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# Fact Sheet: Environmental Characteristics of EPA, NRC, and DOE Sites Contaminated with Radioactive Substances

Quick Reference Fact Sheet

## BACKGROUND

Mathematical models that characterize the source, transport, fate, and effects of hazardous and radioactive materials are used to help determine cleanup priorities and select remedial options at sites contaminated with radioactive materials.

A joint Interagency Environmental Pathway Modeling Working Group has been established by the EPA Offices of Radiation and Indoor Air (ORIA) and Solid Waste and Emergency Response (OSWER), the DOE Office of Environmental Restoration and Waste Management (EM), and the Nuclear Regulatory Commission (NRC) Office of Nuclear Material Safety and Safeguards (NMSS). The purpose of the Working Group is to promote the more appropriate and consistent use of mathematical environmental models in the remediation and restoration of sites contaminated by radioactive substances.

The Working Group has published reports intended to be used by technical staff responsible for identifying and implementing flow and transport models to support cleanup decisions at hazardous and radioactive waste sites. This fact sheet is one of a series of fact sheets that summarize the Working Group's reports.

## REPORT

### Purpose

This report describes the range of site characteristics at sites contaminated with radioactive materials. The report briefly summarizes the overall waste types, waste forms, and site characteristics of Superfund sites that are contaminated with radioactive materials and sites in the NRC's Site

Decommissioning Management Program (SDMP).

## Contents of Report

The report includes an introduction and a brief overview of the statutory and regulatory programs administered by EPA and NRC to remediate abandoned hazardous waste sites. It provides an overview of site, contaminant, media, and receptor characteristics, a discussion of the data, and conclusions.

The full report describes 45 EPA and 38 NRC sites along with their location, administrative data, and NPL history. It lists the radioactive isotopes and the media contaminated at each site, provides data on the radiochemical and biological properties of identified isotopes, and summarizes the volume, concentration and physical form of the wastes. The environmental and geohydrologic characteristics of the site and characteristics surrounding the site are also noted.

## Method

Data for this report were compiled from various federal and non-federal databases and publications. The emphasis is on the 45 EPA sites containing radioactive materials. Fourteen of these are owned or operated by DOE. For completeness, 38 NRC sites also are reviewed, but the data for the NRC sites may be sparse in some cases. A total of 83 sites are included in the summary of data. For each site, the following information is provided:

- List of sites containing radioactive waste materials.

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- Types of radionuclides found at each site.
- Description of the physical forms of the waste.
- Description of the physical characteristics of the site itself.
- Overview of the demographic characteristics of the region surrounding the site.

Site characteristics were chosen based on usefulness in the selection of particular models. The implications for modeling contaminant mobility at these sites are discussed.

### Findings

Sites are broadly characterized (Figure 1) based on their historical use into nine general types:

- Scrap Metal Recovery.
- Fuel Fabrication and Processing.
- Commercial Manufacturing.
- Research Facilities.
- Low-Level Waste Disposal.
- Commercial Landfills.
- Radium and Thorium Sites.
- Mill Tailings, Processing, and Disposal Sites.
- Defense Plants (all DOE facilities).

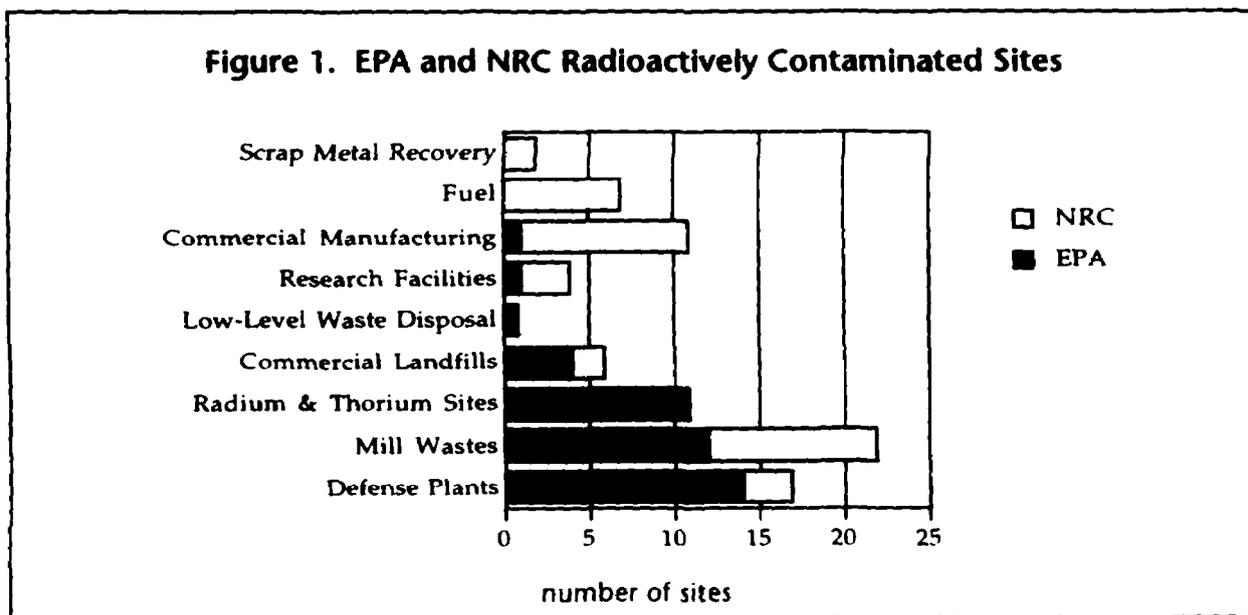
The sites described in this report differ greatly in the quality and quantity of information available

