Hazardous Waste Regulations

(Caution: the regulatory world is full of acronyms. These are commonly used by everyone in the “hazardous waste business” so you should gain a familiarity with the vocabulary. It may be helpful to consult the “acronym list”.)

Federal regulations largely dictate the field of hazardous waste management, by defining what are hazardous wastes and what are contaminated sites. Any waste being defined as hazardous has a large amount of liability and regulatory requirements associated with it. This liability and regulatory tangle is, as you might imagine, also quite expensive. The costs are a big reason many companies are looking into alternative processes to avoid the initial production of hazardous wastes. This chapter provides an overview of the federal regulations pertinent to hazardous wastes and contaminated site clean-up. (The regulations are currently being updated and changed, so keeping current on these can be a full time job. Hazardous waste regulations frequently occupy an entire semester of an Environmental Law course.) State regulations are also important, and may be more stringent than the Federal standards. However, due to significant state-to-state variation, these regulations are not covered here. The chapter also includes an overview of the Brownfields legislation, which encourages site clean-up activities in industrialized areas on the state level. A final section briefly overviews the waste minimization strategy being encouraged by the government. For further information on regulations, you are referred to chapters in the Hazardous Waste Management textbooks by LaGrega et al. (1997) and Wentz (1995), in addition to the wealth of information that can be found on the web (US EPA site: http://www.epa.gov; or state-specific sites).

A summary of most pertinent regulations that you should at least recognize is shown in Table 1 below:

<table>
<thead>
<tr>
<th>Regulation</th>
<th>Year</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAA Clean Air Act</td>
<td>1970 1990</td>
<td>protect and enhance air quality; set primary and secondary Nat’l Ambient Air Quality Standards (NAAQS)</td>
</tr>
<tr>
<td>CERCLA “Superfund” (SARA amendments)</td>
<td>1980 1986</td>
<td>attempt to clean up sites contaminated by past activities; sets EPA authority, taxes to get money to pay for the clean-up of abandoned sites</td>
</tr>
<tr>
<td>CWA Clean Water Act (WQA Water Quality Act)</td>
<td>1977 1987</td>
<td>restore &amp; maintain the chemical, physical, &amp; biological quality of US waters; includes the Ambient Water Quality Criteria (AWQC) for human health and aquatic organisms; established Nat’l Pollutant Discharge Elimination Sys. (NPDES) which permits effluent concentrations for municipal &amp; industrial WW</td>
</tr>
<tr>
<td>EPCRA Emergency Planning &amp; Community Right-to-Know Act</td>
<td>1986</td>
<td>In response to tragedy at Bhopal, requires public disclosure of industrial chemicals on-site and risk management plans that are needed in case of an emergency</td>
</tr>
<tr>
<td>ESA Endangered Species Act</td>
<td>1973 1988</td>
<td>maintain populations of wildlife and plants that are threatened with extinction; also designates critical habitats</td>
</tr>
<tr>
<td>FIFRA Federal Insecticide, Fungicide, &amp; Rodenticide Act</td>
<td></td>
<td>set maximum levels for pesticides in food, procedure for pesticide storage and disposal</td>
</tr>
<tr>
<td>FWPCA Federal Water Pollution Control Act</td>
<td>1956</td>
<td>regulation of effluent and water quality stds</td>
</tr>
<tr>
<td>OSHA Occupational Safety and Health Act</td>
<td>1970</td>
<td>ensures safety of all working environments; includes hazardous waste clean-up activities</td>
</tr>
<tr>
<td>SDWA Safe Drinking Water Act</td>
<td>1974 1986</td>
<td>ensures the safety of drinking water in the U.S., set Maximum Contaminants Levels (MCLs) for compounds in drinking water</td>
</tr>
<tr>
<td>TSCA Toxic Substances Control Act</td>
<td>1976</td>
<td>regulates the manufacture, use, and disposal of chemical substances</td>
</tr>
</tbody>
</table>
The applicable regulations for currently generated wastes are:


RCRA Subtitle C set the criteria for identifying a waste as a “hazardous waste”. It also established the “cradle to grave” manifest system for wastes (which includes responsibilities for generators, transporters, and disposal/treatment facilities) and a permit system for treatment, storage, and disposal facilities (TSDFs). Also described in RCRA was subtitle D which established the Solid Waste Program.

1984 **Hazardous & Solid Waste Amendments (HSWA)**

Amendments to RCRA extended the initial regulations to include requirements for small quantity generators (SQGs, produce 100-1000 kg hazardous waste / month). It implemented a staged land ban on disposal of hazardous wastes, outlined requirements for underground storage tanks (UST) (Subtitle I), established a medical waste program (Subtitle J), and set corrective action and export notification requirements.

In 1995 there were over >20,000 RCRA-defined large quantity generators (LQGs) of hazardous wastes (>1000 kg haz waste/month) and >3000 TSDFs. The largest of the LQGs is the DuPont Chambers Works in Deepwater, NJ = 46.7 Mtons/yr generated

A waste is defined/identified as a Hazardous waste based on four criteria outlined in RCRA Subtitle C (CFR 40):

1. the waste is a specifically listed material (on one of 4 lists)
2. the waste exhibits 1 of 4 hazardous characteristics based on experimental testing
3. the waste is a mixture containing a listed waste, or is from the treatment, disposal, or storage of a listed waste

AND the waste is not specifically listed as an exclusion from RCRA solid or hazardous waste.

