For those of you that bothered to come to class last time . . .

- I hope you enjoyed the quick tour of Valdosta’s new wastewater treatment plant.
- I was very impressed.
- We’ll come back to wastewater in a bit.
I’m going to take a more ‘holistic’ approach to the problems of water, solid, and hazardous wastes.

* I’ve done this before when we’ve had a documentary, and I’ve mainly showed you just the graphics from the chapter for the sake of time.

* This time I’m covering the material from three separate chapters, so I need to just stress those most important concepts encapsulated by the graphics, in order to get through it all.

* As usual, the exam will only include things from the slides or videos.
Water pollutants include sources of nitrogen and phosphorous, nutrients, which lead to eutrophication; heavy metals, acids, salts, pesticides, petroleum derivatives, and other toxic chemicals; and disease causing organisms (pathogens).
A healthy stream ecosystem

We talked about this in the hydrology chapter.

Plenty of oxygen for aerobic organisms, and not such a high nutrient load that would cause an algal bloom and eutrophication.

Good light penetration supports photosynthesis of attached algae, aquatic plants, and abundant food chains.

Many hiding and resting places for small fish, etc.

Bacteria, protozoan insect larva attached to rocks.

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Very little light means very little photosynthesis, which means very little oxygen for aerobic organisms.

Or eutrophication due to a very high nutrient load causing an algal bloom and subsequent algal die-off, leading to rampant aerobic decomposition that robs the water of oxygen. Same result, different means.
Aquatic photosynthesizers

(a) BENTHIC PLANTS
- Cattails
- Bulrushes
- Pond weeds
- Muskgrass
- Water lily
- Arrowheads

Submerged aquatic vegetation

(b) PHYTOPLANKTON
- Filamentous green algae
- Green algae
- Diatoms
- Cyanobacteria

Remember the 50% of our oxygen thing!

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Eutrophication

OLIGOTROPHIC

- Low in nutrients
- Phytoplankton limited
- Water clear
- Light penetrates
- Submerged aquatic vegetation (SAV) thrives

NUTRIENT INPUTS

- Nutrient-rich
- Phytoplankton thrive
- Water turbid
- SAV shaded out

EUTROPHIC

- Nutrient-rich
- Rapid turnover of phytoplankton
- Accumulation of detritus of dead algae
- Decomposers feed on detritus
- Depletion of dissolved oxygen
- Fish and shellfish suffocate

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So, one of the main sources of these excess nutrients that can cause eutrophication . . . .

* Is raw sewage!
* Of course, this can also be a source of pathogens (and toxic chemicals).
* And that’s one of the reasons we spent the time to tour Valdosta’s new Mud Creek Wastewater Plant. They are doing it right — cleaner, more pure water is put back into Mud Creek than is there upstream.
The rest of the world doesn’t have it nearly so nice.

Percentage of population using improved sanitation

- Less than 50%
- 50 – 75%
- 75 – 90%
- 90 – 100%
- Missing data

More than 1 billion people lack safe drinking water; 2.5 billion don’t have proper sewage treatment; each year over 2 million deaths are attributed to waterborne disease, especially cholera.
And biological nutrient removal

The microbes munch up the excess nutrients.
The Mud Creek Plant used all those technologies.

* In particular . . . . Remember from the tour . . .
* Excess sludge is pressed and dried, and can be used as a biomass fuel, or as compost/fertilizer.
* Just the right amount of activated (with all the microbes in it) raw sludge is piped off to be used in the secondary, biological treatment, where the microbes eat up all the nitrogen, sulfur, phosphorous, and other nutrient compounds.
* This is accomplished by ‘starving’ them in tanks with very little oxygen, and then increasingly aerating them with lots of oxygen. Gotta keep them ‘bugs’ happy!
* And, finally the effluent is disinfected with Ultraviolet light (not chlorine). This breaks DNA.
But not everybody's on the municipal sewage system. Most rural homes have their own, natural, biological sewage treatment plant right in their backyard!

About 25% of the U.S. population uses these — my wife and I do.
From water waste, onto solid waste.

- You’ve heard the mantra before . . .
- Reduce, . . .
- Reuse, and . . .
- Recycle!

