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WELDON SPRING SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1992

Weldon Spring Site Remedial Action Project
Weldon Spring, Missouri

JUNE 1993 **REV. 0**

U.S. Department of Energy
Oak Ridge Field Office
Weldon Spring Site Remedial Action Project
7295 Highway 94 South
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A MORRISON KNUDSEN COMPANY

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Weldon Spring Site Remedial Action Project

EXECUTIVE SUMMARY

Environmental Report for Calendar Year 1992

Revision 0

June 1993

Prepared by

MK-FERGUSON COMPANY
and
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for the

U.S. DEPARTMENT OF ENERGY
Oak Ridge Field Office
Under Contract DE-AC05-86OR21548

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EXECUTIVE SUMMARY

This *Weldon Spring Site Environmental Report for Calendar Year 1992* has been prepared to provide information about the public safety and environmental protection programs conducted by the Weldon Spring Site Remedial Action Project (WSSRAP). The Weldon Spring site is located in southern St. Charles County, Missouri, approximately 48 km (30 mi) west of St. Louis. The site consists of two main areas, the Weldon Spring Chemical Plant and raffinate pits and the Weldon Spring Quarry. The chemical plant and raffinate pits are located on Missouri State Route 94, 3.2 km (2 mi) southwest of U.S. Route 40/61. The quarry is also located on Route 94, approximately 6.4 km (4 mi) south-southwest of the chemical plant.

The objectives of the *Site Environmental Report* are to present a summary of data from the environmental monitoring program, to characterize trends and environmental conditions at the site, and to confirm compliance with environmental and health protection standards and requirements. The report also presents the status of remedial activities and the results of monitoring these activities to assess their impacts on the public and environment.

The scope of the environmental monitoring program at the Weldon Spring site has changed since it was initiated. Previously, the program focused on investigations of the extent and level of contaminants in the groundwater, surface waters, buildings, and air at the site. In 1992, the level of remedial activities required monitoring for potential impacts of those activities, particularly on surface water runoff and airborne effluents.

This report includes monitoring data from routine radiological and nonradiological sampling activities. These data include estimates of dose to the public from the Weldon Spring site; estimates of effluent releases; and trends in groundwater contaminant levels. Also, applicable compliance requirements, quality assurance programs, and special studies conducted in 1992 to support environmental protection programs are reviewed.

There were no unplanned releases from the site in 1992. Dose estimates presented in this report are based on hypothetical exposure scenarios of public use of areas near the site. In addition, release estimates have been calculated on the basis of 1992 National Pollutant Discharge Elimination System (NPDES) and air monitoring data. Effluent discharges from the site under routine NPDES and National Emission Standards for Hazardous Air Pollutants

(NESHAPs) monitoring were below permitted levels for total suspended solids and biochemical oxygen demand except on four occasions.

MONITORING OVERVIEW

WSSRAP environmental management programs are designed to ensure that releases from the site are at levels demonstrably and consistently "as low as reasonably achievable" (ALARA). The ALARA principle drives the work activities related to site remediation and contaminant cleanup programs under U.S. Environmental Protection Agency (EPA) enforcement of the *Comprehensive Environmental Response Compensation and Liability Act* (CERCLA).

The ALARA principle is applied through effluent and environmental monitoring programs that provide early detection of contaminants and provide data required to assess potential impacts to the environment. Routine monitoring also ensures compliance with applicable State and Federal permits and regulations.

The data presented in this report have been collected from a variety of monitoring locations, stations, and sampling events. These programs include:

- An expanded air particulate monitoring program with 17 locations at the perimeters of the chemical plant, raffinate pits, and quarry, and at five off-site critical receptor locations.

- An increase in the number of NPDES locations in order to support operations at the water treatment plants at the chemical plant and the quarry. Twenty-seven surface water sampling locations were maintained in 1992.

- Operation of 31 monitoring locations for measuring external gamma radiation and radon.

- Operation of 70 groundwater wells and piezometers at the chemical plant and quarry. Five spring locations are also monitored in the vicinity of the chemical plant.

- Establishment of routine geochemical monitoring to identify contaminant transport mechanisms in groundwater.

- Monitoring of biota, including game species in the August A. Busch, Weldon Spring, and Howell Island wildlife areas to ensure public safety and environmental protection.

REGULATORY COMPLIANCE

The Weldon Spring site is listed on the National Priorities List (NPL) and is governed by the CERCLA. Under the CERCLA, the WSSRAP is subject to meeting or exceeding applicable or relevant and appropriate requirements of Federal, State, and local laws. These include the *Resource Conservation Recovery Act* (RCRA), *Clean Water Act* (CWA), *Clean Air Act* (CAA) and, because the U.S. Department of Energy (DOE) is the lead agency for the site, the requirements of the *National Environmental Policy Act* (NEPA).

A major accomplishment under the CERCLA in 1992 was the presentation of the remedial investigation, feasibility study, baseline risk assessment, and proposed plan documents for remedial action at the chemical plant area of the Weldon Spring Site. These documents were submitted for public review on November 20, 1992.

Other notable compliance activities included completion of a floodplains/wetlands assessment and publication of a notice on the site water treatment plant effluent pipeline in the *Federal Register*, approval of a monitoring plan for radionuclide and asbestos hazardous air pollutant (HAPs) under the *Clean Air Act*, permitting of two additional NPDES outfalls to support operations at the site and quarry water treatment plants, and signing of the *First Amended Federal Facilities Agreement* (FFA) between the DOE and the EPA.

MONITORING SUMMARY

Environmental monitoring data showed that total emissions of radiological contaminants from the Weldon Spring site were low in 1992. Airborne particulate monitoring indicated no distinguishable difference in effluent releases from the Weldon Spring site as compared to background levels. Above background radon concentrations were found in 1992, although the release estimate was 8.9 Ci and below the 1991 release estimate for radon of 14.2 Ci.

Release estimates for water increased from 0.059 Ci estimated in 1991 to 0.15 Ci in 1992. These effluent releases continued to be below compliance levels. Data from groundwater and surface water monitoring indicated no measurable impact on drinking water sources from Weldon Spring site contaminants.

Dose Estimates

In 1992, the maximum committed dose to a hypothetical individual at the boundary of the chemical plant site was 0.21 mrem (0.0021 mSv). The maximum committed dose to a hypothetical individual at the boundary of the quarry was 1.9 mrem (0.019 mSv). These scenarios assumed an individual walking along the perimeter of the site—once a day at the chemical plant/raffinate pits and twice a day at the quarry—250 days per year. This hypothetical individual also consumes fish, sediment, and water from lakes and other bodies of water in the area.

The collective dose, based on an affected population of 7,232, was 0.021 person-rem (0.00021 person-Sv). This calculation is based on recreational use of the Busch Wildlife Area and the Missouri Department of Conservation recreational trail (the Katy Trail) near the quarry. These estimates are below the DOE guideline of 100 mrem (1 mSv) annual committed effective dose equivalent for all exposure pathways. Section 4 and Appendix C of this report provide additional information on the dose assumptions and calculations.

Air Monitoring

No airborne radionuclide releases other than radon occurred at the site perimeter or at off-site monitoring locations in 1992. Statistical analysis of air particulate data indicates that the concentrations at the site perimeter were no greater than those recorded at background locations. The average radon concentration at the quarry perimeter was 0.4 pCi/l above background and the estimated Rn-222 release was 9.2 Ci (3.3×10^{11} Bq). The radon concentrations at the chemical plant perimeter were 0.1 pCi/l above background. No estimated release for Rn-222 could be calculated since there were no activities in perimeter areas of the chemical plant where measurable radon was recorded that could be identified as potential sources of radon emissions.

The results of NESHAPs monitoring indicated that all doses to the public at critical receptor locations were less than 1.0 mrem per year. This dose is below the NESHAPs standard of 10 mrem per year. Critical receptor locations upon which this dose was estimated included the Missouri Highway Maintenance Facility, Francis Howell High School, and the Department of the Army Weldon Spring Training Area.

During periods of asbestos abatement work, airborne asbestos was monitored as a part of the nonradiological air monitoring program. The results indicated that concentrations ranging from < 0.0002 fibers per cubic centimeter of air (f/cc) to 0.01 f/cc. These concentrations were within the range of normal background fiber concentrations and indicated that containment was effective.

NPDES Monitoring

Intermittent surface runoff at the Weldon Spring Chemical Plant transported uranium from the site in 1992 through five major discharge routes as identified in Section 6 of this report. Radionuclide release estimates were calculated on the basis of the activity of uranium. The estimate of uranium released to water was 0.0079 Ci for U-234, 0.0037 Ci for U-235, and 0.078 Ci for U-238.

The annual average uranium concentration increased at the Frog Pond outfall (NP-0002) and the Ash Pond outfall (NP-0003) due to increased work activity in these drainages. Annual averages in the southeast area of the site (NP-0005) decreased to its lowest level since 1987. This reduction is attributed to removal of contaminated soil during construction of the site water treatment plant in 1991 and to effective erosion control measures.

Preoperational monitoring of the Missouri River was conducted in 1992 in support of quarry and site water treatment plant operations. Surface water and sediment samples were taken from the river and analyzed for uranium. The river receives discharges from the water treatment plants.

Surface Water

Surface water monitoring in 1992 indicated that the distributions and concentrations of contaminants remained similar to historic levels. The furthest monitoring locations downstream

from the chemical plant (SW-2001 and SW-2016) remained within background ranges. Uranium concentrations were at above background at Busch Lakes 34, 35, and 36 and at the Femme Osage Slough.

Groundwater

The groundwater monitoring program included extensive monitoring for radiological and nonradiological compounds. Radiological results for the St. Charles County well field remained within background levels. No detectable concentrations of the six nitroaromatic compounds of concern were found in groundwater monitoring wells south of the Femme Osage Slough, which is near the quarry. A program of more frequent monitoring was initiated at monitoring well MW-1011, just south of the Femme Osage Slough, in response to indications in the second bimonthly sampling period that uranium concentrations had increased slightly. Statistical analysis of the data for this location indicated no upward trend in concentrations.

At the chemical plant, uranium, sulfate, nitrate, and nitroaromatic compounds in groundwater and springs remained near historic ranges. High concentrations of uranium typically occur in groundwater wells near Raffinate Pit 4 and at the southeast corner of the chemical plant. Contaminant transport continued to be confined to the upper weathered zone of the bedrock aquifer at the plant.

Biological

The results of biological monitoring of fish from Busch Lakes 34, 35, and 36 showed uranium concentrations ranging from 0.001 pCi/g to 0.558 pCi/g in edible portions. The levels in Lakes 35 and 36 continued to be statistically different from background lakes, but did not pose a threat to human health.

Corn, soybeans, and milo were sampled under the foodstuffs monitoring program. Uranium concentrations were less than 0.05 pCi/l with no significant difference among crop types.