1 Hazardous Wastes Lists (4 lists):
each list contains specific waste groups with a number and a hazard code related to the four categories of hazardous waste characteristics (examples of each given)

- **F List** - wastes from non-specific sources
  includes waste solvents, electroplating, dioxin-bearing, wood preserving wastes, etc.
- **K List** - wastes from specific sources
  sources: wood preservation, inorganic pigments, organic chemicals, pesticides, explosives, petroleum refining, leather tanning/finishing, iron and steel manufacture; such as: wastewater treatment sludge from chrome yellow pigments, tar sludge from coking operations, etc.
- **P List** - acutely hazardous commercial chemical products
  warfarin >0.3%, dinoseb, parathion, arsenic trioxide, nicotine and salts, tetraethyl lead, etc
- **U List** - toxic commercial chemical products
  such as: creosote, DDT, lead acetate, mercury, 111TCA, warfarin<0.3%

2. Four Hazardous Waste Characteristics (TRIC)
   - **i. ignitable (D001, Haz Code I)**
     liquid with flash point <60°C, non-liquid capable under normal conditions of spontaneous and sustained combustion, ignitable compressed gas, oxidizer examples: methanol, toluene, acetone
   - **ii. corrosive (D002, Haz Code C)**
     liquid with pH <2 or pH >12.5; liquid which corrodes steel at rate >0.25 inch/yr example: sulfuric acid, hydrochloric acid, elemental fluorine, chlorine, and bromine
   - **iii. reactive (D003, Haz Code R)**
     normally unstable or reacts violently with water, forms explosive mixture with water, generates toxic gases when mixed with water, cyanide or sulfur and generates toxic gases
between pH 2 and 12.5, detonates if heated, detonates at standard temperature and pressure, listed by DOT as Class A or B explosive; example: Na metal, nitroglycerin

iv. toxic (D004 - D017, Hazard Code E or T)
   based on mg/L of listed toxic compounds in “extracted” material (TCLP or EPTOX test)
   concentrations >100x drinking water standard
   increases mortality, serious irreversible illness, or incapacitating reversible illness
   poses a significant present or potential hazard to human health or environment

4. Exclusions from RCRA Hazardous Wastes (regardless of having one of the 4 characteristics of a hazardous waste; list includes but is not limited to):
   Publicly-Owned Treatment Works domestic sewage
   radioactive wastes (regulated under Atomic Energy Act)
   household waste and ash waste from MSW incinerators
   agriculture waste including crop residue and manure
   mining overburden returned to mine site
   ash and scrubber waste from coal combustion
   solid wastes from ore extraction and refining
   secondary materials reclaimed and returned for reuse in original process

   The RCRA regulations cover the generators of hazardous wastes, transporters of the waste, and the treatment, storage, and disposal facilities (TSDFs) responsible for the final fate of the waste. This is termed “cradle to grave” waste management. There is a manifest system which is highly paperwork and tracking intensive, and ensures that the regulations are followed. If there is ever a future problem with the wastes, it also allows the proper persons responsible for the problems to be penalized.

   The generators of hazardous wastes are categorized based on the quantity the waste they produce:
   LQG = large quantity generator; produces >1000 kg hazardous waste/month OR >1 kg acutely hazardous waste/month
   SQG = small quantity generator; produces 100-1000 kg hazardous waste/month AND <1 kg acutely hazardous waste/month
   Conditionally Exempt SQG produces <100 kg haz waste/month AND <1 kg acutely hazardous waste/month

   These generator categories were initially regulated on different timetables. It is also interesting to note that the largest 10% of waste generators produce over 90% of the total quantity of hazardous wastes in the U.S. Many of these LQGs are also TSDFs. By treating generated wastes on-site, the companies save costs and shoulder the complete responsibility for proper treatment. In the past, companies have been held liable when people they contracted to treat their waste did not fully comply with treatment requirements (or the regulations later changed and made formerly legal activities inadequate).

   Note that industrial wastes may also fall under the RCRA Subtitle D Solid Waste Program, which contains most of the “excluded” hazardous wastes, such as wastes from agriculture, oil & gas production, mining, iron/steel, pulp/paper, municipal waste, etc.

REGULATIONS FOR CONTAMINATED SITES

1980  Comprehensive Environmental Response, Compensation, & Liability Act (CERCLA) aka. SUPERFUND
   revised the National Contingency Plan which allocates authority and provides cleanup management protocol
   established guidelines for inclusion of sites on the National Priorities List (NPL), based on the Hazardous waste site Ranking System (HRS)
   established Superfund, money to be used for cleanup of sites on the NPL, from money generated by taxes on crude oil, petroleum products, feedstock chemicals
established Post Closure Liability Trust Fund, applicable to RCRA facilities
defines hazardous substances by compiling lists from RCRA, CWA, CAA, & some TSCA
requires reporting of releases of hazardous substances to the National Response Center,
except for releases permitted under RCRA, CWA, CAA, or FIFRA
allows EPA to clean up, order abatement, and recover costs of clean up

1986 Superfund Amendments and Reauthorization Act (SARA)
expanded Superfund, and sources of the money
established a leaking underground storage tank (LUST) Trust Fund
included an Emergency Planning & Community Right-to-Know Act (EPCRA)
required reevaluation of the HRS
addressed cleanup criteria; changed settled provisions (liability and cost recovery)
ASTDR prepare list of haz. substances most commonly found at CERCLA sites

Superfund includes approximately 1300 sites on the National Priorities List (NPL) of worst sites. Of those NPL sites, remedial action construction is complete at only about 10%. Of the NPL sites, which can be ranked on the basis of the HRS scores (#1 being the very worst), many of the nationally famous cases are not actually ranked very high; for example, Valley of the Drums, Ky #96; Love Canal, NY #158; Times Beach, MO #492. Approximately 20% of the NPL sites are former municipal landfills, 10% are past recycling facilities.

In addition to the official “Superfund” hazardous waste sites, there are a number of other sites that are contaminated but not to the same extent. This includes: 36,000 sites in the CERCLA Inventory of Sites (CERCLIS); also an estimated total inventory of sites of 425,000 (US Congress Gov’t Acct Office 1991 report). Federal Facilities of the US government also account for 61,155 sites, with an estimated cleanup cost of $230 billion to $290 billion over the next 75 years. Types of Federal sites includes abandoned mines, former weapons manufacturing facilities, underground tanks, and landfills. (Defense Environmental Restoration Program Annual Report to Congress for Fiscal Year 1995)

1986 Emergency Planning & Community Right-to-Know Act (EPCRA)
The impetus for this regulation was the Bhopal accident in December 1984, when 40 tons of methyl isocyanate gas was released due to a tank explosion at the Union Carbide plant. There were 3500 people dead within days, and an estimated 6000-10,000 total deaths and approximately 20,000 people permanently injured.
set up Toxic Release Inventory (TRI)
requires companies which process >25,000 lb/yr or use 10,000 lb/yr of any of 654 listed chemicals to report all wastes generated and all releases and transfers of that chemical;
Total TRI: 3.2 billion lbs in 1993; 59% to air, 13% to land, 21% deep well injected, 7% to water in 1991 of 3.4 billion lbs total (note: Clean Air Act requires 90% reduction from the 1990 levels in the releases to the air)
top released compounds: ammonia, HCl, HPO4, MeOH, Toluene, H2SO4, acetone
TRI released compounds are not included in “hazardous waste”
EPCRA enables communities to protect themselves from catastrophic accidents via emergency response plans, public notification, etc.

