EVALUATION OF ENVIRONMENTAL DATA FOR HISTORICAL PUBLIC EXPOSURES STUDIES ON ROCKY FLATS

CHAPTER I

INTRODUCTION

The Rocky Flats Environmental Technology Site is owned by the U.S. Department of Energy (DOE) and is currently contractor-operated by Kaiser-Hill Company. For most of its history, the site was called the Rocky Flats Plant (RFP) and was operated by Dow Chemical Company as a nuclear weapons research, development, and production complex (Figure I-1). The RFP is located on approximately 2650 ha (6500 acres) of federal property, within a few miles of the cities of Arvada, Westminster, and Broomfield, Colorado, and 26 km (16 mi) northwest of downtown Denver, Colorado. The production area, now sometimes called the industrial area, is surrounded by a security perimeter fence. The original 156-ha (385-acre) main production area is surrounded by a 2490-ha (6150-acre) buffer zone that now delineates the RFP boundary.

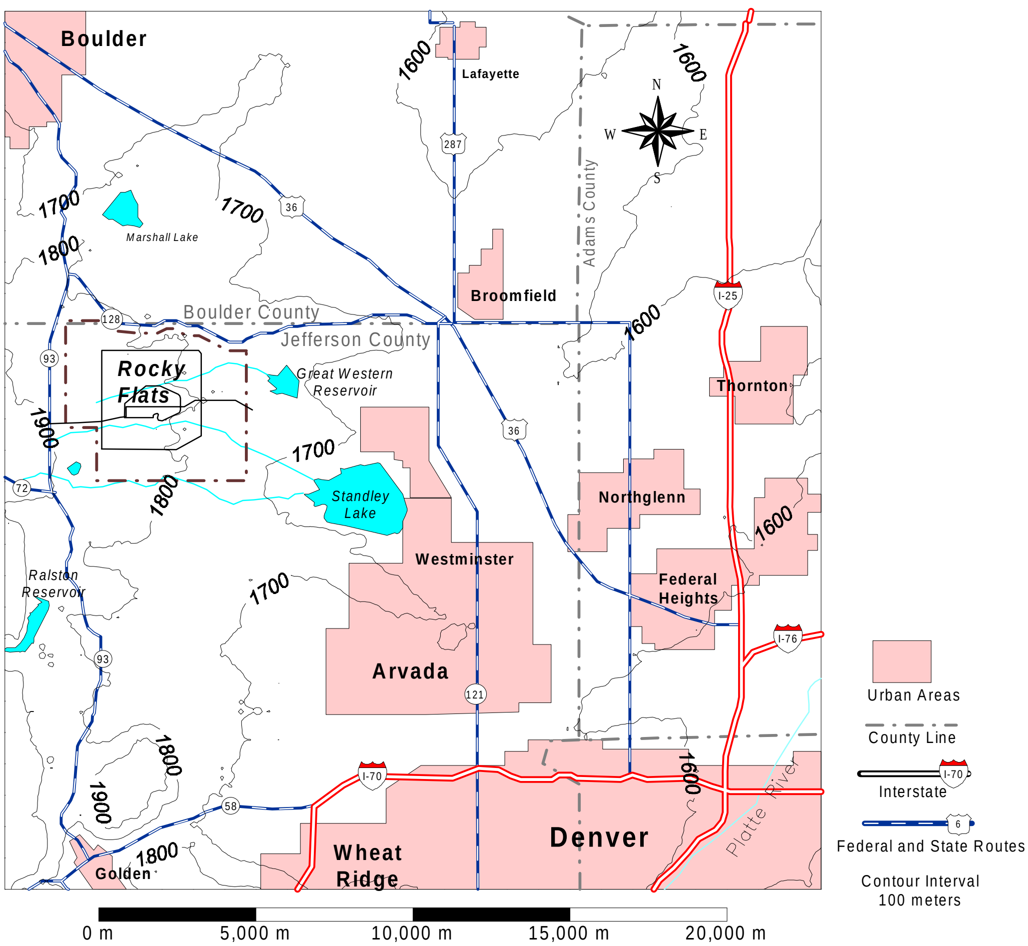


Figure I-1. The location of the Rocky Flats Plant, and nearby urban areas in 1980, as approximated from 7.5-minute USGS topographic maps.

THE ROCKY FLATS HISTORICAL PUBLIC EXPOSURES STUDIES

Through a 1989 Agreement in Principle between DOE and the State of Colorado, DOE provided the State with funding and technical support for health-related studies. The purpose of the Historical Public Exposures Studies on Rocky Flats is to identify potential health effects in residents in nearby communities who may have been exposed to past toxic and radioactive releases. The Colorado Department of Public Health and Environment (CDPHE) first invited a national panel of experts to help design the health studies. Because of intense public concern about Rocky Flats contamination among Denver metropolitan area residents following a Federal Bureau of Investigation raid of Rocky Flats in June 1989, a Health Advisory Panel (HAP) was established with the responsibility of overseeing the health studies. This panel decided to stress public involvement and to separate the research into two major phases conducted by two different contractors to enhance accountability and credibility.

This study focuses on exposure of the public to releases of radioactive materials and chemicals from the Rocky Flats Plant. A separate joint study prepared by the Colorado Department of Public Health and Environment and the University of Colorado Health Sciences Center will address worker exposures.

Phase I of the study was performed by ChemRisk (a division of McLaren/Hart, Environmental Engineering). In Phase I, ChemRisk conducted an extensive investigation of past operations and releases from the RFP. The Phase I effort identified the primary materials of concern, release points and events, quantities released, transport pathways, and preliminary estimates of dose and risk to offsite individuals. The conclusions from Phase I were released in a public summary document (HAP 1993) and a series of task reports by ChemRisk. Several articles have also appeared in the journal *Health Physics*.

Radiological Assessments Corporation (*RAC*) was awarded the contract to conduct Phase II of the study, which is an in-depth investigation of the potential doses and risks to the public from important historical releases from Rocky Flats. Recommendations for work to be performed in Phase II are outlined in the Phase I summary document (HAP 1993).

