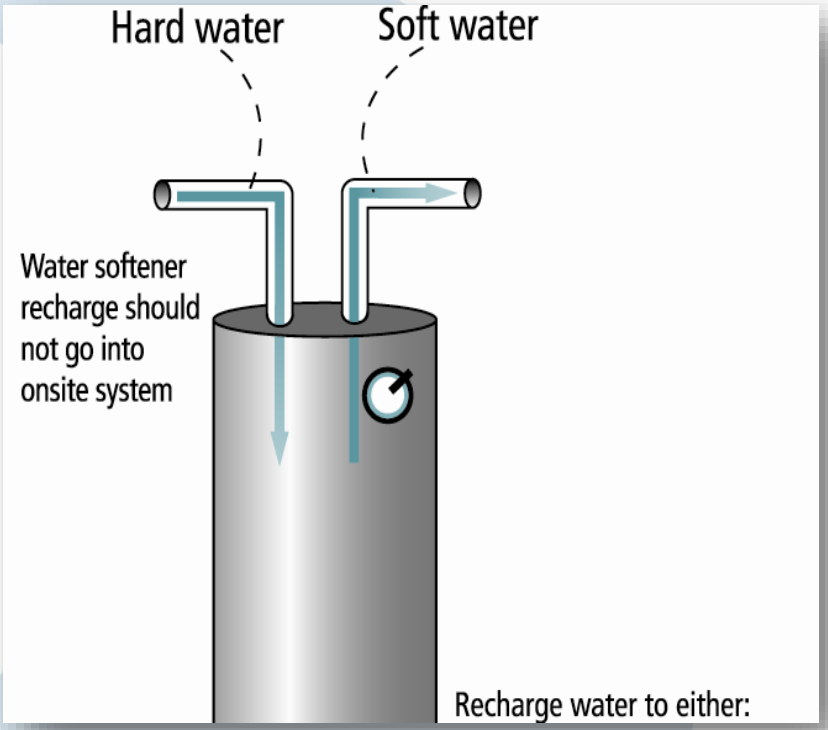
Measuring Actual Flows

- Methods
  - Meter
  - Pump
- Units
  - Gallons
  - Cubic feet
  - 7.5 gallons in 1 cubic foot

What is NOT Part of the Flow

- Clear water
  - Rain water/sump pump discharge
  - Water softener recharge water or other water treatment device
  - Treated water (hot tubs and pools)
- What to do with it?
  - On surface or below surface in separate trench
  - Do not put on neighbors property or into lake, river or stream
  - Recommended setback from wells is 20 ft

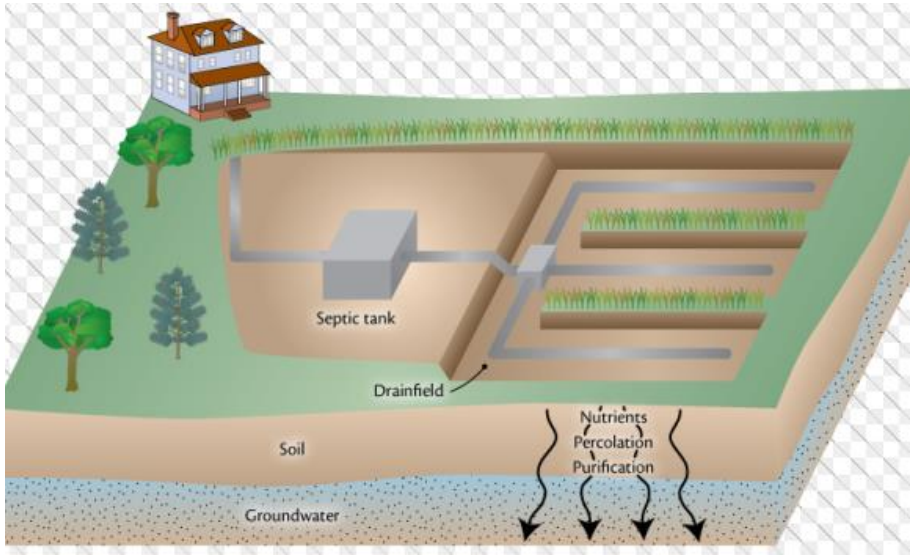
Water Softener Recharge Water



- Does NOT require treatment
- Impact to system:
  - Adds water
  - May affect tank stratification
  - May damage the concrete or other components like pumps
- Management
  - Discharge to different place
  - Reduce recharge frequency