Several white-tailed deer samples were obtained from the Busch Wildlife Area to support human health studies and were analyzed for radionuclides. Uranium concentrations in muscle

tissue ranged from 0.003 pCi/g to 0.007 pCi/g. These concentrations posed no threat to human health.

Several Federal and State threatened and endangered species were observed in the wildlife areas, including the bald eagle, loggerhead shrike, brown creeper, Cooper's hawk, northern harrier, and osprey. Only one species, the State-endangered Swainson's hawk was observed on the site, and it was shown not to be nesting or breeding on the site.

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ABSTRACT

This *Site Environmental Report for Calendar Year 1992* describes the environmental monitoring programs at the Weldon Spring Site Remedial Action Project (WSSRAP). The objectives of these programs are to assess actual or potential exposure to contaminant effluents from the project area by providing public use scenarios and dose estimates, to demonstrate compliance with Federal and State permitted levels, and to summarize trends and/or changes in contaminant concentrations from environmental monitoring program.

In 1992, the maximum committed dose to a hypothetical individual at the chemical plant site perimeter was 0.21 mrem (0.0021 mSv). The maximum committed dose to a hypothetical individual at the boundary of the Weldon Spring Quarry was 1.9 mrem (0.019 mSv). These scenarios assume an individual walking along the perimeter of the site—once a day at the chemical plant/raffinate pits and twice a day at the quarry—250 days per year. This hypothetical individual also consumes fish, sediment, and water from lakes and other bodies of water in the area.

The collective dose, based on an effected population of 7,232, was 0.021 person-rem (0.00021 person-Sv). This calculation is based on recreational use of the August A. Busch Wildlife Area and the Missouri Department of Conservation recreational trail (the Katy Trail) near the quarry. These estimates are below the U.S. Department of Energy guideline of 100 mrem (1 mSv) annual committed effective dose equivalent for all exposure pathways. Results from air monitoring for the NESHAPs program indicated that the estimated dose was 0.2 mrem which is below the EPA standard of 10 mrem per year.

Comprehensive monitoring indicated that emissions of radiological compounds in airborne and surface water discharges from the Weldon Spring site were 8.9 Ci and 0.1531 Ci, respectively. No unplanned releases occurred in 1992. There was no measurable impact to any drinking water source. Substances of concern in groundwater south of the Femme Osage Slough and the St. Charles County well field continued to remain within background ranges.

Four additional National Pollutant Discharge Elimination System outfall monitoring locations were added to the program in 1992 to support preoperational monitoring at the chemical plant and quarry water treatment plants. Various State and Federal permit levels are monitored under these NPDES permits. In 1992, all permit levels were maintained except on three occasions for total suspended solids and once for biochemical oxygen demand. The NPDES compliance rate was 98 % in 1992.

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1 INTRODUCTION

The Weldon Spring Site Remedial Action Project (WSSRAP) is part of the U.S. Department of Energy (DOE) Environmental Restoration Program, one of the remedial action programs under the direction of the DOE Office of Environmental Restoration and Waste Management. This *Site Environmental Report for Calendar Year 1992* is a summary of the environmental monitoring results obtained in 1992 and the status of Federal and State compliance activities.

DOE requirements for environmental monitoring and protection of the public, as well as the mandate for this document, are designated in DOE Order 5400.1, *General Environmental Protection Program*, and DOE Order 5400.5, *Radiation Protection*.

1.1 Purpose

The purposes of the *Site Environmental Report for Calendar Year 1992* are to:

- Provide general information on the WSSRAP and the current status of remedial activities.
- Present data and interpretations for the 1992 Weldon Spring site environmental monitoring program.
- Document continuing Weldon Spring site compliance with Federal, State, and local requirements.
- Provide dose estimates for radiological and chemical compounds as appropriate for the Weldon Spring site.
- Summarize trends and/or changes in contaminant concentrations to support remedial actions, ensure public safety, and maintain surveillance monitoring levels.

1.2 Scope

In 1992, environmental monitoring activities were conducted to support remedial action under the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA), the *Clean Air Act* (CAA), the *National Environmental Policy Act* (NEPA), the *Clean Water Act* (CWA), and applicable regulatory requirements. The monitoring program at the WSSRAP has recently been modified to ensure protection of public safety and to evaluate the effects on the environment, if any, from cleanup activities, including increased perimeter and work zone emissions monitoring, erosion control monitoring, water treatment plant discharge monitoring, and groundwater monitoring at new remedial action areas such as the site water treatment plant and storage areas at the Weldon Spring Chemical Plant.

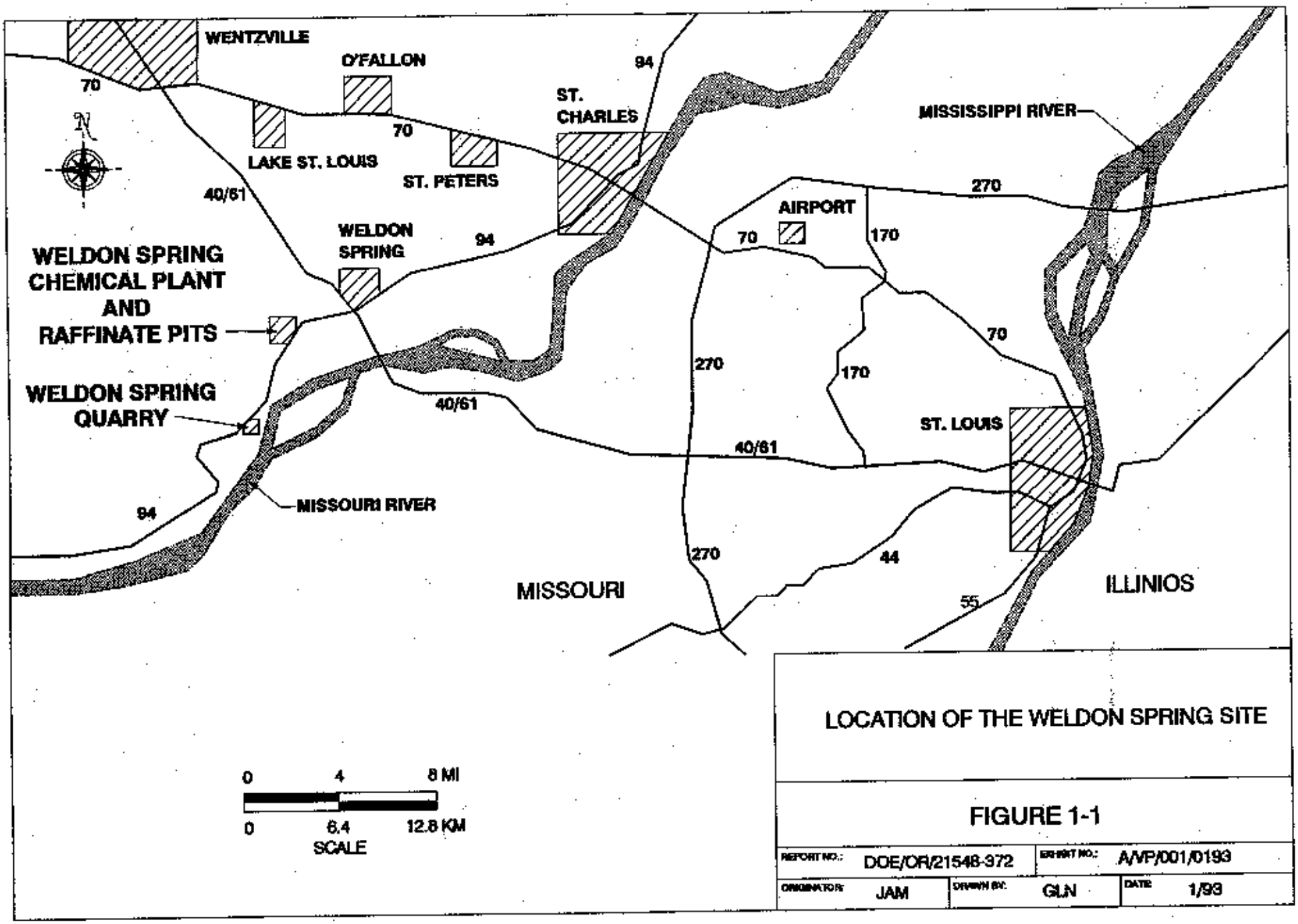
1.3 Site Description

The Weldon Spring site is located in southern St. Charles County, Missouri, approximately 48 km (30 mi) west of St. Louis (Figure 1-1). The site consists of two main areas, the Weldon Spring Chemical Plant and raffinate pits and the Weldon Spring Quarry. The chemical plant and raffinate pits are located on Missouri State Route 94, 3.2 km (2 mi) southwest of U.S. Route 40/61. The quarry is also located on Route 94, approximately 6.4 km (4 mi) south-southwest of the chemical plant.

1.3.1 Weldon Spring Chemical Plant/Weldon Spring Raffinate Pits

The Weldon Spring Chemical Plant is a 67.2 ha (166 acres) area which operated as the Weldon Spring Uranium Feed Materials Plant (WSUFMP) until 1966. It consists of 13 major buildings and 27 smaller buildings (Figure 1-2). Of the former, five were used as process buildings, and eight were major support buildings. The entire chemical plant site is fenced, and access is controlled with 24 hour security.

