Water Pollution II

Reducing Water Pollution
Terminology

- **Sewer**: Underground pipe system that carries waste water to treatment plant
- **Sanitary Sewer**: carries wastewater
- **Storm Sewer**: carries runoff from rain or snow melting
- **Combined Sewer**: carries both. Can cause Combined Sewer Overflow (CSO)
- **CSO**: are major cause of beach closings, pollution
- **Still common in Eastern US.**
Water Treatment

- **Primary treatment** = removal of solids
- **Secondary treatment** = biological degradation of organic matter using bacteria, chlorine, ozone & UV
  - Sludge can be a source of organic matter if not toxic
- **Tertiary treatment** = remove excess nutrients (nitrates & phosphates)
  - Makes water drinkable
Water Treatment

Primary
- Bar screen
- Grit chamber
- Settling tank

Secondary
- Aeration tank
- Settling tank
- Chlorine disinfection tank

Sludge
- Activated sludge
- Sludge digester
- Air pump

To river, lake, or ocean

Disposal:
- Disposed of in landfill or ocean
- Applied to cropland, pasture, or rangeland

Raw sewage from sewers
Sludge

- Dumping, Landfill, incineration
- In USA,
  - dumping in the sea is prohibited
  - Sludge is treated to remove heavy metals, contaminants
  - pH balanced with lime
  - 60% of the treated sludge (biosolids) are spread in farms, forests, parks, golf courses
- Pathogens, PCBs, metals can survive
- Metals (such as Cadmium) keep on accumulating and can be passed on to crop
  - USA has relaxed standards for biosolids
  - Europe has far stricter standards
Industrial Wastewater

- Industries used to pay municipalities to treat their waste water along with municipal waste water.
- Industrial pollutants can cause problems and can contaminate sludge.
- EPA now requires industry to pre-treat their waste water.
- Some Industry now completely treat their waste water.
Alternative wastewater treatment

- Small communities can use artificial (constructed wetlands
  - Suspended solids drop out
  - Nutrients are used by plants and microorganisms which degrade organic chemicals also
  - Metals are absorbed in soils and are contained
- French Experiment:
  - Planting chrysanthemums in the mix of plants in wetlands
  - Removes 40 to 80% of nutrients, 95% of suspended solids, 91% of BOD
  - Chrysanthemum can be harvested for natural insecticide *pyrethrín*, which is in high demand
- Greenhouse with complete ecosystem and a slow moving stream
  - After screening and grit removal wastewater is fed to bacteria, algae, zooplanktons and plants which removes nutrients, suspended solids and BOD
Human Waste

- Why do we deliberately pollute clean water with human waste?
- Once dirty the water needs to be cleaned and disinfected before releasing it to waterways
- 30% of household water use
- Source of
  - excessive nutrients (phosphorus and nitrogen)
  - Drugs – difficult to remove
  - Hormones – estrogen from birth control pills affect aquatic life
  - Antibiotics – giving rise to antibiotic resistant bacteria
A Swiss proposal

- NoMix toilet
- Separate feces and urine. Only feces carries to a central plant
- Uses 80% less water, produces less sludge
- Urine contains 80% reactive nitrogen load and 50% phosphorous load of a wastewater plant
- Swiss propose to use urine as a source of nitrogen and phosphorous fertilizer.
  - No mining, save environment, save natural resource
  - Urine is a renewable resource
Reuse

- Gray water: non-sewage household waste water
- Can be used to flush toilets, wash cars or water yards
- In many cities, waste water is reclaimed and used for cooling, industrial process, commercial washing, fountains, fire fighting, golf course irrigation
- Pathogens need not be completely eliminated because the water is not used for drinking
Reducing Non-point Sources

- Much more difficult to reduce
- Major sources:
  - Agriculture
  - Logging
  - Mining
  - Construction
  - Urban
- Excessive water use causes more run-offs
## Agricultural Run-offs

<table>
<thead>
<tr>
<th>Sources</th>
<th>Pollutant</th>
<th>Mitigation</th>
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<tbody>
<tr>
<td>Agriculture (growing crops)</td>
<td>Soil, fertilizers, pesticides</td>
<td>• Trap runoff by strip of vegetation</td>
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<tr>
<td></td>
<td></td>
<td>• no till farming to reduce soil erosion</td>
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<td></td>
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<td>• precision farming to reduce fertilizer use</td>
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<tr>
<td></td>
<td></td>
<td>• Integrated pest management (IPM)</td>
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<td></td>
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<td>• Newer and better herbicides</td>
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<tr>
<td>Agriculture (animal operations)</td>
<td>Animal waste and pathogens, <em>Giardia</em> and <em>Cryptosporidium</em>, nutrients, BOD, suspended solids</td>
<td>• Barriers to prevent leaks from lagoons</td>
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<td>• Treat feces/ urine in factory farms</td>
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<td>• Discourage factory farms, encourage family farms</td>
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</tbody>
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### Non-point source (..contd)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Impacts</th>
<th>Mitigation Measures</th>
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| Logging  | Soil, BOD, nutrients | • Buffer strip of uncut trees near streams  
• Make logging roads and skid trails to follow contour  
• Build wetlands to capture and treat run-off |
| Mining   | Acid discharge, soil, metals | • Grow vegetation on site to retain soil and pollutants  
• Seal mine  
• For strip mines restore polluted water and damaged land |
Mountain top removal by strip mining
| Construction Sites | Soil, oil, grease, metals, debris | • Build settlement pond to trap run-off  
• Put hay dam or fabric fence around the site  
• Lay down construction site to follow natural contours. |
Open space designs minimize clearing and grading of existing trees and vegetation, helping to preserve a sense of place.
| Cities, suburbs with paved surface | Oil, grease, metals, PAH (Polycyclic aromatic hydrocarbon) – from auto exhausts, salt, sand, bacteria, soil, animal waste, debris | • Put green strips  
• Re-sculpt the road to redirect run-off into vegetated road margin (not storm drains)  
• Use infiltrators under parking lot to collect storm water and let it percolate to recharge groundwater  
• Use wetlands to store flood water |

90% of water hitting roof and roads ends up in storm drains
Relationship between impervious cover and surface runoff. Impervious cover in a watershed results in increased surface runoff. As little as 10 percent impervious cover in a watershed can result in stream degradation.
Many conventional neighborhoods use curbs and gutters to convey stormwater runoff away from residential streets as quickly as possible.

This photograph is an example of an open channel.
Parking lot with a bioretention facility. Run-off diverted to shallow landscape area, from where the water percolates to groundwater table.
Incentives and Extension programs of USDA
Consultants work with the farmers
Problem more acute in Europe and Asia