Contaminated Sites from the Past – EPA Experience

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Setting the Stage

- **In the U.S., radioactively contaminated sites may be managed by local and state authorities or, at the federal level, by the Department of Energy (DOE), the Nuclear Regulatory Commission (NRC), the Department of Defense (DoD), or the Environmental Protection Agency (EPA), among others.**
- **This presentation focuses on sites where EPA either has the lead or has had significant input into cleanup decisions.**

Types of Contaminated Sites

- **Radium (and vanadium) sites from early 20th century**
- **Sites contaminated from atomic energy and nuclear weapons development programs (includes Manhattan Engineer District (MED) sites and Atomic Energy Commission (AEC) sites)**
- **Uranium mill tailings sites**
- **Sites contaminated from previously allowed practices or small accidental releases (includes nuclear, industrial, medical, research and military uses of radioactive material)**
- **Sites containing naturally occurring radioactive material (rare earth mining, oil and gas industry)**

U.S. Laws for Managing Contaminated Sites

- **No federal laws and regulations specifically addressed cleanup of radioactively contaminated sites until 1970s**
- **Legacy uranium milling sites and vicinity properties are cleaned up under the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA)**
  - UMTRCA is an amendment to Atomic Energy Act (AEA)
- **EPA and DOE may both use the process defined in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) for managing site cleanups**
  - EPA implements CERCLA through the Superfund Program
  - CERCLA/Superfund applies to all hazardous pollutants at a site
- **NRC regulations for cleanup and decommissioning of their licensed facilities are under their AEA authority**

UMTRCA

- **Uranium Mill Tailings Radiation Control Act (1978)**
  - Covers inactive and active U mill sites
  - UMTRCA identified 22 inactive mill sites
- **Using UMTRCA authority, EPA established cleanup standards for sites contaminated with buried and wind-blown tailings (40 CFR part 192, subpart B)**
  - General cleanup standard for Ra-226 in soil is 185 Bq/kg (given as 5 pCi/g) in top 15 cm; 555 Bq/kg below 15 cm (same value for Ra-228 at thorium sites)
  - 555 Bq/kg viewed as a finding tool for locating buried tailings, which were generally much higher in concentration

UMTRCA Sites

Moab Mill Tailings Site

CERCLA and Superfund

- **EPA's Superfund Program implements CERCLA**
  - CERCLA cleanup process is sometimes used by other agencies outside the Superfund program
- **For cleanup under Superfund, a site must first be listed on the National Priorities List (NPL)**
  - NPL listings are determined by a Hazard Ranking System score (for all onsite contaminants except natural background)
  - Cost of cleanup is shared by responsible parties ("polluter pays" doctrine), but the Superfund Program covers the cost of cleanup when no liable parties are identified
- **Superfund funding mechanism allows for stringent risk reduction goals to be achieved**

Overview of CERCLA Process

- **Preliminary Assessment/Site Investigation**
  - Initial site assessment
- **National Priorities List (NPL) Site Listing Process**
  - Uses Hazard Ranking System to identify highest priority sites
- **Remedial Investigation/Feasibility Study**
  - Site characterization phase; includes baseline risk assessment
  - Determination of options for remediation
- **Records of Decision (remedy selection)**
- **Final Steps: Cleanup activities, post-cleanup reviews, eventual removal from the NPL**

Superfund Sites

- **Except for mill tailings sites, most EPA radiation site cleanups are carried out using the CERCLA process**
- **Following cleanup, target residual risk goal is 10^{-4} to 10^{-6} excess cancers**
  - No more than ~ 1 lifetime excess radiogenic cancer among 10,000 individuals exposed at the cleanup level (95^{th} percentile lifetime exposure duration is 25 to 30 years)
  - At current risk estimates, this equates to a cleanup goal of around 100 to 150 µSv per year to a reasonably maximally exposed individual

Superfund vs ICRP 103

- **ICRP Pub. 103 recommends public dose reference levels for existing site cleanups in the range of 1 to 20 mSv/a, with optimization below the reference level**
- **CERCLA-based regulations in the U.S. result in radiation site cleanup goals that yield public doses that are typically 10 to 100 x lower than this range (i.e., in the lower end of ICRP recommended range for planned exposures)**
  - Cleanup goals generally set based on unrestricted future use
  - When unrestricted future use is not achievable, risk objectives may be met by limiting future site use to commercial/ industrial activities or other restricted access uses (park, game preserve, etc.)