Important Sources and Timing of Releases from the Rocky Flats Plant and Global Fallout

For almost 40 years the RFP produced nuclear weapons for national defense. The principal contaminants of concern from past RFP operations identified in Phase I are isotopes of the radioactive element plutonium and the chemical carbon tetrachloride. Possible exposures and risks from another contaminant of concern, beryllium, needed further evaluation in Phase II (HAP 1993). Plutonium was processed at Rocky Flats for nuclear weapons components. Beryllium, a naturally occurring element, was also used in the nuclear weapons produced at the RFP. Carbon tetrachloride is a solvent that was used to clean plutonium metal parts, processing machinery, and instruments.

The principal contaminants of concern identified in Phase I were isotopes of the radioactive element plutonium and the chemical carbon tetrachloride.

Global fallout of plutonium was highest in the early 1960s. Releases of plutonium from Rocky Flats were highest in 1957 and the late 1960s.

To interpret historical measurements of plutonium and related radioactive materials, an understanding of all sources of plutonium in the environment was needed. Two main sources of plutonium in the environment around the RFP were (1) accidental and routine releases from Rocky Flats operations and (2) widely distributed plutonium from the atmospheric testing of nuclear weapons, referred to as global fallout.

Phase I of this study identified the primary sources of past plutonium releases from the RFP. The 903 Area was the source of the largest environmental contamination near the site. At the 903 Area, waste oil containing plutonium leaked from the stored barrels and contaminated the soil. Contamination was subsequently transported by wind, especially after the barrels were removed and the ground surface was disturbed. The highest releases occurred during a 5-year period, 1965–1969. An asphalt cover was applied in 1969 to the former barrel storage pad in the 903 Area. Two other important sources of plutonium releases from the RFP were a major fire in 1957 and resuspension of remaining contaminated soil in the 903 Area in the 1970s. Examining the timing and amounts of plutonium released has provided guidance for interpreting environmental data and allocating resources for the Phase II research.

Phase II Tasks

Phase II of the State of Colorado’s studies of health impacts related to the Rocky Flats nuclear weapons plant was designed to provide an independent review of the Phase I research findings and a detailed analysis of the potential health risks from past Rocky Flats contaminant releases. Phase II was divided into six tasks, which are listed below. The first four are technical tasks designed to develop detailed estimates of community exposures and health risks. Task 5, monitoring recommendations, was partly based on the findings of Task 4. Task 6 allowed two-way communication with the community through public meetings, workshops, and other outreach activities to discuss Phase II progress and results.

- **Task 1** Coordinate with ChemRisk to ensure quick and efficient access to the records and individuals contacted by ChemRisk during Phase I of the project
- **Task 2** Verify the radionuclide and chemical release estimates and associated uncertainties that were developed during Phase I of the project
- **Task 3** Conduct an independent assessment of the risks from past Rocky Flats operations using state-of-the-art methods to ensure those risks to the public are carefully identified
- **Task 4** Evaluate historical environmental data, which can provide a basis for risk assessment and for reconstruction of releases
- **Task 5** Provide recommendations for additional offsite measurements using knowledge gained to ensure that new measurements focus on the most important locations and releases
- **Task 6** Provide support for the public involvement efforts.

Task 4, Evaluation of Historical Environmental Data

A more in-depth look at the environmental data was one area emphasized for Phase II of the Historical Public Exposures Studies on Rocky Flats. The final report of Phase I (ChemRisk 1994b) states that the following would be given high priority as part of the Phase II follow-up to Phase I work:

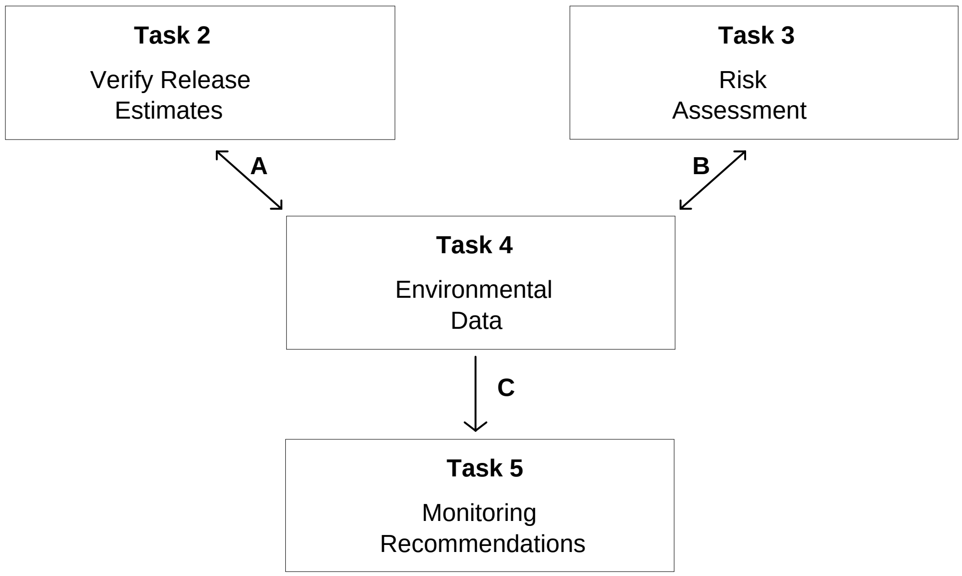
> "The identification of additional environmental data that could be used to establish whether the predicted exposures are consistent with actual measurements taken in the environment."

Figure I-2 illustrates the relationship between Task 4 and several of the other tasks in Phase II.

Use of Environmental Data in Phase I

Although Phase II has examined environmental data in more detail, some environmental data were used in Phase I (ChemRisk 1994a) in four important areas:

1. Environmental measurements of plutonium in soil were used with transport models to estimate the plutonium release rate from the 903 Area. Measured concentrations of plutonium in the soil were assumed to represent the total deposition of plutonium released from the 903 Area. A fugitive dust model of atmospheric transport was used to estimate the release rate that would be consistent with the plutonium deposition.
2. Environmental measurements of gross alpha activity in air were used to
   - determine an upper bound on the source term of fine particles from the 1957 fire
   - establish the time period of major plutonium releases from the 903 Area
   - evaluate the potential for a wind speed dependency for contaminant release from the 903 Area
   - compare with predictions from releases from the 903 Area
   - compare with predicted concentrations from the 1969 fire.
3. Historical reservoir and drinking water monitoring data, which were collected from cities near the RFP, were used to evaluate exposures associated with releases to surface water. Screening calculations, believed to be conservative, were used to calculate radiation doses associated with the elevation of radioactivity measured in the Great Western Reservoir, which possibly resulted from Rocky Flats releases.
4. Environmental measurements of radioactivity in vegetation were used to
   - develop an upper limit for the 1957 fire source term for coarse particles
   - compare with calculated deposition patterns for various release scenarios for the 1957 fire to select the most appropriate scenario.



