United States
Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R10-93/057
December 1992

EPA

Superfund Record of Decision:

US DOE Idaho National Engineering Laboratory (Operable Unit 4), ID

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. EPA/ROD/R10-93/057	2	3. Recipient's Accession No.

4. Title and Subtitle
SUPERFUND RECORD OF DECISION
USDOE Idaho National Engineering Laboratory (Operable Unit 4), ID
Sixth Remedial Action

5. Report Date 12/10/92

6.

7. Author(s)

8. Performing Organization Rept. No.

9. Performing Organization Name and Address

10. Project Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

13. Type of Report & Period Covered
800/800

14.

15. Supplementary Notes
PB94-964611

16. Abstract (Limit: 200 words)

The 1,700 by 1,900 feet USDOE Idaho National Engineering Laboratory (Operable Unit 4) is part of the 890-square mile U.S. Department of Energy (USDOE) facility located in Idaho Falls, Idaho. The primary mission of the Idaho National Engineering Lab (INEL) is nuclear reactor technology development and waste management. Land use in the area is predominantly industrial with mixed uses (restricted agricultural and recreational uses). The site, also known as the Test Reactor Area (TRA), contains more than 73 buildings and 56 structures such as tanks, cooling towers, laboratories, offices, and three high neutron flux nuclear test reactors, of which only one is currently operational. Approximately 7,700 people are employed at the INEL, with an estimated 600 employed at the TRA. Drinking water for the employees is obtained from production wells located within the facility. The site is contained within the northeastern portion of the Eastern Snake River Plain (ESRP), borders a floodplain to the west and north, and overlies the Snake River Plain Aquifer, which is a sole-source aquifer. The TRA was established in the early 1950s to operate and test high neutron flux nuclear test reactors. Prior to 1964, most of the chemical and radioactive wastewater generated during site operations was discharged directly to six wastewater ponds at the TRA. Use

(See Attached Page)

17. Document Analysis a. Descriptors
Record of Decision - USDOE Idaho National Engineering Laboratory (Operable Unit 4), ID
Sixth Remedial Action
Contaminated Medium: None
Key Contaminants: None

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 58
	20. Security Class (This Page) None	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse* OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

Abstract (Continued)

of these ponds has contributed to the formation and contamination of the Perched Water System. From 1964 until 1982, wastewater was injected directly into the Snake River Plain Aquifer, which did not contribute to the perched water contamination. Currently, there are four active disposal units that receive waste effluent generated at the TRA. These are the warm waste pond, which receives radiologically-contaminated wastewater; the cold waste pond, which receives primarily reactor cooling water with no radiological activity; the chemical waste pond, which is used for disposal of wastewater from ion exchange units and water softeners; and the sanitary waste ponds. Studies of the perched ground water and the Snake River Plain Aquifer, conducted by DOE, identified low-level contamination by VOCs, other organics, metals, other inorganics, and radionuclides. Previous 1992 RODs addressed sediment at the Warm Waste Pond, ordnance and contaminated soil, contaminated ground water at the Technical Support Facility, and contaminated sediment and sludge in the evaporation pond, discharge pipe, and waste sump as OUs 5, 23, 2, and 22, respectively. This ROD addresses the contaminated Perched Water System within the TRA, as OU4. Other 1993 RODs addresses the Perched Water System, the CFA Motor Pool Pond and Pit 9 of the Subsurface Disposal Area, as OUs 4, 9, and 18 respectively. Because public access to the TRA is restricted and the Perched Water System is approximately 50 to 150 feet below the ground surface, current public exposure to the perched water is unlikely. Furthermore, results of human health and ecological risk assessments demonstrate no unacceptable risk to human health and the environment. As a result, no remedial action is necessary for the Perched Water System at the TRA; therefore, there are no contaminants of concern affecting this site.

The selected remedial action for this site is no further action, with ground water monitoring. To support the no remedial action decision, DOE will begin a minimum 10-year decontamination and decommission period in the year 2007, when operations at the TRA have ceased; maintain existing institutional controls, including land use restrictions and property access restrictions; and replacing the existing warm wastewater pond, which is the major source of contamination in the perched ground water, with a new lined pond in 1993. Future contact with the Perched Water System also is unlikely because it is predicted to dissipate within about 7 years of ceasing disposal of wastewater to the ponds at the TRA according to modeling results. Results of human health and ecological risk assessments demonstrate no unacceptable risk due to potential future use. There are no costs provided for this no action remedy.

PERFORMANCE STANDARDS OR GOALS:

Not applicable.

RECORD OF DECISION

FOR THE TEST REACTOR AREA PERCHED WATER SYSTEM

OPERABLE UNIT 2-12

AT THE

IDAHO NATIONAL ENGINEERING LABORATORY

TABLE OF CONTENTS

STATEMENT OF BASIS AND PURPOSE iv

DESCRIPTION OF THE SELECTED REMEDY iv

DECLARATION v

DECISION SUMMARY 1
Introduction 1

1. SITE NAME, LOCATION, AND DESCRIPTION 1

2. SITE HISTORY AND ENFORCEMENT ACTIVITIES 2
2.1 Site History 2
2.2 Current Facility Operations 3
2.3 Previous Groundwater Investigations 4
2.4 Enforcement 4

3. HIGHLIGHTS OF COMMUNITY PARTICIPATION 4

4. SCOPE AND ROLE OF OPERABLE UNIT AND RESPONSE ACTION 6

5. SUMMARY OF SITE CHARACTERISTICS 7
5.1 Geology and Hydrology 7
5.1.1 Surface Water 7
5.1.2 Perched Water 7
5.1.3 Snake River Plain Aquifer 8
5.2 Nature and Extent of Contamination 8
5.2.1 Shallow Perched Zone 9
5.2.2 Deep Perched Groundwater Zone 10
5.2.3 Snake River Plain Aquifer 10
5.2 Groundwater Model 11

6. SUMMARY OF SITE RISKS 12
6.1 Human Health Risk Assessment 12
6.1.1 Identification of Contaminants of Concern 12
6.1.2 Exposure Assessment 13
6.1.3 Toxicity Assessment 15
6.1.4 Risk Characterization 16
6.1.5 Uncertainty 18
6.2 Ecological Risk Assessment 19
6.2.1 Exposure Assessment 19
6.2.2 Risk Characterization 20

7. DESCRIPTION OF NO ACTION DECISION 20

8. EXPLANATION OF SIGNIFICANT CHANGES 21

REFERENCES 22

APPENDICES A-1
Appendix A Public Comment/Response Index A-1

FIGURES 23
Figure 1. Location of the Test Reactor Area 23
Figure 2. Test Reactor Area and surrounding area 24
Figure 3. Generalized cross section showing a TRA waste water disposal pond and the Perched Water System under TRA. 25
Figure 4 Configuration of the deep perched ground water at TRA, March 21, 1991 25
Figure 5. Locations of deep perched monitoring wells. 26
Figure 6. Shallow perched ground water monitoring locations. 26
Figure 7. Locations of Snake River Plain Aquifer wells. 27
Figure 8. Maximum modeled chromium concentrations in the Snake River Plain Aquifer. 28
Figure 9. Maximum modeled tritium concentrations in the Snake River Plain Aquifer. 28
Figure 10. Maximum modeled cadmium concentrations in the Snake River Plain Aquifer. 29

TABLES 30
Table 1. Total and daily process water discharged to the Test Reactor Area pond system. 30
Table 2. Concentration ranges and detection frequency in the shallow perched zone. 31
Table 3. Concentration ranges and detection frequency in the deep perched zone. 35
Table 4. Federal drinking water standards and background concentrations for inorganics, organics, and radionuclides. 37
Table 5. Perched Water System contaminants of concern and deep perched zone mean concentrations. 40
Table 6. Average concentrations of contaminants used for risk assessment and in the Perched Water System predicted by computer model. . . 41
Table 7. Summary of nonradiological carcinogenic risk in year 2115. 42
Table 8. Summary of radiological carcinogenic risk in year 2115. 43
Table 9. Summary of noncarcinogenic hazard indices (child) in year 2115. 44

Table 10. Summary of noncarcinogenic hazard indices (adult) in year 2115. 45
Table 11. Summary of 30-year rolling average concentrations. 46
Table 12. Near-term excess lifetime cancer risks from tritium exposure. 47
Table 13. Near-term hazard quotients for cadmium and total chromium. 48

RESPONSIVENESS SUMMARY 49
Overview 49
Background on Community Involvement 49
Summary of Comments Received During Public Comment Period 50

DECLARATION OF THE RECORD OF DECISION FOR THE TEST REACTOR AREA PERCHED WATER SYSTEM AT THE IDAHO NATIONAL ENGINEERING LABORATORY

SITE NAME AND LOCATION

Perched Water System
Test Reactor Area
Idaho National Engineering Laboratory

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected final remedy (no remedial action with monitoring) for the Test Reactor Area Perched Water System, Operable Unit 2-12 at the Idaho National Engineering Laboratory. The remedy was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act, as amended by the Superfund Amendments and Reauthorization Act, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan. This decision is based on the Administrative Record for the site.

The lead agency for this decision is the U.S. Department of Energy. The Environmental Protection Agency approves of this decision and, along with the State of Idaho Department of Health and Welfare, has participated in the scoping of the site investigations and in the evaluation of remedial investigation data. The State of Idaho concurs with the selected remedy.

DESCRIPTION OF THE SELECTED REMEDY

It has been determined that no remedial action is necessary for the Perched Water System at the Test Reactor Area to ensure protection of human health and the environment. This decision is based on the results of the human health and ecological risk assessments, which determined that conditions at the site pose no unacceptable risks to human health or the environment for expected current or future use of the Snake River Plain Aquifer beneath the Perched Water System at the Test Reactor Area.

Components and assumptions for the No Remedial Action decision are:

- Groundwater monitoring will be conducted to verify that contaminant concentration trends follow those predicted by a groundwater computer model. Within forty-five days of signature of this Record of Decision, a monitoring plan will be developed by the U.S. Department of Energy and submitted to the U.S. Environmental Protection Agency and the Idaho Department of Health and Welfare as a primary document pursuant to the Idaho National Engineering Laboratory Federal Facility Agreement and Consent Order.

- Operations at the Test Reactor Area will continue at least through the year 2007, followed by a minimum estimated 10-year decontamination and decommissioning period. Existing institutional controls, which include land use and property access restrictions, will continue to be maintained during this period.

- The existing warm waste pond, which is the major source of contamination in the perched groundwater, will be replaced by a new lined pond in 1993. The Remedial Investigation incorporated the assumption that the existing warm waste pond would be replaced by the new lined pond.

DECLARATION

It has been determined that no remedial action is necessary to ensure protection of human health and the environment. Because this decision will result in hazardous substances remaining on the site above health-based levels, a statutory review of this decision will be conducted by the Department of Energy, the Environmental Protection Agency, and the Idaho Department of Health and Welfare if any of the assumptions used to arrive at the No Remedial Action decision change, but no-later than three years to ensure that adequate protection of human health and the environment continues to be provided. This review will evaluate the assumptions used to arrive at the No Remedial Action decision.

Signature sheet for the foregoing Operable Unit 2-12 Perched Water System at the Test Reactor Area at the Idaho National Engineering Laboratory Record of Decision between the United States Department of Energy and the United States Environmental Protection Agency, with concurrence by the Idaho Department of Health and Welfare.

[signature] 11/20/92

Augustine A. Pitrolo
Manager
Department of Energy, Idaho Field Office

Date

Signature sheet for the foregoing Operable Unit 2-12 Perched Water System at the Test Reactor Area at the Idaho National Engineering Laboratory Record of Decision between the United States Department of Energy and the United States Environmental Protection Agency, with concurrence by the Idaho Department of Health and Welfare.

Dana A Rasmussen
Dana Rasmussen
Regional Administrator, Region 10
Environmental Protection Agency

DEC 1 0 1992
Date

Signature sheet for the foregoing Operable Unit 2-12 Perched Water System at the Test Reactor Area at the Idaho National Engineering Laboratory Record of Decision between the United States Department of Energy and the United States Environmental Protection Agency, with concurrence by the Idaho Department of Health and Welfare.

Richard P. Donovan (signature) 12/15/92

Richard Donovan
Director
Idaho Department of Health and Welfare

Date

RECORD OF DECISION FOR THE PERCHED WATER SYSTEM AT THE TEST REACTOR AREA, OPERABLE UNIT 2-12, AT THE IDAHO NATIONAL ENGINEERING LABORATORY

DECISION SUMMARY

Introduction

The Idaho National Engineering Laboratory (INEL) was proposed for listing on the National Priority List (NPL) July 14, 1989 [54 Federal Register (FR) 29820]. The listing was proposed by the Environmental Protection Agency (EPA) under the authorities granted EPA by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act of 1986. The final rule that listed the INEL on the NPL was published November 21, 1989, in 54 FR 44184.

In accordance with the CERCLA, Executive Order 12580 (Superfund Implementation) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (EPA 1990), the U.S. Department of Energy (DOE) performed a Remedial Investigation for the Perched Water System. The Remedial Investigation characterized the nature and extent of contamination in the Perched Water System. A Human Health Risk Assessment and an Ecological Risk Assessment were conducted to evaluate potential effects of the Perched Water System on human health and the environment.

