



160155

National Security and  
International Affairs Division

B-279092

February 26, 1998

The Honorable Strom Thurmond  
Chairman  
The Honorable Carl Levin  
Ranking Minority Member  
Committee on Armed Services  
United States Senate

Subject: Environmental Cleanup: DOD's Relative Risk Process

According to the Department of Defense's (DOD) fiscal year 1996 annual report (the most recent report) to Congress, DOD expects to spend about \$27 billion for cleanup of contaminated sites beginning in fiscal year 1997, through the time period represented in the Future Years Defense Plan, and well into the next century. DOD uses a relative risk site evaluation process as part of its decision criteria to allocate resources to contaminated sites that pose the greatest risk to human health and the environment.<sup>1</sup> The Senate Report on the National Defense Authorization Act for Fiscal Year 1998 (Report 105-29, June 17, 1997) requires us to review DOD's implementation of the relative risk site evaluation process. As agreed with your offices, this letter describes DOD's current relative risk site evaluation process. Our analysis of the data that DOD used in the relative risk site evaluation process for fiscal years 1996 and 1997 will be provided at a later time.

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<sup>1</sup>Relative risk site evaluations differ from baseline risk assessments in that relative risk evaluations place sites into high, medium, or low categories that DOD believes are useful in making sequencing and allocation decisions. Baseline risk assessments evaluate the potential adverse health effects caused by contaminant releases from sites and determine whether sites actually should be cleaned up.

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BACKGROUND

The individual defense components propose annual budgets for cleanup. Within DOD's annual budget review process, the proposed budgets are reviewed by managers in the Office of the Deputy Under Secretary of Defense for Environmental Security (ODUSD[ES]). In making these reviews, ODUSD(ES) managers have stated that they consider the results of relative risk evaluations as well as other factors such as site statutory and regulatory status and public stakeholder concerns. ODUSD(ES) provides guidance on the relative risk evaluation process to the defense components. The components are responsible for implementing the guidance and actual cleanup actions.

DOD adopted the relative risk site evaluation process in 1994 to ensure that DOD's environmental restoration efforts address the highest risk problems first. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 serves as the statutory basis for environmental remediation. DOD sites contain carcinogenic substances as well as other toxics that pose a significant threat to human health. DOD's cleanup efforts are aimed at reducing the risk to an acceptable level. In March 1996 testimony and a June 1997 report we provided information on the status of DOD's efforts to apply the relative risk site evaluation process to cleanups and conducted preliminary analyses of the data obtained from the process.<sup>2</sup>

Defense components conduct relative risk evaluations at installations using two basic ODUSD(ES) guidance documents: the Relative Risk Site Evaluation Primer (summer 1996, updated in 1997) and the Relative Risk Site Evaluation Quality Assurance Plan (summer 1997). The primer details the steps required for defense components to conduct the evaluations. The quality assurance plan defines objectives for relative risk site evaluation data as established by the ODUSD(ES). DOD published the plan to ensure that relative risk evaluations are being performed throughout the Department according to procedures and requirements outlined in the primer. DOD expects the defense components to use the documents to ensure consistency throughout the Department.

DOD does not require relative risk evaluations or updates to evaluations previously conducted when (1) cleanup remedies are in place, (2) no further

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<sup>2</sup>Environmental Protection: Issues Facing the Energy and Defense Environmental Management Programs (GAO/T-RCED/NSIAD-96-127, Mar. 21, 1996) and Environmental Protection: Information Used for Defense Environmental Management (GAO/NSIAD-97-135, June 11, 1997).

cleanup action is required (also referred to as response complete), (3) sufficient information is not available, or (4) sites comprise only abandoned ordnance.