Wastewater Treatment

- Goal of onsite/decentralized systems
  - Treat wastewater
    - Environmentally safe
    - Safe for humans
  - Return to environment



Wastewater Treatment

- Physical treatment
  - Settling of heavier materials
  - Floating of lighter materials
  - Filtering by size
- Biological treatment
  - Microorganisms breakdown waste
  - Biological reactions

Biology - Microorganisms

- Source
  - Human waste
  - Laundering/bathing
  - Food waste

Biology - Microorganisms

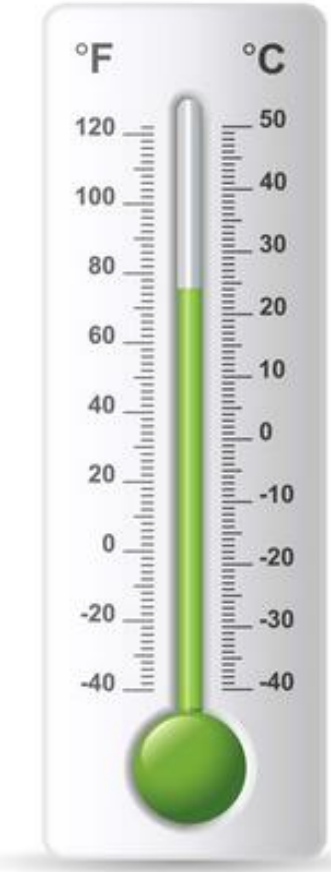
- Microorganisms affected by:
  - Presence/absence of oxygen
  - Temperature
  - Chemicals
  - Medications

Oxygen Requirements

- Aerobic organisms require free oxygen
  - from atmosphere
  - dissolved oxygen (DO) in water
- Anaerobic do not need free oxygen
  - get energy using other compounds
- Facultative can live in either environment
  - Aerobic
  - Anaerobic

Temperature

- Some organisms thrive in high temperatures
- Some thrive in moderate temperatures
- Some like it cold
- Usually, chemical reactions and biological growth occur more rapidly in warmer temperatures.

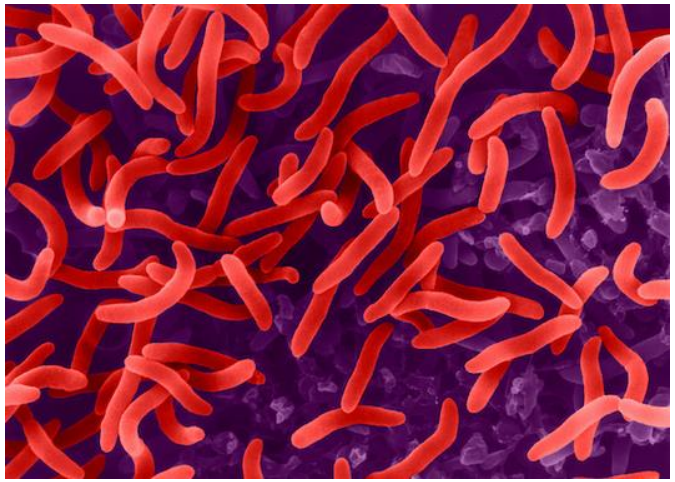


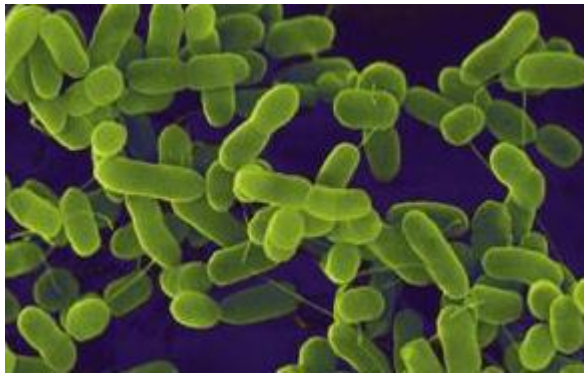
Chemicals and Meds

- Excessive chemical use can cause microorganisms to die off
- A very large percentage of medications are secreted in the urine
- Flushing of medications should never happen