1. SITE NAME, LOCATION, AND DESCRIPTION

The INEL is an 890-square mile federal facility operated by the DOE (Figure 1). The primary mission of the INEL is nuclear reactor technology development and waste management.

Current land use at the INEL is industrial. Approximately 7,700 people are employed at the INEL, with an estimated 600 employed at the Test Reactor Area. The nearest off-site populations are in the cities of: Atomic City (13 miles southeast of the Test Reactor Area), Arco (17 miles west), Howe (14 miles north), Mud Lake (32 miles northeast), and Terreton (34 miles northeast).

The INEL has semi-desert characteristics with hot summers and cold winters. Normal annual precipitation is 8.7 inches. Twenty distinctive vegetation cover types have been identified at the INEL. Big sagebrush, the dominant species, covers approximately 80 percent of the area. The variety of habitats on the INEL support numerous species of reptiles, birds, and mammals. Underlying the INEL are a series of silicic and basalt lava flows and relatively minor amounts of sedimentary interbeds. The basalts immediately beneath the site are relatively flat-lying and covered with 20 to 30 feet of alluvium. The Snake River Plain Aquifer underlies the INEL and was designated a sole source aquifer in 1992 pursuant to the Safe Drinking Water Act.

The Test Reactor Area is located in the southwestern portion of the INEL approximately 47 miles west of Idaho Falls (Figure 1). The Test Reactor Area covers an area of approximately 1,700 by 1,900 feet and is surrounded by a double security fence (Figure 2). Located inside the fence are more than 73 buildings and 56 structures, such as tanks, cooling towers, laboratories and offices. The facility contains three high neutron flux nuclear test reactors: the Materials Test Reactor, the Engineering Test Reactor, and the Advanced Test Reactor. Only the Advanced Test Reactor is currently operational.

The area around the Test Reactor Area is relatively flat with the exception of several construction rubble piles resulting from Test Reactor Area activities. Generally, the land surface slopes gently from the west-southwest corner to the east-northeast corner of the facility. The only surface water bodies at the Test Reactor Area are the four wastewater disposal ponds located outside the security fence (Figure 2). The Big Lost River channel is located 4,480 feet south of the Test Reactor Area. Drinking water for employees at the TRA is obtained from production wells in the northeast part of the facility (see Figure 7).

Chemical and radioactive wastewater have been and continue to be generated from scientific and engineering research at the Test Reactor Area. Wastewater discharged to unlined surface ponds at the Test Reactor Area percolates downward through the surficial alluvium and the underlying basalt bedrock. A shallow perched water zone has formed at the interface between the surficial sediments and the less permeable underlying basalt approximately 50 feet below land surface. Further downward movement of groundwater is again impeded by a low permeability layer of silt, clay, and sand encountered at a depth of about 150 feet. The deep perched water zone occurs on top of this low permeability interbed. Figures 3 and 4 illustrate the vertical and areal extent, respectively, of the perched groundwater at the Test Reactor Area.

2. SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 Site History

The Test Reactor Area was established in the early 1950s to operate and test high neutron flux nuclear test reactors. Wastewater generated during operations is disposed of in the wastewater ponds at the Test Reactor Area. Six disposal units have been used that have contributed to the formation and contamination of the Perched Water System; the retention basin, chemical waste pond, sanitary waste (sewage) pond, warm waste pond, cold waste pond, and former disposal Well U.S. Geological Survey (USGS)-53.

The chemical composition of water discharged to the ponds has varied over the years. Prior to 1962, all wastewater generated at the Test Reactor Area, except sanitary sewage, was discharged directly to the warm waste pond. From 1952 to 1962, radionuclides, water softener and ion exchange column regeneration fluids, reactor cooling water containing hexavalent chromium, and other miscellaneous wastes were all disposed to the warm waste pond. In 1962, the regeneration fluids were diverted to the chemical waste pond for disposal. Water used in the secondary reactor cooling system that contained hexavalent chromium was disposed to the warm waste pond from 1952 until November 1964.

Two different wells were used for disposal of waste water at the Test Reactor Area. From 1964 until 1972, the Test Reactor Area disposal well was used to dispose of the secondary reactor cooling water. This disposal well injected directly into the Snake River Plain Aquifer and did not contribute contaminants to the Perched Water System. After 1972, hexavalent chromium was no longer used as a rust inhibitor in the cooling systems and was no longer discharged to the disposal well or to the ponds. Use of the disposal well ceased in 1982. From 1960 to 1964, during peak wastewater generation, a second well, USGS-53, was used intermittently to inject wastewater to the Perched Water System as the warm waste pond had insufficient capacity.

The volume of discharged wastewater has been estimated for each pond system over the operating period from 1952 to present, and is summarized in Table 1. For the period of record from 1962 to 1990, a total of 6,770 million gallons of water were discharged from the waste streams to the Perched Water System. Discharge volumes have remained near 200 to 300 million gallons per year, except for a 3-year period from 1979 to 1981 when discharge volumes were only 70 to 100 million gallons per year.

Water level elevations and areal extent of the deep perched groundwater fluctuate in response to the volume of water being discharged to the surface ponds. Water movement in the deep perched groundwater zone is both lateral and vertical. The size of the deep perched groundwater zone has remained fairly uniform over the years except between 1979 to 1981 when the size of the deep perched groundwater zone greatly decreased due to decreased discharge to the surface ponds. With increased discharge to the surface ponds since 1982, the deep perched groundwater zone has returned to its previous size.

2.2 Current Facility Operations

Four disposal units are currently active and receive waste effluent currently generated at the Test Reactor Area. These are the warm waste pond which receives radiologically contaminated wastewater, the cold waste pond which receives primarily reactor cooling water with no radiological activity, the chemical waste pond which is used for disposal of wastewater from ion exchange units and water softeners, and the sanitary waste ponds for sanitary (sewage) wastes. These discharge ponds are identified on Figure 2.

Discharge rates to each pond are summarized in Table 1. The greatest volume of wastewater is discharged to the cold waste pond at approximately 500 gallons per minute. Water discharged to the cold waste pond is nonradioactive wastewater. The water is uncontaminated secondary reactor cooling water and is discharged in significant volumes to the Perched Water System.

2.3 Previous Groundwater Investigations

A number of groundwater investigations have been conducted since 1949 in the vicinity of the Test Reactor Area to characterize the quality of the Snake River Plain Aquifer. The USGS began installing monitor wells and evaluating waste migration from the deep perched groundwater to the Snake River Plain Aquifer in 1960. USGS monitoring parameters have included nitrate, chloride, pH, specific conductivity, sodium, hexavalent chromium, total and dissolved chromium, chromium-51, tritium, cobalt-60, cesium-137, and strontium-90.

2.4 Enforcement

A Consent Order/Compliance Agreement (COCA) (EPA 1987) was entered into between DOE and EPA in August, 1987, pursuant to the Resource Conservation and Recovery Act (RCRA). The COCA required DOE to conduct an initial assessment and screening of all solid waste and/or hazardous waste disposal units at the INEL. The release of radioactive and/or hazardous contaminants to the disposal ponds and the deep injection well were identified and evaluated during investigations conducted in accordance with RCRA corrective action requirements.

As a result of the INEL's listing on the NPL in November 1989, DOE, EPA, and the State of Idaho Department of Health and Welfare (IDHW) entered into a Federal Facility Agreement and Consent Order (FFA/CO) (EPA 1991a) in December 1991 pursuant to CERCLA and the Idaho Hazardous Waste Management Act. The FFA/CO superseded the COCA and established a procedural framework for agency coordination and a schedule for all FFA/CO remedial action activities conducted at the INEL as a result of the NPL listing. The Perched Water System Remedial Investigation (EG&G 1992) was conducted in accordance with the FFA/CO.

3. HIGHLIGHTS OF COMMUNITY PARTICIPATION

Community participation activities have been conducted in compliance with CERCLA Sections 113(K)(2)(b)(i-v) and 117, and Section 24 of the FFA/CO.

To announce the beginning of the Perched Water System investigation project, public informational meetings were held in late July 1991 in Idaho Falls, Pocatello, Twin Falls, Boise, and Moscow. The meetings were to explain the CERCLA process and to introduce the Perched Water System investigation project to the public. These informational meetings were announced via the INEL Reporter newsletter, which is distributed to INEL employees as well as the general public, through newspaper and radio advertisements, and in an INEL press release. Personal phone calls were made to key individuals, environmental groups, and organizations by the INEL field offices in Pocatello, Twin Falls, and Boise. The Community Relations Plan Coordinator also made calls to community leaders in Idaho Falls and Moscow.

When the investigation was completed, a Notice of Availability for the Proposed Plan (USDOE 1992) for no remedial action of the Perched Water System was published June 26, 1992, in the *Post Register* (Idaho Falls), *Idaho State Journal* (Pocatello), *Times News* (Twin Falls), *Idaho Statesman* (Boise), and *Daily News* (Moscow/Pullman). A similar newspaper advertisement appeared in the same newspapers the following week repeating the announcement of the public meeting locations and times. Personal phone calls, as noted above, were also made to inform interested individuals and groups about the opportunity to comment.

The Proposed Plan for the remedial action of the Perched Water System was mailed June 26, 1992, to 6,500 individuals on the INEL mailing list. It included a cover letter from the Director of the Environmental Restoration Division of the DOE Idaho Field Office urging citizens to comment on the Proposed Plan and to attend public meetings. Copies of the Proposed Plan and the Administrative Record were available to the public in six regional INEL information repositories: the INEL Technical Library in Idaho Falls; and city libraries in Idaho Falls, Pocatello, Twin Falls, Boise, and Moscow. The original documents comprising the Administrative Record are located at the INEL Technical Library; copies are present in the five other libraries. These copies were placed in the information repository sections or at the reference desk in each of these libraries.

The public comment period on the Proposed Plan for the Perched Water System was held from July 6 to August 5, 1992. No requests for extensions were made. Technical briefings were conducted via speaker phone to interested members of the public in Twin Falls, Moscow, and Pocatello on July 13, 14, and 15, 1992, respectively. Public meetings were held July 20, 21, 22, and 23, 1992, in Idaho Falls, Burley, Boise, and Moscow, respectively. At these meetings, representatives from DOE, EPA, and IDHW discussed the project, answered questions, and received public comments. Verbatim transcripts of each public meeting were prepared by a court reporter. In addition to accepting oral comment during the meetings, written comment sheets and an audio tape recorder were made available at the meeting to accept public comments. Written comments were accepted throughout the 30-day comment period.

A Responsiveness Summary has been prepared as part of this Record of Decision. All verbal comments, as given at the public meetings, and all written comments, as submitted, are repeated verbatim in the Administrative Record for the Record of Decision. Comments are annotated to indicate which response in the Responsiveness Summary addresses each comment. It should be noted that the Responsiveness Summary groups similar comments together, summarizes them and provides a single response for each comment group.

Persons on the mailing list will receive a notice of availability stating that the signed Record of Decision is available. Copies of the signed Record of Decision and the Responsiveness Summary will be placed in the Administrative Record and in the information repositories, and will be provided to the public upon request.

4. SCOPE AND ROLE OF OPERABLE UNIT AND RESPONSE ACTION

Under the FFA/CO, the INEL is divided into ten waste area groups (WAGs) which generally correspond to facility areas. The WAGs are further subdivided into operable units (OUs). The Test Reactor Area has been designated WAG 2, and the Perched Water System has been designated OU 2-12, one of the thirteen OUs identified at the Test Reactor Area. OU 2-12, the subject of this Record of Decision, addresses the risk due to infiltration of the contaminated perched water into the Snake River Plain Aquifer. The following three separate OUs will address sediment/soil contamination resulting from the wastewater discharge:

OU 2-09

OU 2-09 will evaluate contaminated sediments in the cold waste pond and the sewage lagoons. Preliminary investigations are currently underway to determine if the sediments in the sewage lagoons or the cold waste pond present an unacceptable risk.

OU 2-10

Risk calculations have already demonstrated that the warm waste pond sediments currently pose an unacceptable risk. An Interim Action Record of Decision for OU 2-10 was signed December 5, 1991, which addresses the pond sediments. A new lined replacement pond for the warm wastewater is currently under construction. The existing warm waste pond will be closed in 1993 when the new pond is completed, at which time wastewater will no longer be discharged to the pond.

OU 2-11

OU 2-11 consists of the retention basin and the Test Reactor Area disposal well. The disposal well was used to inject wastewater directly to the Snake River Plain Aquifer and was an additional source of aquifer contamination; however, it was not a source to the Perched Water System.

The retention basin is part of the warm wastewater system. Wastewater passes through the basin to allow short-lived radionuclides time to decay before reaching the pond. Evidence of a leak was discovered in the retention basin and was studied in 1971 (Langford, 1971). The preliminary investigation for OU 2-11 will determine if the contaminated sediments resulting from the leakage present an unacceptable risk.

In addition to these three investigations, a final WAG 2 investigation (OU 2-13) will be conducted to evaluate remaining sources within the Test Reactor Area and consider the potential risk from the perspective of the entire WAG. This investigation is scheduled to begin in 1996.