### RESULTS IN BRIEF

DOD's relative risk evaluations are carried out by the defense components using guidance provided by ODUSD(ES). Using this guidance, defense components collect and record background information about sites and evaluate specific information about contaminants and their potential effects. The end result is that sites are assigned a relative risk ranking of "high," "medium," or "low." This ranking is based on the evaluation of (1) contamination levels, (2) likelihood of migration, and (3) potential receptors.<sup>3</sup>

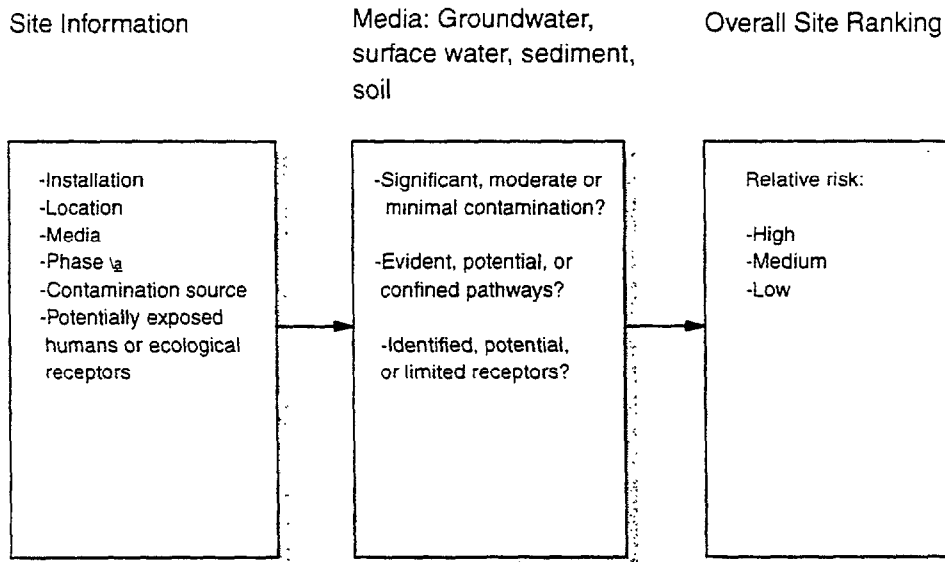
### DOD'S RELATIVE RISK SITE EVALUATION PROCESS

DOD guidance requires defense components to (1) gather and record key site information; (2) evaluate the media (groundwater and surface water, sediments, and soils); and (3) determine an overall site risk category of high, medium or low. Assignment to a relative group considers the level of contamination at the site (What chemical concentrations are there?); pathways through which the contaminants could migrate (Is the contamination moving or will it move?); and the potential contacts that the contaminants could have with receptors. Figure 1 illustrates DOD's relative risk site evaluation process.

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<sup>3</sup>DOD refers to the people, animals, or locations that could be affected by contaminants as receptors.

Figure 1: DOD's Relative Risk Site Evaluation Process



<sup>a</sup> Phase refers to cleanup phase such as "study," "design," or "cleanup."

Source: Summarized from the DOD Relative Risk Site Evaluation Primer, (summer 1996, updated in 1997).

#### Gathering and Recording Key Site Information

Defense components begin the relative risk site evaluation process by obtaining and recording site information. The data include

- site name and description;
- nature and source of contamination; and
- human or ecological receptors (people, animals, or environments that may be exposed).

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The components also are to obtain laboratory analyses of current contaminant samples. DOD's primer cites four media and their types of exposure to use in the relative risk site evaluation process:<sup>4</sup>

- groundwater, human;
- surface water, human and ecological;
- sediments, human and ecological; and
- surface soils, human.

DOD's primer states that the site information aids field personnel in understanding the quality of information used in site assessments, the level of uncertainty associated with the data, and anticipated follow-on phases of cleanup work. It can also be used to assist in explaining site activities to stakeholders.

Defense component field representatives enter the site information and resulting calculations manually or electronically onto relative risk site evaluation worksheets (see app. I). The worksheets are the basic document for recording all pertinent site and ranking information. According to DOD's primer, data are extracted from the worksheets for component and ODUSD(ES) managers to use in conjunction with other factors in making work sequencing and resource allocation decisions.

