Description of the Northwest Hazardous Waste Site Data Base and Preliminary Analysis of Site Characteristics

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WASTE SITE DATA BASE AND PRELIMINARY
ANALYSIS OF SITE CHARACTERISTICS

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PREFACE

The Northwest Hazardous Waste Research, Development, and Demonstration Center (the Center) was created as part of an ongoing federal effort to provide technologies and methods that protect human health and welfare and the environment from hazardous wastes. The Center was established by the Superfund Amendments and Reauthorization Act (SARA) to develop and adapt innovative technologies and methods for assessing the impacts of and remediating inactive hazardous and radioactive mixed-waste sites.

The Superfund legislation authorized \$10 million for Pacific Northwest Laboratory (PNL) to establish and operate the Center over a 5-year period. Under this legislation, Congress authorized the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) to each provide \$5 million to support research, development, and demonstration (RD&D) on hazardous and radioactive mixed-waste problems in Idaho, Montana, Oregon, and Washington, including the Hanford Site.

The mission of the Center's RD&D program is to advance the state of the art of technologies needed to manage hazardous and radioactive mixed-waste sites in the states of Idaho, Montana, Oregon, and Washington, including the Hanford Site. These advances may come about by developing new technologies or by adapting existing technologies. The Center's primary goals in support of this technology development mission are

- to adapt or improve existing technologies or develop new and innovative technologies for characterizing, assessing, and remediating hazardous and radioactive mixed-waste sites located in the Northwest and elsewhere in the nation
- to transfer these technologies to DOE, EPA, other federal and state agencies, communities, and the private sector for application to hazardous and radioactive mixed-waste problems in the Northwest.

In conducting this primary mission of technology development, the Center will seek to involve Northwest universities; federal, state, and local agencies; and private industry in the planning and conduct of its RD&D program. The Center will manage the cooperative RD&D involving these groups.

As part of the Center's RD&D planning process to identify technology needs, a data base of hazardous waste site characteristics was developed from information on Northwest hazardous waste sites included in EPA's Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS). An initial analysis of the characteristics of these sites has been performed to assist the Center in setting priorities for technology development. Both the data base and the results of this analysis are described in this report. For a more complete discussion of the Center's RD&D program and its technology development priorities see the Center's Program Plan for 1988 (PNL 1988).

EXECUTIVE SUMMARY

The Northwest Hazardous Waste RD&D Center (the Center) conducts research, development, and demonstration (RD&D) activities for hazardous and radioactive mixed-waste technologies applicable to remediating sites in the states of Idaho, Montana, Oregon, and Washington. To properly set priorities for these RD&D activities and to target development efforts it is necessary to understand the nature of the sites requiring remediation. A data base of hazardous waste site characteristics has been constructed to facilitate this analysis.

The data base uses data from EPA's Region X Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) and from Preliminary Assessment/Site Investigation (PA/SI) forms for sites in Montana. The Center's data base focuses on two set of sites--those on the National Priorities List (NPL) and other sites that are denoted as "active" CERCLIS sites. Active CERCLIS sites are those sites that are undergoing active investigation and analysis. The data base contains information for each site covering site identification and location, type of industry associated with the site, waste categories present (e.g., heavy metals, pesticides, etc.), methods of disposal (e.g., tanks, drums, land, etc.), waste forms (e.g., liquid, solid, etc.), and hazard targets (e.g., surface water, groundwater, etc.). As part of this analysis, the Northwest region was divided into three geographic subregions to identify differences in disposal site characteristics within the Northwest.

The analysis of the Northwest active CERCLIS and NPL sites addresses three basic questions:

1. Are technologies needed to remediate NPL sites the same as those needed to remediate the remaining active CERCLIS sites or are there significant differences?
2. Do technology development priorities differ significantly between the Northwest subregions?
3. What are the significant problems at hazardous waste sites that set priorities for development of treatment technologies?

The data base has been shown to be an effective tool for analyzing hazardous waste site characteristics and for assessing technology development needs, specifically the applicability of emerging treatment technologies. The data base will need to be updated regularly as new information on site characteristics is generated throughout the course of site investigations and assessments. The most useful data for the present set of analyses have been those on waste categories, waste forms, and disposal methods.

Heavy metal contamination was found to be the most common waste category, occurring at 46% of the Northwest sites. In addition, 42% of the sites in the data base had more than one waste category present, with heavy metals in combination with chlorinated aliphatics (solvents) the most common mixture. Consequently, remediation technologies that address heavy metals will have broad applicability throughout the Northwest, and methods that can deal with multiple waste categories will also be useful.

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The preparation of the data base was made possible by the cooperation of EPA Region X and Region VIII. Region X shared data from its CERCLIS data base for the states of Idaho, Oregon, and Washington. Region VIII shared PA/SI data forms for the state of Montana. We also thank James N. Hartley for his extensive review of a previous draft of this report.

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1.0 INTRODUCTION

This report summarizes an analysis of hazardous waste site characteristics in the Northwest and describes a data base of site characteristics that has been constructed.

1.1 PURPOSE

The purpose of this study was to help the Northwest Hazardous Waste RD&D Center (the Center) establish its research, development, and demonstration (RD&D) priorities to meet the technology needs of Northwest and the Hanford Site hazardous and radioactive mixed-waste sites. To properly target technology RD&D activities it is necessary to have a clear understanding of what remedial action requirements the technologies must meet. In part, the remedial action requirements are dictated by the Superfund Amendments and Reauthorization Act (SARA) process, including Remedial Investigation/Feasibility Study (RI/FS) activities. In addition, the remedial action requirements are also dictated by the characteristics of the sites themselves; that is, the types of wastes present, the methods of disposal and containment, and the nature of the threat to the environment. Based on a knowledge of site characteristics (problems) and availability of proven and emerging technologies, technology gaps can be identified. Understanding the site characteristics is an important element in setting technology RD&D priorities. This work goes hand in hand with ongoing reviews of the state of the art of technologies for site characterization, environmental and human health assessment, and waste treatment.