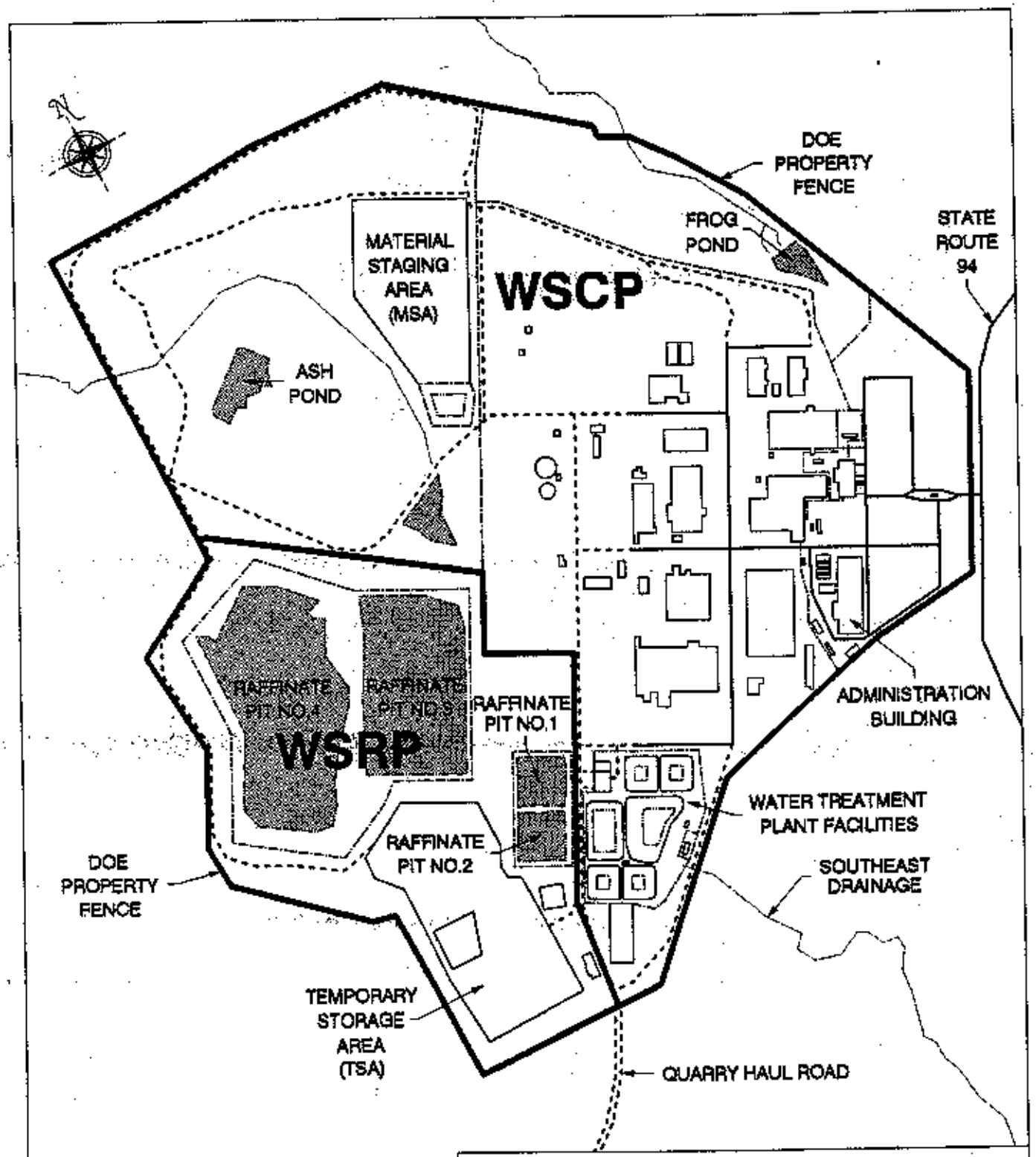
The interiors of the eight major support buildings are heavily contaminated with uranium while the remaining buildings are contaminated with small quantities of both uranium and thorium. Hazardous chemical substances are also present in the buildings. Radiological and chemical contaminants are also found in the soil in several areas of the site. These substances include asbestos (in buildings), polychlorinated biphenyls (PCBs), nitroaromatic compounds, metals, and inorganic ions.



LOCATION OF THE WELDON SPRING SITE

FIGURE 1-1

REPORT NO.:	DOE/OR/21548-372	EXHIBIT NO.:	A/VP/001/0193		
ORIGINATOR:	JAM	DRAWN BY:	GLN	DATE:	1/93



WELDON SPRING CHEMICAL PLANT AREA AND WELDON SPRING RAFFINATE PIT AREA

0 500 1000 FT
0 152.4 304.8 M
SCALE

FIGURE 1-2

REPORT NO.:	DOE/OR/21548-372	EXHIBIT NO.:	A/CP/002/0193		
ORIGINATOR:	JAM	DRAWN BY:	GLN	DATE:	1/93

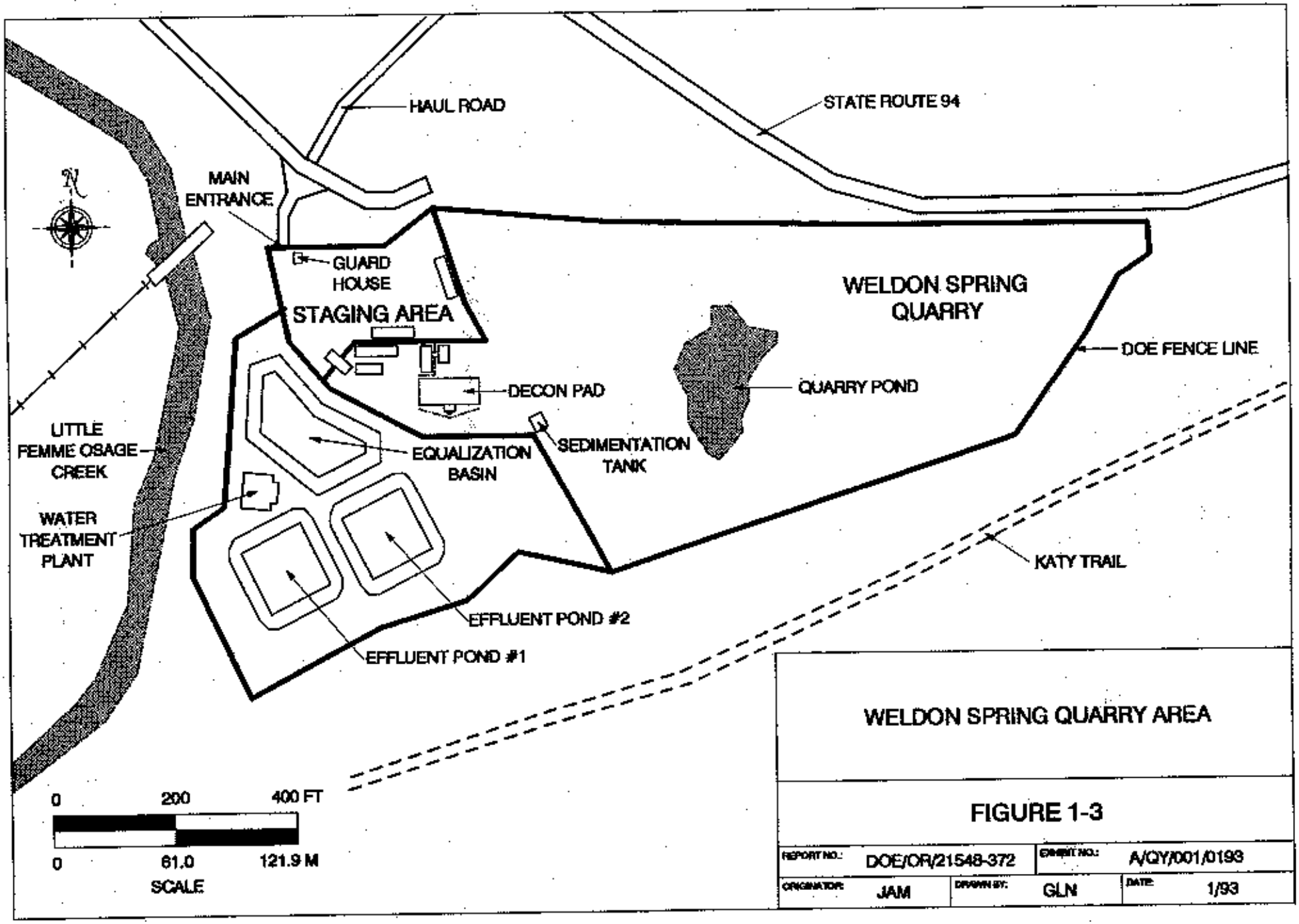
The site water treatment plant was recently constructed in the southeast portion of the chemical plant area. The purpose of the plant is to treat contaminated surface waters on site to facilitate remedial action. It consists of one process building, two effluent ponds, and one equalization basin. Plans are under way to begin treatment of contaminated water from the chemical plant area in 1993. The site water treatment plant discharge outfall will be located at Missouri River mile 47.5.

The raffinate pits are on the chemical plant site in a 20.7 ha (51 acre) area that includes four settling basins (the pits) that cover approximately 10.5 ha (26 acres) (Figure 1-2). These pits contain radioactive residues (raffinates) from uranium and thorium processing operations at the WSUFMP. The pits were constructed by excavating into the existing clay soils and using the natural clay material to build dikes. They hold approximately 2.15 x 10^8 liters (57,000,000 gal) of contaminated water.

All drains and transfer lines from the raffinate pits to the chemical plant process sewers have been sealed (Ficker 1981). In 1992, surface water covered most of the surface area of the pits. However, small areas of sediments were exposed around the perimeter of the pits in the late summer due to the seasonal drop in water level. The raffinate pits are radiologically contaminated with uranium and thorium residues. Chemical contaminants include nitrate, fluoride, PCBs, and various heavy metals.

1.3.2 Weldon Spring Quarry

The Weldon Spring Quarry is a former 3.6 ha (9 acres) limestone quarry located south-southwest of the chemical plant area (Figure 1-3). The quarry is essentially a closed basin; surface water within the rim flows to the quarry floor and into a pond which covers approximately 0.2 ha (0.5 acres). The pond contains approximately 12 million liters (3 million gal) of water and is 6.1 m (20 ft) deep at its deepest point (ANL 1989). The amount of water in the pond varies seasonally, but it is never dry. The quarry contains radiological and chemical contaminants including uranium, thorium, metals, nitrates, PCBs, semivolatiles, nitroaromatics, and asbestos. Access to the quarry is restricted by a locked 2.1 m (7 ft) high chain link fence with 24 hour on-site security.


HAUL ROAD
STATE ROUTE 94
MAIN ENTRANCE
GUARD HOUSE
STAGING AREA
WELDON SPRING QUARRY
DOE FENCE LINE
DECON PAD
QUARRY POND
LITTLE FEMME OSAGE CREEK
EQUALIZATION BASIN
SEDIMENTATION TANK
WATER TREATMENT PLANT
KATY TRAIL
EFFLUENT POND #2
EFFLUENT POND #1
0 200 400 FT
0 61.0 121.9 M
SCALE
WELDON SPRING QUARRY AREA
FIGURE 1-3
REPORT NO.: DOE/OR/21548-372
EXHIBIT NO.: A/QY/001/0193
ORIGINATOR: JAM
DRAWN BY: GLN
DATE: 1/93

The quarry water treatment plant was completed in 1992 and consists of a process building and three holding basins. The treatment plant was built to support interim remedial actions for the quarry and is further documented in the *Engineering Evaluation/Cost Analysis (EE/CA) for Proposed Management of Contaminated Water in the Weldon Spring Quarry* (ANL 1989). The water treatment plant discharge outfall is located approximately 2.4 km (1.5 mi) northeast of the quarry. An underground pipeline was constructed from the quarry treatment plant area to the Missouri River in 1990. The outfall structure is located approximately at Missouri River mile 48.3.

1.4 Site History

From 1941 to 1945, the U.S. Department of the Army produced trinitrotoluene (TNT) and dinitrotoluene (DNT) in the Weldon Spring Ordnance Works, which covered 6,974 ha (17,232 acres) of land that now includes the Weldon Spring site. Four of 20 TNT and DNT production lines were located in the chemical plant area. The remaining 16 production lines were distributed across an adjacent property which is now referred to as the U.S. Army Reserve and National Guard Training Area. By 1949, all but about 809 ha (2,000 acres) had been transferred to the State of Missouri (August A. Busch Wildlife Area) and to the University of Missouri (agricultural land). Except for several small parcels transferred to Saint Charles County, the remaining property became the Army training area.

