Green Concepts in Water Treatment

Venkata D. Gullapalli
Ph.D. Candidate
Civil and Environmental Engineering Department
Urban Streams

- Historically recreational places
- Home for different aquatic species
- Combination of both natural and manmade channels
- Watershed ranges from:
  - Pervious to Impervious surfaces
  - Vegetated to Construction zones
Urban Stream Pollution

- Citizens and industries contribution
- Alteration of stream channels and lining
  - Concrete lining
    - Impervious channels
  - Change of routing
    - Natural flow is altered
- Urban Runoff
  - Insecticides from back yards and gardens
  - Impervious streets with Hydrocarbons
  - Animal and human waste
Stream Health Indicators

- Temperature
- Dissolved Oxygen
- pH
- TDS
- Nutrient Levels
Urban Stream Pollution

- Combined Sewer Overflow (CSO)
  - Sewage and storm water combination
  - Over flows routed into urban streams
  - Blocked inlets routes the water into water bodies
  - Water quality depends on the storm event
Pollution & Elimination

• Urban stream pollution
  • Chemical (Gasoline, pesticides..etc)
  • Biological (Sewer outflows, animal waste)
  • Physical (plastics, car tires, bumpers..etc)

• Not accessible because of the pollution in it
  • No recreational activities

• Posted signs to STOP DUMPING

• Cleaning the physical waste

• Tree shade for DO improvement

• Reduce channelization
Pollution & Prevention

- Dumping has to be eliminated
  - Posted signs at Inlets
- Storm-water BMPs
  - Installation of Rain Barrels
  - Installation of Pervious pavements
  - Rain Gardens
- Vegetation restoration
- Sewer outflow event reduction
Beargrass Creek

- Approx. 61 Sq. Mi. of water shed
- 3 branches
  - South Fork
    - 41% of impervious
    - 27 sq. mi.
  - Middle Fork
    - 33% of impervious
    - 25 sq. mi.
  - Muddy Fork
    - 26% of impervious
    - 9 sq. mi.
Green Concepts for Water Treatment

- Uses natural resources
- No chemical by-products
- Do not require expertise for maintenance and operation
- Involves 3 steps
  - Filtration
  - Disinfection
  - Aeration
Water Treatment System

- Water Storage
- Filtration
- Solar Disinfection
- Aeration
Green “Filtration”

- **Sand & Gravel**
  - Conventionally used and Gravitational flow
  - Disinfects after development of bio-film called “Schmutzdecke”
  - Suspended solids are trapped between voids
  - Easy to operate and do not require skilled personnel for maintenance
  - Green project -- Can use local materials for construction
  - Do not completely eliminate **Chemicals** *
  - Limited capacity constrains service to smaller communities
  - May require relatively large space
  - Current water treatment practice typically uses Rapid-sand filters
Green “Filtration”

- **Anthracite**
  - Removes residual precipitated hardness salts
  - Mostly used in Rapid Sand filters along with sand
  - Used in industrial water treatment
  - Expensive than Sand
  - Not readily available in nature for direct use
  - Replacing part of gravel bed in slow sand filters with Anthracite can help in reducing hardness chemicals

- **Oyster Shells**
  - Oysters are good water purifying creatures
  - Oyster shells are proven successful in reducing Phosphorus concentration in water
  - Waste product of Seafood and Pearls industries
  - Research is in early stage
  - Not readily available but good for coastal people
Disinfection

- Removal of disease causing pathogens
- Chlorine used as disinfectant
- Boiling of Water upto 100 degree Celsius
- Ozone, and H2O2
- Ultra Violet Radiation
  - Solar Radiation
    - Electromagnetic waves from SUN in form of Light and Heat
    - Significant bands based on wavelength
      - UV (100 – 400 nm)
      - Visible Light (400 – 780)
      - Infrared Radiation (IR) (780 nm – 1 mm)
    - The lower the wave length is, higher is the risk
Solar UV Radiation

- UVC is most dangerous for all creatures
  - Naturally filtered by stratospheric oxygen
  - Commercially developed systems are Expensive
- UVB is proved to best naturally available disinfection radiation
  - Major portion is absorbed by OZONE (90%)
  - Less dangerous to creatures
  - Natural radiation data made available by Univ. of Colorado, NREL
  - Solar Disinfection research studies are based on UVB
- UVA is less harmful to human beings
  - Abundant in natural Sunlight
  - Recent studies proved it can effectively eliminate *E. Coli*
  - Research is still in early stages
  - Natural Radiation data available for very few sites
Solar Flow Reactor

• Thermal inactivation
  - Heating up of water above 45 degrees C

• Optical inactivation
  - UVB modifies the DNA of bacteria
  - UVA plays major role in ROS (Reactive Oxygen Species) formation
    • singlet oxygen, superoxide, hydrogen peroxide, and hydroxyl radical

• Combined thermal inactivation
  - A combination of both inactivation concepts
  - Helps in reduction of survival rate
Solar Flow Reactor
Reactive Oxygen Species

- Reason for disinfection
- UVA plays major role in formation
- UVC does this in Ozone layer for O$_3$ production
- Closed channels reduce this effect
- An open channel can increase this because of the O$_2$ availability
- Can simulate in streams
Water Sampling

• Sampling water for
  • Temperature
  • DO
  • pH
  • Bacterial Concentration

• Bacterial Concentration
  • Test for Gram Negative Bacteria concentration
    • MacConkey Agar plates
Application on Streams

- Hyporheic zones
  - Beneath and Alongside of a stream bed
  - Mixing of ground and surface waters
  - Fish spawning
- Destroyed because of the channelization
  - Ecosystem imbalances
Hyporheic Zone as Water Treatment Facility

• Construction of Seepage pits
  • Filled with Filter materials
  • Increases ground and surface water mixing
  • Reduces polluted water entering into ground water

• Construct weirs on stream bed
  • Creates ripples
  • Aerates water
  • DO increase
Beargrass Falls

- Karen Lynch Park @ Brownsboro Rd. & Story Ave.
- An outdoor class and Natural Research Center
- Impervious Pavement
  - MSD
- Chlorine Generator
  - Waterstep
- Rain Garden
  - Univ. of Kentucky extension office
- Shelter
  - Youth Build America
- Solar Power, Green water treatment concepts
  - UofL KIESD, Get Outdoors Kentucky, 9th District Green Triangle
Study Area

• Lower Beargrass Creek watershed
• Upstream of Beargrass pumping station
• Maps are available
THANK YOU ......!!!!
QUESTIONS...??
or
SUGGESTIONS...!!