Hazardous Waste Management

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Volpe Center

- National center of expertise for transportation related issues
- Environmental engineering support for the FAA, EPA, USCG, USPS, FRA, DoE, DoD, and other federal agencies

John A. Volpe
- Massachusetts Governor
- Transportation Secretary

Hazardous Chemicals

- 70,000 on the US market
- 1,000 new added per year
- Many beneficial, but 35,000 are potential or confirmed health hazards
“Control” of Nature

- Pesticides
- Herbicides
- Insecticides

**DDT**
- dichloro diphenyl trichloroethane
- Paul Hermann Muller won the 1948 Nobel Prize in medicine for its invention

Indiscriminate Use of Chemicals
Landmark Poisoning Episodes

- **DDT**
  - Residues found in deep-sea squid, Antarctic penguins, human fatty tissue, affects bird reproduction

- **Mercury**
  - Discharges of methyl mercury in Minamata Bay, Japan
    - Bioaccumulation in shellfish, neurological disorders
  - Fungicide contamination in seed grain in Iraq

- **Polychlorinated biphenyls (PCBs)**
  - 100 million lbs./yr during the 1960s and 1970s
  - Accidental contamination of cooking oil in Japan and Taiwan resulting in birth defects

Rachel Carson

- Renowned nature author
- Marine biologist - US Fish & Wildlife Service
- Friend alerted her to bird kills on Cape Cod, Massachusetts caused by the use of DDT
Silent Spring

- 1962 ‘landmark book’
- Scientific proof of the dangers of DDT, arsenic and other chemicals
- Meticulously described how chemicals enter food chain and harm wildlife

Conceived in Arrogance

“The ‘control of nature’ is a phrase conceived in arrogance, born of the Neanderthal age of biology and the convenience of man.”

- Rachel Carson (1962)
Opposition

✓ Harsh reaction of chemical industry
✓ Monsanto warns of devastation, famine, disease, and inconvenience resulting from banning pesticides
✓ Personal attacks question Carson’s integrity and sanity

Vindication

✓ Overwhelming scientific evidence, leading scientists supported Carson’s findings
✓ President Kennedy’s Science Advisory Committee fully vindicated *Silent Spring*
✓ Carson’s work sparked the environmental movement in the United States
Environmental Protection Agency

- EPA established on December 2, 1970
- Mission is “to protect human health and to safeguard the natural environment--air, water, and land--upon which life depends.”

Hazardous Waste

- 250 million metric tons hazardous waste produced each year
- In the recent past, 1/2 the amount of hazardous waste produced was indiscriminately dumped
- Defined by RCRA (separate from MSW)
Defining Hazardous Waste

- Exhibits hazardous characteristics
  - Ignitable (flash point) = D001
  - Corrosive (pH) = D002
  - Reactive (cyanide, sulfide) = D003
- Toxic (TCLP test)
  - D004 to D043
- Listed Waste
  - F, K, P, U

Laboratory Test Methods

- Organics
  - Volatile Organic Compounds (VOCs)
  - Semivolatile Organic Compounds (SVOCs)
    - Polynuclear Aromatic Hydrocarbons (PAHs)
  - Petroleum Hydrocarbons (TPH)
    - Volatile petroleum hydrocarbons (VPH)
      - Gasoline, mineral spirits, petroleum naphthas
    - Extractable petroleum hydrocarbons (EPH)
      - Kerosene, #2, 4 & 6 fuel oil, diesel fuel, jet fuel, lubricating oils
  - Pesticides
  - Herbicides
  - Dioxin/Furans (PCDDs, PCDFs)

- Inorganics
  - Metals (As, Pb, Hg, …)
  - Other (radon, F, …)
Love Canal

Niagara Falls, New York

History of Love Canal

- 1892 abandoned canal
- 1920s to 1950s
  - 20,000 tons dumped (80 chemicals)
- 1953 donated to city for $1
- Later, homes and an elementary school were built
- 1976-77 heavy rains trigger discovery
Love Canal Toxins

✔ Benzene, dioxin, DCE, chloroform, etc.
✔ Alleged miscarriages, birth defects, blood & liver abnormalities, chromosome damage
  – Health authorities could not link to Love Canal

Evacuation and Cleanup

✔ 1980 - President Carter visits Love Canal and provides funds to relocate 950 families
✔ Love Canal problem led to Superfund laws
✔ Cleanup continues
✔ Over $275 million spent on cleanup so far
Uncontrolled Sites

- Past uncontrolled dumping
  - Leaky drums, liquids in unlined pits, chemical waste abandoned in fields, dumped along roads
- 43,806 sites in CERCLIS
  - 32,582 sites archived
- 1,235 sites on NPL
  - Termed serious health threats
- Massachusetts
  - 335 in CERCLIS
  - 34 NPL sites