A. Environmental data could be used directly in Task 2 to reconstruct the source term for fires and episodic releases from the 903 Area. Environmental data may identify additional contaminants or episodic releases as well as verify routine release estimates.

B. Environmental data assist in defining model structure and parameters for risk assessment. Data sets for model validation can be developed. If complete, high quality environmental data are available, they may be used directly to quantify human exposures for some pathways.

C. Review of historical environmental data provides one basis for developing recommendations for further monitoring.

Figure I-2. Relationship of Task 4 to other tasks in Phase II.

Purpose and Scope of this Report

This report communicates our findings about historical environmental monitoring around Rocky flats to the HAP for the Rocky Flats Public Exposures Studies, the DOE and RFP personnel, the scientific community, and other interested persons. An earlier version of this report (Rope et al. 1997) served as a reference document for environmental information used in other tasks of Phase II. It has been revised and reprinted at the end of the project to include all environmental monitoring information necessary to support the Phase II risk assessment reports.

Because of the historical emphasis of this work, the scope of the report extends up to 1990. In most cases, monitoring data from the earliest decades (1950s, 1960s, and 1970s) received the most attention. Because Phase I identified plutonium as a primary material of concern, our focus in this report was on historical environmental data for plutonium and gross alpha radioactivity. Two other contaminants, beryllium and carbon tetrachloride, were identified as important for historical public exposures. Environmental monitoring data for these contaminants were very limited (see next section).

FRAMEWORK FOR EVALUATING USEFULNESS OF ENVIRONMENTAL DATA

Some general discussion about which environmental data received the greatest attention is appropriate here. *RAC* has been involved in several other historical dose reconstruction studies in which environmental data played an important role. However, each site is different in terms of the contaminants of concern, the release timing and mechanisms, factors that influence environmental transport, and the extent and quality of environmental data.

In an early progress report for this task (Rope et al. 1993), we outlined a framework for evaluating the utility of environmental data, which guided the progress of the work. The general questions involved in this framework are discussed briefly below. Chapter II of this report presents conclusions about what environmental data tell us about past releases from Rocky Flats.

Inhalation is the primary way that people were exposed to releases from the Rocky Flats Plant. Thus, we gave historical air sampling data careful attention.

Was the contaminant of interest monitored in the environment?

This is an obvious question, but it is a particularly relevant one for Rocky Flats. Historically, there was no routine environmental monitoring of carbon tetrachloride or other volatile organic compounds in air or surface water. Recent monitoring of groundwater is not relevant to historical exposures, because available data indicate that groundwater has not yet moved contamination offsite (HAP 1993). Beryllium was routinely monitored in ambient air for a limited time in the 1970s.

Was the contaminant of interest monitored during the time period of interest?

For the purposes of this discussion about historical releases from the RFP, the primary time period of interest is before 1970. According to the Phase I work, this is the period during which the major releases from Rocky Flats occurred.

Data generated after 1970 may be useful for evaluating spatial and temporal trends, if the source and release mechanisms are similar to those before 1970. Around 1970, there is a major break point in the environmental monitoring data record for the RFP. After the fire in Building 776/777 in 1969, the routine monitoring by the RFP contractor was expanded to include soil, more sampling locations for other media, and analyses for specific contaminants like plutonium in addition to gross counts of radioactivity. Other monitoring programs (e.g., Colorado Department of Health, City of Broomfield, and City of Westminster) were instituted or expanded after 1970.

The term "media" refers to types of environmental samples, like air, soil, or water.

Was another contaminant monitored that is closely related to the contaminant of interest?

The environmental measurements made during the time period of interest at Rocky Flats were mainly gross counts of alpha and beta radioactivity. The gross alpha measurements could be indicative of plutonium concentrations. However, a number of factors must be analyzed, including the contributions of naturally occurring alpha emitters. This was, in fact, done during Phase II of this project for air monitoring data near the 903 Area before 1970.

Were concentrations onsite generally higher than offsite?

This question addresses the general issue of whether the facility had any measurable impact on environmental contaminant concentrations. In this question, the term “onsite” means generally closer to the plant and “offsite” is farther away. Inherent in this question is the issue of extremely low levels of the contaminant. If the contaminant concentrations are generally not detectable or if there is no apparent influence by the RFP, then the data are likely to be of marginal use for the study. They could perhaps provide an upper bound on the amounts released, but that is subject to evaluating sampling efficiency and quality.

Is the media a sink for the contaminant?

An environmental sink is a place in the environment where the contaminants tend to accumulate. An example for plutonium is soil. Monitoring of environmental sinks provides data that may be useful for estimating inventories (total amounts present), but the data are less useful for explaining temporal trends (changes in environmental concentrations over time).

The questions posed above are shown in Figure I-3 in the form of a logic diagram, which provides a framework for evaluating the utility of environmental data for the dose reconstruction. This exercise identified several areas that deserved a high level of attention (Table I-1) and other areas that were unlikely to be useful (Table I-2).

Table I-1. Routine Environmental Monitoring Data That Are Useful to the Reconstruction of Historical Public Exposures[a]

Type of data[b] and source	Possible uses
Plutonium in vegetation (RFP contractor 1957, 1969–1972, 1979–1990)	• Assess source term from fires • Verify routine release estimates • Establish spatial and temporal trends
Plutonium in air (RFP contractor 1970–1990)	• Verify routine release estimates • Establish spatial and temporal trends
Plutonium in air (independent agencies 1965–1990)	• Establish spatial and temporal trends in fallout plutonium • Cross-check contractor results
Plutonium in dustfall (RFP contractor 1969–1971)	• Verify routine release estimates • Establish spatial trends
Plutonium in soil	• Perform inventory analysis • Establish spatial trends
Plutonium in sediment	• Establish temporal trends
Gross alpha activity in air, vegetation, and water (RFP contractor 1950s–1960s)	• Establish spatial and temporal trends • Identify relative magnitude of routine releases
Gross alpha activity and plutonium in water at discharge points from ponds (contractor 1970–1974)	• Reconstruct releases of plutonium in water

[a]Preliminary assessment based on framework exercise (Rope et al. 1993, 1997). See Chapter II of this report for an update and expansion of the data determined to be useful to the study.