Some of the hazardous waste sites in the Northwest have been identified as proposed or final National Priorities List (NPL) sites requiring further characterization, assessment, and possibly remediation. These waste disposal sites have released, or pose a significant potential for releasing, toxic substances to the environment. In addition, the waste disposal sites located at the Hanford Site in southeastern Washington contain radioactive mixed wastes. Other federal RD&D programs address the development of some waste site assessment and remediation technologies, but there is a need to focus

and integrate technology development for waste types and site conditions specific to the Northwest region, including the Hanford Site.

1.2 OBJECTIVES OF THE STUDY

The objectives of this study include the following:

- provide support to the Center in setting RD&D priorities by providing an in-depth examination of Northwest site characteristics and needs
- develop a data base and demonstrate its application to support planning by the Center and other agencies needing information on Northwest hazardous waste sites.

1.3 GEOGRAPHIC DESCRIPTION OF THE NORTHWEST REGION

For purposes of analyzing variations in site characteristics, the Northwest region was divided into three distinct geographic subregions. These subregions, as shown in Figure 1.1, are identified as

- Cascade - the Cascade Mountains and the region west of those mountains
- Intermountain - the region between the Cascade and Rocky Mountains
- Rocky Mountain - the Rocky Mountain areas of Idaho and all of Montana.

The geographic characteristics within these subregions have influenced the development of industry and commerce and therefore the types of hazardous wastes and disposal sites. The geographic characteristics have also influenced the manner in which hazardous wastes threaten resident populations and the environment.

The Cascade subregion is characterized as a marine environment. Rainfall in most of this area exceeds 30 inches per year. A major portion of the soils of this subregion is volcanic in origin and has been transported by water and deposited in sedimentary layers. Groundwater tables in this region are generally shallow, typically less than 50 feet deep. The forests

FIGURE 1.1. Location of Northwest Hazardous Waste Sites

west of the Cascades are highly productive, resulting in a major forest products industry that produces pulp and paper, lumber, telephone and power poles, and railroad ties. The region contains several large metropolitan areas, particularly on the coast of Washington and Oregon. These areas have numerous secondary industries that take advantage of the international trade opportunities afforded by major seaports and support the primary Northwest industries.

The Intermountain subregion lies in the rain shadow of the Cascade Mountains. This subregion is characterized by less than 30 inches of rainfall per year and by porous volcanic soils that have generally been wind deposited. The groundwater tables in this subregion are much deeper, typically 150 to 200 feet, than those west of the Cascades. The economy of the area is dominated by dry land and irrigated agriculture and by food-processing industries. In addition to agriculture, the economy is influenced by the defense and energy research and development operations conducted at the Hanford Site. Located in the Columbia Basin, the Hanford Site receives very little precipitation (approximately 7 inches per year) and is relatively isolated from large metropolitan areas.

The Rocky Mountain subregion was formed by geologic processes, resulting in an area rich in minerals. Precipitation is somewhat higher than in the

Intermountain subregion, facilitating significant timber production. The soils in this subregion are a mixture of volcanic (from eruptions outside the region) and nonvolcanic soils; the region is also characterized by deep groundwater tables. Predominant economic activities in this area are those associated with the mineral (mining, milling, smelting, and refining) and timber industries.

1.4 OVERVIEW OF THE REPORT

This report describes an electronic data base that has been prepared to support the Center's RD&D planning activities. Section 2.0 describes the structure and composition of the data base as presently configured and summarizes the types of questions it can answer or its capabilities. Section 3.0 illustrates the application of the data base to some issues of interest to the Center. Section 4.0 draws some conclusions from this initial effort relative to the implications of the data for setting technology development priorities and for determining extensions to the data base. The Northwest sites included in this report are currently on the U.S. Environmental Protection Agency's (EPA's) Comprehensive Environmental Response, Compensation, and Liability System (CERCLIS) data base.

2.0 NORTHWEST HAZARDOUS WASTE SITE DATA BASE

2.1 SOURCES OF DATA

Several sources of information, primarily from EPA, were used to develop a data base of hazardous wastes sites located in Washington, Oregon, Idaho, and Montana. EPA's Region X Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) provided site characteristic data for sites in Washington, Oregon, and Idaho. Data for Montana sites were obtained from Preliminary Assessment/Site Investigation (PA/SI) forms provided by EPA's Region VIII. Information is considered current through December 1987. Sources of information, however, are in draft form and subject to change by EPA, which is continually updating its CERCLIS data base as new information is obtained. This includes, but is not limited to, changes in status (i.e., NPL, active, or inactive), changes in estimates of site characteristics, such as waste categories, waste forms, and disposal methods, or the addition of new sites to the data base.

The two primary sources of EPA information vary somewhat in format and content. More detailed information was available from PA/SI forms regarding specific hazardous waste chemicals than from the Region X CERCLIS data base. Therefore, while Montana site information is available in greater detail in the data base, for purposes of comparison with other states, a common format was developed to merge the two data sets. The intent is to provide a useful working tool for the Center, allowing flexibility to update the data base as needed or as more information becomes available.

2.2 SITES INCLUDED IN THE DATA BASE

The EPA's CERCLIS data base includes all of the sites currently identified as posing a risk or potential risk to human health or the environment. After initial analysis, which generally includes a PA and/or an SI, the site is evaluated and scored using the hazard ranking score (HRS) system. As the system is currently used, scores greater than 28.5 make a site eligible for the NPL. For the purposes of our analysis, sites that are undergoing the initial data gathering and PA/SI investigation are considered active CERCLIS

sites. However, sites that have been reviewed and determined to not pose a risk to human health and the environment remain on the CERCLIS, but are considered inactive. Therefore, there are three subgroups of sites within the CERCLIS: 1) inactive CERCLIS, 2) active CERCLIS, and 3) NPL sites. The analyses in this report are based only on NPL and active CERCLIS sites. Availability of information on inactive sites is usually minimal.