### Evaluating the Media

Once the site information has been gathered, defense components evaluate media (groundwater, surface water, sediments, and soils) to determine whether (1) contamination at a site is significant, moderate, or minimal; (2) pathways are evident, potential, or confined; and (3) receptors are identified, potential, or limited. These determinations are recorded on the relative risk worksheets as factors for contaminant hazard, migration pathway, and receptor.

### The Contaminant Hazard Factor

The "contaminant hazard factor" is a ratio that compares contamination levels with goals that DOD calls comparison values. DOD derived the comparison values from Environmental Protection Agency (EPA) remediation goals. These goals designate the acceptable level of risk to the public from exposure to

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<sup>4</sup>DOD defines "exposure point" as a location of potential contact between a receptor and a contaminant (chemical or physical agent).

cancer-causing contaminants (carcinogens).<sup>5</sup> DOD's relative risk site evaluation primer lists and describes how to calculate the comparison values and contamination factors.

Defense components calculate the contaminant hazard factor starting with laboratory analyses of media samples for the contaminants. The calculation is made for each contaminant in all media at a site. For media that contain more than one contaminant, the ratios from each contaminant are added. Components then compare the sum of the ratios to a scale developed by DOD to determine whether the contaminant is significant, moderate, or minimal.

To illustrate, at a Norton Air Force Base site, officials found that the solvent dichloroethylene was present in groundwater. To determine the contaminant hazard factor for that particular groundwater contaminant, officials divided the maximum concentration level they found (120.00) by the comparison value taken from the DOD primer. The resulting ratio of 2.18 represents a moderate contamination hazard within DOD's ranking system. Table 1 shows the information taken from the relative risk worksheet for the Norton Air Force Base site.

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<sup>5</sup>DOD's comparison values are derived from EPA's Region IX Preliminary Remediation Goals, second half 1995, September 1, 1995. The Region IX values are based on toxicological information documented by EPA in the Integrated Risk Information System and Health Effects and Assessment Summary Tables databases.

Table 1: Groundwater Contaminant Hazard Factor Example at a Norton Air Force Base Site

Contaminant	Micrograms per liter		Ratio
	Maximum concentration	Comparison value <sup>a</sup>	
1,2-dichloroethylene (mixture)	120.00	55.00	2.18

<sup>a</sup>The sample relative risk worksheets in DOD's Relative Risk Site Evaluation Primer (summer 1996, updated in 1997) use the term "comparison value" to represent this numeric value. The relative risk worksheets provided to us by defense components used the term "standard," which was the term in the Relative Risk Site Evaluation Primer (summer 1994 edition).

Source: U.S. Air Force.

The complete listing of contaminant hazard factors for the site are listed in appendix I. Appendix II contains a detailed description of the DOD risk range and comparison values.

#### The Migration Pathway Factor

Evaluating relative risk also requires determining whether the contamination is moving (migrating) or likely to move. The "migration pathway factor" is the assessment of the likelihood or extent that the contaminant will migrate from the source of contamination. According to DOD's primer, this likelihood is determined by matching available pathway site information with corresponding DOD definitions of the likelihood of contaminant migration. The following are DOD's definitions:

"Evident"—Analytical data or observable evidence indicates that contamination in the media is moving away from the source.

"Potential"—The contamination could possibly be present at or move to a point where a receptor could be exposed; or sufficient information is not available to make a determination of evident or confined.

"Confined"—Information indicates that the contaminant is unlikely to migrate from the source for such reasons as geological structures or physical controls.

DOD's primer also instructs users to consider media-specific information described in the primer and professional judgment in making decisions on migration pathway factors. For example, in evaluating groundwater, the primer instructs users to base relative risk evaluations on groundwater samples affected by the site, attribute contamination to the site, and exercise care in selecting data when more than one source could be influenced by the contamination.