Other Environmental Crises

High Profile Events:

- 1986: Chernobyl
- 1984: Bhopal
- 1980: Three Mile Island
Responsible Management

- Resource Conservation and Recovery Act (RCRA)
  - "cradle to grave" approach
- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)
  - Superfund, Brownfields

Superfund Authorization

- Enacted in 1980
  - Re-authorized 1986
  - Expired in 1995
  - Still "operational" thru annual EPA budget appropriations
- Authorized federal government to respond to:
  - Spills
  - Releases of hazardous substances
  - Uncontrolled waste dumps
Super-funding

- $14 billion over 20 years
- Reimbursement from polluters
  - Liability
  - Deep vs. empty pockets
- Taxes on crude oil and 42 chemicals
- General treasury
- Congress suspended industry taxes in 1995
  - 1995: 79% industry, 21% taxpayers
  - 1999: 50% industry, 50% taxpayers
  - Trust fund depleted from $3.8 billion in 1996 to $0 in 2004
- Bill to reinstate industry taxes
  - Defeated in March 2003

Other Superfund Provisions

- National Contingency Plan (NCP)
  - EPA and Coast Guard
- National Priority List (NPL)
- ATSDR established
- States share cost
- Emergency Planning and Community Right-to-Know Act (EPCRA)
Superfund Goals

- Cleanup standards
  - Protective of public health and environment
  - Cost effective
  - Comply with state and federal laws

- Accelerate cleanup schedules
  - Relatively small number of sites cleaned up so far
    - This is due to groundwater contamination which is present at most sites and typically takes decades to reach cleanup goals

- Public involvement
  - Citizen task force, TAG grants

Superfund Progress

- Progress perceived as slow
- EPA reports “construction completion”
  - Actual completion can take decades
State Superfund Laws

- Massachusetts Contingency Plan (MCP)
  - 310 CMR 40.0000
  - Regulations adopted to implement M.G.L. 21 E
  - Administered by MADEP
    - Bureau of Waste Site Cleanup (BWSC)
  - MCP requires:
    - Release notification to MADEP
    - Timely response
    - Site classification
      - Tier I (serious), Tier II (less serious)
    - Determination of cleanup levels
      - Based on degree of risk, proximity to drinking water sources
        - S-1, S-2, S-3; GW-1, GW-2, GW-3

Federal Facilities

- Hundreds of sites identified
- Cleanup paid for by polluting agency
- Cleanup required before resale
- Military bases, weapons plants
Federal Agency Hazardous Waste Compliance Docket

✓ Hundreds of federal facilities listed


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<th>Facility Address</th>
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FAA Technical Center

✓ 5,000-acre aviation research center
✓ 8-miles northwest of Atlantic City, New Jersey
AOC 29 - Fire Training Area

Contaminants: Known mercury

Resource Concerns: Site presents potential risk to wetland protection areas, which are designed to prevent the contamination of groundwater and surface water resources. Site is located in proximity to wetland and shoreline areas, which are sensitive to contamination from hazardous wastes.

Data Sources: USGS, US EPA, NWR, NJ DEP GIS, NAIP, US Census

AOC U - Mercury Investigation

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Final ESCR

Lecture Slides Handout
Superfund Liability

- Determining when contamination occurred is important
  - Evaluation of breakdown products, sediment chronology, etc.

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<th>Symbol</th>
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<td>Palladium</td>
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Case Study

- Baird & McGuire Superfund Site
  - 1912-1983 chemical mixing & batching co.
  - Pesticides, herbicides, insecticides, wood preservatives, fertilizers, etc.
Contamination

- Arsenic, lead, dioxin, phenols, BTEX, DCE
- naphthalene, DDT, DDD, 2,4-D, 2,4,5-T
- Soil, groundwater, river sediments,
- Town of Holbrook water supply wells

Hydrologic Cycle
Subsurface Concepts

Groundwater Monitoring

✔ Chemical analysis, water level observation
Groundwater Plume

LNAPL

Light Non-Aqueous Phase Liquid (LNAPL)
Remediation Strategy

- Excavation and on-site incineration of soils and river sediments
- Groundwater pump-and-treat
- LNAPL recovery and off-site disposal

Groundwater

- Reverse natural groundwater flow
- Contain plume
- Treat water on-site
- Return treated water to aquifer
- Pollution reduction over long period
Water Treatment Process

- Equalization & Oil skimming
- Coagulation for arsenic and iron removal
- Aeration (stripping) with fume collection and treatment for organics
- Sand Filtration
  - Suspended solids
- Carbon Adsorption
  - Remaining organics