There are currently 1074 sites entered into the data base used for this report. For the purpose of this analysis of waste site characteristics, sites have been placed into one of the following three status categories:

- NPL sites - There are currently 41 sites in the four states listed on the NPL. These sites have scored greater than 28.5 on the HRS and are eligible for Superfund monies for site remediation. A list of these sites is provided in Appendix A.
- "active" status sites - There are 653 sites on active status. These include sites recently listed on CERCLIS and sites currently being evaluated in the PA/SI process. Also listed are sites that have completed the PA/SI process and did not score greater than 28.5 on the HRS, but are still considered to pose some risk to human health or the environment.
- "inactive" status sites - These sites have completed the PA/SI process and are considered not to be a threat to human health or the environment; no hazardous substance exists at the site, or if any exists it is of minimal concern; or the site is regulated under other legislation.

The recent inclusion of federal facilities under the new SARA guidelines is reflected in the data base. Some federal facilities are now included on the NPL or in active CERCLIS status. For this analysis the Hanford area sites are listed as four active status sites (administrative units) corresponding to the 100, 200, 300, and 1100 areas.

2.3 DESCRIPTION OF SITE INFORMATION INCLUDED

This section describes the format and type of information included in the data base. Table 2.1 is an example of a record form used for each site. Six areas of information entered were:

1. site identification and location
2. type of industry and site owner
3. waste categories
4. methods of disposal
5. waste form
6. hazard targets.

2.3.1 Site Identification and Location

EPA's identification number is assigned to each site at the time it is listed on CERCLIS. The site name, city, county, and state information entered are self explanatory. One site may have several commonly used names;

TABLE 2.1. Sample Record Form Used to Record Data for Northwest Sites

<u>Example Site Form</u>		
ID #:	Industry:	Priority:
Name:	PRP:	NPL:
City:		
State:	Land Disposal:	Soil:
County:	Tank Disposal:	Surface Water:
Longitude:	Drum Disposal:	Groundwater:
Latitude:	Pile Disposal:	Drinking Water:
Region:	Spills:	
Acres:	Disposal Comments:	
H Metals:	Liquid Waste:	
Chlor Aliph:	Solid Waste:	
Chlor Aromat:	Sludge:	
Nonchlor Arom:	Dust & Gas:	
Nonchlor Alip:	Waste Form Comments:	
Cyanides:		
Tox Anions:	Total Categories:	
Pesticides:	Total Disposal:	
Munitions:	Total Forms:	
Radioactive:		
Category Comments:		

however, the name used in this data base is the one found in the CERCLIS data base. Longitude and latitude information is entered when provided, primarily for Montana sites. Site acreage is available and entered for approximately 20% of the sites. This information, however, measures acreage owned rather than acreage or volume contaminated and thus does not represent overall site hazard.

Sites are divided into three distinct geographic subregions:

- Cascade (CA) - the Cascade Mountains and areas to the west
- Intermountain (IM) - the region between the Cascade and Rocky Mountains
- Rocky Mountain (RM) - the Rocky Mountain areas of Idaho and all of Montana.

Figure 1.1 shows the general delineations of each region. In most cases entire counties are placed within a particular region; however, in some instances, several sites located in one county might be placed in two different geographic regions based on geographic circumstances. Table 2.2 shows a breakdown of the number of sites in each subregion for active and NPL status sites.

2.3.2 Type of Industry and Owner

More than 20 types of activities or industry types are documented in the data base. These are agriculture and related practices, chemical processing, electronics, government disposal, junkyards and salvage operations, laboratory/hospital, manufacturing, metal processing and finishing, military

TABLE 2.2. Distribution of Site Status by Northwest Subregions

	<u>Active CERCLIS</u>	<u>NPL</u>	<u>Total</u>
Cascade	392	20	412
Intermountain	173	12	185
Rocky Mountain	88	9	97

operations, mining and smelting operations, paint stripping, private disposal, private residences, public utilities, road oiling, trade, transportation, and wood and paper industries. The following 10 most commonly occurring activities are examined in this report:

1. agriculture and related
2. chemical processing
3. government disposal
4. private disposal
5. manufacturing
6. metal processing/finishing
7. military operations
8. mining and smelting
9. wood and paper
10. other.

Government and private disposal refers to either licensed sanitary landfills, sites where illegal dumping practices have occurred, or both. Government or private refers to ownership of the site.

Government-owned sites are further divided into federal, state, county, municipal, or Indian land. Some sites claim joint ownership by a combination of several branches of government, or joint private and public ownership.

2.3.3 Waste Categories Present

The following 10 categories of hazardous waste are catalogued: heavy metals, four types of organics (chlorinated aliphatics, chlorinated aromatics, nonchlorinated aliphatics, and nonchlorinated aromatics), cyanides, toxic anions, pesticides, munitions, and radioactive wastes. For the purposes of this report, waste category analysis was performed for five commonly occurring waste types:

1. heavy metals
2. pesticides
3. chlorinated aliphatics
4. chlorinated aromatics
5. nonchlorinated aromatics.

Heavy metals, for example, constitute one waste category even though more than one heavy metal may be present in the waste. In a similar manner, hazardous waste compounds for which the same treatment technology would be appropriate were categorized together. The categories included heavy metals, pesticides, chlorinated aliphatics (solvents, etc.), chlorinated aromatics (PCBs, PCPs, etc.), and nonchlorinated aromatics (PAHs, oils, etc.). The remaining types of hazardous waste are much more site specific and collectively are only a small percentage of the waste categories.

2.3.4 Waste Form

Four waste forms are included in the data base:

1. liquid waste
2. solid waste
3. sludge or slurry
4. dust and/or gas (e.g., resuspended particles and volatile organic compounds).

The information addresses the waste form either at the time of disposal based on historical record or at the time of a site inspection. Many sites have more than one waste form present.