Pathogenic Microorganisms

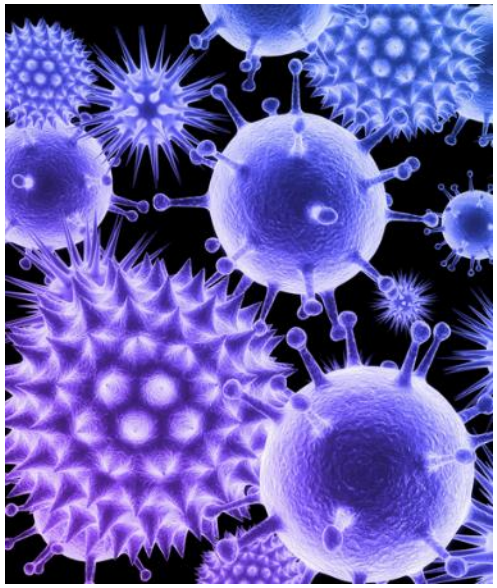
- Cause
  - Cholera
  - Typhoid
  - Salmonella
  - Shigella
  - Water-borne diseases
- Fecal coliform
  - Indicator

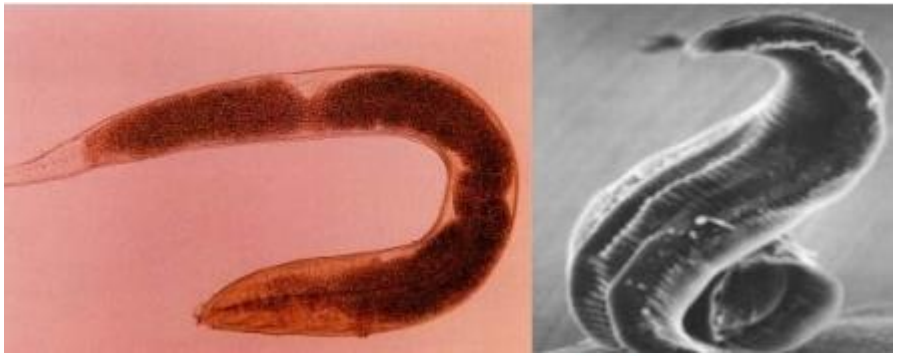




Pathogenic Microorganisms

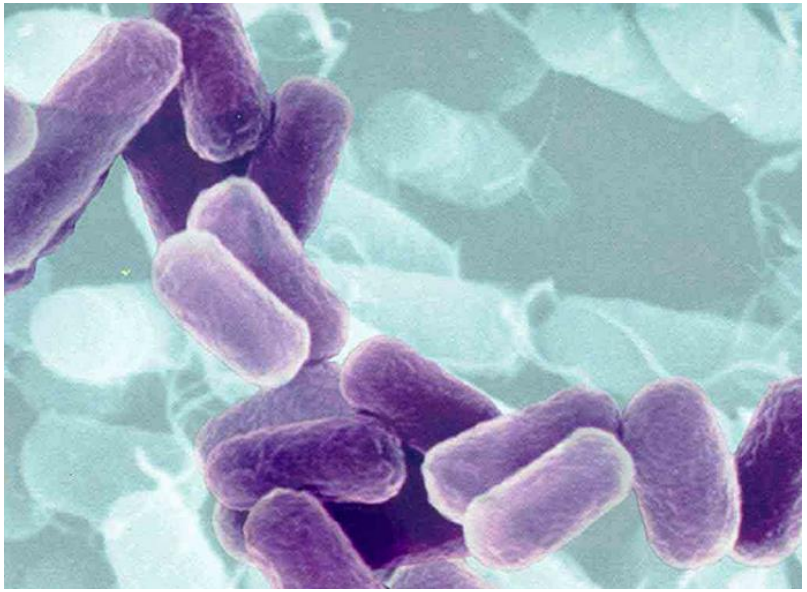
- Viruses
  - Hepatitis A
  - Acute gastroenteritis
  - Polio
- Parasites
  - Protozoa
    - Amoebiasis
    - Giardia
    - Cryptosporidiosis
  - Worms
    - Roundworm