for characterization. One of the most common areas where data are scant is in the characterization of the source of radiochemical contamination. The absence of high quality data at a site may influence the choice and operation of environmental pathway models.

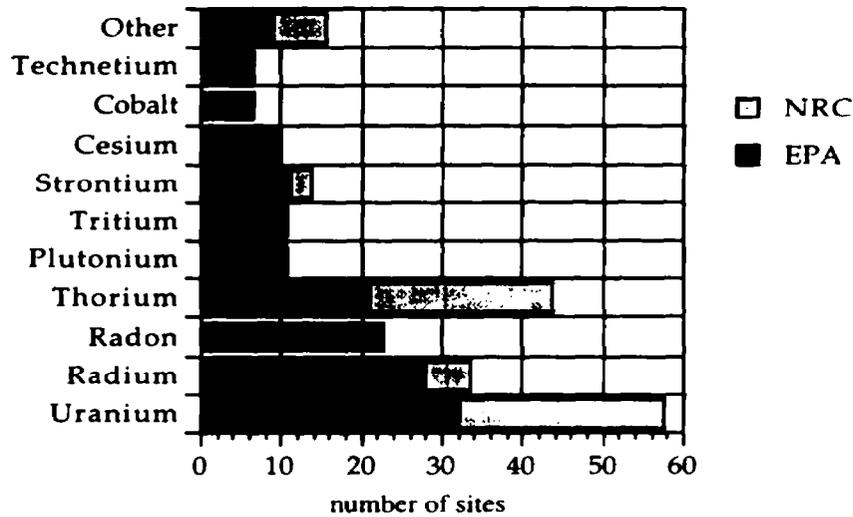
A total of 30 radionuclides were identified at the sites, with uranium, thorium, radium, and plutonium found most frequently (Figure 2). For these dominant isotopes, radioactive daughters may be created that have different chemical, physical, and biological properties from their parents. The principal health hazards at 25 of the 45 radioactively contaminated NPL sites are related to radioactive materials; organic chemicals present the major health hazard at the remaining NPL sites.

The sites cover all the major geologic terrains of the U.S. However, many of the NPL sites occur in either karst or volcanic terrains, where open fracture flow may be important. Although it was originally believed that ground water would be the dominant medium of concern, all exposure pathways are present in roughly equal amounts (Figure 3).

Sources of radioactive wastes can be classified as either a point source (a single location that can be precisely identified) or an area source (occurring



**Figure 2. Isotope Distribution at EPA and NRC Sites**



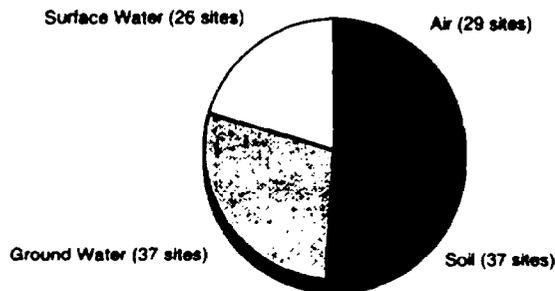
over a measurable area that may be difficult to identify). Only about 25% of the radioactive materials at NPL and SDMP sites can be considered to be point sources. The form of disposal varies widely and affects the type and rate of release of radioactive materials to the environment. Disposal practices included water-based, container-based, and ground-based disposal (Figure 4).