2.3.5 Waste Disposal Method

Four commonly used methods of containerizing or disposal of hazardous wastes are recorded. These are

1. land disposal
2. tank disposal
3. drum disposal
4. pile (mine/mill tailings) disposal.

If leaking tanks or drums are present, they are recorded in land disposal as well as tank or drum disposal. Sites with piles of scrap metal or other material accumulating on the land surface are recorded as land disposal rather than pile disposal. Pile disposal is used exclusively for mining and milling wastes. Again, as with waste forms, numerous sites have more than one disposal method listed.

2.3.6 Total Waste Categories, Waste Forms, and Methods of Disposal

Total numbers of waste categories (up to five), waste forms, etc., are tallied for each site. This information is useful in determining the "complexity" of a site or, for example, to determine the difference in complexity between NPL sites and other active CERCLIS sites.

2.3.7 Hazard Target

Information regarding potential human or environmental hazard targets (i.e., exposure routes) can be obtained for each site. Data are recorded as alleged, potential, or observed. Currently, information is entered for the following exposure routes at NPL sites:

1. soil
2. surface water
3. ground water
4. drinking water.

Other hazard target information available includes worker exposure, population exposure, soil contact, direct contact, air contact, flora damage, and fauna damage.

2.3.6 Total Waste Categories, Waste Forms, and Methods of Disposal

Total number of waste categories (up to 15), waste forms, etc., are listed for each site. This information is used in determining the "complexity" of a site or, for example, to determine the difference in complexity between HPL sites and other active CERCLA sites.

2.3.7 Hazard Targets

Information regarding potential human or environmental hazard targets (i.e., exposure routes) can be obtained for each site. Data are recorded as exposed, potential, or reserved. Currently, information is entered for the following exposure routes at HPL sites:

1. soil
2. surface water
3. ground water
4. drinking water

Other hazard target information available includes worker exposure, population exposure, soil contact, direct contact, air contact, flora damage, and fauna damage.

3.0 ANALYSIS OF WASTE AND SITE CHARACTERISTICS

The analysis of the Northwest CERCLIS and NPL sites addresses three basic questions:

1. Are the technologies needed to remediate NPL sites the same as those needed to remediate the remaining CERCLIS sites, or are there significant differences?
2. Do technology development priorities differ significantly between the Northwest subregions?
3. What are the significant problems at hazardous waste sites that set priorities for development of treatment technologies?

In answering the last question, the data base was used to determine the applicability of a specific treatment technology currently under development by the Center. The purpose of this analysis was to use the data base to determine the number of sites where the technology could potentially be applied. To address each of these questions, the CERCLIS data were divided into subgroups: NPL sites, other active CERCLIS sites, and inactive CERCLIS sites. Section 2.2 contains a more detailed description of these three sets of sites. Only the first two sets are used in this analysis.

3.1 COMPOSITE ANALYSIS OF SITES

3.1.1 Approach

Before the questions posed above were addressed, the aggregate characteristics of all the active CERCLIS sites were reviewed--a total of 694 sites including the NPL sites. These results indicate the overall prevalence of various waste categories, methods of disposal, waste form, and industry type (i.e., site owner). In addition, three measures of site complexity were computed: the number of waste categories per site, the number of waste forms per site, and the number of disposal methods used per site. For example, the number of sites with one waste category, two waste categories, three waste categories, etc., were identified. The waste forms included liquids, solids, sludges, and dust and gas. Finally, the complexity was also evaluated by the

various methods of disposal found at the site. The methods include direct or indirect land disposal, tank disposal, drum disposal, and mine/mill tailing disposal.

3.1.2 Results

Figures 3.1, 3.2, and 3.3 indicate the percent of all active CERCLIS sites (including NPL sites) with various waste categories (Figure 3.1), disposal methods (Figure 3.2), and waste forms (Figure 3.3). The percentages shown on each of the figures exceed 100%. This is the result of more than one waste category, waste form, and method of disposal being employed at a given site.

The most prevalent waste category is heavy metals, while the second most prevalent category is solvents (chlorinated aliphatics).^(a) Figure 3.2

FIGURE 3.1. Distribution of Waste Categories Present at Active CERCLIS and NPL Sites

- (a) Prevalence, however, should not be equated to hazard. Waste quantity, mobility, and toxicity data are not included in the data base, and as a result these statistical results do not represent "risk" or hazard. These data merely provide an overall picture of what waste types are present.

FIGURE 3.2. Distribution of Disposal Methods Used at Active CERCLIS and NPL Sites

FIGURE 3.3. Distribution of Waste Forms Used at Active CERCLIS and NPL Sites

indicates that direct disposal to the land was the predominant method of disposal. Solid waste, which occurs at 49% of active CERCLIS and NPL sites, is considered the least mobile form. While dust and gas are mobile, they represent only 5% of the waste forms that one might expect to encounter. The remaining two forms, liquid (73%) and sludge (43%), represent a significant percentage of the waste forms present at these sites (Figure 3.3). These waste forms, when used in combination with direct disposal to the land, pose a significant potential for contaminated vadose (unsaturated soil) and saturated (groundwater) zones. This potential will be examined in greater detail in Section 3.3 of this report.

Figure 3.4 indicates the industry type for NPL and active CERCLIS sites. The three major industry types associated with hazardous waste sites are disposal by government entities (federal, state, and municipal), chemical processing, and wood product-related activities in descending order of prevalence.