Radium Sites from before ~1940

- **Curies discovered radium (RaCl) in 1898**
- **Some rare earth mining (e.g., vanadium) left behind radium in tailings**
- **Many radium sites associated with early 20th century uses and misuses of radium**
  - Radio-luminescent dials
  - Medical treatments (some legitimate) and quackery
  - Radium research activities
- **Many contaminated sites ignored or not discovered until mid-20th century or later**
- **Radium sites now cleaned up following CERCLA process**

Lansdowne, Pennsylvania Site (example of legacy radium site)

- **1924 – 1944: University of Pennsylvania physics professor enriched radium ore in his home**
- **1964: Pennsylvania Department of Health performs partial cleanup**
- **Pennsylvania informs EPA of site in 1983 and it is listed on NPL in 1985; Cleanup is federally funded**
- **Threat from radium and radon assessed in house and vicinity property**
- **Result: removal of 1,300 metric tons of contaminated building rubble and 3,700 metric tons of contaminated soil; Site removed from NPL in 1991**

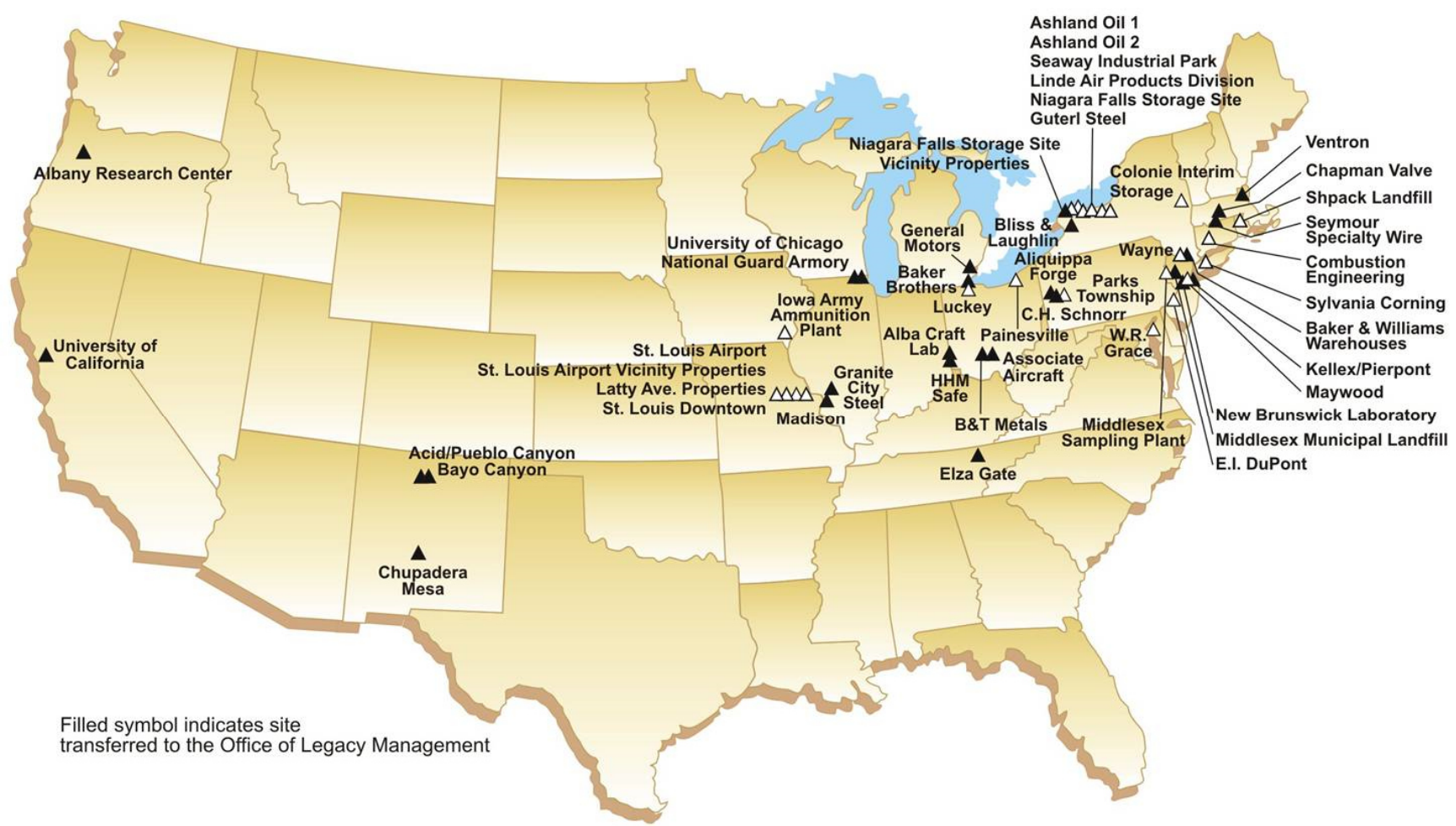
Montclair/West Orange Radium Site (legacy radium site in New Jersey)