[b]An arbitrary cutoff date of 1990 was applied to examining environmental data.

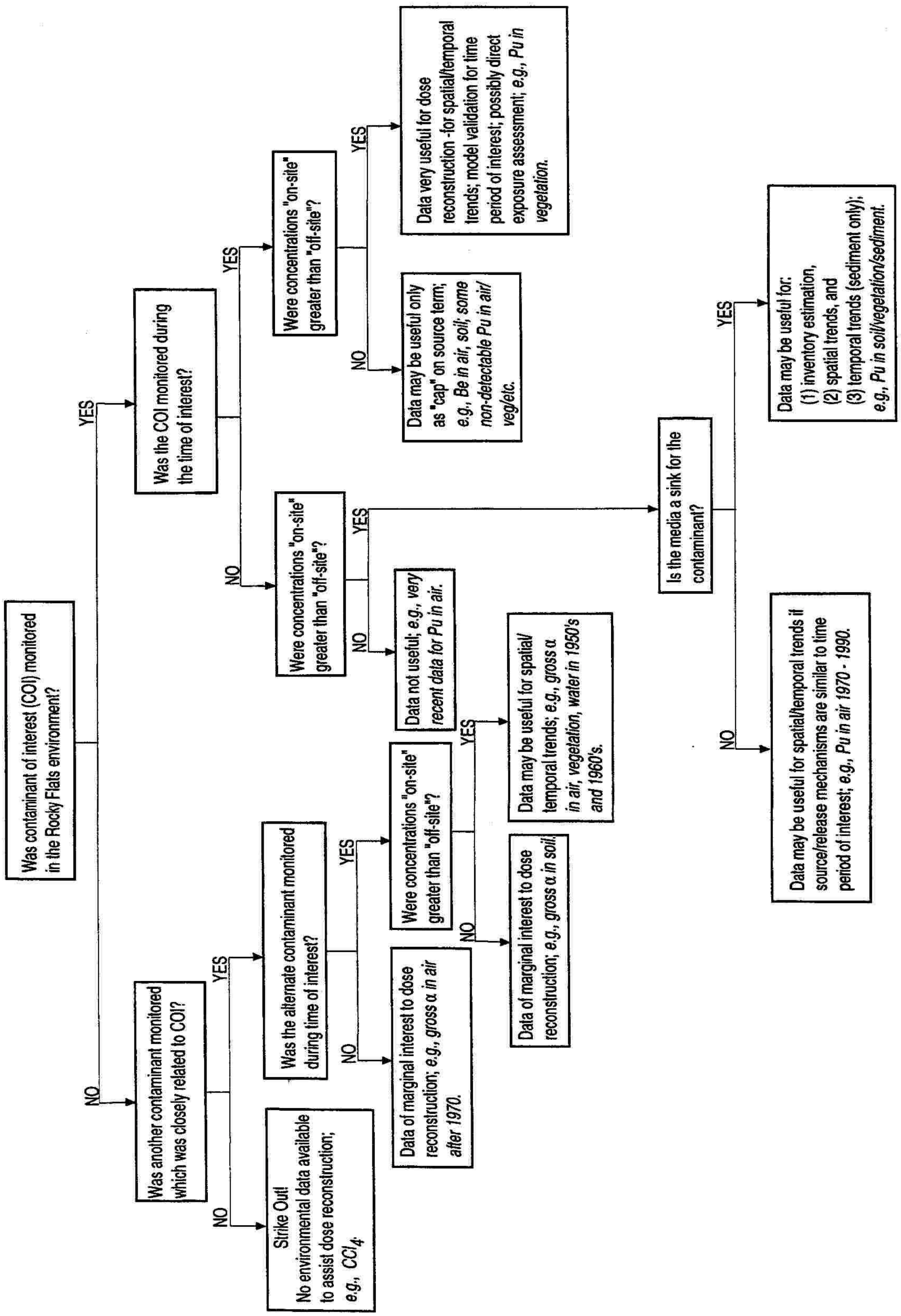


Figure I-3. Framework for evaluating availability and usefulness of routine environmental monitoring data in the historical public exposures studies.

Note that considerations of data quality arose only for the monitoring data that have been identified as likely to be useful. We generally addressed data quality issues by attempting to quantify bias and uncertainty in the measurements. Because the sources of information about past releases were limited, we tried to use as many of them as possible. Therefore, data sets were not discounted without careful consideration of their potential usefulness in the historical reconstruction of public exposures. This approach is in contrast to current characterization work for future risk assessments, in which strict data usability criteria are applied (DOE 1991).

Table I-2. Routine Environmental Monitoring Data That Are Not Useful to the Reconstruction of Historical Public Exposures

Type of data	Why unlikely to be useful
Gross beta activity (all media)	• Not closely related to contaminant of interest • Highly influenced by global fallout
Gross alpha activity in soil	• Greatly influenced by presence of naturally occurring alpha emitting radionuclides and highly variable • Onsite concentrations not clearly greater than offsite
Gross alpha activity in air and other media after 1970 (Colorado Department of Health and contractor monitoring)	• Outside of time period of interest • Confounded by presence of naturally occurring alpha-emitting radionuclides
Beryllium in soil	• Onsite concentrations not greater than offsite • Will receive another look in Phase II
Very recent (after 1990) measurements of plutonium in air	• Concentrations onsite are not much greater than offsite

Other conclusions drawn from this exercise include:

1. No routine measurements of carbon tetrachloride have been located that could be used to support the historical public exposures studies. Recent measurements in groundwater and local drinking water supplies are unlikely to provide useful data for our purposes.
2. The routine environmental monitoring data will help verify Phase I routine releases and identify spatial distribution of the 903 Area resuspended material. Because the 903 Area is believed to be the largest contributing source to offsite exposures (ChemRisk 1994b), this is an important contribution. However, the routine environmental data will probably not help with reconstruction of source terms from the two major fires beyond that achieved by the Phase I work. We have reviewed those Phase I efforts and attempted to obtain more original sources of information in some cases.

3. Future monitoring recommendations (Task 5) were developed that might benefit this study, considering the data gaps in the historic monitoring record and other factors (Case et al. 1994).

PRINCIPLES APPLIED IN EVALUATING ENVIRONMENTAL DATA

During our development of Task 4 for the Rocky Flats Dose Reconstruction Project, we followed a number of principles that guided our search for and analysis of the environmental monitoring data. They are listed below with a capsule summary of their meaning. Although the order of priority is not of great significance, they fall into a general sequence of relative importance from the highest to lowest.