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FIGURE 3.4. Distribution of Industry Types for Active CERCLIS and NPL Sites

Figures 3.5, 3.6, and 3.7 are displays of site complexity. Figure 3.5 relates to waste categories, Figure 3.6 to waste forms, and Figure 3.7 to methods of disposal. Figure 3.5 shows the percentage of sites that have one waste category per site (58%), two waste categories per site, etc. Unlike the previous three figures, these totals equal 100%. Therefore, while 58% of the sites in the Northwest have one waste category, 42% of the sites have two or more waste categories per site. The implication of this analysis is that treatment technologies will have to be able to treat multiple types of waste or they will need to be sufficiently compatible to be linked together to develop a remedial action that treats multiple waste types. One treatment technology will not be sufficient to remediate a site unless it is a relatively simple site, and the statistics from Figure 3.5 would suggest that such is not the case at many hazardous waste sites. Further discussion of this point will be addressed in a subsequent section of this report. As previously discussed with waste categories, the waste forms and methods of disposal also show complexity. Figure 3.6 illustrates the percentage of

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FIGURE 3.5. Complexity--Sites with Multiple Waste Categories

FIGURE 3.6. Complexity--Sites with Multiple Waste Forms

FIGURE 3.7. Complexity--Sites with Multiple Disposal Methods

each waste form (solid, liquid, etc.) to be found at waste disposal sites. Two or more waste forms are found at 55% of all sites. Remedial actions must deal with multiple categories of waste and multiple waste forms. In addition, complexity caused by multiple methods of disposal per site must be considered. Figure 3.7 shows the number of methods of disposal per site. Two or more methods of disposal (landfills, tanks, etc.) were employed at 42% of the CERCLIS and NPL sites.

In summary, hazardous waste sites are complex--displaying multiple waste categories, forms, and disposal methods. Actions necessary to remediate a site will, in all probability, have to treat more than one waste type, in more than one setting, and in multiple forms. This complexity requires a technology or group of technologies that have to meet complex site cleanup objectives. Some technologies may be targeted to clean up organics in the soil/waste matrix, while other technologies may address the groundwater environment.

3.2 COMPARISON OF NPL AND ACTIVE CERCLIS SITES

3.2.1 Approach

In directing resources for treatment technology development, the Center needs to know the potential applicability of the proposed technology. NPL sites are first in line for remediation, but many other active CERCLIS sites and other sites not yet identified will also require remediation. One question to resolve is whether technologies appropriate to remediate NPL sites will also be appropriate to remediate the other active CERCLIS sites. The greater the similarities between the two sets of sites, the wider the applicability of technologies developed for NPL sites.

These two sets of sites were compared using four characteristics: 1) waste categories, 2) waste forms, 3) method of disposal, and 4) industry type. There are 41 NPL sites and 653 other active CERCLIS sites used in this comparison.

3.2.2 Results

Figures 3.8, 3.9, and 3.10 illustrate waste categories, waste form, and method of disposal, respectively, for the NPL sites versus other active CERCLIS sites. Figure 3.8 shows that while some minor differences exist between the two groups of sites, the character of waste types is relatively similar. For example, within each group, heavy metals are the most prevalent waste type followed by chlorinated aliphatics (solvents) and nonchlorinated aromatics (oils, fuel, PAH, etc.). One exception is the relative prevalence of nonchlorinated aliphatics. This category of chemicals includes compounds such as methyl ethyl ketone (MEK) and methyl isobutyl ketone (MIBK). These compounds are typically used as feed stock materials and extractants. This waste category is found less frequently at active CERCLIS sites than at NPL sites.

Figure 3.9 compares waste forms for the two groups of sites. Again, while differences exist between the two groups, liquids were the predominant waste form at the time of disposal.

Figure 3.10 indicates the distribution of disposal methods for the wastes. While some minor differences exist between the NPL and other active CERCLIS sites, they are considered insignificant. Only 2% of the NPL sites

FIGURE 3.8. Waste Category--Active CERCLIS Versus NPL Sites

FIGURE 3.9. Waste Forms--Active CERCLIS Versus NPL Sites

FIGURE 3.10. Method of Disposal--Active CERCLIS Versus NPL Sites

(i.e., one site) did not have wastes disposed directly to the land. Direct disposal to land was the most frequently occurring disposal method for both sets of sites.

Figures 3.11, 3.12, and 3.13 examine the relative complexity of the two groups of sites. Figure 3.11 indicates a difference between the two groups

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FIGURE 3.11. Waste Category Complexity--Active CERCLIS Versus NPL Sites

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FIGURE 3.12. Waste Form Complexity--Active CERCLIS Versus NPL Sites

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FIGURE 3.13. Disposal Method Complexity--Active CERCLIS Versus NPL Sites

of sites with regard to waste category. A higher percentage of active CERCLIS sites have only one waste category per site, while the NPL sites more frequently have three, four, or five waste categories per site. The NPL sites are more complex than the active CERCLIS sites in terms of the technologies that will need to be linked to form an effective remedial action. However, because the individual waste categories at NPL and other active CERCLIS sites are similar, the appropriate technologies will be similar. The apparent greater complexity for NPL sites may be the result of more complete data collection for those sites, while the other active CERCLIS sites are still undergoing the data collection process.

Figure 3.12 also supports the argument that the NPL sites are more complex than the other active CERCLIS sites. While multiple waste forms per site occur in both categories of sites, they are much more prevalent at NPL sites. This is particularly evident for the percent of sites at which there are three or four different waste forms to be found--45% for NPL sites and 16% for other active CERCLIS sites.

Figure 3.13 also indicates greater complexity for the NPL sites. This evidence, however, is not as strong as is shown in the two previous figures.

NPL sites show a greater fraction with two and four methods of disposal per site, but the other active CERCLIS sites show a greater fraction with three methods of disposal.

These results suggest that the NPL sites tend to be more complex than the remaining active CERCLIS sites. The question remains whether technologies developed for application at NPL sites will be useful for remediating the other active CERCLIS sites. The conclusion to be drawn from the data is that technologies are needed to remediate multiple waste categories in multiple forms. In addition, development of remediation methods appropriate for NPL sites will also remain useful and appropriate for other active CERCLIS sites. Primary waste categories of concern are heavy metals, solvents, and nonchlorinated aromatics (e.g., PAHs). Further, combinations of these wastes can be expected at a given site, although this complexity will be somewhat more prevalent at NPL sites. Therefore, development of a treatment technology useful at a "typical" NPL site will remain useful for a "typical" active CERCLIS site, although differences between the two groups of sites appear to exist.