- 469 residential properties and ten municipal properties (total of ~50 hectares) contaminated from nearby radium processing facilities that operated in early 1900s
- State of New Jersey discovered high indoor radon and gamma levels in 1983; listed on NPL in 1985
- Estimated that 170,000 m^3 of radium-contaminated soil was spread across the site over time
- Remedy involved excavation and off-site disposal of all radium-contaminated soil, followed by restoration of the properties (some residents temporarily relocated)
- Cleanup began in 1990, was completed in 2004, and site was removed from NPL in 2015

Formerly Utilized Sites Remedial Action Program (FUSRAP)

- **Program started in 1974 to address sites with contamination resulting from U.S. atomic energy and nuclear weapons programs (1940s – 1960s)**
  - Sites contaminated with low levels of uranium, thorium and radium, and their decay products
- **Cleanup responsibility transferred from U.S. Department of Energy (DOE) to the U.S. Army Corps of Engineers (ACE) in 1998**
  - Sites being cleaned up using CERCLA process
  - Following cleanup, sites transferred to DOE Legacy Management Program

FUSRAP Sites



Niagara Falls Storage Site (FUSRAP)

- **Site was used by MED/AEC from 1947 – 1952 to store residues from uranium ore processing**
- **Site is 77 hectares on federal land**
- **Radioactive waste is impounded in a 4 hectare interim waste containment structure**
  - 184,000 m^3 of soil contaminated with U-238, Th-230, Cs-137,and Ra-226; includes ~3,000 m^3 of Ra-226 at 19 MBq/kg (legacy Belgian Congo ore)
  - US ACE is in charge of ongoing site management and cleanup activities

Summary

- **EPA regulations under Superfund and UMTRCA have guided the cleanup of most legacy radiation sites since ~1980s**
- **Cleanup of existing exposure situations in the U.S. often results in residual doses to the public well below ICRP Pub. 103 reference levels**
- **EPA's management of contaminated sites uses the ICRP process of optimization to determine cleanup goals**
  - Superfund baseline risk assessments for determining risk-based cleanup goals rely on ICRP biokinetics and dosimetry
- **Legacy radiation site management in the U.S. is a continuing effort**

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