To illustrate, at the Norton Air Force Base site, officials determined that contamination had migrated beyond the base boundary and decided that the migration pathway factor was "evident."

### The Receptor Factor

The third factor in evaluating the relative risk of sites requires determining whether humans or sensitive environments may be affected by the contamination.<sup>6</sup> "Receptor factors" are rated as identified, potential, or limited. DOD's primer instructs users to match available information on receptors at sites with the definitions in the primer. The receptors may vary depending on the media. Table 2 lists receptors for media as defined in DOD's primer.

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<sup>6</sup>Sensitive environments are included in a listing of ecological receptors as defined in DOD's Relative Risk Site Evaluation Primer (summer 1996, as updated). They include areas identified under the National Estuary Program, 33 U.S.C. 1330.



Table 2: Receptors by Media Type

Media	Receptor/definition
Groundwater	Individuals may be exposed to contamination via onsite and downgradient water supply wells used for human consumption or in food production. Ecological receptors are not evaluated.
Surface water	Individuals may be exposed to surface water contamination through on-site and downgradient water supplies and recreational areas. Receptors include downgradient water supplies used for drinking water, irrigation of food crops, watering of livestock, aquaculture, and recreational activities such as fishing. Ecological receptors are limited to critical habitats and other environments that can be reasonably expected to be impacted by a site.
Sediment	Individuals may be exposed to sediment contamination through on-site and downgradient water supplies and recreational areas. Receptors include downgradient water supplies used for drinking water, irrigation of food crops, watering of livestock, aquaculture, and recreational activities such as fishing. Ecological receptors are limited to critical habitats and other environments that can be reasonably expected to be impacted by a site.
Soil	Individuals include residents, people in schools and day care, and workers who have direct access to contamination on a frequent basis. Ecological receptors are not considered for evaluation of the surface soil since ecological standards are generally not available for the contaminant hazard factor calculations. Ecological receptors may be incorporated into the soil evaluation if ecological standards become available.

Note: "Downgradient" refers to the direction of water movement. It is similar to "downstream."

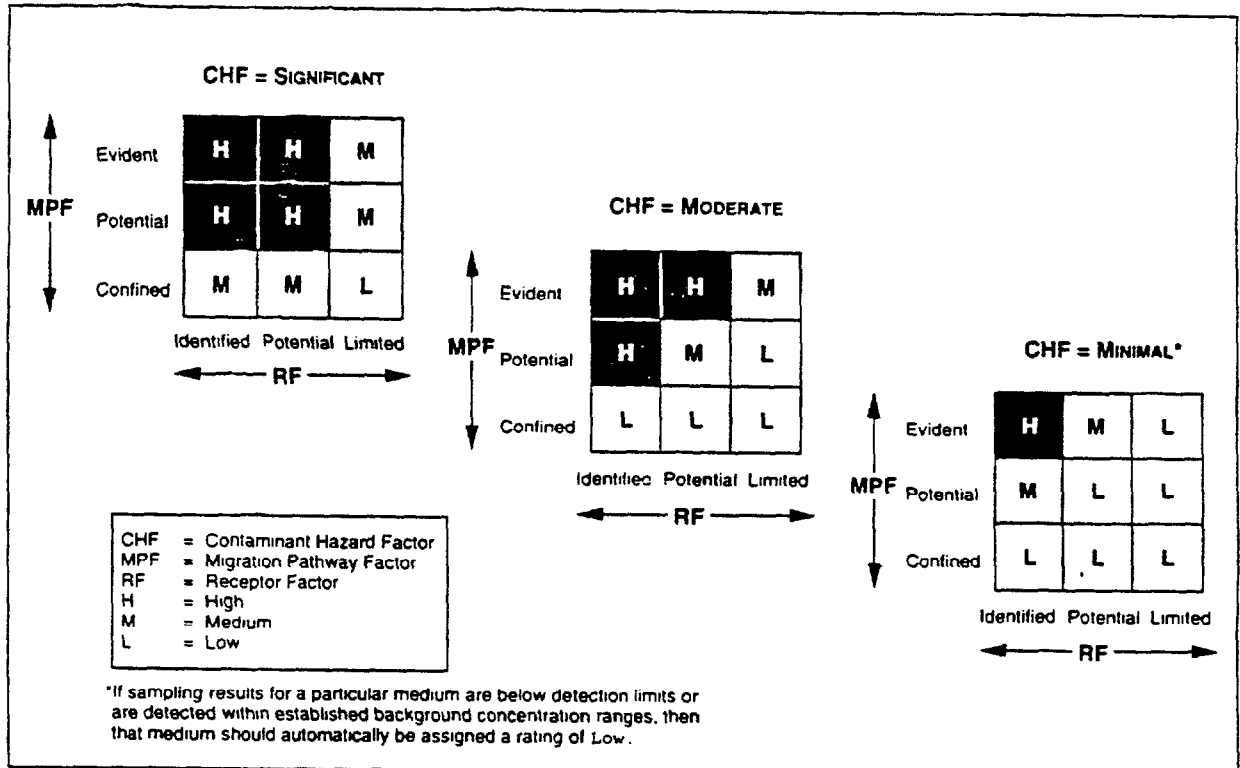
Officials determined that the Norton Air Force Base site, for example, had groundwater that was a current source of drinking water for the human receptor and source of water for other beneficial uses such as irrigation.