Through a Memorandum of Understanding between the Secretary of the Army and the General Manager of the Atomic Energy Commission (AEC), 83 ha (205 acres) of the former ordnance works property were transferred in May 1955 to the AEC for construction of the WSUFMP, now referred to as the Weldon Spring Chemical Plant. Considerable explosives decontamination was performed by Atlas Powder Company and the Army prior to WSUFMP construction. From 1958 till 1966, the WSUFMP converted processed uranium ore concentrates to pure uranium trioxide, intermediate compounds, and uranium metal. A small amount of thorium was also processed. Wastes generated during these operations were stored in four settling basins (the raffinate pits) on the site property.

In 1958, the AEC acquired title to the Weldon Spring Quarry from the Army. The quarry is located approximately 5.6 km (3.5 mi) south of the WSUFMP. The Army had used it since 1942 for burning wastes from the manufacture of TNT and DNT and disposal of TNT-contaminated rubble during the operation of the ordnance works. Prior to 1942, the quarry was

mined for limestone aggregate used in the construction of the ordnance works. The AEC used the quarry from 1963 to 1969 as a disposal area for uranium residues and a small amount of thorium residue. Most of the material disposed of there consisted of building ruble and soils from the demolition of a uranium ore processing facility in Saint Louis. These materials were contaminated with uranium and radium. Other radioactive materials in the quarry include drummed wastes, uncontained wastes, and contaminated process equipment.

The WSUFMP was shut down in 1966, and in 1967 the AEC returned the facility to the Army for use as a defoliant production plant to be known as the Weldon Spring Chemical Plant. The Army started removing equipment and decontaminating several buildings in 1968. However, the defoliant project was canceled in 1969 before any process equipment was installed. The Army retained responsibility for the land and facilities of the chemical plant, but the 20.6 ha (51 acre) tract encompassing the Weldon Spring raffinate pits was transferred back to the AEC.

The Weldon Spring site was placed in caretaker status from 1981 through 1985, when custody was transferred from the Army to the Department of Energy. In 1985, the DOE proposed designating control and decontamination of the chemical plant, raffinate pits, and quarry as a major project, and designation was effected by DOE Order 4240.1E, dated May 14, 1985. A Project Management Contractor (PMC) for the Weldon Spring Site Remedial Action Project was selected in February 1986. In July 1986, a DOE project office was established on site, and the PMC, MK-Ferguson Company and Jacobs Engineering Group, Inc., assumed control of the site on October 1, 1986. The quarry was placed on the Environmental Protection Agency National Priorities List (NPL) in July 1987. The DOE redesignated the site as a Major Acquisition System in May 1988. The chemical plant and raffinate pits were added to the NPL in March 1989.

Under the CERCLA process, a focused RI/FS-Environmental Assessment was used to document the proposed management of the wastes in the quarry. Compared to a full-scope RI/FS, the focused RI/FS is appropriate for the bulk wastes since removal will decrease the threat of release of contaminants and is consistent with a permanent remedy for the entire site (ANL 1990b). The NEPA/CERCLA environmental documentation process for the quarry bulk wastes is complete, and remedial activities began in 1991.

Remedial investigations were conducted at the chemical plant/raffinate pits area in 1988 and 1989 under the CERCLA RI/FS process. These investigations included characterization of the groundwater; on-site soil contamination; contaminated sediments in off-site surface drainages, lakes, surface water, and springs; and chemical and radiological contaminants in the raffinate wastes. Other smaller sampling efforts were also included. The results of each of these investigations have been published in the *Remedial Investigation Report for the Chemical Plant Area of the Weldon Spring Site* (MKF and JEG 1992p). The environmental documentation process for the chemical plant area is under public review. The *Record of Decision* (ROD) (DOE 1990) will mark the selection of the final cleanup and disposal method for the chemical plant and bulk wastes from the quarry. The ROD is expected to be issued in September 1993.

Several small interim actions have been conducted at the WSSRAP. Interim actions are activities that will not change the ultimate disposal method but have been conducted to mitigate or eliminate conditions that pose immediate or potential threats to worker safety, public health, or the environment (Peterson et al. 1988). These actions have included removal of exposed friable asbestos, overhead piping, PCB electrical equipment, power poles, and wires; demolition of nonprocess-building; isolation of Ash Pond; and consolidation of containerized chemicals.

A more detailed presentation of the production, ownership, and waste history of the Weldon Spring site is available in the *Remedial Investigation for Quarry Bulk Wastes* (MKF and JEG 1989b) and the *Remedial Investigation for the Chemical Plant Area of the Weldon Spring Site* (MKF and JEG 1992p).

1.5 Geology and Hydrogeology

The Weldon Spring site is situated near the boundary between the Central Lowland and the Ozark Plateau physiographic provinces. This boundary nearly coincides with the southern edge of Pleistocene glaciation that covered the northern half of Missouri over 10,000 years ago (Kleeschulte et al. 1986).

Three bedrock aquifers underlie St. Charles County. The shallow aquifer consists of Mississippian limestones, and the middle aquifer consists of the Kimmswick Limestone. The deep aquifer consists of formations from the top of the St. Peter Sandstone to the base of the Potosi Dolomite. Alluvial aquifers are present near the Missouri and Mississippi rivers.

Clay-rich soil units overlie the Mississippian carbonate rocks in the site vicinity. A residuum unit overlies the bedrock and is believed to be either a weathering product of remnant Warsaw or upper Burlington-Keokuk Limestone. It consists of clayey gravel to gravelly clay. Overlying the residuum and/or bedrock units is glacial drift and loess of the Pleistocene Series. These sediments consist of silty clay, clayey silt, gravelly clay, or clayey gravel. In some upland valleys, alluvium of the Holocene Series either overlies the glacial drift and loess or lies directly upon the Paleozoic bedrock (MKF and JEG 1992p).

The aquifer of primary concern beneath the chemical plant, raffinate pits, and vicinity properties is composed of saturated rocks of the Burlington-Keokuk Limestone. This unit constitutes the upper portion of the Mississippian Devonian aquifer. This heterogeneous anisotropic aquifer can be described in terms of diffuse Darcian flow overlain by high porosity discrete flow zones and conduits. Aquifer heterogeneity in the Burlington-Keokuk formation is believed to be randomly distributed and is a function of fracture spacing, solution voids, and preglacial weathering.

The Weldon Spring quarry is located in low limestone hills near the western bank of the Missouri River. The mid-Ordovician bedrock of the quarry area is predominantly limestone and dolomite. Near the quarry, the carbonate rocks dip to the northeast at a gradient of 11 m/km to 15 m/km (58 ft/mi to 79 ft/mi) (Berkeley Geoscience Associates 1984).

Bedrock near the quarry is overlain in the upland areas by wind-deposited glacial debris. In the Missouri River bottomland areas, the bedrock is overlain by as much as 30 m (100 ft) of alluvial material. The sides of the quarry expose the Ordovician Kimmswick Limestone Formation, and the bedrock floor of the quarry lies in the upper portion of the Decorah Group (Figure 1-4). The Kimmswick Limestone Formation, mined during quarry operations, is predominantly a crystalline limestone about 20 m (66 ft) thick. East and south of the quarry, the Plattin, Decorah, and Kimmswick limestones and shales are replaced by bottomland alluvium, consisting of a surficial layer of 3 m (10 ft) or more of silt underlain by about 6 m (20 ft) of sand. The surficial material south of the Femme Osage Slough coarsens with depth and southward toward the river, grading from clayey silt to sand to gravel to cobbles and boulders. The average thickness of surficial material in the St. Charles County well field is approximately 24 to 30 m (80 ft to 100 ft) (Layne Western Company 1986).

SYSTEM	SERIES	STRATIGRAPHIC UNIT	TYPICAL THICKNESS (ft)	LITHOLOGY	HYDROSTRATIGRAPHIC UNIT
QUARTERNARY	HOLOCENE	ALLUVIUM	0.5-4		ALLUVIAL AQUIFER
	PLEISTOCENE	LOESS, GLACIAL TILL, INTERGLACIAL SEDIMENT AND RESIDUUM	15-55		(unsaturated) *
MISSISSIPPIAN	MERAMECIAN	SALEM FORMATION	0-15		(unsaturated) *
		WARSAW FORMATION	60-80		
	OSAGEAN	BURLINGTON-KEOKUK LIMESTONE	100-200		MISSISSIPPIAN-DEVONIAN AQUIFER SYSTEM
		FERN GLEN FORMATION	45-70		
	KINDERHOOKIAN	CHOUTEAU GROUP	20-50		
		BUSHBERG SANDSTONE	5-20		
DEVONIAN	UPPER	LOWER SULPHUR SPRINGS GROUP (UNDIF)	0-2		ORDOVICIAN LEAKY CONFINING UNIT
ORDOVICIAN	CINCINNATIAN	MAQUOKETA SHALE	10-30		
	CHAMPLAINIAN	KIMMSWICK LIMESTONE	70-100		
		DECORAH GROUP	30-80		
		PLATTIN LIMESTONE	100-130		
		JOACHIM DOLOMITE	80-105		
		ST. PETER SANDSTONE	120-150		ORDOVICIAN-CAMBRIAN AQUIFER SYSTEM
	CANADIAN	POWELL DOLOMITE	60-60		
		COTTER DOLOMITE	200-260		
		JEFFERSON CITY DOLOMITE	160-180		
		ROUBIDOUX FORMATION	150-170		
		GASCONADE DOLOMITE	260		
CAMBRIAN	UPPER	EMINENCE DOLOMITE	200		
		POTOSI DOLOMITE	100		

* THESE UNITS ARE BELIEVED TO BE UNSATURATED IN THE WSS VICINITY

GENERAL STRATIGRAPHY AND HYDROSTRATIGRAPHY OF THE WELDON SPRING AREA

FIGURE 1-4

REPORT NO.: DOE/OR/21548-372		EXHIBIT NO.: A/PI/011/0191	
ORIGINATOR: JAM	DRAWN BY: SRS	DATE: 1/91	

The hydrogeology of the quarry area consists of highly permeable alluvial deposits which decrease in thickness to the north and west. The water level in the alluvial aquifer is controlled by the stages of the Missouri River. Water movement is from the river west toward the pumping wells in the St. Charles County well field, which lies east of the quarry. This alluvial aquifer is underlain by, and terminates against, the Kimmswick, Decorah, and Plattin formations. These formations contribute water to the fine grained alluvium at the edge of alluvial valley.