Brownfields Initiative - to encourage redevelopment of contaminated sites in urban areas. Discussed further later.

Hazardous Ranking System (HRS)
The HRS is a method used to determine if a contaminated site is hazardous enough to be added to the National Priority List (NPL) and be eligible to receive money from the Superfund for clean-up. The original HRS established in 1980 CERCLA was revised in 1990.
Under the HRS, each site gets three overall “scores”:
Migration (Sm), Direct Contact (Sdc), and Fire/Explosion (Sfe)
After these 3 scores are combined using a specific formula, if total score (S-tot) exceeds 28.5, the site will be listed on the National Priorities List (NPL). This means that the site is a Superfund site whose clean-up is regulated under the U.S. Federal Government Environmental Protection Agency (EPA). If the total score is less than 28.5, the site falls under state or local jurisdiction for clean-up, but may still be included on the CERCLIS. This cut-off value of 28.5 was originally established in order to have a given number of sites on the NPL (of all the sites for which HRS values had been calculated at the time). This value therefore has no scientific basis in terms of risk to human health or the environment, but simply indicates an approximate, relative ranking of hazard.

1. Of the migration score (S-m), three migration routes are considered:
   air (Sm,a), groundwater (Sm,gw), and surface water (Sm,sw)
   The specific components to each migration score are:
   1. observed or potential release
   2. route characteristics
      for both observed and potential releases
      site characteristics relevant to each migration route
   3. containment
   4. waste characteristics
      toxicity/persistence (human and ecosystem)
      reactivity and incompatibility
      quantity
      mobility
      bioaccumulation
   5. targets
      small exposures to large populations
      maximally exposed individual
   Total Migration Score = \( \frac{(S_{m,a}^2 + S_{m,gw}^2 + S_{m,sw}^2)^{0.5}}{1.73} \)

2. Onsite Exposure Pathway (replaced direct contact, used for HRS score)
3. Fire and Explosion (not used in total HRS score)

** for each contaminated site, must consider exposures pathways during the RI stage

**General “PATH” for Remediation of Sites under Federal EPA Control:**

- site discovery -> preliminary assessment (PA) -> site inspection -> HRS score ->
- NPL listing -> RI/FS -> Record of Decision -> Remedial Design -> Remedial Action -> Closure -> post closure

**Remedial Investigation (RI)**
CERCLA - conduct a remedial investigation (RI) to determine extent of contamination at the site and the risk to public health and the environment

Three Levels in RI:
   I. Problem Identification and Scoping - use existing site information
   II. Problem Quantification - collect enough site samples and field data to:
      - identify contaminants
      - verify actual exposure pathways
      - characterize the site sufficiently to support screening of remedial alternatives
   III. Problem Quantification and Detailed Investigation
      - if level II data are insufficient, gather more data to allow detailed analysis of alternatives and selection of a cost-effective alternative
      - may involve bench and pilot-scale studies
The RI is linked to the Feasibility Study (RI/FS) and is “risk”-linked.

**Feasibility Study (FS)**
- characterize problem and ID general response actions & possible remedial technologies
- screen possible technologies for feasibility based on technical, environment and public health, and cost
- select Alternative Remedial Actions and analyze each in detail

Average Time Between Site Discovery by EPA and Completion of RI/FS = 8 years!!
Average time between listing on NPL and completion of remedy construction = 12 years!

New Program: Superfund Accelerated Clean-up Method (SACUM)
- This program began in 1992, and was designed to shorten the time spent in the “investigative” stage of the Superfund process in order to begin implementing remedies sooner.
- It was also hoped that this would save costs in the long run.

Generally the clean-up “standards” are determined in the **Record-of-Decision (ROD)** for the site (which follows the RI/FS), and the **Consent Decree** is signed. These clean-up levels are determined on the basis of “Applicable, Relevant, and Appropriate Requirements” (aka ARARs) or they may be risk-based. Current trends encourage the Risk-Based Clean-up Actions (or RBCA) over more traditional ARARs. In addition, past RODs which were “optimistic” in terms of clean-up standards have been subsequently renegotiated. For example, the Stringfellow site in California has had four different RODs over time (between 1983 and 1990). At many large sites, the overall project is broken down into smaller, more manageable pieces called “operable units”. Operable units (OUs) are a grouping of individual waste units based primarily on geographic area and common waste sources. There may be different RODs for each OU.

The standards “applicable” under ARARs could be drinking water standards (MCLs from the SDWA), TCLP or EPTOX levels from RCRA, Clean Air Act levels, etc. These were often difficult to attain on-site, particularly for groundwater clean-up aimed at Drinking Water standards. In response to lessons learned, the EPA published the “Guidance for Evaluating the Technical Impracticability of Groundwater Restoration” in 1993. And on the basis on this new guidance, many old RODs have been revised.

**Future of Hazardous Waste Regulations:**

Since passage of the SARA, recently three bills have been proposed in the legislature to Amend or Reform Superfund Act.
- Two bills in the House: Reform of Superfund Act of 1995
  - Superfund Reform Act of 1995
- Bill in the Senate: Accelerated Cleanup and Environmental Restoration Act of 1995

Note that these “proposals” can change daily, and keeping current is difficult. (However, visiting the government web-site can give you the most up-to-date information.
http://www.epa.gov/epaoswer/hwirwste.htm; and ...../hwirmdia.htm)

New Bills Include:
* language related to “risk assessment” and cost-benefit analysis for remedial actions
  - example1: “Remedies would protect human health and the environment from realistic and significant risks through cost-effective and cost-reasonable means.” HR 2500
  - example2: “Remedies would be selected among significant alternatives, giving consideration to:.... substitution risks, including short term risks posed by the implementation of the remedy to the affected community, to those engaged in the cleanup effort, ...and... the reasonableness of the cost of the remedial alternative.” HR 2500
example3: “...demonstrate that the chosen alternative is cost-effective...the incremental cost...will be reasonably related to the incremental risk reduction...considering both short and long-term costs.”