#### Determining Overall Risk Category

Once the information for the contaminant, migration pathway, and receptor categories has been calculated and assessed, DOD's primer directs users to assign an overall relative risk ranking of high, medium, or low using DOD's relative risk evaluation matrix. For each medium, factor ratings are compared with DOD's matrix to determine the environmental media-specific rating of high, medium, or low. The site is then placed in an overall relative risk category of

high, medium, or low based on the highest media-specific rating, or on the sum of media ratings. According to the primer, if all analytical data are within established background ranges for media or sites, the media are automatically assigned a rating of low.<sup>7</sup> The Norton Air Force Base site used as an example received an overall relative risk ranking of "high." Figure 2 shows DOD's Relative Risk Site Evaluation Matrix.

Figure 2: DOD's Relative Risk Site Evaluation Matrix.



Source: ODUSD(ES).

Managers within the defense components and ODUSD(ES) may use the resulting relative risk evaluation information in different ways. DOD's primer states that field activities within the components use the information as one means of representing the status of their environmental restoration program to DOD, regulators, and local stakeholders. Information on site relative risk is to be used by each military installation or formerly used defense site, in conjunction with other risk management considerations, to help decide which

<sup>7</sup>Established background ranges are measurements of the non-contaminated areas surrounding the contamination site.

sites should be worked on first in light of available resources. Component headquarters offices use the information to identify to Congress, regulators, and other stakeholders the distribution of sites in the three relative risk categories—high, medium, and low. ODUSD(ES) may use relative risk evaluation information to establish goals and performance measures for the environmental restoration program, and in making resource allocation decisions.

#### SCOPE AND METHODOLOGY

To describe DOD's process for evaluating relative risk, we examined DOD headquarters and component documents showing overall guidance and the process in use. We focused mainly on DOD's Relative Risk Site Evaluation Quality Assurance Plan (summer 1997) and Relative Risk Site Evaluation Primer (summer 1996, updated in 1997). We also discussed the process with ODUSD(ES) officials and at military headquarters. We did not verify the data in the examples because the data were used only for explanations of the process.