OU 10-4 is the Comprehensive/Snake River Aquifer RI/FS investigation at the INEL. After information concerning each source is evaluated in the individual WAGs, risks will be investigated for the INEL in its entirety as OU 10-4 with particular attention given to the Snake River Plain Aquifer. An evaluation of the impact to the Snake River Plain Aquifer from the Test Reactor Area will be included in the INEL-wide investigation.

5. SUMMARY OF SITE CHARACTERISTICS

5.1 Geology and Hydrology

The INEL is located along the northern edge of the Eastern Snake River Plain, a 50- to 70-mile wide northeastern trending geologic basin extending from the vicinity of Twin Falls on the southwest to the Yellowstone Plateau on the northeast. The Eastern Snake River Plain is underlain by a substantial volume of volcanic rocks with relatively minor amounts of sediment, except along its margins where drainages emerge from the nearby mountain ranges. The Test Reactor Area is underlain by 30 to 50 feet of surficial alluvium and a thick sequence of fractured basalt flows with thin sedimentary interbeds. These alluvial sediments are primarily composed of sandy gravel with minor amounts of silt and clay. Quartz is the major mineral component of the alluvium, followed by plagioclase and alkali feldspar and minor amounts of clays.

Fractured basalt flows underlie the surficial alluvium and are separated by sedimentary interbeds that vary in thickness and lateral extent. The most extensive interbed occurs approximately 150 feet below the surface. Similar to the surficial alluvium, quartz is the major mineral component of the sedimentary interbeds, followed by plagioclase and alkali feldspars. The Snake River Plain Aquifer occurs in this sequence of basalt with sedimentary interbeds at a depth of approximately 480 feet beneath the Test Reactor Area (see Figure 3).

5.1.1 Surface Water

Most of the INEL is located in a topographically closed drainage basin, referred to as the Pioneer Basin, where the Big Lost River, Little Lost River, and Birch Creek once drained from the mountain ranges to the west and north. Today, most of the water flowing in these streams is diverted upstream of the INEL for irrigation purposes.

The Big Lost River is the principal natural surface-water feature on the INEL and is the closest major drainage to the Test Reactor Area. The Big Lost River has not flowed on the INEL since 1984. Neither the Test Reactor Area facilities nor ponds are located within the 100- or 500-year flood plain of the Big Lost River.

5.1.2 Perched Water

The presence of perched water at the Test Reactor Area is directly related to infiltration from wastewater disposal ponds. Perched groundwater occurs when downward flow of the wastewater to the aquifer is impeded by fine-grained sediments and/or dense basalt flows having relatively low permeability. Two distinct perched water zones, shallow and deep, have been recognized at the Test Reactor Area (see Figure 3). The shallow perched groundwater occurs in the immediate vicinity of the ponds and retention basin, and forms on the interface between the surficial alluvium and the underlying basalts at about 50 feet below land surface.

The deep perched groundwater is caused by low-permeability sediments and/or sediment infilling of fractures within the interbedded basalt-sediment sequence. The top of this interbedded basalt-sediment sequence begins at depths of approximately 140 feet below land surface and ends at depths of about 200 feet below land surface. This perching zone includes silt, clay, sand, cinders, and gravel, and appears to be laterally continuous in the vicinity of the Test Reactor Area.

Water levels in the deep perched monitoring wells and the areal extent of the deep perched groundwater have fluctuated in response to the volume of water discharged to the surface ponds. During March 1991, the areal extent of the deep perched groundwater was about 6,000 by 3,000 feet (see Figure 4). The volume of deep perched groundwater was calculated to be approximately 1.4 billion gallons at these dimensions.

5.1.3 Snake River Plain Aquifer

The eastern portion of the Snake River Plain Aquifer extends from Ashton, Idaho, on the northeast to Hagerman, Idaho, on the southwest. The aquifer occurs within a series of basalt flows with interbedded sedimentary deposits. Recharge to the aquifer is primarily due to valley underflow from the mountains to the north and northeast of the plain, and from infiltration of irrigation water. Recharge to the aquifer within the INEL boundaries is primarily due to underflow from the northeastern portion of the plain and from the Big Lost River.

Site-wide water-level data show that the general direction of groundwater flow across the INEL is toward the south-southwest at an average gradient of about 4 ft/mi. The depth to the water table varies from about 200 feet below the surface in the northern portion of the INEL to about 900 feet below the surface in the southern portion. At the Test Reactor Area, the depth to groundwater is at approximately 480 feet and the gradient is about 2 ft/mi.

Aquifer permeability is controlled primarily by fractures, fissures, and voids along the upper and lower contacts of basalt flows, large interstitial voids, and intergranular pore spaces. Based on site-specific data, the average groundwater flow velocity at the Test Reactor Area was estimated to be 4.3 feet per day.

5.2 Nature and Extent of Contamination

All available data were used to evaluate the nature and extent of groundwater contamination for the Perched Water System Remedial Investigation. In addition to the data collected by the USGS from 1949 to 1990, groundwater was sampled between January and

March, 1991 for a comprehensive water quality evaluation specifically for this investigation. The purpose of this sampling effort was to analyze for additional parameters not routinely monitored by USGS. USGS monitoring parameters have included nitrate, chloride, pH, specific conductivity, sodium, hexavalent chromium, total and dissolved chromium, chromium-51, tritium, cobalt-60, cesium-137, and strontium-90. Groundwater samples were collected from the existing monitoring wells and production wells including six shallow perched wells, 22 deep perched wells, and 11 Snake River Plain Aquifer wells. The location of the shallow perched, deep perched, and Snake River Plain Aquifer wells sampled for this investigation are identified on Figures 5 through 7.

Samples were analyzed in 1991 for volatile organics, acrylonitrile, semivolatile organics, pesticides, metals, hexavalent chromium, and radionuclides. In addition, samples were analyzed for field parameters of specific conductivity, pH, and temperature. Laboratory analyses were performed for the water quality parameters: alkalinity, fluoride, total dissolved solids, nitrate, nitrite, phosphate, chloride, silica, and sulfate. Results of the 1991 groundwater sample analysis are discussed below and summarized in Tables 2 and 3. As a point of comparison, concentrations observed in the Perched Water System were compared to primary or secondary maximum contaminant levels (MCL) and site-specific background. A primary MCL is the concentration of a constituent allowed in a public drinking water system determined under the Safe Drinking Water Act. A secondary MCL pertains to control of contaminants in drinking water that primarily affect aesthetic qualities. Table 4 summarizes the drinking water standards and background concentrations for inorganics, organics and radionuclides.

5.2.1 Shallow Perched Zone

Organics

Volatile organic compounds detected above the quantitation limit in shallow wells near the cold waste pond include low concentrations of toluene, xylene, and various derivatives of benzene, which are common constituents of hydrocarbon fuels. Trace volatile organics were also detected in wells beneath the chemical waste pond. Of the semivolatile organic compounds analyzed, low concentrations of bis(2-ethylhexyl)phthalate appear to be the most prevalent and were detected in shallow wells beneath the retention basin and the cold waste pond.

Inorganics

Mercury, manganese, and iron were the only metals detected which exceeded MCLs in the filtered samples of shallow perched groundwater. Results of metals analyses on unfiltered samples collected from shallow perched zone wells indicated that several metals exceeded their MCLs. These metals included cadmium, chromium, lead, manganese, and mercury.

Radionuclides

Several radionuclides were detected in Wells SB-01, SB-02, and SB-04 located near the retention basin. The radionuclides detected above MCLs include cobalt-60, cesium-137, americium-241, tritium, and strontium-90.

5.2.2 Deep Perched Groundwater Zone

Organics

Volatile organic compounds detected above the quantitation limit in the deep perched water included chloroform, methylene chloride, toluene, benzene, and 1,1,1-trichloroethane. Of the semivolatile organic compounds detected, low concentrations of bis(2-ethylhexyl)phthalate were the most widespread. No pesticides were detected in the deep perched groundwater.

Inorganics

Concentrations of cadmium, chromium, and manganese in the filtered samples collected in the deep perched wells were above MCLs. Cadmium concentrations exceeded the MCL of 10 μg/L in the filtered water sample from one well. Filtered groundwater samples from four wells near the chemical waste disposal pond exceeded the MCL for manganese. Fluoride, sulfate, and phosphate were detected at elevated concentrations in the deep Perched Water System.

Chromium is the most frequently detected metal in the deep perched zone. Chromium concentrations were detected up to 1125 μg/L which is well above the MCL of 50 μg/L. The highest concentrations of chromium occur in the north central portion of the deep perched groundwater zone, north of the warm waste pond.

Radionuclides

Of the radionuclides analyzed, tritium and strontium-90 were detected above the MCL of 20,000 pCi/L (picocuries per liter) and 8 pCi/L, respectively. These radionuclides appear to be the most widespread of all contaminants in the deep perched groundwater. This is likely caused by the continuing discharge of the warm waste stream to the warm waste pond. The concentration of tritium in the deep perched groundwater ranged from below detection limits to 752,000 pCi/L (1990 USGS monitoring data); strontium-90 concentrations ranged from below detection limits to 124 pCi/L. These concentrations are approximately one order of magnitude less than those in the shallow perched groundwater near the retention basin, indicating dilution from the cold waste pond discharge and attenuation in the soil column.

5.2.3 Snake River Plain Aquifer

Organics

Groundwater samples were collected from 11 Snake River Plain Aquifer wells during the 1991 sampling activities. Trace levels of volatile organic compounds were detected in groundwater samples from the aquifer wells at estimated concentrations less than 1 μg/l. Phthalates were the only semivolatile organic compounds detected. The presence of phthalates is not likely to be the result of site activities because phthalates typically occur in plastics and are also common laboratory contaminants. No pesticides were detected. Of the volatile and semivolatile organics detected, none were detected above MCLs.

Inorganics

Chromium was the only metal detected in groundwater samples from the Snake River Plain Aquifer which exceeded MCLs. Since 1968, the concentration of total chromium in samples from down-gradient Well USGS-65 has generally declined from about 750 μg/l to current levels of about 179 μg/l. This decline is anticipated to continue because chromium has not been disposed at the Test Reactor Area since 1972.

Radionuclides

Tritium was the only radionuclide detected above natural background levels or MCLs. Since 1970, the concentration of tritium in samples from Well USGS-65 has generally declined from about 220,000 pCi/L to current levels of about 61,000 pCi/L. This decline will likely continue once the new lined evaporation ponds for warm waste disposal are operational, and the tritium source is eliminated. The tritium concentrations in down-gradient Well USGS-76 have remained less than the MCL since 1965.

5.2 Groundwater Model

A computer model was developed using both historic and recent information concerning groundwater flow and contamination in the Perched Water System and in the underlying Snake River Plain Aquifer in the vicinity of the Test Reactor Area. The computer model predicted concentrations from the present through a point in time 125 years in the future. These predicted concentrations were then used in the risk assessment calculations. Development of the model began with identification of the assumptions on which the model is based. The assumptions are based on existing knowledge of groundwater flow in the vicinity of the Test Reactor Area. A comparison of modeling results was made with historical data to ensure that it represented groundwater flow in the Perched Water System in order to provide confidence in the useability of the model for predictions.

Among the assumptions on which the model is based are: 1) the Warm Waste Pond, as the major source of contamination, will be removed from service within one year. This assumption is based on the fact that construction of a new lined replacement pond has already begun, and; 2) The Cold Waste Pond will remain in service at least through the year 2007. This is based on the expected operational lifetime of the Test Reactor Area which would then be followed by a 10-year decommissioning period through the year 2017.

6. SUMMARY OF SITE RISKS

Trends simulated by the model are shown in Figures 8 through 10 for several key contaminants in the Snake River Plain Aquifer. In addition to chromium and tritium, which currently exceed MCLs, the only other contaminant predicted by the model to exceed its MCL in the Snake River Plain Aquifer is cadmium.

The risk assessment for the Perched Water System considered both human health and ecological risks. The human health risk assessment included calculations of risk for future (in year 2115) and near-term receptors. The risk assessments were conducted in accordance with the EPA *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual* (EPA 1989b) and *Volume II: Environmental Assessment Manual* (EPA 1989f) and other EPA national guidance. The risk assessment methods and results are summarized in the following sections.

6.1 Human Health Risk Assessment

The risk assessment consisted of contaminant identification, exposure assessment, toxicity assessment, and human health risk characterization. The objective of the contaminant screening was to identify chemicals based on concentration and toxicity, that are most likely to contribute significantly to risks. The exposure assessment detailed the exposure pathways that exist at the site for various receptors. The toxicity assessment documented the adverse effects that may be caused in a receptor as a result of exposure to a site contaminant.

The human health risk assessment evaluated potential risks associated with exposure to chemical contaminants present in the Snake River Plain Aquifer due to infiltration of contaminants from the Perched Water System. Both carcinogenic and non-carcinogenic risks were evaluated. The health risk evaluation used both the exposure concentrations and the toxicity data to determine a hazard index for potential noncarcinogenic effects and a cancer risk level for potential carcinogenic contaminants. In general, a hazard index of less than 1 indicates that even the most sensitive population is not likely to experience adverse health effects. The excess cancer risk level is the increase in the probability of contracting cancer. The NCP acceptable risk range is 1 in 10,000 to 1 in 1,000,000. An excess lifetime cancer risk of 1 in 10,000 (10^{-4}) indicates that an individual has up to a one chance in ten thousand of developing cancer over a lifetime of exposure to a site-related contaminant.