All these risks assessment actions have the problems of who will define “realistic and significant risks”? and who will determine what is a “reasonable” cost? Note that these questions involve placing a dollar value on human life and health. It also implies an accuracy in risk assessments so that a comparison can be made between short and long term risks. Whether or not our current knowledge base supports this assumption is debatable.

* changes in the liability provisions
  1. liability eliminated at municipal landfills
  2. liability for de minimis parties eliminated, releasing 10s of 1000s of small businesses from litigation
  3. “liability will be tied to “equitable factors” such as the amount of hazardous substances for which the party is responsible, the toxicity of the substances,...”
  4. limits the liability for natural resource damage of the responsible parties to $50 million, “fund” covers excess costs (up to $150 million)

* changes in the state role
  such as state costs reduced to 10% of total clean-up responsibility, and the states must agree with the addition of new sites to the NPL

* changes in the procedures for listing sites on the NPL
  “No more than a total of 125 sites can be listed on the NPL over the next seven years...increase the NPL by roughly 10 percent over its current level”
  after 7 years no more sites can be listed (!)
  ** this assumes that within 7 yrs all the bad sites will already have been discovered

* money issues related to the “super”fund
  Authorizes continued collection of the taxes which contribute to the fund, and dictates that these funds MUST be spent on clean-up and cannot be spent on EPA overhead.

**BROWNFIELDS AGENDA**

Brownfields are abandoned, idle, or underused industrial or commercial sites where redevelopment or expansion is complicated by real or perceived environmental contamination. Because redevelopment of these sites could aid urban renewal in many cities across the U.S., the EPA has established the “Brownfields Economic Redevelopment Initiative”. This plan empowers States, localities, and other agencies of economic redevelopment to work together to prevent, assess, safely clean up, and sustainably reuse brownfields. The benefits of the Brownfields Initiative will be realized through a cleaner environment, new jobs, and an enhanced tax base.

On January 25, 1995, EPA announced the Brownfields Action Agenda which outlines EPA’s activities and future plans to help implement the Brownfields Initiative. Implementation of this agenda will help reverse the spiral of unaddressed contamination, declining property values, and increased unemployment often found in inner city industrial areas, in addition to maintaining deterrents to future contamination and cleaning up the worst sites first. This agenda will continue to evolve with input from a range of stakeholders. The efforts outlined in the Brownfields Action Agenda can be grouped into four broad and overlapping categories:

I. Brownfields Pilots

EPA will select a minimum of 50 locations for Brownfields pilots by the end of 1996. The pilots, each funded at up to $200,000 over two years, will test redevelopment models, direct
special efforts toward removing regulatory barriers without sacrificing protectiveness, and facilitate coordinated public and private efforts at the Federal, State, and local levels.

II. Clarification of Liability and Cleanup Issues
   EPA is working with States and localities to clarify the liability of prospective purchasers, lenders, property owners, and others regarding their activities at a Brownfields site. The EPA will in specific situations not pursue future developers for clean-up liability. EPA anticipates that clear liability statements will alleviate concerns these parties may have and will facilitate their involvement in cleanup and redevelopment.

III. Partnerships and Outreach
   EPA is committed to building partnerships with States, cities, and community representatives and among Federal agencies to develop strategies for promoting public participation and community involvement in Brownfields decision making.

IV. Job Development and Training
   EPA Brownfields staff, local contacts, and community colleges have established partnerships to develop long-term plans for fostering workforce development through environmental education, ensure the recruitment of students from socioeconomically disadvantaged communities, provide quality worker training, and allow local residents an opportunity to qualify for jobs developed as a result of Brownfields efforts.

The specific activities and benefits under each of these four areas are summarized below.

I. BROWNFIELDS PILOTS
   The pilot project is intended to provide useful information and new strategies for promoting a unified approach to environmental assessment, cleanup, and redevelopment at Brownfields sites. EPA will work with cooperative agreement recipients and other stakeholders to better understand and overcome unnecessary or perceived liability barriers to the cleanup and redevelopment of brownfields. EPA has already seen dramatic results from the first $200,000 Brownfields pilot awarded in 1993 to Cuyahoga County (Cleveland), Ohio. As a result of this pilot, $1.6 million in private cleanup dollars has been leveraged, $110,000 in private foundation money has been invested, and over $625,000 has been generated in new tax dollars. In addition, nearly 100 new jobs have been created, with more expected in the future.
   Additional National pilots are currently underway, with EPA will funding a total of 72 Brownfields pilots at up to $200,000 each, to support creative two-year demonstrations of assessment activities leading to cleanup and redevelopment solutions. The benefits of these pilots are to:
   - Encourage community groups, investors, lenders, developers, and other affected parties to join forces and develop creative solutions to assess and clean up contaminated sites and return them to productive use;
   - Provide concrete data on Brownfields issues that highlight positive aspects of EPA's waste policies and identify areas that could be improved; and
   - Provide models of administrative, managerial, and technical processes from which others can learn as they set up processes to redevelop sites of their own.

II. CLARIFICATION OF LIABILITY AND CLEANUP ISSUES
   A significant barrier to assessing, cleaning up, and redeveloping brownfields is the public's apprehension about becoming involved with a site for fear of inheriting cleanup liabilities for contamination they did not create (as has been true under past Superfund legislation). Therefore EPA is clarifying relevant liability issues to encourage the purchase, cleanup, and redevelopment of sites that might otherwise be avoided due to an exaggerated sense of the risk of incurring Federal liability. Specific liability issues targeted by the Brownfields Initiative to date include prospective purchaser liability, the liability of owners of property containing contaminated aquifers, lender liability, municipal acquisition liability, and lender liability at Underground
Storage Tank (UST) sites. EPA also archived 24,000 of the 40,000 sites which had been listed in the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) database where no further Federal action is planned (completed February 1995). Many of these sites were found to be clean, while others are being addressed by State cleanup programs. The Federal government is unlikely to have any further Superfund interest in these archived sites. This action should reduce any stigma associated with Federal involvement at these sites and remove potential obstacles to their cleanup and redevelopment. EPA plans to improve access to information gathered during the investigations conducted at these sites and to further clarify the risk, or lack of risk, of incurring Federal liability at these sites. This will also clarify for the lending and business communities the distinction between archived sites and those remaining on CERCLIS, which will ultimately encourage cleanup and economic redevelopment of these properties.