#### AGENCY COMMENTS AND OUR EVALUATION

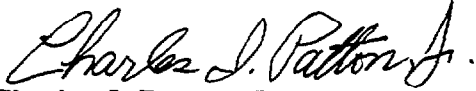
In written comments on a draft of this report, DOD agreed with our description of the relative risk site evaluation process but suggested that the term "relative risk site evaluation" be used instead of "relative risk assessment." DOD also suggested other changes such as specifying receptor categories of pathway and receptor in figure 1, and clarifying source documentation in table 1. We incorporated all suggested changes, as appropriate. DOD's comments are included in appendix III.

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As arranged with your office, we plan no further distribution of this letter until 30 days from its issue date, unless you publicly announce the letter's contents earlier. We will send copies to the Secretaries of Defense and the Army, the Navy, and the Air Force; the Commandant, Marine Corps; the Directors, Office of Management and Budget and Defense Logistics Agency; the Administrator of the Environmental Protection Agency, and other interested parties.

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Please contact me on (202) 512-8412 if you have any questions about this report. Major contributors to this report were Uldis Adamsons, Elizabeth Mead, and Virgil Schroeder.

A handwritten signature in black ink that reads "Charles I. Patton, Jr." with a stylized flourish at the end.

Charles I. Patton, Jr., Associate Director  
Defense Management Issues

SAMPLE RELATIVE RISK WORKSHEET

## RELATIVE RISK EVALUATION WORKSHEET

SITE BACKGROUND INFORMATION

Installation Name:		Date Entered (month/day/year):	6/29/93
<u>NORTON</u>		Media Evaluated (GW, SW, Sediment, Soil):	<u>GW, SOIL</u>
Location (City/County and State):		Site Type:	<u>Impoundment/Lagoon - SI</u>
<u>San Bernardino, CA</u>		Phase of Execution (SI, RI, FS, EE/CA, IRA, RD/RA, or equivalent RCRA Stage):	<u>RI</u>
Site Name/DERPMIS ID:		Agreement Status (enter the appropriate DERP regulatory agreement code):	<u>A-FFA(NPL)</u>
<u>Industrial Waste Lagoon</u>	<u>/ SI001</u>		
Point of Contact (Name/Phone):			
<u>Pradip Badheka (909) 382-5064</u>			
NPL/Proposed NPL (Y/N):	<u>Yes</u>		

Overall Project Risk: HIGHSITE SUMMARY

## Brief Project Description (include site type, materials disposed, dates of operation, and other relevant information)

Disposal site of liquid industrial waste from 1950 to 1960. Chromates, organic solvents, and other miscellaneous wastes were reportedly disposed of in unlined lagoons from maintenance operation on 7th street in the Central Base Area. About 1960, the lagoons were backfilled and became part of the golf course. This site is a potential source for the central base area TCE plume.

## Brief Description of Pathways (Groundwater, Soil, Surface Water (human), Surface Water (ecological), Sediment (human), Sediment (ecological)):

Leaching of contaminants from soil into groundwater. Over 50 off-base wells define extent of groundwater contamination. Samples collected from these wells show that plume has migrated beyond SW boundary of the base.

## Brief Description of Receptors (Human and Ecological):

Approximately 17 municipal wells on the downgradient leading edge of the plume have shown contamination. These wells are drawing water for human consumption and agricultural use.

Source: Document provided by the U.S. Air Force for Norton Air Force Base.

SAMPLE RELATIVE RISK WORKSHEET

GROUNDWATER

CONTAMINANT HAZARD FACTOR (CHF):

Significant (If Total > 100):  
 Moderate (If Total 2-100): X  
 Minimum (If Total < 2):

Contaminant	Max Concentration (ppb)	Standard (ppb)	Ratio
1,2-Dichloroethylene (mixture)	120.00	53.00	2.18
Tetrachloroethylene (PCE)	3.90	110.00	0.04
Trichloroethylene (TCE)	940.00	160.00	5.88
Uranium 238 (radionuclide)	40.00	15.00	2.67
Vinyl chloride	1.00	2.00	0.50
		Total	11.36

MIGRATION PATHWAY FACTOR (MPF):

- Evident - Analytical data or observable evidence indicates that contamination in the media is moving away from the source.
- Potential - Possibility for contamination to be present at or migrate to a point of exposure; or information is not sufficient to make a determination of Evident or Confined.
- Confined - Information indicates that the potential for contaminant migration from the source is limited (due to geological structures or physical controls).