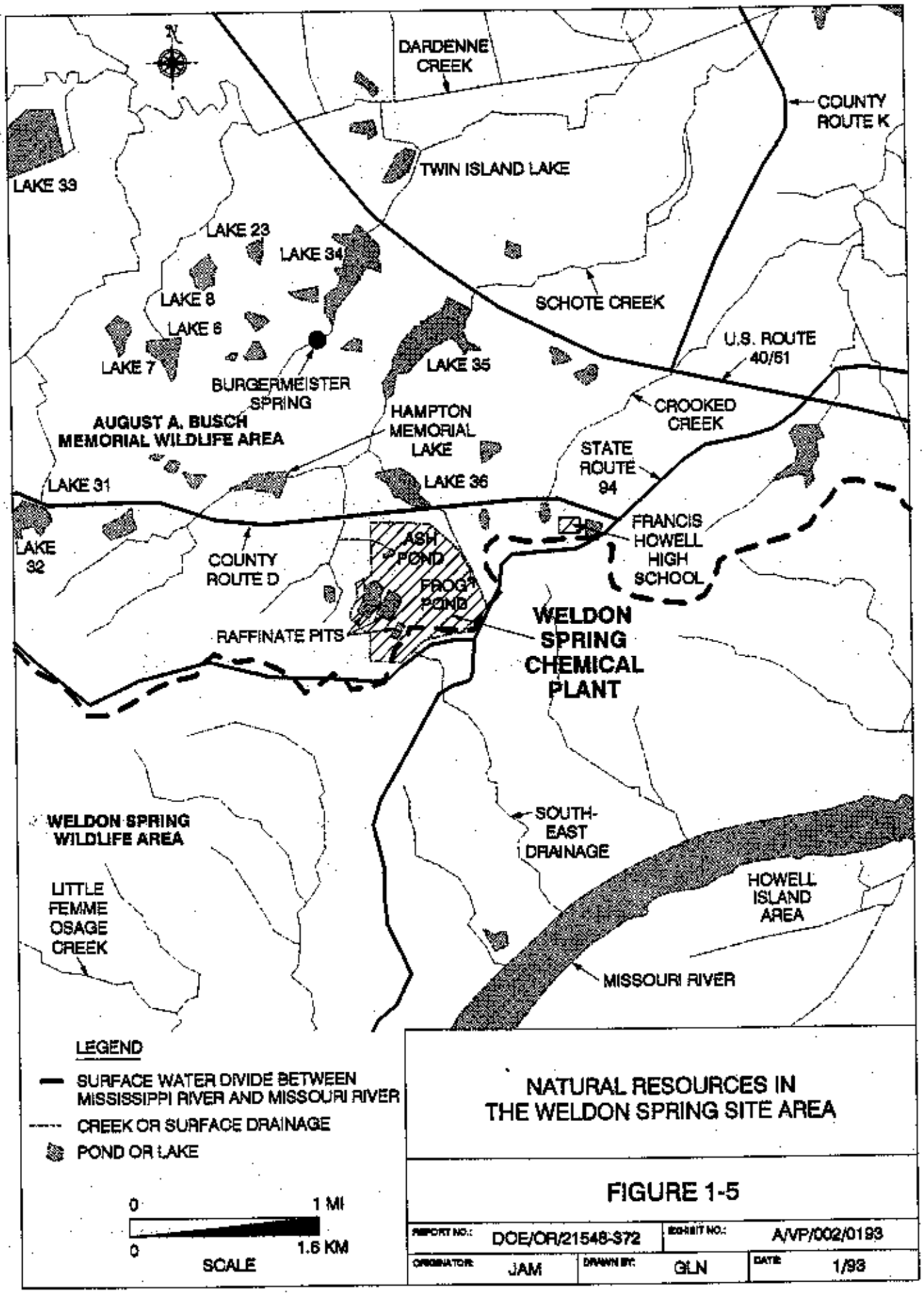
1.6 Surface Water System and Use

The chemical plant/raffinate pits area is located on the Missouri-Mississippi River surface drainage divide (Figure 1-5). Elevations on the site range from approximately 185.4 m (608 ft) above mean sea level (msl) near the northern edge of the site to 205 m (672 ft) above msl near the southern edge. The topography of the site is gently undulating in the upland areas, typical of the Central Lowlands physiographic province. South of the site, the topography changes to the narrow ridges and valleys and short, steep streams common to the Ozark Plateau physiographic province (Kleeschulte et al. 1986). A topographic ridge dividing the two surface drainages bisects the raffinate pit/chemical plant area in a southwest to northeast trend.

No natural drainage channels traverse the site, although remnants of a channel through the Ash Pond area are present. Drainage from the southeastern portion of the site generally flows southward in a tributary referred to as the Southeast Drainage (5300 Drainageway), that flows to the Missouri River. Six surface water bodies exist at the chemical plant area. These are the four raffinate pits covering 10.5 ha (26 acres), Ash Pond covering approximately 1 ha (2.5 acres), and Frog Pond covering 0.3 ha (0.7 acres).

The on-site surface waters and off-site drainages, including the Southeast Drainage, are radiologically and chemically contaminated as a result of previous plant operations. Presently, these areas are ponded year-round due to surface water runoff and precipitation, except Ash Pond, which has been drying up in late summer since the construction of a diversion ditch in 1988. The waters are not used for remedial operations or by the public.

In the surrounding areas, man-made lakes in the August A. Busch Wildlife Area are used for public fishing and boating. No swimming is allowed in the wildlife area, although some may



NATURAL RESOURCES IN THE WELDON SPRING SITE AREA

FIGURE 1-5

REPORT NO.: DOE/OR/21548-372		EXHIBIT NO.: A/VP/002/0193	
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 1/93	

occur. No surface water is used for irrigation or public drinking water supply. The northern and western portions of the site, including the raffinate pit and Ash Pond areas, drain to tributaries for Busch Lake 35 and Schote Creek, which in turn enters Dardenne Creek, which ultimately drains to the Mississippi River.

Water flows from the Frog Pond area to Busch Lake 36, which discharges into Busch Lake 35. Burgermeister Spring, a major spring with perennial flow, is also located in the Busch Wildlife Area near Lake 34 and receives groundwater flow from bedrock beneath the chemical plant/raffinate pits area. These drainages, Burgermeister Spring, and Lakes 34, 35, and 36 are radiologically and chemically contaminated as a result of previous plant operations.

The Weldon Spring Quarry is situated on a bluff of the Missouri River valley about 1.6 km (1 mi) northwest of the Missouri River at approximately river mile 49 (Figure 1-3). No direct surface water runoff enters or exits the quarry due to the topography of the area. A 0.2 ha (0.5 acre) pond in the center of the quarry proper acts as a sump which accumulates both direct rainfall within the quarry and the groundwater. This sump discharges to the groundwater. The surface water of the sump is contaminated with radiological and chemical compounds. The quarry pond is not used for any operational or public water supply and is maintained by the DOE as an access controlled and restricted area.

In the Weldon Spring Quarry area, there are several surface water bodies which factor into the monitoring program. These include the Missouri River, located less than a mile east of the quarry, Femme Osage Creek, Little Femme Osage Creek, and Femme Osage Slough. The Missouri River is used for transportation and recreation, and as a source for drinking water for St. Louis City and County from a supply intake approximately 24 km (15 mi) downstream of the quarry. Femme Osage Creek and Little Femme Osage Creek are used for irrigation and recreational fishing. The Missouri River, Femme Osage Creek, and Little Femme Osage Creek have been investigated and have shown no evidence of contamination from the quarry.

Femme Osage Slough, located approximately 213 m (700 ft) south of the quarry is a 2.4 km (1 mi) section of the original Femme Osage Creek and Little Femme Osage Creek. The University of Missouri dammed portions of the creeks between 1960 and 1963 during construction of a levee system around the University's experimental farms (ANL 1990b). The slough receives discharge of contaminated groundwater from the quarry, increasing the uranium

concentrations in the slough to several hundred pCi/l. The slough is used for recreational fishing.

The DOE routinely monitors Femme Osage Slough for groundwater, surface water, sediment, and biota. The radiological concentrations found in these media are used to calculate dose to recreational users of the slough. Doses to individuals are calculated to be less than 1 mrem/yr. This information is provided to the Missouri Department of Conservation (MDOC) which manages the wildlife area and controls use of the slough.

1.7 Ecology

The Weldon Spring site is surrounded primarily by state wildlife areas including the 2,828 ha (6,987 ac) Busch Wildlife Area to the north and the 2,977 ha (7,356 ac) Weldon Spring Wildlife Area to the east and south. The Howell Island Wildlife Area, covering 1,031 ha (2,547 ac) is also a part of the Busch Wildlife Area complex that includes the Busch and Weldon Spring wildlife areas. It is an island in the Missouri River located southeast of the chemical plant and east of the quarry (Figure 1-5).

The Weldon Spring Wildlife Area is densely vegetated in the area of the quarry and has rugged terrain, whereas the chemical plant/raffinate pits area has gently rolling terrain. Most of the surrounding area is forested (64%) with upland species consisting of white oak, northern red oak, and shagbark hickory. Slope, palustrine, and bottomland forests consist of sugar maple, American elm, silver maple, box elder, willow, and eastern cottonwood.

Much of the chemical plant area consists of maintained grasslands and old fields that are periodically mowed 65.5 ha (162 acres). Grasses and forbs are found in this habitat including big bluestem, timothy, red tip grass, foxtail, fescue, thistle, and goldenrod. The northwest portion of the chemical plant area (22 ha [55 acres]) is relatively natural and contains forest habitat typically found in the upland areas of eastern Missouri.

The quarry is surrounded by the Weldon Spring Wildlife Area and consists primarily of forest with some old field habitat. Much of the quarry floor is old-field habitat and contains a variety of grasses, herbs, and shrubs. The rim and upper portions of the quarry consist primarily of slope and upland forest including cottonwood, sycamore, and oak (ANL 1990b).

Twenty-nine species of mammals, 47 reptile species, and 25 amphibians species have been reported in St. Charles County (DOE 1992c). St. Charles County is also located along the Mississippi Flyway, a major north-south route for migratory North American birds, and over 295 avian species have been reported. The MDOC actively manages fish and game species in the wildlife areas, and conducts a goose management program. The MDOC reports 105 species of fish in St. Charles County, which include big river, warm water lake, and stream species (DOE 1992c).

Only one Federally listed threatened or endangered species, the bald eagle, *Haliaeetus leucocephalus*, occurs in the Weldon Spring area. A night roost for overwintering eagles is located at Howell Island Wildlife Area east of the site across the Missouri River. No critical habitat for this species exists at the quarry or the chemical plant. Two Federal candidate species (C2) are listed for St. Charles County: the sicklefin chub, *Hybopsis meeki*; and the sturgeon chub, *Hybopsis gelida*. These species may occur in the Missouri River near the quarry but are primarily restricted to the open channels of the Missouri River (Pflieger 1975). Two State listed species are known to occur in the Weldon Spring area: the endangered Cooper's hawk, *Accipiter cooperii*, and the rare wood frog, *Rana sylvatica*.