Key steps taken in the risk assessment process are summarized in Sections 6.1.1 through 6.1.5.

6.1.1 Identification of Contaminants of Concern

Potential contaminants of concern are those that are released to the environment at a site that may pose a health risk to humans who come into contact with them. A contaminant screening process was completed for the Perched Water System to reduce the number of chemicals carried through the computer model and quantitative risk assessment, and focus on those contaminants that contribute significantly to the overall risk. The first step in contaminant identification was to compare analytical results for each chemical from the Perched Water System investigation to the background concentration for that chemical. Background concentrations were derived by calculating the arithmetic mean concentration for each chemical from the analytical data from production wells TRA-03 and TRA-04 and the Site 19 well. These wells are upgradient from the shallow and deep perched zone and are unaffected by contamination from the Perched Water System. The next screening step was to consider the half-life and concentration of detected radionuclides. Radionuclides with a half-life of less than 5-years were eliminated at this step because they decay rapidly. Next, an evaluation of the concentration, toxicity and mobility of each contaminant was completed to determine the contribution of each contaminant to the total risk. Contaminants that represented a small percentage of the risk were eliminated (less than 1 percent). Although chromium, tritium, and strontium-90 represent less than 1 percent of the site risk, these contaminants were retained because of the historical association with the facility. Table 5 lists the contaminants of concern that were included in the risk assessment.

6.1.2 Exposure Assessment

Exposed Populations

Only exposure pathways deemed to be complete (i.e., where a plausible route of exposure can be demonstrated from the site to a receptor) were quantitatively evaluated in the risk assessment. The populations at risk due to exposure to the perched water were identified by considering both current and future use scenarios.

Currently, public access to the Test Reactor Area is restricted so public exposure to the perched water is not likely. Exposure to contaminants in the Perched Water System by site employees is also unlikely, as the Perched Water System is approximately 50 to 150 feet below the ground surface and is not used. The potential exposure to contaminants in the perched water during environmental sampling is addressed separately by health and safety documentation for each individual activity. The potential for current exposure to contaminants in the Perched Water System was judged to be low and risks associated with current exposure scenarios were not evaluated. Production wells at the TRA from which workers obtain drinking water from the Snake River Plain Aquifer are upgradient of the contamination and are monitored regularly to ensure that they produce clean water.

Future contact with the Perched Water System is unlikely because the Perched Water System is predicted to dissipate within about 7 years of ceasing disposal of wastewater to the ponds at the Test Reactor Area according to the modeling results. Future exposure resulting from the migration of contaminants from the Perched Water System to the Snake River Plain Aquifer was evaluated for a hypothetical resident living on the site.

An agricultural scenario was determined to be the most probable scenario for future use at the Test Reactor Area. The exposed population would consist of site resident farmers, including both adults and children. For the purpose of the risk assessment, onsite residence with agricultural land use was assumed to occur 125 years in the future based on planned operations at the Test Reactor Area. This period was selected based on an expected 25 years of operation and decommissioning followed by 100 years of institutional controls.

Exposure Pathways

The exposure pathways identified for the future resident farmer scenario consist of:

- Ingestion of groundwater from domestic wells in the Snake River Plain Aquifer
- Ingestion of garden grown fruits and vegetables irrigated with Snake River Plain Aquifer water
- Ingestion of domestically grown livestock.

Exposure Point Concentrations

Chemical concentrations at points where the potential for human exposure is expected to occur are necessary to evaluate the chemical intake of potentially exposed individuals. Exposure pathways from the source to receptors were evaluated using a groundwater transport computer model. The results of the computer modeling are expressed as predicted concentrations in drinking water from the Snake River Plain Aquifer. The concentrations predicted by the model which were used in the risk assessment are shown on Table 6. Groundwater transport modeling was used to estimate future concentrations of the chemicals of concern in the Snake River Plain Aquifer. These concentrations are considered reasonable maximum concentrations because the highest model-predicted concentrations in the Snake River Plain Aquifer were selected for the risk assessment exposure concentrations. This is generally directly below the perched zone in the upper part of the Snake River Plain Aquifer before any dilution in the aquifer would occur.

Exposure to contaminants of concern from the Perched Water System could result from ingestion of crops irrigated with contaminated water pumped from the Snake River Plain Aquifer. The potential exists for contaminants to accumulate in surface soils as a result of irrigation and may be available for plant uptake. The concentration of contaminants in onsite soils as a result of irrigation with contaminated water was calculated in the Risk Assessment by applying recommended methods in *Risk Assessment Guidance for Superfund. Human Health Evaluation Manual Part A. Interim Final* (EPA, 1989a).

Contaminant concentrations in crops were assessed by estimating uptake and accumulation through roots from the soil. Separate calculations were performed for vegetative (leaf and root) and reproductive (fruit and seed) portions of crops.

Chemical Intake by Exposure Pathway

Chemical intakes for each exposure pathway were based on the exposure point concentrations calculated from the modeled concentrations in the Snake River Plain Aquifer directly below the Test Reactor Area and other exposure parameters, such as water ingestion rates, crop and livestock ingestion rates, body weights, and exposure frequency and durations recommended in the risk assessment guidance.

There are multiple conservative or upper bound assumptions in the health risk characterization for the Perched Water System:

- An individual consumes all drinking water from an onsite well
- An individual derives a reasonable maximum amount of his diet from onsite sources
- An individual lives for 30 years at or near the site (90 percent of time spent in one house)
- An individual has continuous, daily exposure to constituents detected at the site
- Cancer risks are linearly related to exposure (i.e., carcinogenic effects have no thresholds)
- Contaminant concentrations remain constant over the exposure period
- Exposure remains constant over time
- Risks are additive
- All intake of contaminants is from the exposure medium being evaluated.

6.1.3 Toxicity Assessment

The toxicity assessment addresses the potential for a chemical to cause adverse effects in exposed populations and estimates the relationship between extent of exposure and extent of toxic injury (i.e., dose-response relationship). Qualitative and quantitative toxicity information for the contaminants was acquired through evaluation of relevant scientific literature (e.g., *Health Effects Assessment Summary Tables*, EPA 1991). The most directly relevant data came from human studies. Most of the useable information on the toxic effects of chemicals came from controlled animal experiments.

6.1.4 Risk Characterization

Risk characterization is the process of combining the results of the exposure and toxicity assessments. This process provides numerical quantification relative to the existence and magnitude of potential public health concerns related to contamination detected at the site. A summary of the calculated future carcinogenic and non-carcinogenic risk estimates is presented in Tables 7 through 10.

Risk calculations are divided into carcinogenic and non-carcinogenic categories. The calculation of health risks from potential exposure to carcinogenic compounds involves the multiplication of cancer slope factors for each carcinogen and the estimated intake values for that chemical.

Noncarcinogenic risk is assessed by comparison of the estimated daily intake of a contaminant to its applicable Reference Dose. A Reference Dose is a provisional estimate of the daily exposure to the human population that is likely to be without an appreciable risk of deleterious effects during a portion of the lifetime. The estimated daily intake of each chemical by an individual route of exposure is divided by its Reference Dose and the resulting quotients are calculated to provide a hazard index.

Future Risk

Lifetime cancer risks from potential exposure to each carcinogenic contaminant were added across all of the exposure pathways. Cancer risks from the different routes of exposure were assumed to be additive, as recommended by EPA guidance. It should be noted that adding cancer risks from different exposure routes provides health-protective risk estimates. The excess cancer risk to the future (year 2115) onsite residential farmer is shown in Tables 7 and 8. This risk (5.6×10^{-9}) is dominated by the ingestion of cobalt-60 through the drinking water pathway, but is well below the acceptable 10^{-4} to 10^{-6} risk range.

The potential future exposure to non-carcinogenic contaminants falls below the individual Reference Doses for each contaminant of concern. Non-carcinogenic hazard indices are presented in Tables 9 and 10 for child and adult exposures, respectively. The non-carcinogenic constituent at the site that poses the greatest potential for adverse health effects at year 2115 is cadmium (HI=0.17). These results suggest that chronic exposure to modeled concentrations of contaminants in the Snake River Plain Aquifer are unlikely to represent significant non-carcinogenic health effects to humans.

Near-Term Risk

In addition to the risk calculations, contaminant concentrations were compared to MCLs for both the Perched Water System and the Snake River Plain Aquifer. Concentrations for several contaminants currently exceed these levels in the Perched Water System. However, there is no risk associated with these contaminants because there is no current use of the Perched Water System itself. Although tritium and chromium exceed MCLs in the aquifer, there is also no current use of the contaminated water in the Snake River Plain Aquifer beneath the Test Reactor Area. The closing of the warm waste pond, scheduled for 1993, will eliminate future discharge of tritium to the Perched Water System, and therefore the concentrations of tritium (with a half-life of 12.5 years) in the Snake River Plain Aquifer will decrease due to radioactive decay. The computer model predicts the concentration of tritium will meet its MCL during the year 2004 (See Figure 9). Concentrations of chromium in the Snake River Plain Aquifer have declined since 1972 when discharge of chromium to the warm waste pond ceased. Chromium is predicted to meet its MCL by the year 2016. The model also predicted that cadmium would exceed its MCL in the late 1970s and would again drop below the MCL by 2027 (See Figure 10). Cadmium levels have never been observed above the MCL in water samples collected from Snake River Plain Aquifer wells at the TRA. Therefore, the model is considered to be conservative for cadmium and it is not certain that the cadmium MCL will be exceeded. For several contaminants of concern, including cadmium, the model used the average concentration in the shallow perched water for contaminant input to the system because there was limited data on the amount of the contaminants that had been released through time. This input concentration was then assumed to remain constant throughout the life of the TRA facility which is unlikely since the Warm Waste pond will be eliminated as a source of contamination in the next year.

Near-Term Human Health Risk Assessment

Due to the uncertainty of future land use at the INEL and the fact that MCLs are currently exceeded in the Snake River Plain Aquifer, the computer groundwater modeling results were used to evaluate near-term risks. This evaluation was completed to provide an estimate of the risk posed by the contaminants that currently exceed, or are predicted to exceed, MCLs in the Snake River Plain Aquifer (chromium, tritium, and cadmium). This assessment evaluated ingestion of contaminated groundwater for chromium, tritium, and cadmium and vapor inhalation for a residential adult receptor for several periods in the future.

Groundwater model results were used to calculate exposure concentrations for five 30-year periods. The scenarios include years 1990 to 2020, 1995 to 2025, 2000 to 2030, 2005 to 2035, and 2010 to 2040. Average concentrations for each thirty-year period are shown on Table 11.

The lifetime excess cancer risk due to tritium under the 1990 to 2020 scenario is estimated to be 3×10^{-4}. This calculated risk then decreases with time and falls well below one chance in 10,000 which is within the acceptable target risk range for later years. Table 12 summarizes the results from the near-term risk assessment for tritium.

The hazard quotients for chromium and cadmium were calculated for the five 30-year exposure scenarios. For the 1990 to 2020 time period, the hazard quotient for chromium and cadmium were estimated to be 0.6 and 1.3, respectively. The hazard quotient for cadmium is one or below thereafter. These results are summarized in Table 13.

6.1.5 Uncertainty

Risk assessments are subject to uncertainty from sampling and analysis, fate and transport estimation, exposure estimation, and toxicological data. Uncertainty was addressed by using health-protective assumptions that systematically overstate the magnitude of health risks. This process bounds the plausible upper limits of risk and facilitates an informed risk management decision. The following is a summary of risk assessment uncertainties:

- Uncertainty associated with sampling and analysis includes the inherent variability (standard error) in the analysis, representativeness of the samples, sampling errors, and heterogeneity of the sample matrix. While the quality assurance/quality control used in the investigation serves to reduce such errors, it cannot eliminate all errors associated with sampling and analysis. The samples were analyzed using EPA-approved analytical methods. These data were evaluated by the agencies to ensure they were representative of the area of investigation.

- Sources of uncertainty arising from the fate and transport modeling include the contaminant concentration in the effluent waste stream, the impact of mixing in the shallow perched water zone, and uncertainty of assumed adsorption coefficient values for each contaminant. Additional parameters that were most sensitive include the infiltration rate of wastewater and the saturated hydraulic conductivity of the lower interbed at about 150 ft. The model was most sensitive to the values for contaminant attenuation and the concentration used for infiltrating wastewater. The hydraulic conductivity of some model layers was also found to be a sensitive parameter.

  An example of the sensitivity of the infiltration parameter is illustrated by the concentrations for cadmium. The modeled concentration for cadmium, as well as other contaminants of concern, is probably higher than what will actually occur in the Snake River Plain Aquifer. This is attributed to the higher than normal infiltration (recharge) rate used in the model. The infiltration rate used in the model was 15 cm/yr. A more realistic value is 1.5 to 5 cm/yr. Thus, the modeled cadmium concentration of 15 μg/L at approximately 2010 is probably an overestimate and adds to the conservatism of the risk assessment. The projected concentration for cadmium may not exceed the Federal Drinking Water Standard of 5 μg/L.