Guidance on Agreements with Prospective Purchasers of Contaminated Property (Issued May 1995) states the situations under which EPA may enter into an agreement to not file a lawsuit against a prospective property purchaser for contamination that existed prior to the purchase. The benefit of these agreements is to eliminate the "retroactive liability" concern.

Policy Toward Owners of Property Containing Contaminated Aquifers (Issued May 1995) regards the liability of owners of uncontaminated property containing groundwater that has been contaminated by a neighboring property. This provides assurance that EPA does not anticipate suing the property owner for groundwater contamination if the owner did not cause or contribute to the contamination. This removes roadblocks to the redevelopment of these properties and allows the properties to be bought and sold free from the impediment of direct Federal liability.

Land Use in the CERCLA Remedy Selection Process (Issued May 1995) regards the increased consideration of anticipated future land uses in remedy selection decisions at NPL sites. The guidance encourages discussions among local land use planning authorities and the community as early as possible in the site assessment process. It also ensures that EPA considers future land use during Superfund cleanups which will speed and yield more cost-effective cleanups, in addition to garnering community support for selected remedies.

Model Comfort Letter for Transfers of Federally Owned Property (Issued August 1995) addresses issues concerning perceived NPL stigma and Superfund liability by clarifying some common misunderstandings about NPL listing and liability, and highlighting provisions concerning the transfer of Federally owned properties. It clarifies that parcels of military bases identified as uncontaminated under the Community Environmental Response Facilitation Act (CERFA) are not part of the NPL listing. This serves to reduce the perceived NPL stigma at closing military bases; and encourages the redevelopment of decommissioned military bases.

Underground Storage Tank (UST) Lender Liability Rule (Issued September 1995) clarifies when a lender may be exempt from UST liability, which removes a major barrier to financing the cleanup and redevelopment of UST sites, which constitute a large percentage of brownfields nation-wide.

Policy on CERCLA Enforcement Against Lenders and Government Entities That Acquire Property Involuntarily (Issued September 1995) EPA and the Department of Justice (DOJ) jointly explain their policy on CERCLA enforcement against lenders and government entities that acquire property involuntarily. The EPA and DOJ intend to apply as guidance the provisions of the "Lender Liability Rule" promulgated in 1992, and will not pursue cleanup costs from those lenders that provide money to an owner or developer of a contaminated property and do not actively participate in daily management of the property. CERCLA releases from liability governmental units that involuntarily take ownership of property through Federal, State, or local law. The benefits of this policy are to: increase the availability of financing for parties willing to assess, cleanup, and redevelop sites by assuring lenders they are not liable for cleanup costs of land they simply accepted as collateral for a loan; foster economic redevelopment efforts; and encourage municipalities to start the process of getting a site put back into productive use.
Draft Soil Screening Guidance (Issued December 1994) EPA issued guidance which will help decision-makers quickly determine which portions of a site require further study and which pose little risk to human health and may therefore be ready for redevelopment even without extensive cleanup. The benefits are to streamline the study of toxic chemicals in soils at Superfund sites; remove barriers that currently hinder the redevelopment of sites that pose little risk to human health; and allow cleanup efforts and funding to target the worst areas.

Risk-Based Corrective Action (RBCA) at Underground Storage Tank Sites (Initiated 1994) EPA has adopted the Risk-Based Corrective Action (RBCA) decision-making model at UST sites as a method of risk management. RBCA is a framework for considering both the contamination and the site-specific factors to determine the danger to human health and the environment from a given release. EPA is providing training to State UST program staff in this approach, enabling them to create systems appropriate for their own States. This allows environmental response action at all contaminated UST sites, while focusing resources on sites posing the highest risk; and allow more UST sites to be "closed," and thus available for reuse.

Corrective Action at RCRA Sites (December 1995) EPA is revising its corrective action regulations (the "Subpart S" rule) for RCRA sites, which exists to clean up currently operating hazardous waste TSDFs that are required to have a RCRA permit. These sites often contain inactive, contaminated plots awaiting cleanup. The benefits are to provide incentives for streamlined remediations at operating RCRA sites; create a consistent, holistic approach to RCRA facility cleanups; and establish a protective, common-sense cleanup goals at RCRA sites.

III. PARTNERSHIPS AND OUTREACH EPA is committed to building partnerships with States, cities, and community representatives to develop strategies for promoting community involvement in Brownfields decision making. EPA will continue to work with other Federal agencies on a national and local level to ensure a coordinated approach to the cleanup and redevelopment of brownfields. EPA is also forming partnerships with States, cities, and other organizations to streamline and improve Brownfields efforts. Specific activities and their associated benefits include:

Regional Brownfields Coordinators (Completed Spring 1995) Each of EPA's 10 Regions has designated a Brownfields Coordinator and Brownfields Team members to help guide Region-specific projects to promote brownfields assessment, cleanup, and redevelopment. This enhances communication between EPA Headquarters and the Regions, thereby keeping both abreast of new information in the brownfields arena and aiding coordinated efforts toward the development of national Brownfields Initiative strategies.

State Voluntary Cleanup Programs (Workgroup formed Spring 1995) EPA is working with States, other Federal agencies, and the Association of State and Territorial Solid Waste Management Officials (ASTSWMO) to assess how its possible endorsement of State voluntary cleanup programs could encourage brownfields redevelopment by assuring property owners that State approval of a voluntary cleanup holds virtually the same authority as Federal approval. This mitigates the threat of Federal involvement at sites cleaned up under "endorsed" State programs, streamlines the redevelopment processes at these sites, helps reduce the transaction costs of brownfields remediation, and allows Federal cleanup efforts and funding to target the worst sites first.

Revised Community Reinvestment Act (CRA) (Issued May 1995) EPA revised the 1977 CRA to support the goals of the Brownfields Initiative. Under the CRA, financial institutions are required to make loans to meet the needs of their communities, including low- and moderate-income areas. The regulations allow banks to meet their CRA obligations by making loans for the redevelopment of Brownfields, which provides incentive for financing Brownfields projects and represents the first time banks have been given CRA credit for environmentally-related lending.
NEJAC's Public Dialogues on Urban Revitalization and Brownfields (Conducted Summer 1995; follow-up ongoing)

The National Environmental Justice Advisory Council (NEJAC) conducted a series of one-day dialogues in 5 cities across the country in an effort to involve community groups and environmental justice advocates in the Brownfields Initiative. This served as a mechanism for getting information to the public, allowed EPA to gather input from and develop partnerships with affected communities, and connects other Federal agencies to communities to address problems related to grassroots urban revitalization. A report included a summary of the Public Dialogues and recommendations for improvements to the Brownfields Initiative.