1.8 Climate

The climate in the Weldon Spring area is continental in nature with warm to hot summers and moderately cold winters. Alternating warm/cold, wet/dry air masses converging and passing through the area cause frequent changes in the weather. Temperature changes are also frequent in Missouri. Although winters are generally cold and summers hot, prolonged periods of very cold or very warm to hot weather are unusual. Occasional mild periods with temperature above freezing occur almost every winter and cool weather interrupts periods of heat and humidity in the summer (Ruffner 1978).

The average annual temperature is 12.8° C (55.1° F). Average daily maximum and minimum temperatures are 19° C (66.2° F) and 6.5° C (43.8° F), respectively. On the average, there are about 49 days a year when maximum temperatures are above 32.2° C (90° F). Minimum daily temperatures below 0° C (32° F) occur about 111 days of the year. Temperatures below -18° C (0° F) are infrequent, only about five days per year.

Mean annual precipitation in the area is approximately 92.7 cm (36.5 in.) Between 1951

and 1986, the maximum monthly precipitation was 31.29 cm (12.32) in. in June of 1957. The minimum monthly precipitation was 0.1 cm (0.04) in. in January of 1970. The maximum daily precipitation of 11.43 cm (4.5 in.) occurred on June 15, 1957 (NOAA 1984).

Wind data recorded at St. Louis for the period 1941 to 1970 indicate that prevailing winds are from the south during summer and fall, and from the northwest and west-northwest during winter and early spring. The average annual wind speed is about 15.3 kpm (9.5 mph) from the south.

1.9 Land Use and Demography

The population of St. Charles County in 1990 was 212,907 persons, about 20% of whom lived in the city of St. Charles, located approximately 22.4 km (14 mi) northeast of the Weldon Spring site. The population in St. Charles increased by 48% from 1980 to 1990. The two communities closest to the site are Weldon Spring and Weldon Spring Heights, about 3.2 km (2 mi) to the northeast. The combined population of these two communities is approximately 850 persons. No private residences exist between Weldon Spring Heights and the site. Urban areas occupy about 6% of county land, and nonurban areas occupy 90%; the remaining 4% is dedicated to transportation and water uses.

Most of the land surrounding the Weldon Spring site is State-owned wildlife areas. The site is bordered by the August A. Busch Wildlife Area to the north, the Weldon Spring Wildlife Area to the south and east, and the Weldon Spring Training Area to the west. The wildlife areas are managed for multiple uses, including timber, fish and wildlife habitat, and recreation. Fishing comprises a relatively large portion of the recreational use (Appendix H). Seventeen percent (17%) of the area is open fields which are leased to sharecroppers for agricultural production. In these areas, a percentage of the crop is left for wildlife use. The main agricultural products are corn, soybeans, milo, winter wheat, and legumes (MKF and JEG 1992a). The district staff for these wildlife areas consists of 18 full-time employees supplemented by 15 to 20 workers during the summer months (Appendix H). The Busch and Weldon Spring wildlife areas are open year-round, and the number of annual visits to both areas totals about 1,200,000 (Appendix H).

Francis Howell High School is about 1 km (0.6 mi) northeast of the site along State Route 94. The school employs approximately 160 faculty and staff, and about 1,600 students

attend school there (Appendix H). Students and staff generally spend about 7 to 8 hours per day at the school. The buildings are also used for other activities, such as athletic events and school meetings. About 300 ha (740 acres) of land east and southeast of the high school is owned by the University of Missouri. The northern third of this land is being developed into a high-technology research park.

2 ENVIRONMENTAL PROTECTION/RESTORATION PROGRAM OVERVIEW

2.1 Project Purpose

The U.S. Department of Energy (DOE) is responsible for the remedial action activities at the Weldon Spring site. The DOE designated the site as a major project in May 1985, and since then has redefined it as a Major System Acquisition. The program is known as the Weldon Spring Site Remedial Action Project (WSSRAP). The major goals of the WSSRAP are to eliminate potential hazards to the public and the environment and, to the extent possible, make surplus real property available for other uses.

Remedial actions are subject to U.S. Environmental Protection Agency (EPA) oversight under the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA) of 1980, as amended by the *Superfund Amendments and Reauthorization Act of 1986* (SARA). Remedial actions at the site are subject to CERCLA requirements because the site is listed on the EPA National Environmental Priorities List (NPL). The DOE is also responsible for complying with the various Federal compliance acts including the *National Environmental Policy Act* (NEPA) of 1969. NEPA requires that Federal agencies consider the environmental consequences of proposed actions as part of the decision making process. Section 3 of this document further discusses applicable Federal, State, and local compliance requirements and the current status of compliance activities at the Weldon Spring site.

2.2 Project Management

In order to manage the WSSRAP under the CERCLA, the proposed strategy for remedial activities at the Weldon Spring site is organized into four separate operable units: Weldon Spring Quarry Bulk Waste, Weldon Spring Chemical Plant, Chemical Plant Groundwater, and Quarry Residuals. The Weldon Spring Chemical Plant Operable Unit includes the buildings, soils, raffinate pits, and surface waters in the chemical plant boundary. The Chemical Plant Groundwater Operable Unit includes the groundwater at the chemical plant and vicinity areas. The Quarry Residuals Operable Unit includes the groundwater; quarry basin; and groundwater, surface waters, and soils in vicinity areas. A CERCLA-NEPA document will be prepared for each of the operable units to analyze various alternatives for conducting remedial actions at the site.

In 1990, the *Feasibility Study for Management of Bulk Wastes at the Weldon Spring Quarry* (ANL 1990b) was issued, and the *Record of Decision* (ROD) (DOE 1990) was signed in March 1991. The Remedial Investigation/Feasibility Study-Environmental Impact Statement (RI/FS-EIS) document for the chemical plant area was issued in December of 1992, and the ROD is expected to be signed in late 1993. The third operable unit currently under way is the Quarry Residuals, for which the work plan is being prepared. The fourth operable unit, Chemical Plant Groundwater, is in the pre-scoping phase.

2.3 Environmental Monitoring Program Overview

The overall goal of the WSSRAP is different from that of most of the operating and production facilities for which DOE Order 5400.1, *General Environmental Protection Program*, was developed. At the WSSRAP, environmental monitoring is conducted as required by Order 5400.1 to measure and monitor effluents and to provide surveillance of effects on the environment and public health. In addition to these objectives, environmental monitoring activities support remedial activities under the CERCLA. This situation requires a careful integration of WSSRAP activities to implement, when possible, all the environmental and public health requirements of the CERCLA, and DOE and other relevant Federal and State regulations and orders.

The WSSRAP also complies with Order 5400.1 requirements for preparation of an *Environmental Protection Program Implementation Plan* (EPPIP) (MKF and JEG 1992f). The EPPIP details the programs in place at the WSSRAP to provide management direction, environmental protection goals and objectives, and the overall frame for the protection program at the WSSRAP. In 1992, the WSSRAP reviewed and revised the EPPIP to reflect the remedial status of the project.

Also in compliance with DOE Order 5400.1, the WSSRAP has prepared an *Environmental Monitoring Plan* (EMP) (MKF and JEG 1992o) which is reviewed annually and revised as necessary. The EMP was revised in 1992 to support the environmental protection program. These two main documents provide the basis for conducting environmental monitoring at the Weldon Spring site and meeting the requirements of the Order.

The Environmental Safety and Health department at the WSSRAP conducts both radiological and nonradiological environmental monitoring programs at the site and vicinity properties. These site monitoring programs have specifically been developed to:

- Protect the health and safety of on-site workers and the general public by characterizing actual or potential hazards.
- Provide the capability to detect and report unplanned releases of material from the site and implement corrective actions as necessary.
- Assess compliance with all applicable environmental quality standards and public exposure limits.
- Determine the background levels and site contributions of contaminants.
- Determine the long term buildup and predict environmental trends from site-released contaminants.

The WSSRAP environmental protection program is separated into two distinct functions: effluent monitoring and environmental surveillance. Effluent monitoring assesses the quantities of substances at the facility boundary, in migration pathways from the site, and in pathways subject to compliance with applicable regulations (e.g., *National Emission Standards for Hazardous Air Pollutants* [NESHAPs]) or permit levels and requirements (e.g., *National Pollutant Discharge Elimination System* [NPDES]). Environmental surveillance consists of analyzing environmental conditions within or outside the facility boundary for the presence and concentrations of site contaminants. The purpose of this surveillance is to detect and/or track the migration of contaminants. Surveillance data are used to assess the presence and magnitude of radiation and toxicological exposures and to assess the effects, if any, on the general public and the environment.

Until recently, environmental conditions at the Weldon Spring site remained relatively consistent since cessation of plant operation and decontamination of some process buildings in the early 1970s. This condition has allowed the project to establish a baseline to track the migration of contaminants from the site. Since the site is presently under active remediation, the nature of the waste units and their physical positions and chemical states are subject to

disturbance. The monitoring program for 1992 was designed to address the changes in affected pathways and constituents likely to be found in this remedial setting.

Additions to the 1992 monitoring program (as compared to the 1991 plan) included monitoring two NPDES permitted outfalls as part of the newly-constructed water treatment plants at the quarry and chemical plant, geochemical monitoring of groundwater at the chemical plant to monitor contaminant migration patterns, and five new air particulate monitoring stations at the quarry, the chemical plant, and a background location to support remedial activities.

The WSSRAP environmental monitoring program monitors various media for radiological elements, primarily U-234, U-238, Ra-226, Ra-228, Th-228, Th-230, and Th-232. These radionuclides are the primary contaminants of concern at the Weldon Spring site. Radiological monitoring is conducted routinely at the perimeters and at off-site locations near the chemical plant and quarry for air particulates, ambient gamma radiation, and radon. Radiological monitoring is conducted on liquid effluents in the form of NPDES discharges, streams, lakes, ponds, and groundwater wells and springs.

Nonradiological monitoring is primarily conducted at the chemical plant and quarry areas but also includes monitoring at off-site locations to confirm that no unplanned releases have occurred. The nonradiological compounds included in the routine 1992 monitoring program are metals, inorganic ions (nitrate and sulfate), and nitroaromatic compounds. Other nonradiological compounds are monitored as part of the environmental monitoring program. This includes asbestos at site perimeter locations, limnological parameters for ecological studies, and geochemical parameters such as calcium, manganese, and sodium to assist in groundwater characterization, flow, and transport studies.

Table 2-1 lists the environmental sample types collected for study in the WSSRAP monitoring program. The broadest range of radiological and nonradiological parameters is specified in the NPDES permits for the site water treatment plant effluent. Primarily, these compounds are associated with priority pollutant monitoring required annually at the quarry water treatment plant.

