Groundwater—The Invisible Threat

CSS 235
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Perceptions & Misconceptions

- Americans think of fresh water as surface water – free flowing rivers & streams, natural lakes, impoundments & reservoirs
- We fail to recognize 97% of the earth's liquid fresh water is stored in aquifers
- World population has doubled since 1968 and demand for food has more than doubled
- Rivers, streams & lakes have become more polluted
- We increasingly turn to aquifers to supply drinking & irrigation water

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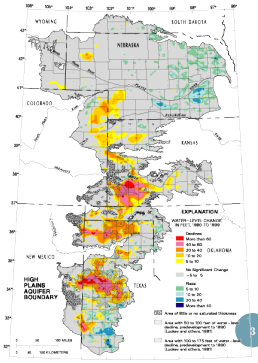
Ogallala Aquifer

- Some areas have 50 to 100 ft. of water level decline
- Some have experienced 100 to 175 ft. of water level decline
- Recharge lags far behind consumption from pumping



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Center pivot Irrigation .5 & 1 mile in Diameter –

Finney County, SW Kansas

Ogallala aquifer

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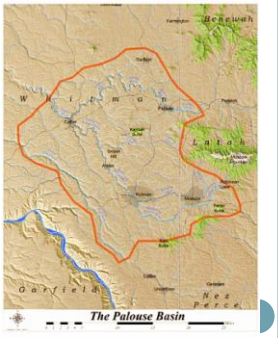
Palouse Basin Aquifer

- Much of the water we're consuming seeped into the Grande Ronde basalts during the last ice age.
- It is 10,000-20,000 years old, pristine but mostly irreplaceable.
- Soil research shows that little precipitation is able to penetrate to the basalt layers from which we draw our water.
- Moscow wells declined 3 feet per year for past 30 years.



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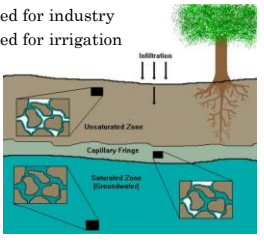
Groundwater—An Invaluable Resource

- Half of the household water used in USA
- Worldwide, groundwater supplies:
  - 50% of all drinking water
  - 40% of all water used for industry
  - 20% of all water used for irrigation

The Water Table



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We think groundwater is safe from contaminants

- Not only is it susceptible to pollution . . .
- It is in many ways more vulnerable than surface water!
- Groundwater is slow moving
- It stores pollutants far longer than surface water, air, or even soil
- Aquifers can become long-term sinks for pollution
- River water cycles through every ~16 days
- Pollutants are flushed out to sea or become diluted with constant additions of fresh water
- Not so with groundwater

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An Accumulating Problem

- Average length of time groundwater remains in an aquifer is 1,400 years.
- Aquifers accumulate contaminants for years
- Bioremediation (natural breakdown of pollutants) occurs in the unsaturated soil levels, seldom in the aquifer.
- Herbicide alachlor ½ life in soil is 20 days, in groundwater ½ life is 4 years

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Where does pollution come from?

Many Sources




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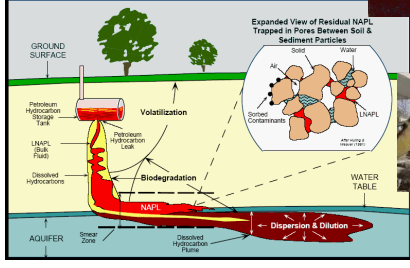
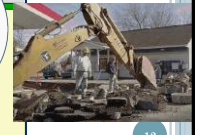
Many Sources

Light Non-aqueous Phase Liquids (gasoline)



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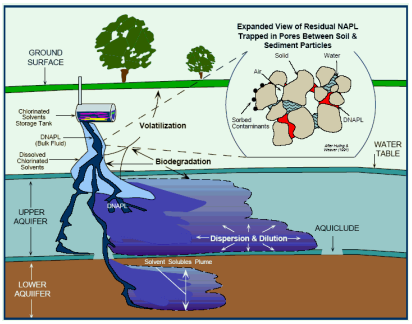
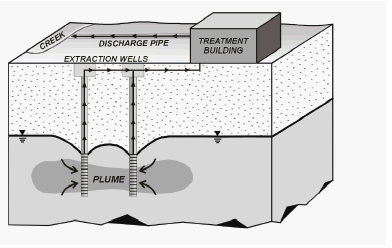
Dense Non-Aqueous Phase Liquids (dry cleaning solvents)