Principle 1. The Physics and Chemistry of Plutonium and Other Materials Released by Rocky Flats

The physics and chemistry of plutonium (and most other materials considered during Phase II of the Rocky Flats Dose Reconstruction Project) are well established and documented. Although there are areas where additional research could yield more insight, most basic properties of these materials are indisputable. Furthermore, the environmental behavior of these contaminants has been studied extensively, and a number of conclusions can be drawn, especially with regard to plutonium. Examples of known facts about the environmental properties of plutonium are:

1. Because of the long physical half-life of isotopes of plutonium released by Rocky Flats, once it enters in the environment, it will remain for a very long time, far longer than the period being considered in this assessment.
2. Once deposited on soil, plutonium can be resuspended and transported from the original site of deposition. This resuspension of deposited material can occur over a very long period of time because most of the plutonium initially deposited on the soil surface remains near the surface and is available for remobilization by wind. The resuspension of initially deposited material creates a secondary source of plutonium that must be addressed in the study. After plutonium is deposited on soil from a primary event, much of this material remains near the location it first deposited and small amounts are resuspended over a long time.
3. After it is deposited in sediment, plutonium is not readily transported from the site of sedimentation, assuming the sediment bed is not disturbed. The layering of plutonium in sediments is created primarily by the continued deposits of sediment over time, rather than the movement of plutonium within the sediment bed.
4. Plutonium is not readily taken up by vegetation. Plutonium that enters the food chain through consumption of vegetation around the RFP was more likely to have resulted from direct deposition on the vegetation from the atmosphere or by resuspension of the plutonium from soil rather than direct uptake by roots. This is an important principle to understand because the unavailability of plutonium in food products and its low uptake through the gastrointestinal tract of humans (see “5” below) establishes the dominance of the inhalation pathway over ingestion.
5. Even when consumed through ingestion, insoluble chemical forms of plutonium are not readily taken up by the body. This contrasts significantly with the inhalation of plutonium

where, depending on particle size and chemical form, plutonium can be readily taken into the body through inhalation and is not readily removed.

6. Measurement techniques exist that can detect plutonium at very low concentrations. These techniques can distinguish between plutonium that was released by the RFP and plutonium released to the environment through the atmospheric testing of nuclear weapons.

Principle 2. Use of Direct Measurements to Reconstruct Doses

In dose reconstruction and when possible, doses should be based on direct measurements of contaminants if these measurements are of sufficient quality and quantity. However, even in the best situation, measurements of contamination generally do not indicate dose directly (i.e. measure internal deposition). Therefore, even when measurement data are available for environmental contamination, this information needs to be combined with calculations to estimate doses. Data that indicate concentrations in areas as close as possible to the receptor are needed for estimating doses directly.

Principle 3. Collection, Documentation, and Analysis of Monitoring Records in Historical Dose Reconstruction

The collection, documentation, and analysis of monitoring data for historical dose reconstruction is a key step in dose reconstruction. This task must be completed before the final transport and dose calculations are made to have information available for comparison with predictions. The report should consider available monitoring data from any source and for as many different environmental media as possible. Several points are important to consider when collecting environmental data:

1. Special effort must be given to locating data that were collected by organizations that are independent from the site being considered.
2. There will be a broad range in quality, thoroughness, and availability of data.
3. Methods for monitoring and procedures for analysis have improved significantly over time. However, the releases were often higher during earlier time periods. For this reason, early monitoring data must be examined and careful consideration must be given to sources of uncertainty and bias.

Principle 4. Nonselectivity of Data

It must be emphasized that in collecting and reviewing monitoring data for dose reconstruction, *all* information must be considered. The quality and thoroughness of monitoring data will vary widely, however data must not be selectively used or dismissed without a valid scientific reason. This principle also implies that if researchers accept the use of certain data to support or refute a hypothesis about releases, environmental concentrations, or doses, the same consideration must be given to all remaining data. The objective is to develop a consistent picture of historical releases.

Principle 5. Background

In this report, background is defined as the concentration of contaminants that would be present if the RFP did not exist. Background levels of contaminants can be either natural or man-made. In the case of ^{239,240}Pu, virtually all background is from a man-made source, the testing of nuclear weapons. In dose reconstruction, a clear understanding of the source, quantity, and trends in background must be established. This information is needed primarily to help understand the magnitude of contamination released by the site and to determine how far contaminants transported from the facility are distinguishable above background levels. The fact that contamination released by the facility becomes indistinguishable from the contribution from background does not imply there was no risk beyond that point. However, such comparisons do indicate the regions around the plant where the highest risk may have occurred.

Principle 6. Analysis of Environmental Monitoring Data

There are many ways to analyze the environmental data. The magnitude of the measurements themselves is only one way in which the data may be viewed. Other analyses that are very helpful in dose reconstruction include:

1. Trends in the data, for example, increases or decreases over time
2. The relative magnitude of concentrations when compared to other contaminants
3. The spatial distribution of contaminants in environmental media
4. Comparisons between predicted and measured values.

Principle 7. Limitation of Monitoring Data without Analysis of Source Terms or Pathways

Environmental measurements are not available for all places and times of interest. The full value of collecting and analyzing environmental data is not realized without a comprehensive analysis of the source term, or estimated releases, and predicting transport and distribution of contaminants in the environment. Therefore this step in dose reconstruction must be accompanied by other, complimentary parts of the research.

Principle 8. Break-point in Historical Monitoring

There is usually a clear break-point in the monitoring data available in historical dose reconstruction. The break-point refers to at least two distinct periods when there is a marked difference in the amount and quality of environmental data that were collected. In historical dose reconstruction related to DOE sites, this period generally occurs around 1970. This time in history is when interest in the environment and environmental quality surged. Consequently, regulations were implemented to control releases of contaminants to the environment and to enforce more strict measurement of contaminant releases and environmental media. This break-point is important to discern for two reasons. First, the quality of data is far superior during the later time, because more emphasis was placed on monitoring and techniques improved. Therefore, the more recent data are generally more reliable, and there are more monitoring locations. Second, it is generally true that more effort is needed to collect and understand data that originated during the earlier period, and that these data may be of extreme importance in reconstructing early doses and risks.