TABLE 2-1 Sample Types Collected for the Weldon Spring Site Environmental Monitoring Program

- Air
  - Radon
  - Air Particulate
  - Thermoluminescent dosimeter
- Surface water
  - Lakes
  - Streams
  - Missouri River
  - Storm water discharge
- Groundwater
  - Alluvial
  - Bedrock
  - Springs
- Sediment
  - Lakes
  - Streams
  - Missouri River
- Soil
- Biota
  - Fish
  - Deer
  - Vegetation
  - Agricultural
  - Invertebrates
  - Rodents

2.4 Project Accomplishments in 1992

Several activities were completed in 1992 under the overall plan for remediation of the site. Three operable units are currently active. Major accomplishments in these units are detailed below.

2.4.1 Weldon Spring Chemical Plant

A significant activity in 1992 for the chemical plant was the presentation of the RI/FS-EIS documents on November 20, 1992. The public comment period was November 20, 1992, through February 1993.

Briefing meetings on the RI/FS-EIS documents were held with Federal and State officials including U.S. senators, U.S. representatives, and Missouri legislators. Briefing meetings were also held with the Francis Howell School superintendent and deputy superintendent, a delegation of private citizens, St. Charles Countians Against Hazardous Waste, Weldon Spring city officials, various other civic leaders, and the news media. The public hearing for the proposed remedial alternatives was held on December 16, 1992. Approximately 150 people attended.

2.4.1.1 Site Water Treatment Plant. The site water treatment plant was constructed to support interim cleanup activities at the chemical plant and raffinate pit area as directed by the *Engineering Evaluation/Cost Analysis* (EE/CA) for the *Proposed Management of Contaminated Water at the Weldon Spring Chemical Plant Area* (ANL 1990c). In 1992, construction and testing of the treatment plant, equalization basin, and effluent ponds was completed.

An alternative method for discharging treated water to the Missouri River was required in 1992. Flow studies (see Section 10.2.2) indicated that contaminated sediments in the natural drainage southeast of the site were resuspending uranium due to the additional water. It was determined that an underground pipeline should be constructed to carry the treated water to the Missouri River. Construction of the pipeline began in late 1992 and is scheduled to be completed in early 1993.

2.4.1.2 Material Staging Area. The material staging area (MSA) is a 2.83 ha (7 acre) area for staging radiologically contaminated building demolition materials. All building demolition and site cleanup material, except concrete rubble, friable asbestos-containing materials (ACM), and soil, is staged there. MSA Phases II and III, which provide additional storage area, were completed in 1992.

2.4.1.3 Building Dismantlement. Asbestos removal, structure and equipment dismantlement, debris cleanup, and glass and roof stabilization activities are ongoing for the two building removal packages started in 1992. Pumping of liquids from sumps has been completed in Building 301, one of the two main process buildings at the chemical plant, and is expected to begin in Building 201 early in 1993. The mobile site water treatment plant was used to treat the water prior to storage in the raffinate pits.

2.4.1.4 RCRA/TSCA Storage. The *Resource Conservation Recovery Act* (RCRA) and *Toxic Substance Control Act* (TSCA) storage facility, Building 434, is currently being upgraded in order to support waste storage capabilities and operational needs. Upgrades in 1992 included the addition of three fireproof storage cabinets for protective equipment behind the storage facility and consolidation area.

2.4.2 Weldon Spring Quarry Bulk Waste

At the quarry, treatment of contaminated water under the EE/CA was started the week of November 9, 1992, and by November 18, more than 1,890,000 l (500,000 gal) of treated water was temporarily stored in Effluent Pond 2. On November 19, representatives of regulatory agencies and news media assembled at the water treatment plant to witness the operation and retrieve samples of treated water for their own analyses. All WSSRAP and regulatory agency samples to date have been analyzed and indicate that the treated effluent water

is well below permitted levels for all parameters. The treated water was released in January 1993 to the Missouri River through a permitted outfall.

2.4.2.1 Temporary Storage Area. A temporary storage area (TSA) for quarry materials is being constructed at the chemical plant to support cleanup of quarry bulk waste. The TSA is a staging area for materials excavated from the quarry and transported to the chemical plant for storage until recovery or disposal as specified by the chemical plant ROD. In 1992, soils were compacted and the TSA surface prepared. All liners have been installed and covered with sand and base aggregate. Currently, electrical and instrumentation work is in progress. TSA basin hydrostatic testing was started in November 1992.

2.4.3 Weldon Spring Quarry Residuals Operable Unit

Efforts have begun on the development of a work plan for remediation investigation of the quarry and surrounding areas, defined as the quarry residuals area. Development of the quarry residual area work plan was started in 1991, and work continues to identify potential routes of human exposure to site contaminants, identify data gaps, and summarize the process and proposed studies for the residuals investigation. Argonne National Laboratory (ANL) is currently developing the work plan for quarry residuals, and the WSSRAP Project Management Contractor (PMC) is developing the sampling plan.

2.5 Incident Reporting - Environmental Occurrences in 1992

DOE Order 5400.1 Part II, 2(b) requires reporting of environmental occurrences for the calendar year as part of the site environmental report. In 1992, nine off-normal and one unusual occurrence were categorized as environmental hazardous substances/regulated pollutants/oil releases under DOE Order 5000.3A, *Occurrence Reporting and Processing of Operations Information*. Table 2-2 lists these environmental occurrences for 1992. No occurrences involved reportable releases, except four occurrences where NPDES permit requirements were exceeded. Total estimated releases for radiological compounds were 0.15 Ci per year, which included both routine and unplanned discharges. Further information is presented in Sections 4 and 6. No estimated releases were calculated for the reportable occurrences of nonradiological parameters since the parameters are not a threat to the environment or public safety.

TABLE 2-2 Environmental Occurrences CY1992

Occurrence Report Number[a]	Final Date	Comments
1992-0001	1/13/92	D018 RCRA liquid spill - benzene <10 lbs
1992-0006	4/30/92	Chemical reaction - NO_x
1992-0010[b]	6/8/92	Exceeded NPDES limit for TSS at chemical plant.
1992-0013	9/11/92	Inapprop. cleaning of removable boot covers (asbestos)
1992-0017[c]	12/7/92	Exceeded NPDES permit for TSS at SWTP
1992-0019	12/17/92	Exceeded NPDES permit for TSS at QWTP
1992-0026	12/1/92	Bldg. 201 asbestos abatement incident
1992-0028	12/1/92	Radioactive test water from QWTP drain piping released to quarry pond area.
1992-0029	2/17/93	Uranium - release of contaminated water to SE drainage via NPDES outfall.
1992-0033	2/17/93	Uranium leak Bldg. 301 and MSA - not reportable quantity

[a] All occurrences off-normal except as noted
[b] Unusual occurrence
[c] Downgraded from Unusual to Off-Normal
[d] Resubmitted final report (investigation completed October 28, 1992)
TSS = Total suspended solids

Occurrence 1992-0010 was a discharge from the administration building via an NPDES outfall to the Southeast Drainage which exceeded the permit level for total suspended solids (TSS) for the reporting period ending March 31, 1992. This occurrence was a result of inadequate flow equalization which resulted in solids washout and filter plugging. Corrective actions included notifying the Missouri Department of Natural Resources (MDNR), design of a flow equalization system, and increased plant monitoring. It was determined that there was no impact to the environment or public safety.

Occurrence 1992-0017 was a discharge of hydrostatic test water at the site water treatment plant which exceeded permit levels for total suspended solids on September 24, 1992. The NPDES limit is 50 mg/l for the hydrostatic tests, and sample results indicated a TSS level of 213 mg/l. Corrective actions included notification to the MDNR, implementation of a program to test hydrostatic water prior to release, and filtering of water if TSS limits were not

obtained or storage of hydrostatic water for future treatment if immediate treatment was not feasible. It was determined that there was no impact to the environment or public safety.

Occurrence 1992-0019 was a discharge from the quarry effluent pond to Little Femme Osage Creek. The discharge was rainwater which accumulated in the effluent basin. The discharge was completed in order to continue repair work on the pond. Under the NPDES permit, the water was sampled during the discharge, and the results indicated that TSS levels were 68 mg/l, which exceeded the permit level of 50 mg/l. Corrective actions included notifying the MDNR, testing of effluent prior to discharge, and filtering of water if TSS limits were not obtained, or storage of effluent for future treatment if immediate treatment was not feasible. It was determined that there was no impact to the environment or public safety.

Occurrence 1992-0029 was a discharge as a result of a hose coupling failure from a manhole in the chemical plant to the Southeast Drainage. An estimated 22,680 l (6,000 gal) of water containing 1,150 pCi/l of uranium was released. Corrective action included mitigation of the drainage with sandbags and straw bales, development of a procedure to test hoses subject to freezing with potable water prior to use, and inspections of hoses. It was determined that there was no impact to the environment or public safety.

2.6 Special 5400.1 Related Programs

In addition to the direct program requirements and documentation required under DOE Order 5400.1, the DOE Order specifically requests that other programs be presented in the *Site Environmental Report*, including the groundwater protection management program, a meteorological monitoring program, and the waste minimization and pollution prevention program. This special section of 5400.1 also addresses programs not mandated by the Order, including the recently implemented radiological control program, self assessments under DOE Order 5482.1B, and the surface water management program in place at the WSSRAP to support the environmental protection program.

2.6.1 Groundwater Protection Management Plan

The WSSRAP has a formal groundwater protection and management program in place, and policies and practices are documented in the *Groundwater Protection Program Management Plan* (MKF and JEG 1992h).

The *Groundwater Protection Management Plan* outlines how monitoring programs will be developed to assess the nature and extent of contaminants in the groundwater, to evaluate potential impacts on public health, and to gather data for remedial decisions. All policies pertaining to groundwater monitoring, including well installation, decontamination, construction, sampling methods, and abandonment methods, are detailed in this plan.

The *Groundwater Protection Management Plan* also outlines the hydrogeological characterization program conducted as part of CERCLA activities. These include fundamental methods such as groundwater sampling, water level monitoring, slug tests, tracer tests, and geologic logging.

2.6.2 Meteorological Monitoring Program

A meteorological station is located at the chemical plant to provide data to support the environmental monitoring programs. Data from this station are used to assess meteorological conditions and air transport and diffusion characteristics which determine possible impacts of airborne releases. In addition, precipitation data are used to correlate water level fluctuations and contaminant concentrations in surface water and groundwater wells.

The meteorological station provides data on wind speed, wind direction, ambient air temperature, barometric pressure, and precipitation accumulation. The results of meteorological monitoring in 1992 are provided in Table 2-3.

In 1992, the meteorological station was in operation the entire year except for a few days when power to the station was lost. Procedures for maintenance, data inspection, and performance audits were refined in 1992 under procedure ES&H 4.8.3s in order to support quarry bulk waste removal in 1993. Maintenance records for the meteorological station were initiated in May of 1992 so that one year of meteorological data could be obtained prior to initiation of quarry bulk waste removal.