Intergovernmental Personnel Assignments (IPAs) to States and Municipalities (On-going; at least one per Region by December 1995)

EPA has assigned 8 staff members, through IPAs, to help develop State and local Brownfields programs. This will help EPA develop an understanding of the challenges faced at the local level in implementing assessment, cleanup, and redevelopment efforts; and enhances the Brownfields Initiative by encouraging understanding among Federal, State, and local environmental agencies with common environmental and redevelopment goals.

Partnerships with Other Federal Agencies (On-going)

EPA signed a Memorandum of Understanding (MOU) with the Economic Development Administration of the Department of Commerce to consult on economic redevelopment and reuse of brownfields to ensure that sound environmental and economic development principles are followed, and to share knowledge and serve on advisory groups regarding brownfields projects. EPA is working with the Department of Labor (DOL) to provide the youth of Brownfields communities with environmental training and job opportunities through DOL's Job Corps program. EPA is working with the Department of Housing and Urban Development (HUD) to understand the factors that impact urban investment and redevelopment decisions, and to collaborate in cities designated as Enterprise Zones/Enterprise (EZ/EC) Communities, where appropriate. This provides a Federal forum for assisting in the transition from site assessment and cleanup to site redevelopment; assures that residents of Brownfields communities are trained for jobs that will allow them to benefit professionally from industrial activities associated with site cleanup; provides valuable information to ensure the successful evolution of the Brownfields Initiative; and provides a more comprehensive Federal approach in local communities through more effective coordination.

Common Sense Initiative (CSI) Industry Groups (On-going)

EPA launched the CSI to work with selected industries, environmental and public interest groups, State regulators, and other stakeholders to achieve "cleaner, cheaper, and smarter" environmental protection. EPA will seek the input of CSI industry groups on relevant brownfields activities. The Iron and Steel CSI sector group is already developing a brownfields strategy. This provides the opportunity to focus on industry-specific solutions to the economic redevelopment challenges of certain brownfields.

Research Efforts (On-going, initiated in 1993)

EPA is funding a series of studies that explore the scope and nature of the brownfields dilemma. Partners in these studies will include for-profit, non-profit, and government entities (including HUD, DOL, and the Institute for Responsible Management - IRM).

IV. JOB DEVELOPMENT AND TRAINING

EPA Brownfields staff, local contacts, and community colleges have established local partnerships to develop long-term plans for fostering workforce development through environmental education, ensuring the recruitment of students from socioeconomically disadvantaged communities, and providing quality worker training to local residents so they can qualify for jobs developed as a result of Brownfields efforts. EPA is working with the Hazardous Materials Training and Research Institute (HMTRI) to expand training and curriculum development at community colleges located near Brownfields pilot sites. This fosters workforce
development and prepares local citizens for Brownfields-related employment in their communities.

EPA provided Cuyahoga Community College (Tri-C) in Cleveland, Ohio, and the Rio Hondo Environmental Education and Training Center in Whittier, California, with funding to improve local workforce development through environmental education, outreach, and training. This funding assures that the areas’ redevelopment efforts have the trained workforce needed to revitalize contaminated properties. 

[source: http://earth1.epa.gov/swerosps/bf/ascii/action.txt (9/15/97)]

Successfully application of the Brownfield’s initiative has been accomplished in Rhode Island (O’Connor and Fine 1997). In 1995 the state passed an Industrial Property Remediation and Reuse Act. The state system uses generic, risk-based soil clean-up standards (a modified RBCA approach) and established a “freedom from liability” system. One specific case where this was useful was in allowing Weeden Street to purchase “impacted” property in an industrial park in norther Rhode Island, which allowed an expansion of existing facilities and creation of 40 to 50 jobs, generation of $60,000 to $75,000 per year in state income taxes, and payment of property taxes to the city. In addition, in the State of Colorado, under the Voluntary Cleanup Act, a site was remediated within 9 to 12 months costing $350,000 and is now being reused; similar clean-up under traditional CERCLA would have taken approximately 5 years and cost greater than $1 million (Duvel 1997). The benefits are clear!

References:
- Kissel, J.C. 1993. Course Notes from Haz Waste Mgmt, ENVH 446. Dept of Environ Health, Univ of WA.
Many contaminated site clean-up activities fall under state regulations. Regulated cleanup levels vary widely between states. In most states there is typically an option for achieving compound-specific concentrations in soil and groundwater versus a risk-based approach (RBCA). The most widely available guidelines are those for hydrocarbon-contaminated soil cleanup. A summary of the range of the cleanup levels across the different states is given in the table below:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cleanup Level, mg/kg</th>
<th>Parameter</th>
<th>Cleanup Level, mg/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPH</td>
<td>10-10,000</td>
<td>benzene</td>
<td>0.005-200</td>
</tr>
<tr>
<td>Total BTEX</td>
<td>10-100</td>
<td>benzo(a) pyrene</td>
<td>0.09 - 100</td>
</tr>
<tr>
<td>Total PAH</td>
<td>0.3-10</td>
<td>dibenzo(ah)anthracene</td>
<td>0.09-140</td>
</tr>
<tr>
<td>Gasoline Range Organics C6-9</td>
<td>5-1000</td>
<td>1,2-dichloroethane</td>
<td>0.02-15</td>
</tr>
<tr>
<td>Diesel Range Organics C10-24</td>
<td>10-5,000</td>
<td>ethylbenzene</td>
<td>0.1-12,000</td>
</tr>
<tr>
<td>Residual Range Organics C25-36</td>
<td>2000</td>
<td>fluoranthene</td>
<td>0.4-45,000</td>
</tr>
<tr>
<td>compound specific:</td>
<td>fluorene</td>
<td>1-24000</td>
<td></td>
</tr>
<tr>
<td>acenaphthene</td>
<td>0.6-22,000</td>
<td>indeno(123-cd)pyrene</td>
<td>0.66-280</td>
</tr>
<tr>
<td>acenaphthylene</td>
<td>0.003-11,000</td>
<td>lead</td>
<td>50-600</td>
</tr>
<tr>
<td>anthracene</td>
<td>0.3-29,000</td>
<td>MTBE</td>
<td>0.04 – 6100</td>
</tr>
<tr>
<td>benzo(a)anthracene</td>
<td>0.4-5.1</td>
<td>naphthalene</td>
<td>0.07-8600</td>
</tr>
<tr>
<td>benzo(b)fluoranthene</td>
<td>0.66-98</td>
<td>phenanthrene</td>
<td>0.02-29,000</td>
</tr>
<tr>
<td>benzo(ghi)perylene</td>
<td>2-45,000</td>
<td>pyrene</td>
<td>0.8-40,000</td>
</tr>
<tr>
<td>benzo(k)fluoranthene</td>
<td>1.26-250</td>
<td>toluene</td>
<td>0.1-23,000</td>
</tr>
<tr>
<td>chrysene</td>
<td>0.5-800</td>
<td>xylenes, total</td>
<td>0.1-230,000</td>
</tr>
</tbody>
</table>