Treatment Objectives

- Drinking water quality Maximum Contaminant Level (MCL)
- Arsenic MCL
  - 50 µg/L (ppb) since 1942
  - Adopted by 1974 SDWA (interim)
  - Uncertainties
  - SDWA amendments
    - 1986: finalize by 1989
    - January 2001: MCL lowered to 10 µg/L
    - March 2001: 10 µg/L MCL rescinded
    - October 2001: 10 µg/L MCL re-instated
      - Effective 2006
Arsenic and Iron Removal

- pH adjustment
  - Lime slurry
- Coagulant addition
  - Ferric chloride, FeCl₃

Metals Removal Process

- Rapid mixing, slow mixing, sedimentation
Sludge

- Sludge thickening and dewatering
- Off-site disposal

Sampling and Analysis

- EPA methods
  - Metals
  - Volatiles
  - Semi-volatiles
  - Pesticides
  - Herbicides, dioxin
- Effluent and process control
Process Control

✔ Establish full-scale parameters
  – Detention time, mixing power, point of chemical addition

✔ Test a range of coagulant dosages and pH
  – Chemical and other analyses to find optimal conditions

Soil Incineration

✔ Thermal destruction of organics
✔ Stabilization of metals
Soil Incineration Process

Field Activities

✓ Excavation, backfill, dewatering, restoration
Incineration Process

- Dryer, Kiln
- Bag house, calciner
- Quench, wet scrubber
  - Wastewater issues

Incineration Process (Continued)

- Secondary Combustion Chamber (SCC)
- Stack to atmosphere
- Stack monitoring
  - Compliance
  - Routine
  - Continuous Emission Monitoring (CEM)
Trial Burn

✓ 99.99% organic DRE
✓ 99.9999% dioxin DRE
✓ Feed rates, temperatures

Other Monitoring

✓ Perimeter
✓ Meteorological
✓ Personal
Progress

✓ Ground water plume
  – Reduced

Wetlands

✓ Restoration underway
Public Attention

✓ Exxon Valdez
✓ Hanford, Wash.
✓ A Civil Action
✓ Erin Brockovich
✓ Libby, Montana

Libby Asbestos Project

✓ W.R. Grace
  vermiculite mine
  – Attic insulation, gardens
  – Contaminated with tremolite asbestos
✓ Non-occupational exposures
✓ Lawsuits, Grace declares bankruptcy

Source: Information based on materials presented in various civil actions brought by Libby miners and their families against W.R. Grace, Inc. Death certificates from 12 states, and from interviews by the FD with family members and physicians in Montana, Arizona, Washington, Oregon and California.
Libby Sister Sites

Plants that processed asbestos-tainted ore

Unintended consequences of Superfund

- Fear of liability drives development of “greenfields” contributing to urban sprawl
- Urban blight resulting from abandoned property
- Loss of jobs, tax base
Brownfields Definition

- Abandoned, idled, or under-used industrial and commercial facilities
  - Expansion or redevelopment is complicated by real or perceived environmental contamination
- Amenable to lightly contaminated sites

Brownfields Features

  - Empowers States, communities, and other stakeholders in economic development to work together in a timely manner to prevent, assess, safely clean up, and sustainably reuse brownfields

Key Features:
- Assessment grants
- Showcase communities
- Grants and revolving loans for clean up
- Job training programs
- Liability relief
- Tax incentives
Brownfields Legislation

- Had eluded Congress for several years
- Brownfields previously operated using Superfund authorization
- Two basic approaches:
  - Superfund reform
  - Stand alone legislation

New Brownfields Legislation

- Small Business Liability Relief and Brownfields Revitalization Act
  - January 11, 2002
- Major Provisions
  - Superfund Exemptions
    - De Micromis, MSW
    - Innocent owners
  - Funding
    - $200M per year
    - Petroleum-contaminated sites included
    - Grants to capitalize revolving loan funds for clean up
    - State programs
  - NPL Deferral
RCRA Background

- 1976 amendment to Solid Waste Disposal Act of 1965
- Defines solid and hazardous waste
- EPA sets standards for those who generate and manage hazardous waste

Other RCRA Features

- Prohibited open dumps
- Nuclear waste not covered by RCRA (Atomic Energy Act)
- Subtitle C: Hazardous waste management
Health & Safety Considerations

✔ Mine Safety and Health Administration
  – historical

✔ OSHA
  – 29 CFR 1910.120
    governs worker health & safety at CERCLA sites
  – medical monitoring
  – emergency response

Safe Work Practices

✔ Work zone designations
  – Exclusion, CRZ, support zones

✔ Decontamination procedures

✔ Personnel Protective Equipment (PPE)
  – Tyvek suits, respirators, boots, gloves
  – Levels A, B, C, D
Better Thinking

- Better management practices
- Pest control techniques suggested by Rachel Carson are now in use
- Example:
  - animal grazing
  - targeted pesticide use
  - introduction of natural enemies
  - selective removal of problem trees
  - planting of competing species and grasses