- Unfortunately, it’s not paid attention to nearly enough. Therefore, . . .
- We have more solid waste than we can handle, and landfills are being filled up. And dumping in the ocean is a terrible, and now illegal, alternative.
U.S. solid waste composition

What it is.

- Paper, paperboard: 32.7%
- Yard waste: 12.8%
- Food wastes: 12.5%
- Plastics: 12.1%
- Metals: 8.2%
- Other: 3.2%
- Wood: 5.6%
- Glass: 5.3%
- Rubber, leather, and textiles: 7.6%
U.S. solid waste disposal

33.4% Recycling (68 million tons)

12.6% Combustion (34 million tons)

54.0% Landfills (128 million tons)

Total MSW = 254 million tons/year

And where it goes.
The Earthlings enter their metal shells, converge on this hive...

Bymor Shopping Mall

...and move objects to a mountain they call "landfill."
A modern landfill’s safeguards

- Dump truck dumps refuse
- Compactor compacts refuse
- Earth mover covers refuse
- Refuse cells
- Groundwater protection features for new landfills

- 6-8" of fill dirt
- 24" of compacted clay
- Plastic
- Leachate collection pond
- Leachate drainage system

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Waste-to-energy combustion

A great idea, but it's associated with tons of real-life, practical problems!
Solid waste recycling in the U.S.

And, yeah, it’s gotten way more popular over the years!

Of course state and national bottle laws would make it even higher, but there’s too much opposition.

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State recycling rates: why no GA data?
And what about the really nasty wastes - HAZMATS!

* These include those heavy metals, and . . .
* All sorts of organic solvents, pesticides, petroleum derived substances, caustic and acidic solutions, and radioactive wastes.
* Of course, they are only hazardous if you are exposed to enough of it, or long enough.
* Really . . . do you really want to be exposed to this stuff at all?
* But, they are all necessary evils of a modern, comfortable, industrialized society.
There is this sort of dose-response curve for most. Too long, or too much, and you get hurt, otherwise, supposedly, no problem. But very long-term consequences of even tiny doses are seldom fully understood.

Harmful effects

Time of exposure

Concentration of chemical

Threshold level

0

No harmful effects

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HAZMAT placards

At least they let you know what they’re hauling!

And, herein lies an In-Class Assignment!
Where the stuff comes from . . .

Pretty much, everything we do!

Mining raw materials generates waste, by-products, and pollution

Refining raw materials into bulk chemicals generates waste, by-products, and pollution

Transportation and accidental spills generate pollution

Use of bulk chemicals to produce consumer products generates waste, by-products, and pollution.

Use of products

Pollution

Household pollution

Landfill pollution
However, the good news is we are generating less and less toxic waste over the years, at least in the U.S. due to policy change and regulation.
Major hazardous-waste laws

EPCRA (Emergency Planning and Community Right-to-know Act)
Informs public about storage and releases of toxic substances

CAA (Clean Air Act)
Limits discharges into the air

DOT (Department of Transportation Regulations)
Assures safe transport

RCRA (Resource Conservation and Recovery Act)
Assures that wastes get to suitable disposal facilities

OSHA (Occupational Safety and Health Act)
Protects workers’ health and safety

Superfund: Provides for cleanup of abandoned hazardous waste sites

TSCA (Toxic Substance Control Act)
Requires new chemicals to be shown safe for specific uses

CWA (Clean Water Act)
Limits discharges into waterways

SDWA (Safe Drinking Water Act)
Sets standards for drinking water

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And how do we get rid of the stuff?

- Same old ways (none that great):
  - Incineration; . . .
  - Deep-well injection (way deep); . . .
  - Surface impoundment (the swimming pool model, like with radioactive waste); and . . .
  - Landfills. Versus, all the illegal ways.

- Which brings us back to Superfund sites, . . .

- With old and new technologies. One of the coolest is . . .

- Bioremediation — let microbes do it!
OK — don’t space it out . . .

We have our fourth exam next class meeting! It will cover all this pollution stuff — that is — environmental hazards, climate change, air and water pollution, and solid and toxic wastes. Plus, there’s that additional 10% extra credit opportunity there in the form of an essay. I won’t tell you what the topic will be, just that it’ll be thought provoking, and you’ll need to use much of what you’ve learned all semester long to adequately answer it.