Evident: X  
 Potential:  
 Confined:

Brief rationale/source for selection: Over 50 off-base wells define extent of groundwater contamination. Samples collected from these wells show that plume has migrated beyond SW boundary of the base.

RECEPTOR FACTOR (RF):

- Identified - There is a threatened or potentially threatened water supply downgradient of the source. The groundwater (contaminated or not) is a current source of drinking water or source of water for other beneficial uses such as irrigation/agricultures (equivalent to Class I or IIA aquifer).
- Potential - There is no potentially threatened water supply well downgradient of the source. The groundwater is potentially usable for drinking water, irrigation, or agriculture, but is not presently used (equivalent to Class IIB aquifer).
- Limited - There is no potentially threatened water supply well downgradient of the source. The groundwater is not considered a potential source of drinking water or is of limited beneficial use (equivalent to Class IIIA or IIIB aquifer, or where perched aquifer exists only)

Identified: X  
 Potential:  
 Limited:

Brief rationale/source for selection: Approximately 17 municipal wells on the downgradient leading edge of the plume have shown contamination. These wells are drawing water for human consumption and agricultural use.

Groundwater Category: **HIGH**

Source: Document provided by the U.S. Air Force for Norton Air Force Base.

SAMPLE RELATIVE RISK WORKSHEET

SOIL

CONTAMINANT HAZARD FACTOR (CHF):

Significant (If Total > 100):  
 Moderate (If Total 2-100):  
 Minimum (If Total < 2): X

<u>Contaminant</u>	<u>Max Concentration (ppb)</u>	<u>Standard (ppb)</u>	<u>Ratio</u>
1,2,4-Trichlorobenzene	48,000.00	580,000.00	0.08
1,2-Dichlorobenzene	230,000.00	2,300,000.00	0.10
Acetone	14,000.00	2,600,000.00	0.01
Iron	14,800,000.00		0.00
		Total	0.19

MIGRATION PATHWAY FACTOR (MPF)

- Evident - Analytical data or observable evidence that contamination is present at, is moving towards, or has moved to a point of exposure.
- Potential - Possibility for contamination to be present at or migrate to a point of exposure; or information is not sufficient to make a determination of Evident or Confined.
- Confined - Low possibility for contamination to be present at or migrate to a point of exposure

Evident: X  
 Potential:  
 Confined:

Brief rationale/source for selection: Stormwater runoff creating leachate. Some contaminated soil at surface.

RECEPTOR FACTOR (RF):

- Identified - Receptors identified that have access to contaminated soil
- Potential - Potential for receptors to have access to contaminated soil
- Limited - Little or no potential for receptors to have access to contaminated soil

Identified: X  
 Potential:  
 Limited

Brief rationale/source for selection: Human and ecological receptors are present.

Soil Category: HIGH

Source: Document provided by the U.S. Air Force for Norton Air Force Base.

DESCRIPTION OF DOD'S RISK RANGE AND COMPARISON VALUES

Remediation goals established by the Environmental Protection Agency (EPA) serve as a basis for the Department of Defense's (DOD) calculation of comparison values. (The comparison values are used in calculating the contaminant hazard factor—one of three factors considered in the relative risk site evaluation process.) These goals are expressed as a numeric range for determining what levels of cancer-causing contaminants (carcinogens) are acceptable when the public is exposed to them.<sup>1</sup> EPA has determined that an acceptable level of risk from exposure to carcinogens falls within a range of 1 in 10 thousand to 1 in 1 million. People exposed to such carcinogens over a lifetime stand a 1 in 10 thousand to 1 in 1 million chance of contracting cancer.<sup>2</sup>

DOD mathematically converted the EPA remediation goals so that the comparison values would reflect a 1 in 10 thousand level of risk.<sup>3</sup> DOD then converted the risk levels so they would be expressed in a single scale, with the value 1.0 representing the 1 in 10 thousand risk level, and the value 0.01 representing the 1 in 1 million risk level. DOD's primer provides guidance on how to determine the significance of contamination using contaminant concentration levels and the comparison values.