3.3 ANALYSIS OF NORTHWEST SUBREGIONS

3.3.1 Approach

The Center is responsible for developing and transferring technology for hazardous waste problems within the Northwest. The Northwest includes the states of Montana, Idaho, Oregon, and Washington. As discussed in Section 1.3 of this report, the region exhibits a wide variety of geographic characteristics. To facilitate analysis of the region, three subregions were defined, each having a different set of characteristics. The following analysis examines two issues: 1) whether the hazardous waste site characteristics justify this subdivision; and 2) assuming differences do exist, are the technology development needs of the three subregions different? All active CERCLIS sites within the four states were separated into the Cascade, Intermountain, and Rocky Mountain subregions on the basis of location. The Rocky Mountain subregion includes the entire state of Montana, including the eastern portion of Idaho. To address the two issues cited above, the method

of data analysis was similar to the approach used in Sections 3.1 and 3.2. Data in this section are reported for a composite set of 694 sites consisting of both the other active CERCLIS and NPL sites.

3.3.2 Results

Figures 3.14, 3.15, and 3.16 indicate the percentage of sites, by sub-region, containing each waste category, waste form, and method of disposal, respectively. Figure 3.14 shows that the relative prevalence of the waste categories differs across the subregions. Heavy metals remain the single most prevalent category of hazardous waste within the Cascade and Rocky Mountain subregions. Pesticides, however, are the most prevalent category in the Intermountain subregion. Differences also exist between the Cascade and Rocky Mountain subregions. Solvents are more common in the Cascade sub-region, while chlorinated aromatics (PCBs) are more likely to be found in the Rocky Mountain subregion. These data indicate that subregional differences do exist and that treatment technologies applicable in one subregion may be less applicable to sites within a different subregion. In establishing priorities for technology development, the total number of sites should be considered--the Cascade subregion has more active CERCLIS sites than the

FIGURE 3.14. Subregional Characteristics--Waste Categories

FIGURE 3.15. Subregional Characteristics--Waste Form

FIGURE 3.16. Subregional Characteristics--Disposal Methods

two other subregions combined. These statistics, however, do not reflect the extent of the hazard nor the magnitude of the population at risk.

Figure 3.15 shows the distribution of waste forms used in each of the subregions. The three subregions have very similar distributions of waste forms. Liquids are the predominant form and are present at almost 75% of the

sites in each of the subregions. Similarly, the method of disposal, as shown in Figure 3.16, does not show significant variation across subregions with one exception--mine/mill tailings disposal in the Rocky Mountain subregion. Together, the data on Figures 3.15 and 3.16 suggest the potential for ground-water contamination, because of the relative prevalence of both direct disposal to the land and liquid waste forms. When both methods are used, the potential for percolation through the soil column to the groundwater is present. This issue is addressed in more detail in Section 3.4.

Figure 3.17 shows the distribution of site owners by industry type for each subregion. Again, categories, subregional differences are apparent. For example, chemical processing, mining/milling, and wood and paper are more prevalent in the Rocky Mountain subregion while manufacturing is more prevalent in the Cascade subregion. These data confirm the premise that the environmental setting influences the industry types and therefore the hazardous waste categories that appear most frequently. The Cascade subregion has

*Includes electronics, salvage, lab-hospital, public utility, trade, transportation, and private residences

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FIGURE 3.17. Subregional Characteristics--Industry Type

more industries concerned with the final steps in the production process. The Rocky Mountain subregion contains more industry involved with primary extraction (i.e., mineral mining, milling, smelting, and refining) and harvesting (timber) and the initial preparation steps in the production process.

3.4 COMPLEX MIXTURE FREQUENCY

The information contained in the data base can be viewed in various combinations to provide insights into the applicability of specific waste treatment technologies. As noted earlier, the potential for groundwater (and vadose zone) contamination is present when there was direct disposal to the land of a waste form that is either a liquid or a sludge. By selecting only those sites at which this "higher" degree of threat to the soil column or groundwater is present, we can then identify a subset of sites for further analysis. This "filtered" data set consists of 465 sites in the entire region.^(a) The Cascade region contained 279; Intermountain, 125; and Rocky Mountain, 61 sites in the "filtered" data. This subset of sites was then further segmented by the waste categories present at each site. Consequently, we can identify those contaminants that potentially may reach either the soil column or the groundwater and that may need to be treated by a remediation technology.

The "filtered" data base (i.e., the subset of sites with a high potential for groundwater contamination) was further sorted to identify the most prevalent mixtures of hazardous wastes. Table 3.1 displays the results for the entire Northwest region. The most prevalent combination was heavy metals and chlorinated aliphatics (22% of all sites) followed by chlorinated aliphatics and nonchlorinated aromatics (20%). While these combinations are the two most frequently occurring, many other mixtures also occur.

(a) Out of the original 694 active CERCLIS and NPL sites, 465 met the criteria for this filtered data set; that is, they have a liquid or sludge waste that is disposed directly to the land.

TABLE 3.1. Prevalence of Hazardous Waste Mixtures for Sites with High Groundwater Contamination Potential--Northwest Region, Percent of Sites (n = 465)

	<u>Heavy Metals</u>	<u>Pesticides</u>	<u>Chlorinated Aliphatics</u>	<u>Chlorinated Aromatics</u>	<u>Nonchlorinated Aromatics</u>
Heavy Metals	45	8	22	8	19
Pesticides		32	10	4	8
Chlorinated Aliphatics			39	8	20
Chlorinated Aromatics				22	12
Nonchlorinated Aromatics					38

Table 3.2 presents the "filtered" data for each subregion. As indicated above, the sites are only those receiving liquids or sludges disposed directly to the land. The diagonal of each table indicates the total percentage of all sites in this subset that have the indicated waste category present. Because we are using the "filtered" data set rather than all active CERCLIS sites, the percentages do not match those shown in Figure 3.14.