- Because concentrations of contaminants vary over time and the calculated risks are representative of modeled concentrations at only one point in time, this temporal variation is another source of uncertainty.

- The toxicological database is also a source of uncertainty. The EPA outlined some of the sources of uncertainty in its *Guidelines for Carcinogen Risk Assessment*, (EPA 1986). They include extrapolation from high to low doses and from animals to humans; species differences in uptake, metabolism, and organ distribution; species differences in target site susceptibility; and human population variability with respect to diet, environment, activity patterns, and cultural factors.

6.2 Ecological Risk Assessment

The ecological risk assessment qualitatively evaluated the potential ecological effects associated with the presence of the Perched Water System. This ecological evaluation follows the *Risk Assessment Guidance for Superfund Volume II* (EPA 1989b). The evaluation focused on the same contaminants and receptor locations as those evaluated in the human health assessment. Objectives of the ecological risk assessment are to qualitatively evaluate the potential risk to ecological receptors from the contaminants in the Perched Water System. The assessment identified sensitive nonhuman species and characterizes potential exposure pathways including ingestion of contaminated groundwater or vegetation, and contaminant uptake by plants. Similar to the human health risk assessment, no credible current use exposure scenario exists. The future use exposure scenario included using contaminated groundwater for irrigation, with contaminants entering the food chain which could result in potentially complete exposure pathways throughout the ecological system.

The approach used in the ecological risk assessment is consistent with EPA guidance for evaluating ecological risk. The steps included identification of contaminants, assessment of potential exposure pathways, and characterization of threats to exposed biota.

6.2.1 Exposure Assessment

Table 5 lists the contaminants of concern identified in the Perched Water System. The ecological scenarios assume that wildlife would inhabit the site. This assessment was limited to exposure due to contamination of the Perched Water System. Consequently, migration of the contaminated perched groundwater to a potential exposure point via some pathway was considered to be a prerequisite to exposure.

For an ecological risk to exist, there must be a complete pathway for the contaminant to reach an ecological receptor. Either a receptor would need to reach the Perched Water System or the contaminated water would need to get to the surface. The Perched Water System does not recharge any local surface water, and no evidence of any resurfacing exists at the site.

Although some of the animals at the site are burrowing mammals, burrowing activity is usually limited to a few feet below the surface. Therefore, contact with the Perched Water System is not likely. While sagebrush has a deep root system (up to 99 in.), it is not likely to reach the perched water. Some of the trees could have a root system deep enough to penetrate to the shallow Perched Water System; however, the nearest trees are 1 mile from the site and not in the plume area. Therefore, no complete exposure pathway exists between the contaminants and ecological receptors under the current land use scenario.

Similar to the human risk assessment, the ecological risk assessment considered a future land use scenario that includes pumping contaminated water from the Snake River Plain Aquifer onto the surface for agricultural irrigation purposes. Contaminants then enter the food chain resulting in potentially complete exposure pathways throughout the ecological system.

6.2.2 Risk Characterization

Although ecological receptors are currently present on the site, contact with contaminants of concern is not possible under current site conditions. The depth to the Perched Water System and the absence of any resurfacing phenomena prevents contact with the contaminants of concern. Because no complete exposure pathways are identified in the present scenario, the contaminants of concern do not appear to pose a potential ecological risk.

Under a future scenario, it is plausible that ecological receptors could come into contact with contaminants currently in the Perched Water System as these contaminants migrate to the Snake River Plain Aquifer. This water then is pumped to the surface for agricultural use. The water used for agricultural purposes may provide a source of contact to ecological receptors for ingestion. Dermal contact with water and soil is also possible as chemicals are deposited onto soil as a result of irrigation. In addition, plants can cache some of the chemicals of concern, and transfers between trophic levels are possible for some of the chemicals with longer biological half-lives. However, given the concentration of the contaminants of concern, unacceptable risk to ecological receptors is not judged to be likely.

7. DESCRIPTION OF NO ACTION DECISION

Based on results of the human health and ecological risks assessments, the contaminants of concern do not pose unacceptable risks to human health or the environment for the future use scenarios evaluated for the Snake River Plain Aquifer beneath the Test Reactor Area. Therefore, no remedial action is necessary for the Perched Water System OU at the Test Reactor Area. Because this conclusion is based on predictive computer modeling, water quality monitoring activities will be conducted to: (1) evaluate the contaminant concentration trends in the Snake River Plain Aquifer, and (2) evaluate the effect of discontinued discharge to the warm waste pond and fate of contaminants in the Perched Water System.

A groundwater monitoring plan will be developed with the approval of EPA and IDHW. The plan will be a primary document as defined in the FFA/CO and will be submitted for agency review 45 days after signature of this Record of Decision. The plan will define the wells that will be monitored, parameters that will be monitored, frequency of monitoring, reporting requirements and criteria for future decisions. Monitoring data will be made available in the information repositories.

As stated previously in the Declaration Statement, a 3-year statutory review of the No Action decision will be conducted to ensure that human health and the environment are being protected and that the assumptions upon which the No Action decision was based are still valid.

Should the three-year review or post-ROD monitoring or a change in any assumptions used to arrive at the decision indicate that other actions or modifications of the No Action response are required, these will be initiated by the agencies, as appropriate, and in accordance with the FFA/CO.

In addition, it should be noted, as discussed in Section 4, that the WAG 2 Comprehensive RI/FS will evaluate risk from the perspective of the entire TRA facility.

8. EXPLANATION OF SIGNIFICANT CHANGES

There are no significant changes between the recommendations presented in the Proposed Plan and this Record of Decision.

REFERENCES

Batchelder, H.M., 1981, Radioactive waste management information for 1980, Idaho Oper. Rep. IDO-10055(80).

EG&G Idaho, Inc., 1992, *Remedial Investigation Report For The Test Reactor Area Perched Water System (Operable Unit 2-12)*, June 1992.

EPA, 1986, *"Guidelines for Carcinogenic Risk Assessment," Federal Register 51*, pp. 33992-34003.

EPA, 1987, *Consent Order/Compliance Agreement 1085-10-07-3008 in the matter of: the United States Environmental Protection Agency and the United States Department of Energy Idaho National Engineering Laboratory, ID4890008952 proceeding under Section 300 8(h) of the Resource Conservation and Recovery Act, 42 USC, Section 6928(h)*, July 1987.

EPA, 1989a, *Risk Assessment Guidance for Superfund. Human Health Evaluation Manual Part A. Interim Final*, OSWER Directive 9285.701A, December 1989.

EPA, 1989b, *Risk Assessment Guidance for Superfund, Volume II - Environmental Evaluation Manual*, EPA/540/1-89/001, December 1989.

EPA, 1990, *National Oil and Hazardous Substances Contingency Plan (NCP)*, Washington, D.C.: Office of Emergency and Remedial Response, July 1982.

EPA, 1991a, *Federal Facility Agreement and Consent Order 1088-06-29-120 in the matter of the U.S. Department of Energy Idaho National Engineering Laboratory, Idaho Falls, Idaho*. December 1991.

EPA, 1991b, *Health Effects Assessment Summary Tables*, First Quarter, FY 1991, January 1991, OSWER 9200.6-303.

Langford, J.E., 1971, *TRA Retention Basin Study*, Idaho Nuclear Corporation, June 1971.

USDOE, 1992, *Proposed Plan For The Perched Water System At The Test Reactor Area, Idaho National Engineering Laboratory*, June 1992.

Orr, B.R., L.D. Cecil, and L.L. Knobel, 1991, *Background Concentrations of Selected Radionuclides, Organic Compounds, and Chemical Constituents in the Ground Water in the Vicintiy of the Idaho National Engineering Laboratory*, USGS Water-Resources Investigations Report 91-4015.

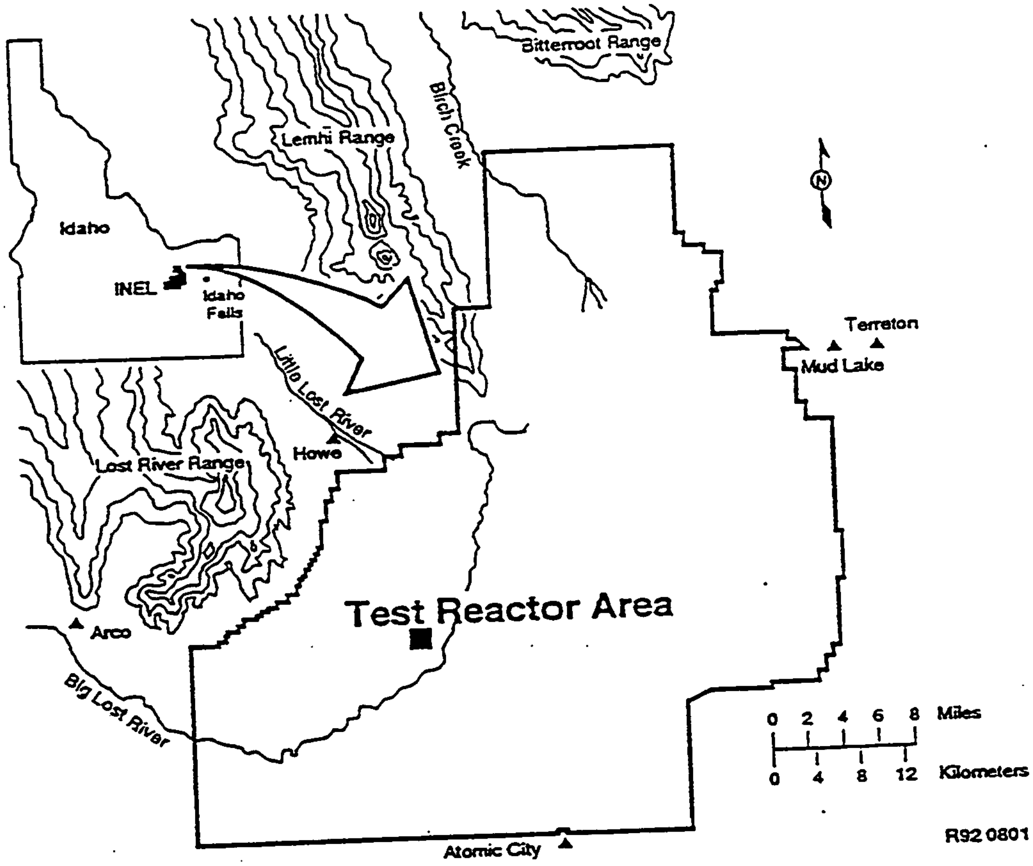

Figure 1. Location of the Test Reactor Area (TRA).

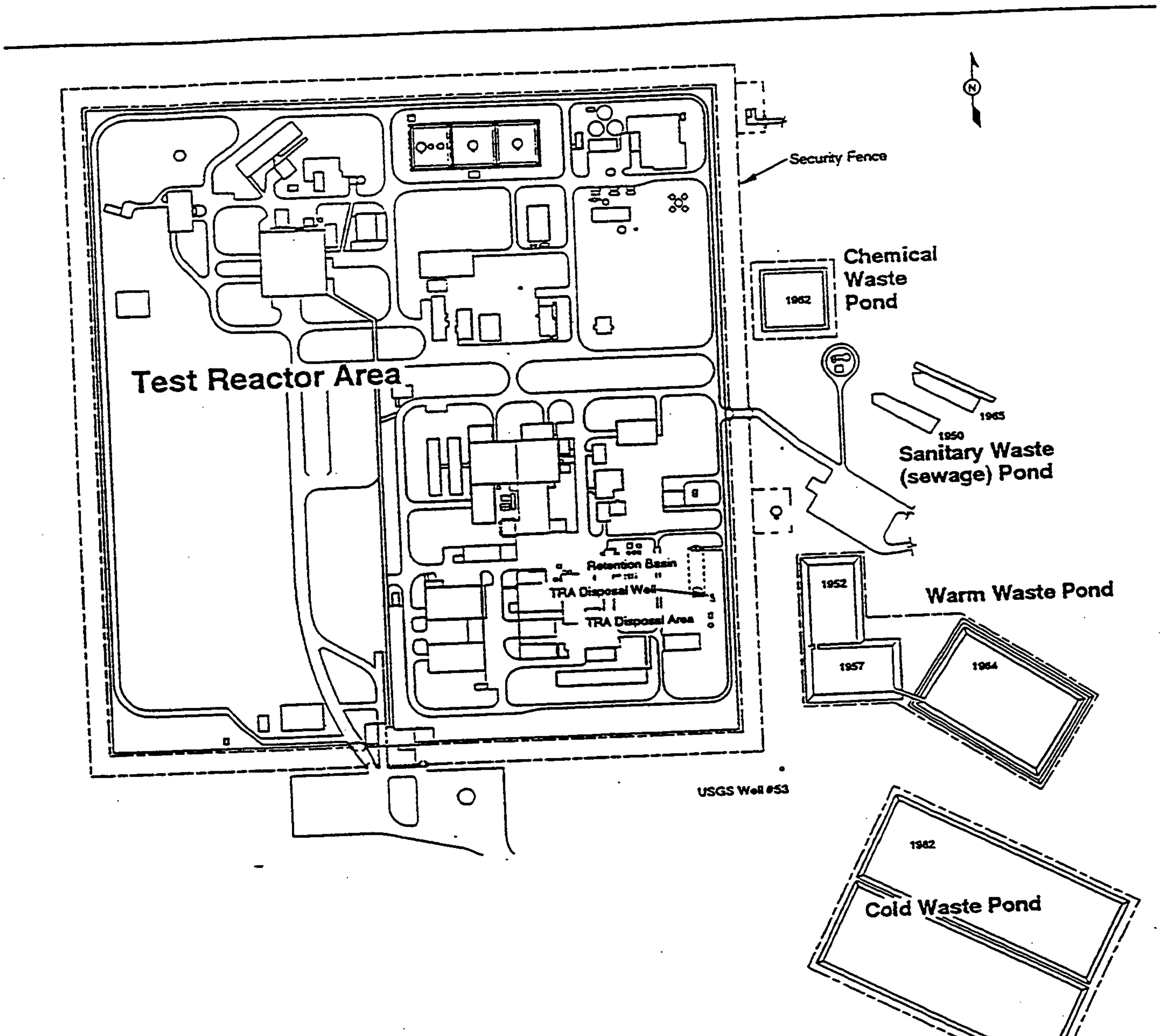

Figure 2. Test Reactor Area (TRA) and surrounding area.
The date of construction is shown for the ponds.