Simultaneous contamination of multiple media is the rule rather than the exception. In addition,

the contaminated media frequently is not homogeneous and the contaminants are found in diverse forms (gases, solutes, solids).

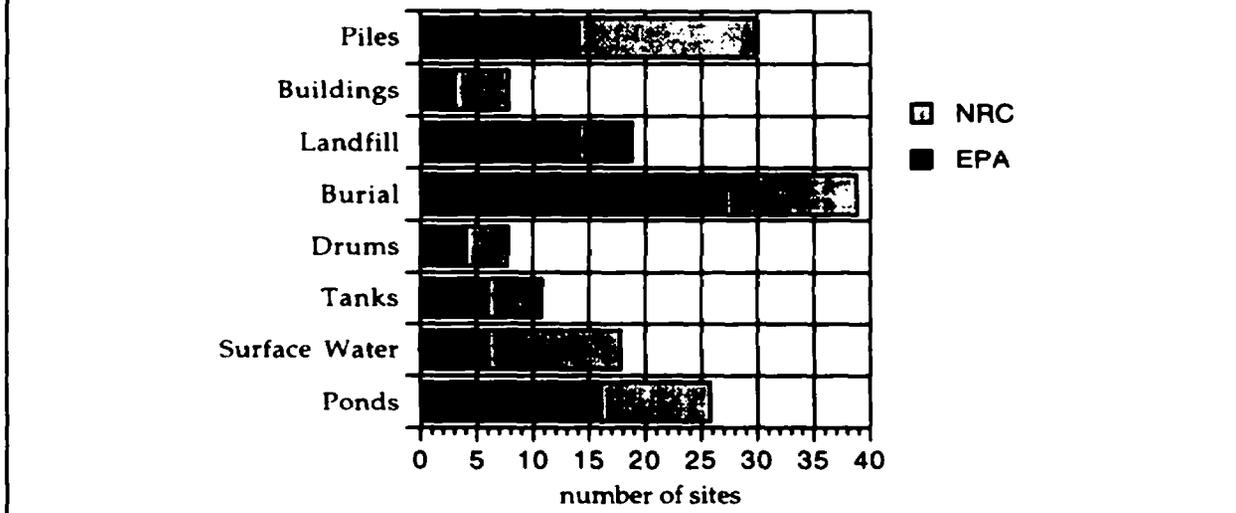
While the physical and chemical processes that control the concentration of a given substance may be complex, it may be possible at some sites to describe contaminant behavior with relatively simple approaches, such as using a sorption coefficient. However, this simple approach may not be valid for radioisotopes, such as uranium, that exhibit complex geochemical behavior strongly affecting contaminant mobility.

**Figure 3. Exposure Pathways at Radioactively Contaminated NPL Sites**



At present, there are few reliable estimates of the population potentially impacted now or in the future from contamination at these sites. Almost all sites are underlain by both confined and unconfined aquifers. Ground water at 33 of the sites is used for drinking water, and four sites are located above designated sole source aquifers. Approximately 70 percent of both NPL and SDMP sites are located in rural or suburban areas. Only seven NPL sites are in urban areas, and all of these are radium sites. Even under circumstances where two sites have the same or very similar environmental characteristics, there may be a need to employ different models where receptor characteristics exert an influence on the approach taken in modeling a given pathway for a site.

**Figure 4. Source Characterization at EPA and NRC Sites**



The 83 NPL and NRC sites reviewed here pose a wide range of challenges to the efficient use of models in environmental and health risk assessment. The findings imply that a mix of models capable of addressing the widest possible range of environmental characteristics may be needed. In addition, model strengths and weaknesses must be carefully examined within the context of the characteristics at any given site.

**CONTACTS**

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**REPORTS**

*Computer Models Used to Support Cleanup Decision-Making at Hazardous and Radioactive Waste Sites*, EPA 402-R-93-005, March 1993. Also available from the National Technical Information Center (NTIS), (703) 487-4650, PB93-183333/XAB.

*Environmental Characteristics of EPA, NRC, and DOE Sites Contaminated with Radioactive Substances*, EPA 402-R-93-011, March 1993. NTIS, PB93-185551/XAB.

*Environmental Pathway Models — Ground-Water Modelling in Support of Remedial Decision-Making at Sites Contaminated with Radioactive Material*, EPA 402-R-93-009, March 1993. NTIS, PB93-196657/XAB.

*Technical Guide to Ground-Water Model Selection at Sites Contaminated with Radioactive Substances*, EPA 402-R-94-012, September 1994. NTIS, PB94-205804/XAB.