For sites within the Cascade subregion the most prevalent waste mixtures are

1. heavy metals and chlorinated aliphatics (solvents)--25%
2. chlorinated aliphatics and nonchlorinated aromatics--22%
3. heavy metals and nonchlorinated aromatics--19%.

For the Intermountain subregion, the most common waste mixtures in order of occurrence are

1. heavy metals and chlorinated aliphatics--19%
2. chlorinated aliphatics and nonchlorinated aromatics--18%
3. heavy metals and nonchlorinated aromatics--16%.

For the Rocky Mountain subregion the most common waste mixtures are

1. heavy metals and nonchlorinated aromatics--25%
2. chlorinated aromatics (PCB) and nonchlorinated aromatics--16%.

TABLE 3.2. Prevalence of Hazardous Waste Mixtures for Sites with High Groundwater Contamination Potential--Northwest Subregions

	<u>Heavy Metals</u>	<u>Pesticides</u>	<u>Chlorinated Aliphatics</u>	<u>Chlorinated Aromatics</u>	<u>Nonchlorinated Aromatics</u>
<u>Cascade Subregion - Percent of Sites (n = 279)</u>					
Heavy Metals	50	11	25	8	19
Pesticides		25	11	3	9
Chlorinated Aliphatics			46	8	22
Chlorinated Aromatics				20	12
Nonchlorinated Aromatics					39
<u>Intermountain Subregion - Percent of Sites (n = 125)</u>					
Heavy Metals	36	6	19	8	16
Pesticides		50	11	6	8
Chlorinated Aliphatics			33	7	18
Chlorinated Aromatics				17	11
Nonchlorinated Aromatics					31
<u>Rocky Mountain Subregion - Percent of Sites (n = 61)</u>					
Heavy Metals	41	2	13	10	25
Pesticides		23	2	8	5
Chlorinated Aliphatics			18	7	13
Chlorinated Aromatics				38	16
Nonchlorinated Aromatics					49

While the Intermountain and Cascade subregions show marked differences when evaluated on the relative distribution of single waste categories (see Figure 3.14), the two subregions are quite similar in terms of the waste mixtures that may be present. Also, site complexity as measured by the average number of waste categories per site is similar (see Figure 3.14). The Cascade subregion has 1.6 waste categories per "typical" site, while the Intermountain subregion has 1.5 waste categories per "typical" site. This measure of complexity is slightly higher when based on the "filtered" data set; i.e., those sites that have potentially contaminated groundwater. The average number of waste categories per site for the Cascade subregion is 1.8; for the Intermountain subregion it is 1.7. In summary, within these two subregions it is likely that if groundwater contamination has occurred it was caused by two waste categories. Moreover, the required remedial actions will need to address similar sets of complex mixtures in these two subregions.

The above conclusion, however, is not as valid for the Rocky Mountain subregion. While site complexity, as measured by average number of waste categories per site, is comparable (1.5 for all sites in the subregion and 1.7 for sites that have potentially contaminated groundwater), the priorities for the most prevalent waste mixtures differ from those found in the other two subregions. Consequently, the required remedial actions may differ. The technology development priorities are not the same for the Rocky Mountain subregion as they are for the other two subregions.

3.5 EVALUATION OF A TREATMENT TECHNOLOGY

This filtered data base was used to assess the potential applicability of a specific waste treatment technology under development by the Center. The technology chosen for this example evaluation was the catalytic destruction technology (Baker and Sealock 1988). The process reduces organics to methane and carbon dioxide in the presence of a catalyst. The process is effective for organic wastes (0.1 to 30 wt%) in aqueous streams (surface or groundwater), provided no strong oxidant is present to "poison" the catalyst. Work is under way to determine if this is a major problem for this technology. Chlorinated organics produce hydrochloric acid, which can act as a

strong oxidant and may foul the oxidant. Consequently, this technology is currently more applicable to sites that have nonchlorinated aromatics but no chlorinated aromatics. In this case, the data base was used to determine the number of sites with potentially contaminated groundwater for which the catalytic destruction process would be an appropriate remediation technology. Table 3.3 shows the number and percentage of potential sites in the Northwest region where this treatment technology might be applicable.

While 40% of all sites in the Rocky Mountain subregion have nonchlorinated aromatics present (Figure 3.15), only slightly more than half (22.7%) are potential sites for application of the catalytic destruction process. The Cascade subregion shows the greatest potential for application of this treatment technology.

Filtering the data base in this manner provides the capability to evaluate the need for any particular treatment technology. In addition, the data base can be "filtered" to gain greater insight as to the types of potential risks that may result from a "typical" site, as well as obtaining information regarding the site character and complexity.

TABLE 3.3. Potential Sites for Catalytic Destruction

<u>Subregion</u>	<u>Number</u>	<u>Percent(a)</u>
Cascade	75	27
Intermountain	25	20
Rocky Mountain	<u>20</u>	<u>33</u>
Total	120	26

(a) These percentages are based on the sites in the "filtered" data base; i.e., those with liquid or sludges discharged to the land. The 120 sites represent 17.3% of the total number of other active CERCLIS and NPL sites in the Northwest region.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The data base of Northwest hazardous waste site characteristics has been shown to be an effective tool for assessing technology development needs for the Center and for characterizing the hazardous waste sites in the Northwest. The following conclusions and recommendations are of two types, those dealing with the future development of the data base and those dealing with the implications of site characteristics for technology development priorities.

4.1 FUTURE ADDITIONS TO THE DATA BASE

More complete specific chemical information is available from PA/SI forms and RI/FS documentation. We examined PA/SI forms for sites in Montana but not for the other sites in the Rocky Mountain subregion. A much greater detailed analysis could be made for site categories in particular if PA/SI forms were examined from Washington, Oregon, and Idaho.

For examining overall site characteristics, we have found the following three general categories to be the most useful:

1. waste categories
2. waste forms
3. disposal methods.