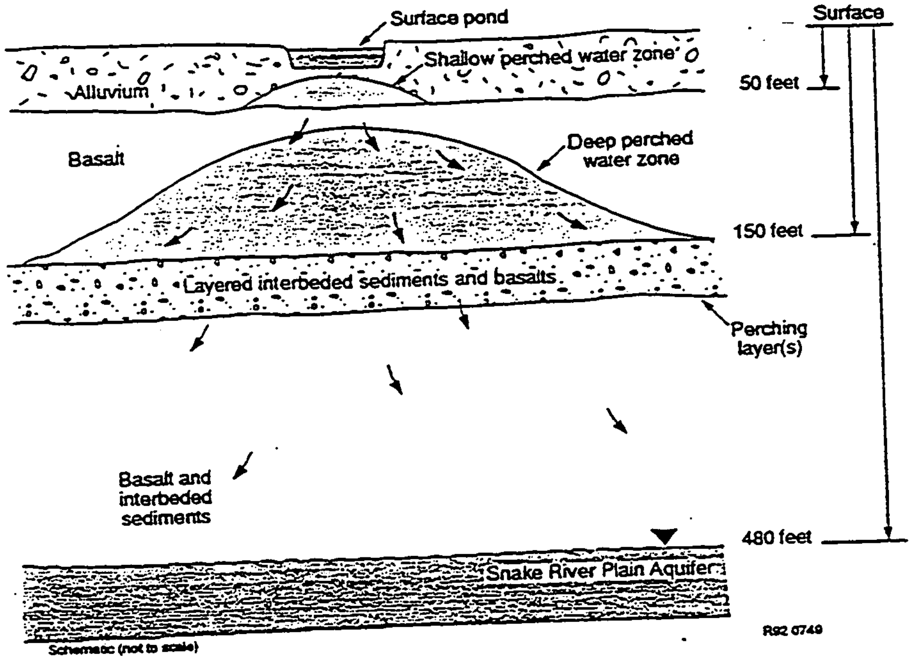

Figure 3. Generalized cross section showing a TRA wastewater disposal pond and the perched water system (PWS) under the TRA.

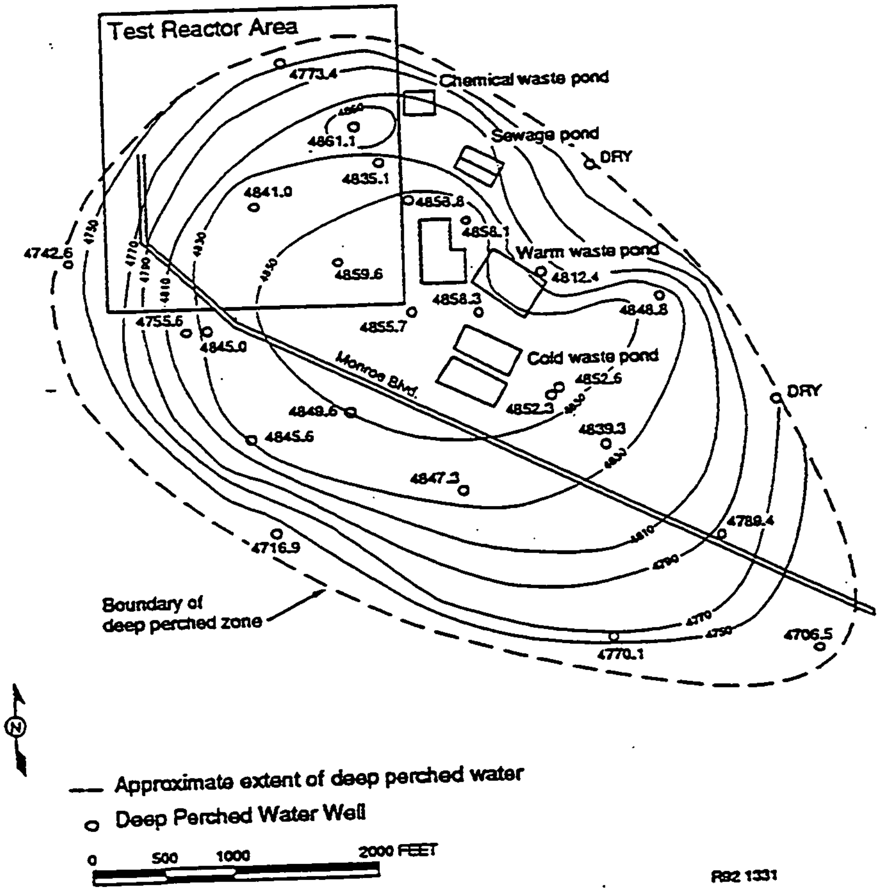

Figure 4. Configuration of the deep perched ground water at TRA, March 21, 1991.

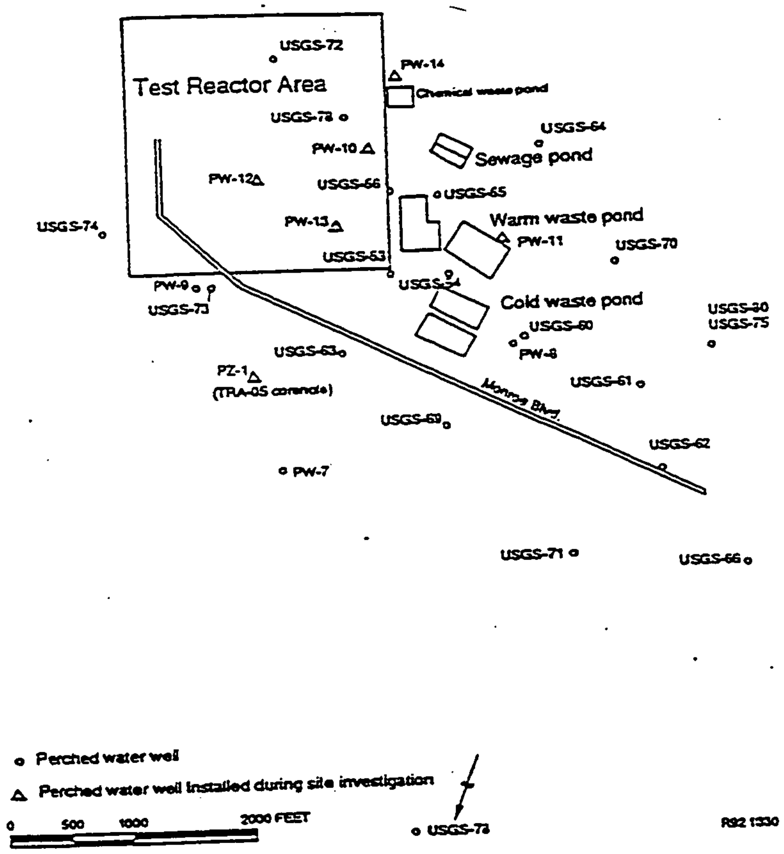

Figure 5. Locations of deep perched monitoring wells.

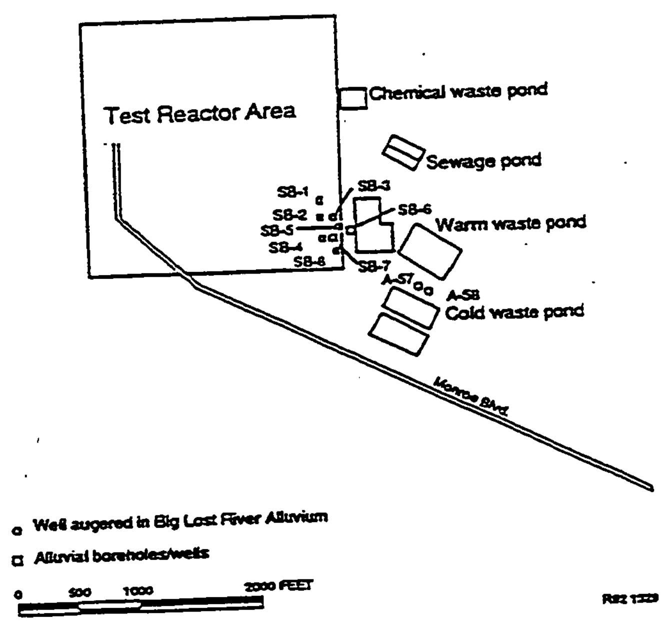

Figure 6. Shallow perched groundwater monitoring locations sampled during the SI.

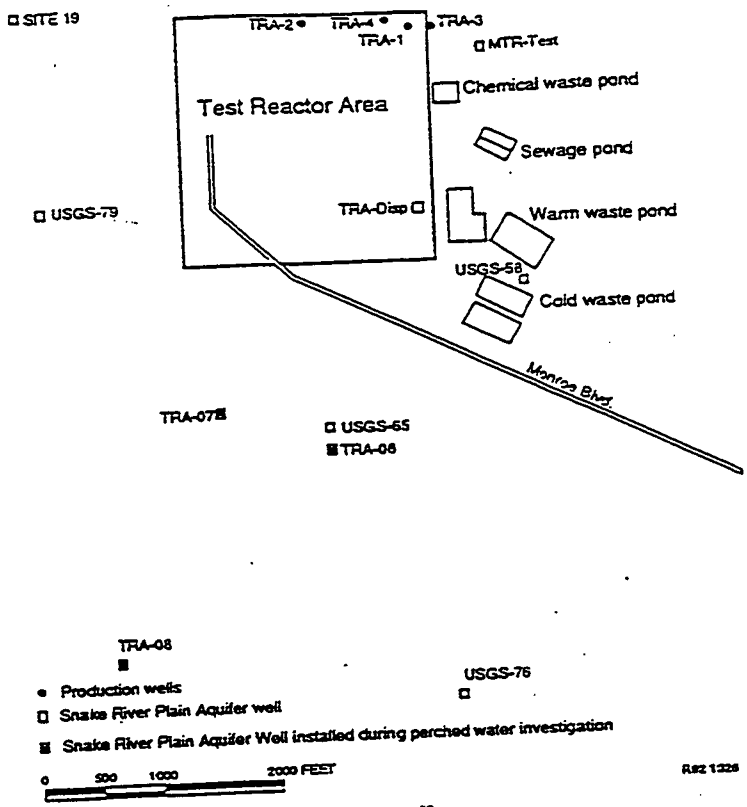

Figure 7. Locations of Snake River Plain Aquifer wells.

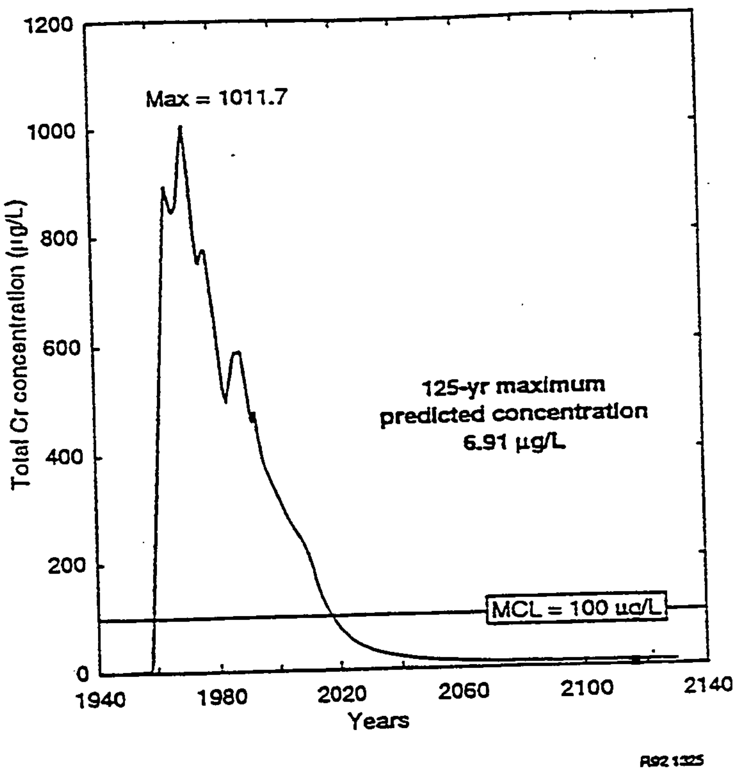

Figure 8. Maximum modeled chromium concentrations in the Snake River Plain Aquifer.