Principle 9. Logical Approach to Analyzing Historical Monitoring Data

When analyzing historical monitoring data, a logical approach must be used. For example, it must be thought, "If this happened, then the result must have been..." The logical approach must take into account all of the aforementioned principles and must consider possible contaminant pathways and the results of movement through those pathways. Whatever the final destination, when plutonium was released to the environment, essentially all of it still exists, somewhere. For example, if plutonium was released to surface water, a researcher must think about where that plutonium is today. Likewise, if plutonium was released to the atmosphere, it must have been dispersed downwind, some of it deposited, and some of it was eroded, or it is still in the atmosphere. By applying the basic principles described above and other pieces of the historical dose reconstruction, we should be able to gain insight about how much exists and where it is.

IDENTIFYING SOURCES OF INFORMATION

This section provides an overview of the sources of information we have investigated for environmental data around the RFP (particularly for Tasks 4 and 5). Additional detail is provided in the chapters of this report that address different media. Table I-3 lists sources that have provided information on past and present environmental monitoring and research activities.

The RFP contractor has routinely monitored radioactivity in the environment around the plant throughout its operating history; however, the program has changed significantly over time. The current program includes routine radiological and nonradiological monitoring of effluent air, ambient air, biota, surface water, groundwater, tap water, stream sediments, and soil at locations on and around the RFP.

Before startup of the RFP, a background survey (which included measurements of gross alpha radioactivity in soil, vegetation, and surface water) was performed by personnel from General Electric at Hanford, Washington. The background sampling was conducted from July to October 1951 to determine the levels of naturally occurring radioactive materials in the RFP environs. These data are discussed in Chapter V.

Early monitoring data for the RFP operations are reported in the *Site Survey–Monthly Progress Reports*. We have obtained these reports for the years 1952 (partial) through 1965, with only two missing months. The types of media collected and analyzed during this time interval are listed in Table I-5 at the end of this chapter. This rather detailed table is presented in this chapter because it includes a number of different media, and the chapters of this report each deal with one medium. The data we examined are discussed in the individual chapters of this report. Although the monitoring continued, the monthly reports of the Site Survey group do not appear to have been produced after the mid-1960s. The data were incorporated into other types of reports produced by the RFP.

Summaries of offsite environmental monitoring data are available in the form of semiannual and annual *Environmental Survey* reports generated by the RFP contractor from 1959 through 1970. In general, the *Environmental Survey* reports do not provide as much detail as the monthly progress reports.

Table I-3. Sources of Information Contacted about Environmental Monitoring around Rocky Flats

INTERVIEWS

- Current RFP employees
- Former RFP employees, including support and discussion groups
- Nonaffiliated scientific researchers
- Interested citizens
- City and county health and scientific personnel
- Colorado Department of Public Health and Environment personnel
- Citizens Environmental Sampling Subcommittee members
- Rocky Flats Citizens Advisory Board members

DOCUMENT REPOSITORIES

I. Onsite (currently Rocky Flats Environmental Technology Site)

- 881 Archives (classified)
- 706 Technical Library (classified)
- Legal/Environmental database (controlled)
- ChemRisk/Woodward-Clyde databases
- Environmental Master File
- Interlocken Library

II. Offsite

- U.S. Attorney's Office (Denver, Colorado)
- Department of Energy Field Office (Albuquerque, New Mexico)
- DOE Records Storage Repositories/National Archives (Washington, DC, area)
- Rocky Flats Reading Room (Front Range Community College)
- Federal Records Center (Denver, Colorado)
- Los Alamos Records Archives (New Mexico)
- Western History Library (Colorado University, Boulder, Carl Johnson files)
- Other technical libraries and private collections of open literature
- Colorado State University (Department of Radiology and Radiation Biology)
- National Air and Radiation Environmental Laboratory, U.S. Environmental Protection Agency (Montgomery, Alabama)
- Environmental Information Network (Lakewood, Colorado)
- ChemRisk files (Oakland, California)

For key time periods and data sets, we made a concerted effort to locate the most original data sources available, like sample counting sheets, analytical data sheets, sample logbooks, and laboratory procedures associated with the environmental monitoring program. For example, a large set of original air-sample record sheets from the 1960s was located and copied from storage in the Federal Records Center in Denver. It is through these types of fundamental records that detailed information can be obtained to help assess the quality of the environmental data. We have not been successful in locating all the original documentation for all types of samples and time periods of interest. The individual chapters of this report discuss the types of information we have located.

A cornerstone of a complete dose reconstruction is making full use of available measurements. Original sources of information, rather than summaries, are best when they can be located.

Beginning in 1971, the environmental monitoring program results were published in annual environmental monitoring reports written by RFP contractors (Dow Chemical, Rockwell International, EG&G Rocky Flats, Inc., and Kaiser-Hill Company). As stated previously, a major break-point in the environmental monitoring data record for the RFP occurred around 1970. It was at this time that the monitoring program was expanded to include more sampling locations, as well as specific analyses for plutonium and other contaminants of interest. Although the early annual environmental monitoring reports are somewhat sparse, the later reports contain significant detail on the sampling and analytical procedures, sampling locations, and methods of data analysis. The usefulness of these annual reports to the historical public exposures studies are somewhat limited because they represent years after the time period of interest. However, the data in these reports are useful in evaluating spatial trends for earlier years (see Figure I-3).

As of 1980 (as described in DOE [1980]), other agencies that conducted independent routine monitoring around the RFP included the Colorado Department of Health, which monitored air, water and soil, and the DOE Environmental Measurements Laboratory, formerly the Health and Safety Laboratory of New York, which maintained particulate air sampling stations in the vicinity of the RFP and periodically performed soil sampling. Also, the Jefferson County Health Department had a continuous particulate air sampler on the site, which the Colorado Department of Health analyzed. Jefferson County also sampled and analyzed sewage plant effluent monthly. The U.S. Environmental Protection Agency provided additional routine liquid effluent monitoring to determine compliance with the National Pollutant Discharge Elimination System permit. We obtained copies of the routine monitoring reports published by the independent organizations shown in Table I-4.