When examining possible remediation technologies or development of new technologies, the most useful division is subregion (Cascade, Intermountain, and Rocky Mountain). Geography has influenced population settlement patterns and development of industry and commerce, and therefore, the type of hazardous wastes that are generated, how they are disposed, and how they interact with the environment.

An obviously important element is regular updating of the data base. Because EPA is continually adding new sites to CERCLIS and collecting specific site data, we would recommend an update every 6 months to 1 year.

4.2 IMPLICATIONS FOR TECHNOLOGY DEVELOPMENT PRIORITIES

As a result of the foregoing analysis, the following guidelines on technology development needs for the Northwest region can be identified.

- More than half the NPL and other active CERCLIS sites in the Northwest have heavy-metal contamination. These heavy metals have resulted from various types of industrial activities, including finishing, processing, milling, smelting, and refining. Heavy-metal contamination is prevalent at sites within each of the three subregions analyzed and at disposal sites located at the Hanford Site. Consequently, remediation technologies that address heavy metal contamination of soils and groundwater would have broad applicability throughout the Northwest and should have priority for the Center's RD&D program.
- The three subregions differ in the relative prevalence of various single waste categories and mixtures of waste categories. Nevertheless, the remediation technologies appropriate for sites in one subregion will generally also be applicable to sites in the other two subregions. The Rocky Mountain subregion differs most from the other two subregions in terms of the relative prevalence of waste mixtures. This analysis has found that the most useful remedial actions will be those capable of concurrently treating heavy metals and solvents.
- As indicated by the mixture complexity index (1.9 for NPL sites and 1.6 for CERCLIS sites), effective site remediation will necessitate treatment of more than one waste category at many sites in the region. As a result, site characterization and risk assessment techniques will need to address the presence of complex waste mixtures rather than single waste forms. In addition, treatment methods will need to address multiple waste forms (e.g., liquids, sludges, etc.) and disposal methods (e.g., tanks, drums, tailings, etc.).
- Three of the four categories of organic wastes, chlorinated aliphatics, chlorinated aromatics, and nonchlorinated aromatics, are significant problems at Northwest sites. Technologies used to remediate these wastes must be effective under various disposal conditions and varying waste forms.

- As the analysis has shown, there is significant potential for vadose and groundwater contamination. Technology development will need to address the remediation of contaminants in both the soil and aqueous media if that technology is to be widely applied.
- Technology needed to assess and remediate the NPL and other active CERCLIS sites would also be appropriate for the individual Hanford CERCLIS sites. Technologies must address mixtures of more than one category of waste, consisting primarily of heavy metals and aliphatic organics (solvents). In addition, the Hanford Site has disposal sites contaminated with nitrates, a waste material not common to NPL and other active CERCLIS sites in the Northwest.
- Finally, based on the example analysis of the catalytic destruction process, the data base could be a useful tool in evaluating the potential for application of a technology at a hazardous waste site. Not only can the number of applicable sites be identified, but the specific site locations can be identified. Therefore, the data base could become a useful market screening tool for the application of technologies under development.

5.0 REFERENCES

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APPENDIX A

LISTING OF CURRENT NORTHWEST NPL SITES

APPENDIX A

LISTING OF CURRENT NORTHWEST NPL SITES (FEBRUARY 1988)

Name	City	State	Region(a)
Anaconda Co. Smelter	Anaconda	MT	RM
Burlington Northern Somers Tie Trt Plt	Somers	MT	RM
East Helena (ASARCO)	East Helena	MT	RM
Idaho Pole Co.	Bozeman	MT	RM
Libby Groundwater Contamination	Libby	MT	RM
Milltown Reservoir Sediments	Milltown	MT	RM
Montana Pole and Treating	Butte	MT	IM
Mouat Industries	Columbus	MT	RM
Silver Bow Creek	Butte	MT	IM
Arrcom Corp. (Drexler Enterprise Inc.)	Rathdrum	ID	RM
Bunker Hill Mining & Metallurgical Cmplx	Kellogg	ID	RM
Pacific Hide & Fur Recycling Corp.	Pocatello	ID	IM
Union Pacific RR Yard	Pocatello	ID	IM
Gould Inc.	Portland	OR	CA
Martin Marietta Corp.	The Dalles	OR	CA
Teledyne Wah Chang Albany	Albany	OR	CA
Umatilla Army Depot (lagoons)	Hermiston	OR	IM
United Chrome Products	Corvallis	OR	CA
American Lake Gardens	Tacoma	WA	CA
Colbert Landfill	Colbert	WA	IM
Commencement Bay-Nearshore Tide Flats	Tacoma	WA	CA
Commencement Bay-South Tacoma Channel	Tacoma	WA	CA
Farm Machinery Corp. (FMC)	Yakima	WA	IM
Fort Lewis (Landfill No. 5)	Fort Lewis	WA	CA
Frontier Hard Chrome	Vancouver	WA	CA
Greenacres Landfill	Spokane	WA	IM
Harbor Island-Lead	Seattle	WA	CA
Kaiser Aluminum Mead Plant	Mead	WA	IM

<u>Name</u>	<u>City</u>	<u>State</u>	<u>Region(a)</u>
Lakewood (Ponders Corner)	Lakewood	WA	CA
McChord Air Force Base	Tacoma	WA	CA
Mica Landfill	Mica	WA	IM
Midway Landfill	Kent	WA	CA
Northside Landfill	Spokane	WA	IM
Northwest Transformer-Salvage Yard	Everson	WA	CA
Pesticide Lab-Yakima	Yakima	WA	IM
Queen City Farms	Maple Valley	WA	CA
Silver Mountain Mine	Loomis	WA	CA
Toftdahl Drum Site	Brush Prairie	WA	CA
U.S. Navy-Bangor Ordinance Disposal	Bangor	WA	CA
Western Processing Co. Inc.	Kent	WA	CA
Wyckoff Co.-Bainbridge	Bainbridge I	WA	CA

(a) CA - Cascade Region
IM - Intermountain Region
RM - Rocky Mountain Region.

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