Treatment is Incredibly Expensive

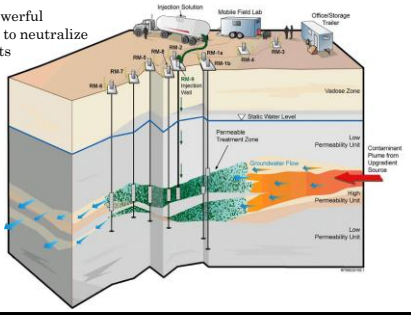
- Pump and Treat – the most commonly used "solution"



Treatment is Incredibly Expensive

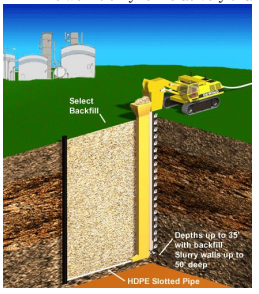
In Situ Redox Manipulation

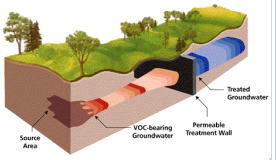
Inject powerful oxidants to neutralize pollutants



Permeable Reactive Barriers

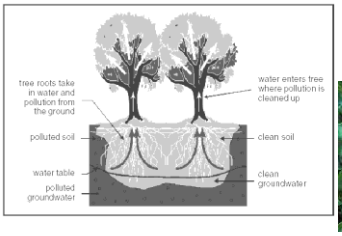
- Intercepting trench backfilled with reactive material such as iron filings, carbon, or peat, which absorb & transform the contaminant as water from the aquifer passes through the barrier.
- This works only for relatively shallow aquifers.

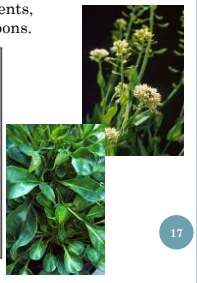




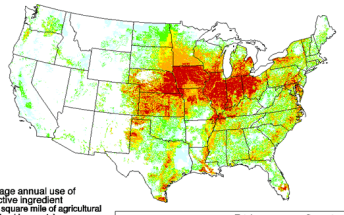
Phytoremediation

- Some plants accumulate heavy metals and metal-like elements, such as arsenic, lead, uranium, selenium, cadmium, and other toxins such as nutrients, hydrocarbons, and chlorinated hydrocarbons.





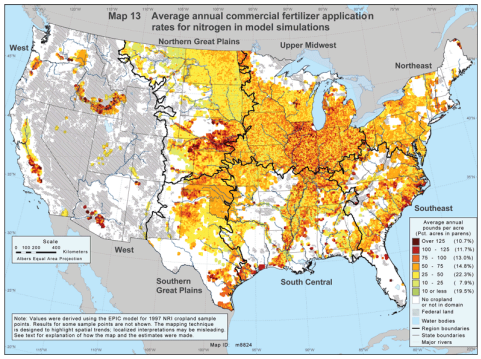
ATRAZINE - herbicide
1997 estimated annual agricultural use



Average annual use of active ingredient (pounds per square mile of agricultural land in county)

- no estimated use
- 0.001 to 0.358
- 0.359 to 2.151
- 2.152 to 9.855
- 9.856 to 32.77
- >= 32.771

Crops	Total pounds applied	Percent national use
corn	62, 361, 038	84. 00
sorghum	6, 750, 038	9. 09
summer fallow	2, 539, 169	3. 42
sugarcane	2, 203, 421	2. 97
sweet corn	340, 452	0. 46
sod harvested	30, 214	0. 04
other hay	13, 224	0. 02
seed crops	5, 833	0. 01



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Bottom Line – Prevention is the ONLY Credible Strategy

- Move away from "end-of-pipe" solutions
- USA: 1/3 to ½ nitrogen fertilizer can't be used
- 85-90% of agriculture pesticides never reach target organisms
- High-input agriculture & vast monocultures overwhelms the land & aquifers with massive applications of agricultural chemicals
- Our automobile-dominated, geographically sprawled cities & impermeable surfaces flood soils & aquifers with petrochemicals, heavy metals & sewage

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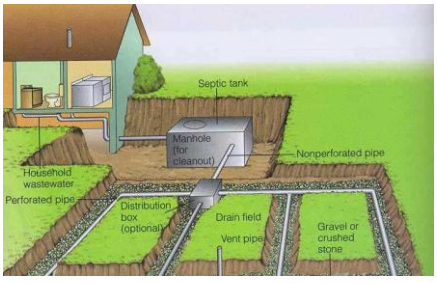

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