Helpful Microorganisms

- Treat Wastewater
  - Anaerobically
    - Septic tank
  - Aerobically
    - Treatment systems
    - Most soil-based treatment
  - Facultative
  - Use wastewater constituents as food source



Raw Sewage Characteristics

Component	Range	Typical
TSS	155 – 330 mg/L	250 mg/L
BOD_5	155 – 286 mg/L	250 mg/L
pH	6 -9 s.u.	6.5 s.u.
Total Coliform	10^8 – 10^{10} CFU/100mL	10^9 CFU/100mL
Fecal Coliform	10^6 – 10^8 CFU/100mL	10^7 CFU/100mL
NH_4-N	4 - 13 mg/L	10 mg/L
NO_3-N	Less than 1 mg/L	Less than 1 mg/L
Total Nitrogen	26 – 75 mg/L	60 mg/L
Total Phosphorus	6 - 12 mg/L	10 mg/L

mg/L = milligrams per liter s.u. = standard units
CFU/100 mL = Colony-Forming Units per 100 milliliters

Adapted From: US EPA 2002

Total Suspended Solids (TSS)

- Source
  - Food waste
  - Human waste
  - Laundering & bathing
- Concern
  - Collect in septic tank
  - Clog soil in drainfield
  - Turbidity (cloudiness) in surface water
- Amounts (TSS)
  - Range 155 – 330 mg/L
  - Typical 250 mg/L (raw)

Measuring Total Suspended Solids

- Total suspended solids (TSS)
  - Run sample thru 0.45 micron filter
  - Solids remaining on filter are SS
  - Solids passing through are dissolved

Biochemical Oxygen Demand

- BOD
- Indirect measure of organic matter
  - Measures amount of oxygen used by microbes to breakdown organic matter
  - 5 day, 20^{o} C (68^{o} F) test
  - Measured in mg/L
- Amounts in wastewater
  - Range 155 – 286 mg/L
  - Typical 250 mg/L

Organic Matter

- Large contributor to BOD
- Digested and undigested animal and vegetable material
- Contain carbon
- How treated?
  - Some is removed in septic tank
  - Effluent screen helps reduce further
  - Serves as food source for microorganisms

Nutrients

- Nitrogen
  - TKN
  - Nitrate (NO_3^-)
  - Nitrite (NO_2)
- Phosphorus
  - Phosphate (PO4)

Nutrients

- Source
  - Food waste
  - Human waste
  - Detergent (P)