Table I-4. Titles and Dates of Series of Routine Monitoring Reports Generated by Organizations other than the RFP Contractor (obtained by *Radiological Assessments Corporation* for Task 4)

Organization	Report title	Years obtained
Colorado Department of Health	Rocky Flats Surveillance Reports	July 1970–1991
City of Westminster	Radiation Data Monthly Report	January 1989–December 1991
City of Broomfield	Radiometric Monitoring Report, Monthly Information Exchange Meeting	September 1981–December 1991
Health and Safety Laboratory	Fallout Program Summary Quarterly Report	1965–1977
U.S. Public Health Service	Radiological Health Data[a]	April 1960–December 1969
U.S. Environmental Protection Agency	Environmental Radiation Data Report[a]	January 1970–present

[a]Titles vary. The U.S. Environmental Protection Agency continued previous monitoring by the U.S. Public Health Service.

Table I-5. Rocky Flats Contractor Environmental Sampling as Reported in Site Survey Monthly Reports (1952–1965)

Month, Year	Stack	Air	Routine Surface Water	Non-routine Surface Water	Vegetation	Soil	Sediment	Incinerator Ash	Incinerator Sludge	Precipitation	Other, notes
Jul-52		X									weather; algae
Aug-52		X	X	X	X	X	X				weather; algae
Sep-52		X	X		X		X				weather; algae
Oct-52		X	X		X		X				weather
Nov-52		X	X		X		X				weather; algae; mice
Dec-52		X	X	X	X		X				weather; algae; mice
Jan-53		X	X		X						weather; mice
Feb-53		X	X								weather
Mar-53		X	X		X	X	X			X	algae; weather; aerovane wind instrument installed on roof of Bld 23 Mar 11. Shifted from use of Bld 91.
Apr-53		X	X		X	X	X			X	weather; algae
May-53		X	X		X	X	X			X	weather; algae; in plant surveys; Ci released from laundry; 2/3 of detection limit used for averages
Jun-53		X	X		X	X					weather; algae; in-plant surveys
Jul-53		X	X		X	X				X	weather; algae; in-plant surveys
Aug-53		X	X		X					X	weather; in-plant surveys
Sep-53		X	X								weather; in-plant surveys
Oct-53		X	X			X			X		weather; in-plant surveys; special soil survey of ditches surrounding laundry
Nov-53		X	X			X		X			weather
Dec-53		X	X			x		X		X	weather; in-plant surveys
Jan-54		X	X					X			weather; in-plant smears
Feb-54		X	X	X	X	X		X			weather; muskrat; in-plant smears
Mar-54		X	X		X	X		X			weather; soil in draw leading from the Beryl Ore Co.; Be in air; in-plant smears
Apr-54		X	X	X	X	X		X			weather (aereovane calibrated); air sampling near Beryl Ore; duck; fish; in-plant smears
May-54		X	X	X	X	X		X		X	weather; prototype fallout tray; prairie rat; fish; in-plant smears
Jun-54		X	X	X	X	X		X			weather; gummed paper; Beryl Ore air; rabbit; in-plant smears
Jul-54		X	X	X	X		X	X	X	X	weather; Beryl Ore air; smears
Aug-54		X	X	X	X	X		X	X	X	weather; fallout tray; smears; note sludge buried outside E security fence
Sep-54		X	X	X	X	X		X		X	weather; fallout tray; bat; snake; smears
Oct-54		X	X	X	X	X	X	X		X	weather; fallout tray; snake; smears
Nov-54		X	X	X	X	X		X		X	weather; smears
Dec-54		X	X	X	X	X	X	X	X		weather; fallout paper; smears
Jan-55		X	X					X	X	X	weather; mice; smears
Feb-55		X	X					X	X	X	mice from bldgs.(high); smears
Mar-55		X	X			X		X			fish; salamander; smears
Apr-55		X	X			X		X	X	X	mouse
May-55		X	X			X		X	X	X	mouse; rabbit; smears
Jun-55		X	X	X		X	X	X	X	X	pheasant; fish; bat; snake; algae; air in Blg 41; special air; smears. Planted fish in holding ponds.
Jul-55		X	X	X	X	X		X	X		special air; smears
Aug-55		X	X		X			X	X	X	precipitation from roof of blg 23; algae; snake; mice; bat from Blg 81; smears
Sep-55		X	X	X		X		X	X		algae; bat; spider; rabbit; fish; smears; mention of marked increase in activity of incinerator ash
Oct-55		X	X	X		X		X	X	X	lizard; mouse; rabbit; smears; special air
Nov-55		X	X			X		X		X	special air; fall out paper; smears
Dec-55		X	X			X		X			snake; smears
Jan-56		X	X		X	X		X			smears
Feb-56	X	X	X		X				X	X	snow; smears
Mar-56	X	X	X		X			X			snow; muskrat; smears

Table I-5. (Continued)

Month, Year	Stack	Air	Routine Surface Water	Non-routine Surface Water	Vegetation	Soil	Sediment	Incinerator Ash	Incinerator Sludge	Precipitation	Other, notes
Apr-56	X	X	X			X		X			special air; smears
May-56	X	X	X		X	X		X			algae (good correlation with water); fish; salamander; mice; snake et al.; special air; smears
Jun-56	X	X	X		X	X		X		X	fish; snake; bat; smears
Jul-56	X	X	X			X		X		X	minnows; rat; fish; mouse; rabbit; smears
Aug-56	X	X	X					X		X	smears; fish; note: two reports
Sep-56	X	X	X					X	X		smears; rabbit; spider
Oct-56	X	X	X					X			smears; special air; snake
Nov-56	X	X	X	X				X		X	long-term trend plots for surface water; smears
Dec-56	X	X	X					X	X		smears
Jan-57	X	X	X					X			
Feb-57	X	X	X					X			rabbit
Mar-57	X	X	X					X			
Apr-57	X	X	X							X	
May-57	X	X	X								
Jun-57	X	X	X					X	X		
Jul-57	X	X	X			X		X			
Aug-57	X	X	X					X			
Sep-57	X	X	X	X	X	X					
Oct-57	X	X	X	X	X	X		X			
Nov-57	X	X	X	X	X	X					
Dec-57	X	X	X	X	X			X			
Jan-58	X	X	X	X	X	X	X	X			
Feb-58	X	X	X	X	X	X	X	X			
Mar-58	X	X	X		X			X			
Apr-58	X	X	X	X	X	X	X	X			algae
May-58	X	X	X	X	X						
Jun-58	X	X	X	X	X			X			
Jul-58	X	X	X	X	X	X	X	X			
Aug-58	X	X	X	X	X			X			
Sep-58	X	X	X		X						
Oct-58	X	X	X	X	X	X			X		fire data summary
Nov-58	X	X	X	X	X	X	X				
Dec-58	X	X	X		X	X					
Jan-59	X	X	X		X			X	X		
Feb-59	X	X	X		X					X	
Mar-59	X	X	X		X					X	
Apr-59	X	X	X	X	X			X			
May-59	X	X	X	X	X					X	
Jun-59	X	X	X	X		X		X		X	
Jul-59	X	X	X								
Aug-59	X	X	X	X	X			X		X	
Sep-59	X	X	*** Offsite monitoring section of 9/59 report was not located								
Oct-59	X	X	X	X		X		X			
Nov-59	X	X	X	X	X						
Dec-59	X	X	X	X						X	