Note the HUGE range!! This is pretty amazing. Of course, many of these are “site” or “case specific”. Of all the states, 29 listed one or more parameter concentrations as “site specific”. Some other states have “categories” of different concentration limits depending on:

- use of groundwater for drinking water, or not used for drinking water
- residential/non-residential/impacted groundwater
- classification of site depending on exposure potential/accessibility of soil, and use of groundwater
- direct exposure pathway for residential or workers; leachability categories

Some states list as few as 4 regulated parameters (generally these are the lumped parameters), while other specifically list as many as 23 regulated parameters. Clearly, these numbers illustrate the diversity of soil clean-up standards from state-to-state. Therefore, depending on the location of the site of concern, very different cleanup goals may be required. Close coordination with the appropriate state regulatory agency (such as the Dept. of: Environmental Management, Quality, Conservation, Control, Protection; Pollution Control and Ecology; Natural Resources) is always needed.
**Waste Management, Recycling, Reduction**

The current industrial schemes for hazardous waste management are now integrated waste management, which includes life-cycle costs and “cradle-to-grave” approaches. This has been brought about largely by the costs associated with hazardous waste treatment, and the public support of environmentally products. The heirarchy of preferred waste management options is:

1. source reduction, waste minimization, waste reduction, and pollution prevention
   - The primary goal is to minimize the quantity and/or toxicity of wastes produced
2. reuse
   - Production of products that can be re-used, so that they do not enter the waste stream. This includes strategies such as the use of refillable containers sent back to the manufacturer, rather than disposable containers.
3. recycling
   - The disposal of products which can be processed for their materials, and these processed materials are then recycled into new products.
4. waste treatment
   - 4a. with energy recovery, useable materials generation (composting)
   - 4b. physical, chemical, thermal, biological, etc.
5. disposal - landfilling

Each of these management options is described in more detail below.

### 1. Waste minimization, waste reduction, pollution prevention

The goal is to minimize quantity and/or toxicity of waste that is generated. Much of the manufacturing wastes are generated from process residues, including sludges, combustion ashes, slag, kiln dust, food processing residue, etc. RCRA Subtitle D covers most of these wastes which are non-hazardous or exempt from the hazardous waste rules. These Subtitle D wastes include 5.9 billion tonnes of wastes that are handled in on-site land based units such as surface impoundments, landfills, or waste piles; this translates into 390 million tonnes on dry weight basis. Of this total dry weight of waste, 35% is from the pulp and paper industry, 20% from the iron and steel industry, and 14% are from inorganic chemicals industries.

The waste minimization process involves looking at the raw materials currently used in the process, the equipment that is used, and current operating procedures. One first looks to good operating practices, to see if minor process modifications can significantly reduce the waste production. An evaluation of alternative raw materials (a change in solvent type to a less toxic form) and processes follows (would a different manufacturing process produce an overall reduction in waste production, and therefore a potential overall cost savings?).

Under the U.S. EPA’s 33/50 Program which was instituted in 1991, the EPA asked companies to voluntarily reduce the release and transfer of 17 high-priority toxic chemicals. They called for a stepwise reduction in the release and transfer of these chemicals, with a 33% reduction by the end of 1992 and 50% reduction by the end of 1995, both as compared to 1988 quantities. These 17 toxic chemicals were: Cd, Cr, Pb, Hg, Ni, benzene, MEK, MIK, toluene, xylenes, CT, CF, DCM, PCE, 111TCA, TCE, and cyanides.

### 2. Reuse

Reusing a product directly for its original purpose is an efficient way to prevent the entry of that product into the waste cycle. This includes refilling containers at a central location rather than buying a new one, internal reuse of cooling water in closed loop rather than flow-through systems (which were more commonly used in the past), etc.

### 3. Recycling

Recycling is familiar in the U.S. as the collection of plastic, paper, glass, and aluminum which is then re-manufactured into new materials. For example, plastics are melted and reformed, or glass is crushed, melted, and reformed. The most efficient form of recycling is in-plant or on-site recycling. This saves mixed waste separation problems and transportation costs. Most common products recycled on-site include water, solvents, oil, and solids such as “cutting waste”. Off-site waste exchanges are also common, such as one company giving its partially “used” solvents of reduced purity to other companies with processes that do not require the higher purity product. Post consumer waste recycling is more commonly associated with recycling, such as curb-side collection of separated newspaper, glass, and cans. Post consumer recycling is, however, less cost efficient.
European countries such as Germany and France have been most aggressive in passing legislative recycling incentives. The “Green Dot” program in Germany has legislated recycling targets, with a charge added to each item purchased to fund recycling costs (typically approximately 1.2 cents/item). In addition, green companies which meet targets for use of recycled materials are able to display the green dot, which lets consumers know the company is environmentally responsible.

4. Waste Treatment

There are a variety of waste treatment options available for industrial wastes, both “hazardous” and non-hazardous. The most common of these “Tier 1” preferred treatment approaches includes composting and incineration with energy recovery. In both of these treatment options, a useful by-product is generated from the treatment process. Composting includes City initiated collect and composting of yard waste, with compost sold back to citizens to fund the program (Des Moines, IA). Waste incineration with energy recovery is fairly common in the U.S., with 143 Waste-to-Energy Facilities operating in the U.S. These plants use so-called “refuse derived fuel” (RDF). Colorado’s only energy incinerator using RDF is located in Denver (at the airport) and generates steam energy; it is owned by the public utility. In many other states, RDF incinerators are also privately owned and/or operated. Many states have aggressive laws to encourage integrated waste management.