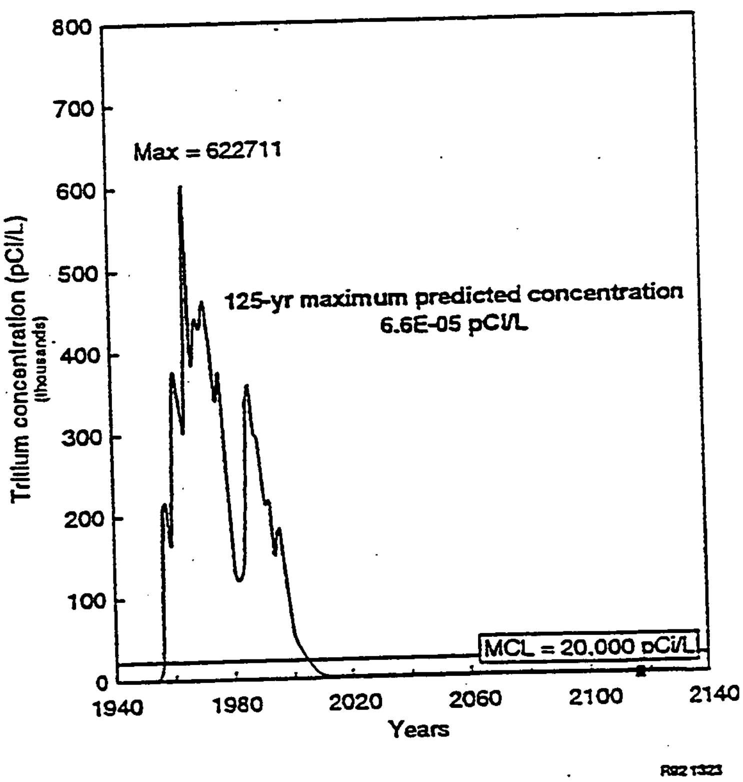

Figure 9. Maximum modeled tritium concentrations in the Snake River Plain Aquifer.

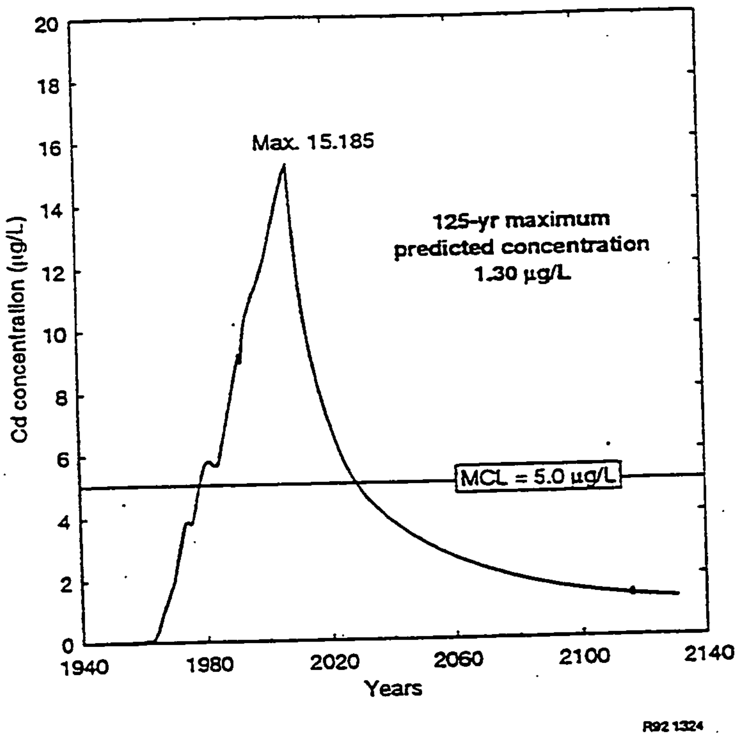

Figure 10. Maximum modeled cadmium concentrations in the Snake River Plain Aquifer.

Table 1. Total and daily process water discharged to the Test Reactor Area pond system.

Pond	Period of Use	Total Discharge (gal)[a]	Current Daily Discharge (gpm)[b]
Warm Waste Pond/ Retention Basin	1952–present	5.35×10^9	30–40
Cold Waste Pond	1982–present	2.13×10^9	500
Chemical Waste Pond	1962–present	7.26×10^8	15–20
Sanitary Waste Pond	1952–present	5.35×10^9	15–20
Injection Well	1964–1982	3.89×10^9	–
USGS-53	1960–1964	2.2×10^8	–

a. Total discharge volume from 1952 through 1990.

b. Daily discharge based on 24 hours per day, 7 days per week. Source: Personal communication with Bob Beatty, EG&G Idaho, Inc., Idaho Falls, Idaho, 1991. The rates shown for the injection well and for USGS-53 are historical. Further, the rates for USGS-53 are only average values when in use, as this well was only used intermittently between 1960 and 1964.

Table 2. Concentration ranges and detection frequency in the shallow perched zone.

Chemical	Maximum Conc. Detected (µg/L)	Minimum Conc. Detected (µg/L)	Quantitation Limit (µg/L)	Arithmetic Mean[a] (µg/L)	Detection Frequency
VOLATILE ORGANIC DATA					
Methylene Chloride	9.0	9.0	0.5	1.7	1/6
Benzene	0.8	0.8	0.5	0.3	1/6
Toluene	4.9	4.9	0.5	1.0	1/6
Ethylbenzene	0.7	0.7	0.5	0.3	1/6
Xylene (total)	4.0	4.0	0.5	0.9	1/6
Xylene (ortho)	2.0	2.0	0.5	0.5	1/6
1,2,4-Trimethylbenzene	0.8	0.8	0.5	0.3	1/6
HEXAVALENT CHROMIUM DATA					
Hexavalent Chromium	178	10.0	5.0	68.5	6/6
SEMIVOLATILE ORGANIC DATA					
bis(2-Ethylhexyl)phthalate	35.0	10.0	20.0	15.3	6/6
NON-METAL INORGANIC DATA					
Fluoride	430	90.0	70.0	180	4/6
Nitrate	6,230	1,020	100	2,690	6/6
Phosphate	2,270	454	100	1,320	5/6
Chloride	31,900	10,000	1,000	12,200	3/6
Silica	109,000	2,240	1,000	36,600	6/6
Sulfate	4,880,000	305,000	5,000	939,000	3/6
INORGANIC DATA					
Aluminum	430,000	13,000	47.0	225,000	6/6
Antimony	16.6	16.6	14.0	8.4	1/6
Arsenic	42.8	5.0	3.0	21.0	6/6
Barium	10,300	567	22.0	4,900	6/6

Table 2. Continued

Chemical	Maximum Conc. Detected (µg/L)	Minimum Conc. Detected (µg/L)	Quantitation Limit (µg/L)	Arithmetic Mean[a] (µg/L)	Detection Frequency
INORGANIC DATA					
Beryllium	136	5.0	1.0	40.1	1/6
Cadmium	177	4.0	4.0	47.5	6/6
Calcium	898,000	130,000	50.0	426,000	6/6
Chromium	4,480	32.0	9.0	1,360	6/6
Cobalt	297	26.0	20.0	131	5/6
Copper	1,930	15.0	15.0	730	6/6
Iron	546,000	9,220	12.0	260,000	6/6
Lead	4,260	31.5	1.0	864	6/6
Magnesium	400,000	57,500	5.0	214,000	6/6
Manganese	92,000	237	3.0	19,500	6/6
Mercury	394	0.1	0.1	71.1	6/6
Nickel	6,680	22.0	14.0	1,420	5/6
Potassium	46,500	10,200	23.0	30,600	6/6
Selenium	13.8	13.8	1.0	2.7	1/6
Silver	70.9	3.0	3.0	23.2	5/6
Sodium	1,390,000	5,650	50.0	245,000	6/6
Thallium	2.5	1.6	1.0	1.8	5/6
Vanadium	764	57.0	7.0	431	6/6
Zinc	10,700	73.0	18.0	2,800	6/6

Radionuclide	Maximum Conc. Detected (pCi/L)	Minimum Conc. Detected (pCi/L)	Quantitation Limit (pCi/L)	Arithmetic Mean[a] (pCi/L)	Detection Frequency
RADIOLOGICAL DATA (ALPHA)					
U-238	2.4×10^{-02}	1.1×10^{-04}	5.0×10^{-05}	4.1×10^{-03}	6/6
U-234	5.2×10^{-01}	2.4×10^{-02}	5.0×10^{-04}	9.2×10^{-02}	6/6
Cm-244	1.6×10^{-01}	5.2×10^{-05}	NR	2.7×10^{-02}	6/6

Table 2. Continued

RADIOLOGICAL DATA (GAMMA)					
Radionuclide	Maximum Conc. Detected (pCi/L)	Minimum Conc. Detected (pCi/L)	Quantitation Limit (pCi/L)	Arithmetic Mean[a] (pCi/L)	Detection Frequency
Co-60	1.22×10^7	1.0×10^4	2.00×10^1	1.53×10^6	3/6
Cs-134	6.24×10^4	1.0×10^2	1.00×10^1	7.83×10^3	3/6
Cs-137	2.10×10^7	2.93×10^4	3.00×10^1	2.63×10^6	3/6
Eu-152	1.08×10^5	6.02×10^2	3.00×10^1	1.37×10^4	3/6
Eu-154	1.30×10^5	2.35×10^2	4.00×10^1	1.63×10^4	3/6
Eu-155	2.04×10^4	2.04×10^4	4.00×10^1	2.57×10^3	1/6
Zn-65	1.05×10^5	1.21×10^3	3.00×10^1	1.33×10^4	2/6
Am-241	1.67×10^4	1.67×10^4	5.00×10^1	2.11×10^3	1/6
Mn-54	3.36×10^2	3.36×10^2	1.00×10^1	4.63×10^1	1/6
Sc-46	4.14×10^3	4.14×10^3	2.00×10^1	5.26×10^3	1/6
Cr-51	2.54×10^6	4.01×10^3	8.00×10^1	3.24×10^5	2/6
Co-58	6.01×10^2	6.01×10^2	1.00×10^1	7.95×10^1	1/6
Fe-59	2.60×10^3	2.60×10^3	2.00×10^1	3.33×10^2	1/6
Zr-95	1.15×10^4	1.15×10^4	2.00×10^1	1.45×10^3	1/6
Nb-95	1.20×10^4	1.0×10^1	1.00×10^1	1.50×10^3	2/6
Ru-103	3.97×10^3	3.97×10^3	1.00×10^1	5.00×10^2	1/6
Ag-108[m]	1.44×10^4	7.0×10^2	1.00×10^1	1.89×10^3	2/6
Sb-124	1.50×10^2	1.0×10^1	1.00×10^1	2.31×10^1	2/6
Ce-141	6.14×10^3	6.14×10^3	2.00×10^1	7.76×10^2	1/6
Hf-175	3.50×10^3	3.50×10^3	2.00×10^1	4.46×10^2	1/6
Hf-181	1.36×10^5	1.36×10^5	2.00×10^1	1.70×10^4	1/6
Ta-182	3.18×10^3	3.18×10^3	5.00×10^0	4.00×10^2	1/6
Hg-203	1.68×10^3	1.68×10^3	1.00×10^1	2.14×10^2	1/6

Table 2. Continued

RADIOLOGICAL DATA (BETA)					
Radionuclide	Maximum Contaminated Detected (pCi/L)	Minimum Detection Concentration (pCi/L)	Quantitation Limit (pCi/L)	Mean (Arithmetic) (pCi/L)	Detection Frequency
Strontium-90	18,000	3.6	1.0	4,560	4/6
Tritium[b]	2,510,000	-	400	1,850,000	-

a. For non-detect concentrations, one-half the quantitation limit was used in calculating the arithmetic mean.
b. The shallow perched tritium concentration used was the peak model input concentration observed during 1987 to 1990.

Table 3. Concentration ranges and detection frequency in the deep perched zone.