Table I-5. (Continued)

Month, Year	Stack	Air	Routine Surface Water	Non-routine Surface Water	Vegeta-tion	Soil	Sedi-ment	Incinerator Ash	Incinerator Sludge	Precipi-tation	Other, notes
Jan-60	X	X	X								
Feb-60	X	X	X			X			X		
Mar-60	X	X	X		X			X			
Apr-60	X	X	X	X							
May-60	X	X	X	X						X	
Jun-60	X	X	X	X							snake
Jul-60	X	X	X	X							
Aug-60	X	X	X	X							
Sep-60	X	X	X	X	X						
Oct-60	X	X	X	X	X						
Nov-60	X	X	X	X	X						
Dec-60	X	X	X		X						
Jan-61	X	X	X		X						
Feb-61	X	X	X		X						
Mar-61	X	X	X		X						
Apr-61	X	X	X		X						
May-61	X	X	X		X						
Jun-61	X	X	X		X						
Jul-61	X	X	X	X	X						
Aug-61	X	X	X		X						
Sep-61	X	X	X		X						
Oct-61	X	X	X	X	X						
Nov-61	X	X	X	X							
Dec-61	X	X	X	X							
Jan-62	X	X	X								
Feb-62	X	X	X	X	X						
Mar-62	X	X	X		X						
Apr-62	X	X	X		X						
May-62	X	X	X		X						
Jun-62	X	X	X	X	X						
Jul-62	X	X	X	X							
Aug-62	X	X	X								
Sep-62	X	X	X	X	X						
Oct-62	X	X	X	X	X						
Nov-62	X	X	X	X	X						
Dec-62	missing										
Jan-63			X		X						
Feb-63			X		X						
3/63			X		X						
4/63			X	X	X	X				X	precipitation from Blg 23 gauge
5/63			X								plutonium fallout deposition
6/63			X	X							plutonium fallout deposition
7/63			X	X	X					X	plutonium fallout deposition
8/63			X		X						plutonium fallout deposition
9/63			X		X						plutonium fallout deposition

Table I-5. (Continued)

Month, Year	Stack	Air	Routine Surface Water	Non-routine Surface Water	Vegeta-tion	Soil	Sedi-ment	Incinerator Ash	Incinerator Sludge	Precipi-tation	Other, notes
10/63			X								plutonium fallout deposition
11/63			X	X							plutonium fallout deposition
12/63			X	X						X	plutonium fallout deposition
1/64			X	X							plutonium fallout deposition
2/64			X		X						plutonium fallout deposition
3/64			X		X						plutonium fallout deposition
4/64			X		X						plutonium fallout deposition
5/64			X	X	X						plutonium fallout deposition; drinking water
6/64			X	X	X						plutonium fallout deposition; drinking water
7/64			X	X	X						plutonium fallout deposition; drinking water
8/96			X	X	X						plutonium fallout deposition; drinking water
9/64			X	X	X						plutonium fallout deposition; drinking water
10/64			X	X	X						plutonium fallout deposition; drinking water
11/64			X		X						plutonium fallout deposition
12/64			X	X	X						plutonium fallout deposition; drinking water
1/65				X							drinking water
2/65			X	X							drinking water
3/65			X	X							drinking water
4/65			X	X							drinking water; rabbits
5/65			X	X							plutonium fallout deposition; drinking water
6/65			X	X							plutonium fallout deposition; drinking water
7/65			X	X							drinking water
8/65			X	X							drinking water
9/65			X	X							plutonium fallout deposition; drinking water
10/65			X	X							drinking water
11/65			X	X							plutonium fallout deposition; drinking water
12/65			X	X							plutonium fallout deposition; drinking water

REFERENCES FOR CHAPTER I

Case, M.J., P.D. McGavran, H.R. Meyer, K.R. Meyer, A.S. Rood, S.K. Rope, D.W. Schmidt, and T.F. Winsor. 1994. *Recommendations for Monitoring to Verify Phases I and II – Part I*, *Radiological Assessments Corporation*, Neeses, South Carolina. November.

ChemRisk. 1994a. *Estimating Historical Emissions From Rocky Flats 1952–1989*. Project Task 5 for Phase I. ChemRisk, Alameda, California. March.

ChemRisk. 1994b. *Dose Assessment for Historical Contaminant Releases from Rocky Flats.* Project Task 8 for Phase I. ChemRisk, Alameda, California. September.

DOE (U.S. Department of Energy). 1980. *Final Environmental Impact Statement (Final Statement to ERDA 1545–D), Rocky Flats Plant Site, Golden, Jefferson County, Colorado*. Report DOE/EIS–0064. National Technical Information Service, Springfield, Virginia.

DOE. 1991. *Final Past Remedy Report. Operable Unit No. 3—IHSS 199*. Environmental Restoration Program, Rocky Flats Plant, Golden, Colorado. May.

HAP (Health Advisory Panel). 1993. *Health Advisory Panel's Report to Colorado Citizens on the Phase I Study of the State of Colorado's Health Studies on Rocky Flats*. Colorado Department of Health, Denver, Colorado. October.

Rope, S.K., L. Bell, K. Meyer, D. Schmidt, E. Stetar, and T. Winsor. 1993. *Task 4. Evaluation of Historical Environmental Data. Progress Report—December 1993*. *Radiological Assessments Corporation*, Neeses, South Carolina.

Rope, S.K., K.R. Meyer, M.J. Case, D.W. Schmidt, T.F. Winsor, M. Driecer, and J.E. Till. 1997. *Evaluation of Historical Environmental Data.* RAC Report # 1 CDPHE-RFP-1997-FINAL. Radiological Assessments Corporation, Neeses, South Carolina. March.