Defense components obtain laboratory analyses of contaminant samples and calculate the contaminant hazard factor by dividing the maximum concentration of a contaminant by the comparison value for that contaminant as recorded in tables in DOD's primer.<sup>4</sup> This process is repeated for each contaminant in all media at the site. For media that contain more than one contaminant, the ratios from each contaminant are added. DOD has determined that if the ratio or sum of the ratios is greater than 100, the contamination hazard is significant; from 2 to 100, moderate; and less than 2, minimal. Factor ratings

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<sup>1</sup>DOD's comparison values are derived from EPA's Region IX Preliminary Remediation Goals, second half 1995, September 1, 1995. The Region IX values are based on toxicological information documented by EPA in the Integrated Risk Information System and Health Effects and Assessment Summary Tables databases.

<sup>2</sup> 55 Fed. Reg. 8666 (Mar. 8, 1990) explains the acceptable risk range in detail.

<sup>3</sup>DOD multiplied the EPA concentration data by 100 to arrive at comparison values—DOD's estimate of contamination with a cancer risk of 1 in 10,000.

<sup>4</sup>DOD's primer states that detected contamination must be recent yet representative of site conditions. The relative risk site evaluation process uses maximum (worst-case) contaminant data drawn from laboratory samples. If multiple samples from a site have different levels of contamination, DOD's primer instructs users to always use the sample with the greatest contamination.



are combined to determine the environmental media-specific rating. Then an overall relative risk evaluation is determined.

Components determine the overall relative risk ranking of high, medium, or low by using DOD's relative risk site evaluation matrix. DOD's primer states that if all analytical data are within established background ranges for media or sites, the media receive a rating of low.<sup>5</sup> In August 1997 DOD revised the primer to require that media with a contaminant hazard factor value below .005 be assigned to the low risk category. According to officials in the Office of the Under Secretary of Defense for Environmental Security, the change was made to ensure that the defense components use only reliable analytical data that are not within background ranges. Previously, factors below .005 but above background levels could be ranked high or medium. Officials believe that assigning such a limit will help them to more accurately identify appropriate relative risk categories.

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<sup>5</sup>Established background ranges are measurements of the noncontaminated areas surrounding the contamination site.

COMMENTS FROM THE DEPARTMENT OF DEFENSE



ACQUISITION AND  
TECHNOLOGY

OFFICE OF THE UNDER SECRETARY OF DEFENSE

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23 FEB 1998

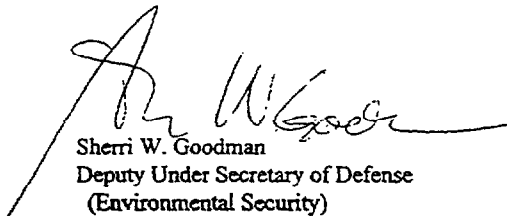
Mr. David R. Warren  
Director, Defense Management Issues  
National Security and International  
Affairs Division  
U.S. General Accounting Office  
Washington DC 20548

Dear Mr. Warren:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report dated January 29, 1998, "ENVIRONMENTAL CLEANUP: DoD's Relative Risk Process," (GAO Code 709287/OSD Case 1533).

The DoD concurs with subject GAO report subject to the enclosed detailed recommendations.

Very truly yours,

  
Sherri W. Goodman  
Deputy Under Secretary of Defense  
(Environmental Security)

Enclosure

Environmental Security



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