Chemical	Maximum Conc. Detected (µg/L)	Minimum Conc. Detected (µg/L)	Quantitation Limit (µg/L)	Arithmetic Mean[a] (µg/L)	Detection Frequency
VOLATILE ORGANIC DATA					
Methylene Chloride	1.5	0.9	0.5	0.3	2/27
Chloroform	1.1	1.1	0.5	0.3	1/27
1,1,1-Trichloroethane	6.3	1.0	0.5	0.5	3/27
Benzene	0.8	0.8	0.5	0.3	1/27
Toluene	0.8	0.7	0.5	0.3	2/27
HEXAVALENT CHROMIUM DATA					
Hexavalent Chromium	160.0	5.9	5.0	31.4	4/27
SEMIVOLATILE ORGANIC DATA					
bis(2-Ethylhexyl)phthalate	190.0	11.0	20.0	21.3	7/27
NON-METAL INORGANIC DATA					
Fluoride	4,050	240	70.0	561	27/27
Nitrate	20,500	370	100	5,180	27/27
Phosphate	1,100	167	100	438	26/27
Chloride	64,800	13,400	1,000	24,500	27/27
Silica	42,300	6,410	1,000	36,600	27/27
Sulfate	388,000	21,000	5,000	93,900	27/27
INORGANIC DATA					
Aluminum	31,600	88.0	47.0	3,820	24/27
Antimony	21.7	21.7	14.0	7.8	1/27
Arsenic	18.1	1.0	3.0	4.9	22/27
Barium	712	52.0	22.0	165	27/27
Beryllium	8	1.0	1.0	1.3	6/27
Cadmium	18	4.0	4.0	3.0	6/27

Table 3. Continued

Chemical	Maximum Conc. Detected (μg/L)	Minimum Conc. Detected (μg/L)	Quantitation Limit (μg/L)	Arithmetic Mean[1] (μg/L)	Detection Frequency
INORGANIC DATA					
Calcium	556,000	66,400	50.0	138,000	27/27
Chromium	1,125	13.0	9.0	93.5	21/27
Copper	103	26.0	15.0	13.8	4/27
Iron	119,000	158	12.0	13,300	27/27
Lead	75.9	1.0	1.0	9.4	18/27
Magnesium	89,100	13,600	5.0	34,700	27/27
Manganese	1,670	6.0	3.0	255	22/27
Nickel	153	14.0	14.0	19.8	13/27
Potassium	19,900	1,870	23.0	4,190	27/27
Selenium	12.0	1.4	1.0	2.3	17/27
Silver	6.1	5.7	3.0	1.7	25/27
Sodium	1,220,000	62.0	50.0	108,000	27/27
Thallium	1.3	1.3	1.0	0.5	1/27
Vanadium	75	9.0	7.0	17.6	22/27
Zinc	3,180	15.0	18.0	145	19/27

Chemical	Maximum Conc. Detected (pCi/L)	Minimum Conc. Detected (pCi/L)	Quantitation Limit (pCi/L)	Arithmetic Mean[1] (pCi/L)	Detection Frequency
RADIOLOGICAL DATA (ALPHA)					
U-238	8.0×10^{-03}	3.5×10^{-03}	5.0×10^{-05}	1.2×10^{-03}	20/27
U-234	1.42×10^{-02}	3.5×10^{-03}	5.0×10^{-04}	2.1×10^{-03}	21/27
RADIOLOGICAL DATA (GAMMA)					
Co-60	6.96×10^{01}	3.0×10^{01}	2.00×10^{01}	1.4×10^{01}	2/27
Cr-51	3.30×10^{02}	3.3×10^{02}	8.00×10^{01}	5.1×10^{01}	1/27
RADIOLOGICAL DATA (BETA)					
Strontium-90	180	15	1.0	32	26/27
Tritium[2]	752,000	–	400	115,000	–

1 The mean concentrations were collected using one-half the reported quantitation limit for nondetect values.

2 The deep perched tritium concentration used was the maximum concentration for the USGS monitoring data from 1987 to 1990.

Table 4. Federal drinking water standards and background concentrations for inorganics, organics, and radionuclides.

Inorganic	Federal Primary Drinking Water Standard 40 CFR 141.11 (μg/L)	Federal Secondary Drinking Water Standard 40 CFR 143.3 (μg/L)	Background[a] (μg/L)
Arsenic	50	–	2-3
Barium	1,000	–	50-70
Cadmium	10	–	<1
Chromium	50	–	2-3
Chloride	–	250,000	–
Copper	–	1,000	–
Fluoride	4,000	2,000	400-500
Iron	–	300	–
Lead	50	–	<5
Manganese	–	50	–
Mercury	2	–	<0.1
Nitrate	10,000	–	<1,400
pH	–	6.5-8.5	–
Selenium	10	–	<1
Silver	50	–	<1
Sulfate	–	250,000	–
TDS	–	500,000	–
Zinc	–	5,000	–

a. Background for Snake River Plain Aquifer in the vicinity of INEL. (From Orr et al. 1991)

Table 4. Continued

Organic	Federal Primary Drinking Water Standard 40 CFR 141.12 40 CFR 141.61 (μg/L)
Volatile Organics	
Benzene	5
Carbon Tetrachloride	5
1,1-Dichloroethylene	7
1,2-Dichloroethane	5
para-Dichlorobenzene	75
Total trihalomethanes	100[a]
1,1,1-Trichloroethane	200
Trichloroethylene	5
Vinyl chloride	2

a. Sum of the concentrations of bromodichloromethane, dibromochloromethane, bromoform, and chloroform.

Table 4. Continued

Radionuclide	Federal Primary Drinking Water Standard 40 CFR 141.15 40 CFR 141.16 (pCi/L)	Proposed Drinking Water Standard[e] (pCi/L)	Background[a] (pCi/L)
Total Uranium [b]	none	20 μg/l ($\approx$ 30 pCi/L)	0 - 9.0
Radium 226 & 228	5.0 (combined)	20 (each)	< 5.0
Radon 222	none	300	0 - 250
Plutonium 238	none [c]	7.02 [f]	0
Plutonium 239, 240	none [c]	62.1 [f], 62.2 [f]	0
Americium 241	none [c]	6.34 [f]	0
Tritium	20,000	60,900	75 - 150
Strontium 90	8.0	42	0
Iodine 129	none [d]	21 [g]	0 - .05
Gross alpha [c]	15	15	0 - 5
Man-made beta [d]	4 mrem/year	4 mrem/year	0 - 8
Cesium 137 (Barium 137)	none [d]	119 [g]	0
Cobalt 60	none [d]	218 [g]	0

a. Background for Snake River Plain Aquifer in the vicinity of INEL (From Orr et al. 1991).

b. Total uranium is the sum of uranium-234, uranium-235, and uranium-238.

c. The MCL for gross alpha particles is for the combined total of alpha emitters excluding radon and uranium.

d. The MCL for beta and photon sources is based on the average annual concentration from man-made sources. If two or more radionuclides are present, the sum total of their annual dose equivalent to the total body or to any organ cannot exceed 4 millirem per year.

e. These standards were proposed in the July 12, 1991 Federal Register (FR, v. 56. no. 138). Although chemical specific standards were proposed for only radon-222, radium-226, radium-228, and uranium (total), standards are also proposed to remain the same for adjusted gross alpha and beta particle and photon emitters (15 pCi/l and 4 mrem/year, respectively). Foot-noted standards listed in this column for alpha and beta/photon emitters are calculated standards listed in the Federal Register based on the entire allowable dose being committed by each chemical alone.

f. These standards are the calculated concentrations for each alpha emitter which would result in a lifetime cancer incidence risk of 1 x 10^{-4}, assuming a daily intake of 2 liters per day.

g. These standards are the calculated concentrations in water which would result in a dose of 4 millirem per year, assuming a daily intake of 2 liters of drinking water over a 50-year period.

Table 5. Perched Water System contaminants of concern and deep perched zone mean concentrations.

Contaminant	Average Concentration	Half-Life
Arsenic	4.9 μg/L	-
Beryllium	1.3 μg/L	-
Cadmium	3.0 μg/L	-
Chromium	93.5 μg/L	-
Cobalt	10.0 μg/L	-
Flouride	561 μg/L	-
Lead	9.4 μg/L	-
Manganese	255 μg/L	-
Americium - 241	25.0 pCi/L	458 years
Cesium - 137	15.0 pCi/L	33 years
Cobalt - 60	14.3 pCi/L	5.3 years
Strontium - 90	31.9 pCi/L	38 years
Tritium	1.15×10^5 pCi/L	12.5 years

Table 6. Average concentrations of contaminants used for risk assessment and in the Perched Water System predicted by computer model.

Contaminant of Concern	Concentration used in future risk assessment for year 2115
Arsenic	3.20×10^{-11} µg/L
Beryllium	5.40×10^{-12} µg/L
Cadmium	1.30 µg/L
Chromium	6.91 µg/L
Cobalt	4.10×10^{-5} µg/L
Fluoride	1.73×10^{-8} µg/L
Lead	5.02×10^{-11} µg/L
Manganese	1.60×10^{-2} µg/L
Amercium - 241	9.54×10^{-5} pCi/L
Cesium - 137	1.17×10^{-16} pCi/L
Cobalt - 60	1.70×10^{-2} pCi/L
Strontium - 90	2.90×10^{-1} pCi/L
Tritium	6.60×10^{-5} pCi/L

Table 7. Summary of nonradiological carcinogenic risk in year 2115.

Chemical	Groundwater Ingestion	Crop Ingestion	Livestock Ingestion	Total Risk
Arsenic	6.6×10^{-16}	7.4×10^{-19}	2.5×10^{-18}	6.6×10^{-16}
Beryllium	2.7×10^{-16}	8.2×10^{-20}	5.1×10^{-19}	2.7×10^{-16}
Lead	2.4×10^{-17}	4.0×10^{-20}	1.3×10^{-20}	2.4×10^{-17}

Table 8. Summary of radiological carcinogenic risk in year 2115.

Chemical	Groundwater Ingestion	Crop Ingestion	Livestock Ingestion	Total Risk
Cobalt-60	5.4×10^{-9}	2.8×10^{-12}	2.0×10^{-10}	5.6×10^{-9}
Cesium-137	6.9×10^{-23}	4.0×10^{-25}	2.6×10^{-24}	7.2×10^{-23}
Barium-137m	5.5×10^{-27}	2.3×10^{-29}	1.5×10^{-30}	5.5×10^{-27}
Americium-241	6.2×10^{-10}	3.0×10^{-14}	4.1×10^{-13}	6.2×10^{-10}
Tritium	7.6×10^{-14}	1.8×10^{-17}	1.7×10^{-15}	7.8×10^{-14}
Strontium-90	1.1×10^{-16}	1.4×10^{-18}	6.3×10^{-20}	1.1×10^{-16}

Table 9. Summary of noncarcinogenic hazard indices (child) in year 2115.

Chemical	Groundwater Ingestion	Crop Ingestion	Livestock Ingestion	Total Hazard Index
Arsenic	2.0×10^{-12}	4.6×10^{-15}	1.5×10^{-14}	2.1×10^{-12}
Beryllium	6.9×10^{-14}	4.1×10^{-17}	2.6×10^{-16}	6.9×10^{-14}
Cadmium	1.7×10^{-1}	3.9×10^{-4}	3.4×10^{-4}	1.7×10^{-1}
Chromium	8.8×10^{-2}	2.6×10^{-6}	1.8×10^{-3}	9.0×10^{-2}
Cobalt	9.9×10^{-6}	9.6×10^{-9}	6.8×10^{-7}	9.7×10^{-6}
Fluoride	1.8×10^{-11}	8.5×10^{-17}	1.0×10^{-11}	2.0×10^{-11}
Lead	2.3×10^{-11}	7.7×10^{-14}	2.6×10^{-14}	2.3×10^{-11}
Manganese	1.0×10^{-5}	8.0×10^{-8}	1.5×10^{-8}	1.0×10^{-5}

Table 10. Summary of noncarcinogenic hazard indices (adult) in year 2115.

Chemical	Groundwater Ingestion	Crop Ingestion	Livestock Ingestion	Total Hazard Index
Arsenic	8.8×10^{-13}	9.8×10^{-16}	3.3×10^{-15}	8.8×10^{-13}
Beryllium	3.0×10^{-14}	8.9×10^{-18}	5.5×10^{-17}	3.0×10^{-14}
Cadmium	7.1×10^{-2}	8.5×10^{-5}	7.3×10^{-5}	7.1×10^{-2}
Cobalt	3.9×10^{-6}	2.1×10^{-9}	1.5×10^{-7}	4.0×10^{-6}
Lead	9.8×10^{-12}	1.6×10^{-14}	5.5×10^{-15}	9.8×10^{-12}
Manganese	4.4×10^{-6}	1.7×10^{-8}	3.3×10^{-9}	4.4×10^{-6}
Fluoride	7.9×10^{-12}	1.8×10^{-17}	2.2×10^{-12}	1.0×10^{-11}
Chromium	3.8×10^{-2}	5.7×10^{-7}	3.9×10^{-4}	3.8×10^{-2}

Table 11. Summary of 30-year rolling average concentrations.

30-year Period	Titium	Chromium	Cadmium
1990-2020	68,000	270	10
1995-2025	37,000	199	10
2000-2030	10,000	146	9
2005-2035	3,000	104	8
2010-2040	1,000	72	6

Table 12. Near-term excess lifetime cancer risks from tritium exposure.

Risk Period	Ingestion	Inhalation	Total
1990 to 2020	2×10^{-4}	9×10^{-5}	3×10^{-4}
1995 to 2025	1×10^{-4}	5×10^{-5}	2×10^{-4}
2000 to 2030	3×10^{-5}	1×10^{-5}	4×10^{-5}
2005 to 2035	9×10^{-6}	4×10^{-6}	1×10^{-5}
2010 to 2040	3×10^{-6}	1×10^{-6}	4×10^{-6}

Table 13. Near-term hazard quotients for cadmium and total chromium.

Risk Period	Cadmium	Chromium
1990 to 2020	0.6	1.3
1995 to 2025	0.5	1.0
2000 to 2030	0.5	0.7
2005 to 2035	0.4	0.5
2010 to 2040	0.4	0.4