A variety of other waste treatment processes are available, although less preferred. Many are similar to traditional wastewater, water, and solid waste treatment approaches that you are familiar with from your other environmental engineering classes. Many of these treatment approaches are covered in detail in the Hazardous Waste Management textbook by LaGrega et al. (1997).

Life Cycle Analysis

Life cycle analysis (LCA) is somewhat different from the other waste management options discussed above, since it includes an analysis of the entire life cycle of a product when comparing manufacturing options. The life cycle of a product includes manufacturing, packaging, sales, distribution, transportation, consumer use, and final disposal. This differs from waste minimization, since that commonly only considers the manufacturing process. The three phases of LCA are:

1. Inventory - This is an objective, data-based quantification of the energy and raw materials requirements throughout the product lifecycle, including all releases to the air, water, and solid wastes. Steps within this phase include:
   a. Assembly of an LCA team
   b. Identification of the target processes for analysis
   c. Generation of a diagram the life cycle
   d. Identification of inputs and outputs (includes targets, location, media, and quantity)

2. Impact Analysis or Interpretation

   The impact analysis is an evaluative process to assess effects of the environmental findings identified during the inventory phase. This includes ecological, human, and economic impacts. Steps within this phase are:
   a. look at any applicable regulations
   b. look at non-regulated targets, specifically risk reduction

3. Improvement Analysis

   Analyze opportunities to reduce negative environmental impacts throughout the product life cycle. Specifically, evaluate alternative options and their relative costs and benefits.

Example LCA

An example of LCA was conducted by McDonald’s, who in 1990 initiated a policy of protecting the environment for future generations. They took a life cycle approach to reducing and managing solid waste. At that time, the McDonalds chain had approximately 8,600 restaurants in the U.S. which produced on average 238 lbs of waste/day, in addition to 34 regional distribution centers generating 900 lb waste/day. Their hierarchy of waste management was:

1. SOURCE REDUCTION: To reduce the toxicity or quantity of waste produced (prior to landfilling or incineration), they collaborated with suppliers by changing supplier specifications. Some examples of this include the change to unbleached paper cups and paper sandwich wraps; looking for alternative materials to polystyrene foam, and reducing the quantity of paperboard used in Happy Meal boxes. The average meal purchased at McD’s in the 1970’s generated 46 g of waste packaging material while the average meal in 1990s generates only 25 g
packaging material. This has resulted in an annual packaging waste reduction of 24 million pounds. In addition, McD’s only purchases materials from suppliers using “environmentally friendly” methods.

2. REUSE: There were few over-the-counter options that maintained the sanitation, speed, and quality of the food and service that could incorporate product reuse. Behind-the-counter reuse options included the use of plastic shipping pallets rather than wood (longer life) and reuse of some plastic items rather than disposable cardboard.

3. RECYCLING: McDonald’s made a commitment to use recycled materials where possible, such as non-food-contacting paper and building and renovation materials. They also tried polystyrene foam recycling with in-restaurant separation, but had poor “compliance” by the customers in self-separating the foam.

4. COMPOSTING: The company committed to the use of compostable materials for packaging, whenever possible, and to separate and collect these materials and send them to composting facilities.

In 1970, the Stanford Research Institute analyzed the manufacturing process through disposal, and concluded that polystyrene packaging was preferable to paperboard for cups and sandwich containers. Therefore, McD’s switched from the use of coated paperboard to the use of polystyrene clamshells for hamburger packaging. This switch to polystyrene actually cost McD’s approximately 0.5 cents more than the cost for paperboard; the cost of coated paper wrappers would be approximately 0.5 cents LESS than clamshells.

The LIFECYCLE ANALYSIS for selection of burger wrappers included:

- cost to extract raw materials
- manufacturing cost
- transportation of materials
- use and disposal of materials
- final fate

Of importance was the cost of each item, plus health and safety issues at each step. In addition, the likelihood of current and future use changes, cost changes, etc. is an important factor to consider. For example, currently 60-70% of the food sold at McD’s is take out; will this figure increase or decrease in the future? An outline of the LCA analysis for the more recent (1989) comparison of burger packaging material is shown below:

### POLYSTYRENE | COATED PAPER
--- | ---
**raw material acquisition**
crude oil production | logging operations (harvest planting, curing, yarding, loading & hauling, pesticides, soil erosion, power usage and equipment air emissions)
natural gas production |
transportation of Oil or Gas to proc. plant |
**“raw” Materials Manufacture**
natural gas processing | pulping (chemical or mechanical)
ethylene, benzene, & styrene production |
polystyrene resin | blowing agent production
**Final Product Fabrication**
extrude polymer in presence of blowing agent and form foam into desired shapes | bleaching
**Packaging and Transportation**
wrapped in PE sleeves, packaged in boxes, shipped by truck or rail | paper wraps packaged in corrugated boxes and shipped by truck or rail
**Disposal**
landfill, incineration, recycling, .. | landfilling, composting (if not wax coated or laminated), recycling

<table>
<thead>
<tr>
<th>Atmospheric Emmissions, lb per 10,000 units</th>
<th>Layered Paper</th>
<th>Polystyrene Foam</th>
<th>Paperboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waterborne wastes, lb / 10000 units</td>
<td>1.4</td>
<td>2.5</td>
<td>4.3</td>
</tr>
<tr>
<td>net energy required, mBTU/10000units</td>
<td>3.3</td>
<td>6.1</td>
<td>8.8</td>
</tr>
<tr>
<td>Total solid waste, cu ft per 10000 units</td>
<td>4.1</td>
<td>16.5</td>
<td>11.7</td>
</tr>
<tr>
<td>lb per 10000 units</td>
<td>130</td>
<td>160</td>
<td>382</td>
</tr>
</tbody>
</table>

**DECISION: LAYERED PAPER (NOV. 1990)**

Reference: Environ Eval/Mgmt Course #ES 4493/5493. Univ. of OK, M. Meo. 1995. ©CAPCO, OKC