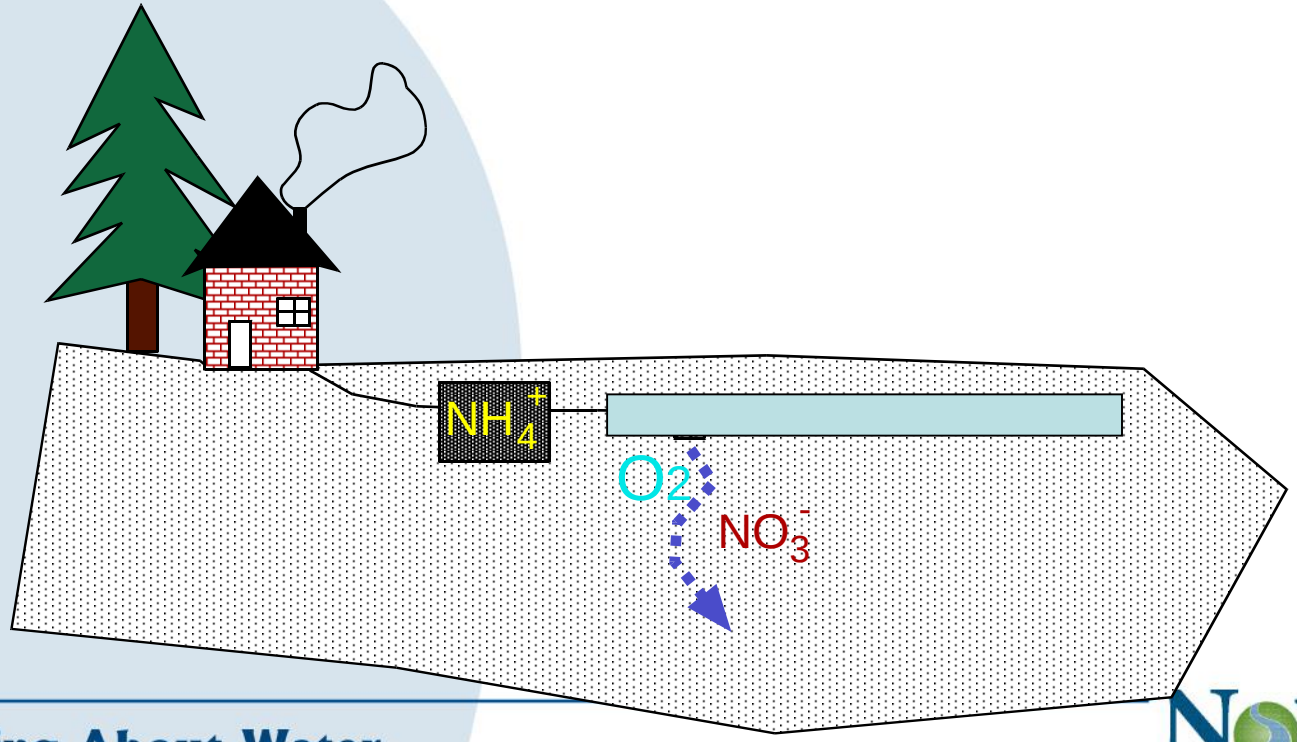
Amounts	Range	Typical
– TKN	26 – 75 mg/L	60 mg/L
– NO3	< 1 mg/L	< 1 mg/L
– Total P	6 - 12 mg/L	10 mg/L

Nutrients

- Concern
  - Water quality – fresh water
    - surface (P)
    - groundwater (N)
  - Human health
    - Nitrate – blue baby syndrome
    - Carcinogen?
    - Birth defects? (Canada, Australia)

Nitrogen

- Moves readily with water as NO_3^-
- Threat to groundwater



Phosphorus

- Binds with other minerals in the soil – called complexes
- Complexes do not dissolve in water – insoluble
- P moves if soil particles move (erosion)
- Some P is used by vegetation
- Soils have limits to the amount of P they can bind

FOG or O & G

- Fats
  - Animal-based (lard)
  - Solid at room temperatures
  - Relatively easy to treat
- Oils
  - Plant-based (corn oil, soybean oil)
  - Liquid at room temperatures
  - More difficult to treat
- Grease
  - Petroleum-based
  - May act like oils or fats

Wastewater - FOG

- Source
  - Food waste
  - Body oils, lotions
- Concern
  - Clog soil in drainfield
- Amounts
  - <30 mg/L

Inorganic Solids

- Minerals, metals and salts from soil material, plumbing, make-up
  - Inert and not subject to decay
  - Causes clouding of water (turbidity)
  - Plugging of soil pores
- How treated?
  - Stored in septic tank and removed when septic tank is pumped
  - Effluent screen helps reduce further

Other Things

- Volatile Organic Compounds – VOCs
  - Paint, solvents, paint thinners
  - Cleaning chemicals
  - Hobbies
- Pharmaceuticals & Personal Care Products – PPCPs
  - Human waste from showering and urine
- Concern
  - Water quality & human health
  - Effect on treatment system

Commercial, Industrial, Recreational Wastewater

- Quantity and quality vary greatly
  - Restaurants
  - Seasonal Campgrounds
  - Butcher shops
- Collect samples and measure flow rates if possible
- Resources
  - Onsite Wastewater Treatment and Disposal System Design Manual, US EPA. 1980.
  - Other professionals with experience

Summary

- Know your wastewater
  - Is the quantity and quality going to be “normal” or “typical”?
  - Are the characteristics or activities at the location that would cause it to be different?
- The system needs to be able to treat the wastewater that is produced
  - Aerobic conditions in the drainfield and/or with added treatment
  - Good microorganism population

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QUESTIONS ?