Lecture 1: Historical Perspective

When did hazardous wastes first become recognized as a problem? What are some "famous" incidents which have influenced regulations and public perception?

1962 Rachel Carson's "Silent Spring" on the effects of the pesticide DDT on birds and the ecosystem (

1978 Love Canal "hits the news" -
1942-1953 site near Niagara Falls, N.Y. received 20,000 metric tons of chemical wastes with >80 different compounds, disposed in clay-lined canal (20m x 1000m x 3m deep)
1953 covered waste canal and sold property to Niagara Falls School Board
school board had KNOWLEDGE of the chemical dumping activities
1955 school opened on site, remaining property sold to housing developers,
by 1972 most homes on the site built
1976 heavy rain, subsidence in landfilled area, ponded surface water contained toxic chemicals
1977 found that 21 of 188 homes adjacent to canal had chemical residues in basements
1978 state of emergency declared by state and federal governments, 237 families evacuated
1989 over $140 million spent to relocate residents and clean up the site
** later review of data on health effects found no clear evidence of significant adverse human health impacts which could be related to the compounds present ! !

Times Beach, Missouri
~1970 application of waste oils containing dioxin to roads and farms for dust control
animals died...found 100 ppm dioxin (TCDD) in soil in town of Times Beach
entire town eventually evacuated

Bhopal, India tragedy Dec. 2, 1984
methyl isocyanate leak from Union Carbide plant
2000-10,000 deaths; >300,000 suffered personal injuries

Chernobyl nuclear disaster, Soviet Union, 26 April 1986
best estimates are: some 2000 extra cancer deaths lifetime among almost 200,000 liquidators from 1986 and 1987; and 4600 deaths among some 6.8 million residents of contaminated territories. Increases of this magnitude would be extremely difficult to detect against an expected background of 41,500 and 800,000 cancer deaths, respectively, among the two groups. The major radiological impact is leukemia, particularly among liquidators. Increases in thyroid cancer among those exposed as children were observed in the more heavily contaminated regions, at rates much higher than predicted from previous studies. Increases in thyroid cancer are also reported among liquidators and the general population. It is important to recognize that current estimates of doses to exposed populations are uncertain; in particular, doses received early after the accident are not well known.

Exxon Valdez Oil Spill - March 25, 1989
several million gallons of crude oil contaminated almost 300 miles of shoreline in Prince William Sound, Alaska. "...the largest cleanup problem in U.S. history" Pritchard et al. 1991

"Our Stolen Future" by XX
A book about the potential endocrine-disrupting effects of pollution. One of the most controversial points was the evidence for decreasing sperm counts in men, and feminization of male animals.

The Solid Waste World

Solid waste is defined as any garbage, refuse, sludge, or other waste material. It includes solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, or agricultural operations or from community activities.

approximately 11.4 B tons/yr total of "non hazardous solid waste" is generated in the U.S.

7600 million tons industrial non-hazardous waste
2095 million tons oil and gas waste
1400 million tons mining waste
180 million tons municipal solid waste
85 million tons utility waste
32 million tons construction and demolition waste
18 million tons other

approx. 275 million tons/yr hazardous waste (~2.4% of total solid waste)
~99% of all hazardous wastes produced by "large" generators
large generators ~2% of total number of hazardous waste generators
~2/3 of hazardous wastes generated in 10 states where most manufacturing located
71% from chemical and petroleum industry; 22% from metal industry, 7% other

Types:
clean-up residuals - from hazardous waste spills and remedial activities
paint production residuals - organic solvents, metal-based pigments, adhesives,...
organic and oily residuals - thick sludges and solids, inorganics and organics
organic sludges and still bottoms - from production of organic chemicals
solvents and organic solutions - from manufacturing pharmaceuticals, plastics, etc
anion complexes - from electrical, machinery, and metal coating production processes
metals and inorganic solutions and sludges - from metal finishing, petroleum refining, ..
pesticides
oils and greases - from vehicles and machinery, dirty oil with solid contaminants
solid inorganic residuals - incineration ash, air pollution control residuals, spent catalysts,...

The "Contaminated Site" Remediation World

Total U.S. "environmental" spending (1993) : $100-134 billion
hazardous waste remediation (early 1990s) : $4-12 billion (5-12% of total env)
1996 $9 billion spent on remediation in U.S. (MacDonald and Rao 1997)
Superfund Remedial Actions: treatment technologies selected through fiscal year 1992

solidification/stabilization:	28%	incineration (on and off site):	26%
soil vapor extraction:	18%	bioremediation (in situ and ex situ):	10%
thermal desorption:	5%	(more than one technology per site may be used)	

bioremediation selected at an increasing number of Superfund sites (1984->1992)

Average cost to clean-up a private sector Superfund site = $25 million / site
Total estimated cost to clean-up National sites (DOD, DOE, DOI, DOA, NASA)
$234 to $289 billion over next 75 years
Total estimated cost to cleanup private sites = $500 billion to $1 trillion

Type of Site	Estimated # of Sites	Types of Contaminants
Superfund	36,800	chlorinated VOCs, BTEX, heavy metals
RCRA	80,000	chlorinated VOCs, BTEX, heavy metals
LUST	1,500,000	BTEX, petroleum hydrocarbons
(LUST = leaking underground storage tanks)		
DOD	24,500	petroleum HC, solvents, heavy metals, PCBs, pesticides, explosives
DOE	>4,000	radioactives, others

Currently, there are approximately 1231 sites on the Superfund National Priorities List (NPL). The most frequently found compounds at NPL sites are lead, trichloroethylene, chromium, benzene, tetrachloroethylene, arsenic, and toluene detected at 43, 42, 35, 34, 28, 28, and 27 percent of the NPL sites. Of the NPL sites, the Agency for Toxic Substances and Disease Registry classified 109 as public health concerns due to actual and highly probable exposures to

toxic chemicals. Public exposure is a concern to approximately 715,000 people who live within a 1-mile radius of these sites. (Watts 1997)

Clean-up at Superfund sites is making progress. Of the 1231 sites: clean-up is completed or remediation is in full operation at 595 (48%), at another 424 sites (34%) a minimum of 1 remedial strategy has been selected and/or is underway, and for 135 sites (11%) immediate actions have been taken to address severe risks but long-term solutions have not been selected. The average time reported to construct the selected remedial process at Superfund sites is on the order of 8 to 10 years, so it takes awhile for sites to reach a "completed" stage. It is predicted that by the year 2010 "remedies should be completed" at 87% of sites currently on the NPL. On average, about 40 sites / year may be added to the NPL, according to EPA. (Sept. 27, 1999 Chemical & Engineering News) For further information: www.gao.gov/RCED-99-245

U.S. Reglations: *solution to pollution is "dilution" -> "regulation" -> "prevention"*

1955 Clean Air Act
- 1967 Air Quality Act
- 1970, 1977, 1990 Clean Air Act Amendments

1956 Water Pollution Control Act
- 1972 Federal Water Pollution Control Act Amendments
- 1977 Clean Water Act. 1987 Water Quality Act

1965 Solid Waste Disposal Act
- 1992 Federal Facility Compliance Act

1970 Resource Recovery Act
1972 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
1976 Toxic Substances Control Act (TSCA)
- 1986 Asbestos Hazard Emergency Respone Act

1976 Resource Recovery and Conservation Act (RCRA)
- 1984 Hazardous and Solid Wastes Amendments

1977 Soil & Water Resources Conservation Act; Surface Mining Control & Reclamation Act
1978 National Ocean Pollution Planning Act
1980 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- 1986 Superfund Amendments and Reauthorization Act (SARA)

1986 Emergency Planning and Community Right-To-Know Act (EPCRA) (Title III of SARA)
1990 Pollution Prevention Act; Oil Pollution Act

Two primary regulatory arenas for hazardous/industrial waste:
1. Currently generated wastes
2. Clean-up of contaminated sites (aka site remediation)

What is the current outlook on site remediation?
Survey of consultants and contractors in Soil and Groundwater Clean-Up

Growth of industry?	42% regressing	25% constant	33% growing (larger companies)

Three issues at the forefront of the soil and groundwater cleanup industry

#1	#2	#3	Source
chlorinated solvents	Risk Based Corrective Action	reuse of remediated land	President Golder Tech.
risk-based clean-up	change liability standards	non-regulation of USTs	Principal fr GEA Engrg
changing regulations	cost/profit	rate of clean-up	Info manager P.W. Grosser
enforcement of regulations	modifying regulations	reg acceptance of natural attenuation	President, OnSite Tech

how clean is clean?	variable goals site by site and state by state	technologies to address recalcitrant compounds	Manager, Roy F. Weston Inc
DNAPL sites	mixed wastes	clean-up levels for soil/GW	VP IT Corp.
unrealistic stds	unrealistic client goals	Liability of owners	President, RT Env. Serv
shrinking market	too many consultants competing for too few jobs	low price conpetition vs quality work	Principal from Hargis Assoc. Inc

Soil & Groundwater Cleanup, Aug/S 1997, "What 3 topics are on contractors' minds?" p. 6-8.

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