TABLE 2-3 Monthly Meteorological Monitoring Results, 1992

Month	Total Precip. (cm)	Average Temp. (degrees C)	Average Barometric Pressure (millibars)	Average Wind Speed (m/sec)	Predominant Wind Direction
May	7.11	17.0	986	2.51	N-NE
June	2.49	21.7	980	2.18	S-SE
July	10.2	24.7	982	2.66	S-SW
August	7.39	21.3	986	2.22	S-SW
September	9.07	19.2	986	2.49	S-SE
October	2.44	13.5	985	3.00	S-SW
November	23.9	8.1	988	3.24	S-SW
December	9.25	1.7	989	3.15	S-SE

2.6.3 Waste Minimization and Pollution Prevention Program

Waste minimization and pollution prevention activities at the Weldon Spring site have been combined and are described in the *Waste Minimization/Pollution Awareness Plan* (MKF and JEG 1991b). The key elements of this program are:

- Chemical Control - To minimize generation of hazardous waste, a review and approval mechanism has been developed to control chemicals.

- Training and Awareness - Personnel at the WSSRAP maintain awareness of waste minimization concepts and on-site policy through periodic presentations, seminars, and other training.

- Work Activity Review - The site has developed and implemented a subcontractor work package review system that allows each affected site organization to review and comment on all proposed subcontracted work. Each package is reviewed to ensure that proper measures have been incorporated into the subcontractor requirements in support of waste minimization and pollution prevention.

- Recycling Program - A small but successful office recycling program was initiated by the WSSRAP in 1990. Conceived by the employees and endorsed by project management, the site presently reuses office materials and recycles office paper to the extent practical. It is also standard practice to purchase recycled paper products in an effort to increase the markets for recyclable materials.

2.6.4 Surface Water Management Program

The WSSRAP maintains a surface water management program to ensure effective implementation of policies detailed in DOE Orders 5400.1 and 5400.5 regarding protection of the environment and public health and compliance with Federal and State regulations. This program also incorporates the as-low-as-reasonably-achievable (ALARA) concept in the execution of the program. The surface water protection program is documented in the *Surface Water Management Plan* (MKF and JEG 1992k).

The *Surface Water Management Plan* identifies existing and potential water sources and water quality categories. The plan also provides requirements and methodologies for proper control, management, and disposition of site waters. Erosion and water control, and water management for the quarry and site water treatment plants are also discussed in the plan. The key elements of the plan are source identification, characterization, monitoring, engineering controls, and management methods.

2.6.5 RADCON Program

In June 1992, the DOE issued its new *Radiological Control Manual* (DOE 1992c), which specifies how the DOE expects all facilities and contractors to conduct and manage their radiation protection programs. The manual contains requirements for all aspects of radiation protection, including protective measures for internal and external contamination control, ALARA practices, dosimetry, protective clothing and equipment, instrumentation and calibration, worker training, warnings and sign postings, survey procedures, waste management, environmental surveillance, and shipping and receiving. The DOE's objective in preparing this manual was to ensure that radiation protection programs and worker training are consistent among DOE facilities.

The WSSRAP is already in compliance with roughly half of the provisions in the manual and has an aggressive implementation plan and schedule for compliance with the remaining provisions by June 1, 1994. The WSSRAP has formed a RADGON Implementation Team, which includes representatives from all affected departments and is responsible for ensuring that actions necessary to attain compliance are completed as scheduled.

2.6.6 Waste Management Activities

The waste management program characterizes hazardous chemicals and wastes located on site with the objective of securing and storing these wastes properly. This program also consolidates sample and hazardous material packaging and shipping activities. Wastes are stored in the on-site RCRA and TSCA storage facility, Building 434, until a final treatment or disposal option is available. The WSSRAP has not shipped any RCRA waste off site and therefore has not been required to comply with RCRA manifest or biennial report requirements.

The current RCRA containerized inventory includes 49 drums of asbestos-containing material, 338 drums of RCRA-regulated material, 49 drums of MDNR regulated material, 12 drums of TSCA-regulated material, 25 drums of RCRA/TSCA-related material, nine drums of RCRA/MDNR-related material, 85 drums of other U.S. Department of Transportation (DOT) hazardous material, and 1,695 drums of nonhazardous material. In addition, 77 sling bags of nonhazardous material are stored in Building 434. The drums are stored in accordance with all applicable RCRA and TSCA standards.

A number of areas on site are used for long term storage of bulk waste. The active bulk waste storage areas consist of two spoil areas, the MSA, the asbestos storage area, the Ash Pond area, and the mulch pile. The two spoil areas and the Ash Pond area are used to store soil and concrete rubble generated during on-site construction. One spoil area is used to store "clean" soil, i.e., soil with U-238 contamination levels less than 15 pCi/g (0.56 Bq/g). To date, approximately 17835 m^3 (23,315 cu yd) of soil has been stored at this location. A second spoils pile is used for the storage of contaminated soil, i.e., soil with U-238 contamination levels greater than 15 pCi/g (0.56 Bq/g). Approximately 10,787 m^3 (14,100 cu yd) of soil has been placed at this location to date. Materials are segregated on the basis of representative on-site sampling.

The asbestos storage area is made up of fifty-five 12 m (40 ft) freight containers which

are water tight and lashed down for security against high winds. At present, approximately 1,806 m^3 (2,362 cu yd) of asbestos-containing materials (ACM) are being stored in these containers. Used, contaminated personal protective equipment is currently being compacted and placed in Building 434 for long-term storage.

2.6.7 Self-Assessment Program

The WSSRAP complies with the guidelines presented in DOE Order 5482.1B for a self- appraisal/assessment program. In 1992, 10 self-assessments of environment related activities were conducted. Table 2-4 is a list of these assessments. Of these 10 assessments, eight were closed in 1992. Corrective actions have been designated for the two open assessments; data verification and surface water management and activities are under way to close these findings.

TABLE 2-4 Self Assessments Conducted at WSS, 1992

Surface water management[a]
Radiation laboratory
Field activities
Data verification[a]
Ecological compliance
HazMat transportation
CERCLA administration record
Chemical characterization
NEPA compliance
Health and safety records

[a] Open as of 12/31/92

2.6.8 Training

Training is a key element of the environmental protection program. Through training, each employee is instructed in the policies and procedures related to environmental protection. On-going training sessions also continually reinforce the objectives of the program.

The training program can essentially be broken into four main areas; (1) documents, (2) procedures, (3) special courses taught on site to convey specific policies or issues and, (4) off-site courses designed to provide instruction for specific areas. Each new employee at the WSSRAP is assigned training requirements based on his or her job assignment. Department managers establish unique training matrixes for each employee that include documents, procedures, and on-site and off-site training courses.

Course selection for each employee is specifically designed to ensure a comprehensive understanding of position requirements and overall policies and program requirements. The need for off-site training to augment site training is evaluated annually and included in annual budgets.

Courses specific to waste management are reviewed and planned throughout the year for general employee training. Other off-site courses are mandated for key individuals as a part of on-going training and certification requirements.

The status of employee training is reported to department managers and individual employees on a monthly basis. Monthly reports include status of documents and procedures reviewed and training programs and off-site courses taken during the current year.

3 COMPLIANCE SUMMARY

3.1 Compliance Status for 1992

The Weldon Spring site is listed on the National Priorities List (NPL), and therefore Weldon Spring Site Remedial Action Project (WSSRAP) is governed by the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA) process. Under CERCLA, the WSSRAP is subject to meeting or exceeding the applicable or relevant and appropriate requirements of Federal, State, and local laws and statutes, such as the *Resource Conservation Recovery Act* (RCRA), *Clean Water Act* (CWA), *Clean Air Act* (CAA), *Toxic Substance Control Act* (TSCA), the *National Historic Preservation Act* (NHPA), the *Safe Drinking Water Act* (SDWA), and Missouri regulations. Because the DOE is the lead agency for the site, the procedural and documentation requirements of the *National Environmental Policy Act* (NEPA) must also be met, as well as the requirements of U.S. Department of Energy (DOE) Orders. Section 3.1.1 is a summary of applicable Federal regulations, and Section 3.1.2 is a summary of the WSSRAP compliance with major DOE Orders.

3.1.1 Regulatory Compliance Status

Comprehensive Environmental Response, Compensation and Liability Act

The WSSRAP has integrated the procedural and documentation requirements of the CERCLA, as amended by the *Superfund Amendments and Reauthorization Act* (SARA), and the NEPA, as required by the policy stated in DOE Order 5400.4. For example, engineering evaluation/cost analyses (EE/CAs) and remedial investigation/feasibility study (RI/FS) documents including (RI/FS) work plans, which are CERCLA documents, contain the required NEPA information for environmental assessments (EAs) and Environmental Impact Statements (EISs). Proposed plans and actions are evaluated in terms of both the NEPA and the CERCLA.

The purpose of an RI/FS work plan is to summarize existing site data and to integrate the site characterization and analysis of alternative phases of the remedial action process. The purpose of an RI sampling plan is to collect data to confirm the presence or absence of contaminants, the contaminant source areas, transport mechanisms, and extent of contaminant migration, and to provide information concerning the effect of the contaminants on public health and the environment.

The purpose of an RI/FS is to assess site conditions and evaluate alternative remedies. The RI report for the chemical plant area presents site characterization information and addresses the nature and extent of contamination. Similar RI/FS documents will be prepared for the Quarry Residuals Operable Unit and the Chemical Plant Groundwater Operable Unit. The *Baseline Assessment for the Chemical Plant Area of the Weldon Spring Site* (BA) (DOE 1992c) evaluates the health and environmental effects that may occur if no action is taken and includes both a baseline human health evaluation and a baseline ecological assessment. The ecological assessment information serves to satisfy the information needs of the Natural Resource Damage Assessment Pre-assessment Screen. The *Feasibility Study for the Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (FS) (DOE 1992a) evaluates the alternatives for the remedial action. The RI, BA, FS, and the *Proposed Plan for Remedial Action and the Chemical Plant Area of the Weldon Spring Site* (PP) (DOE 1992b) (together constituting the RI/FS-EIS) were submitted for public review on November 20, 1992. In addition, the following documents are being prepared: the work plan for the RI/FS-EIS and a quarry residuals sampling plan. These documents will be sent to the U.S. Environmental Protection Agency (EPA), the Missouri Department of Natural Resources (MDNR), and the DOE for review in 1993.

The CERCLA and the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP) spell out responsibilities and requirements for natural resource trustees. As lead Natural Resource Trustee for the WSSRAP, the DOE notified the co-trustees that potential off-site releases of hazardous substances may have occurred and that environmental restoration activities are proceeding. Neither of the co-trustees, the Department of the Interior and the MDNR, has responded to date.

National Environmental Policy Act

As required under the NEPA, a Notice of Availability for the chemical plant area RI/FS-EIS was published in the *Federal Register* on November 27, 1992 (57 FR 56340). The notice required comments by January 20, 1993. The comment period was later extended to February 19, 1993.

In addition to six previously approved categorical exclusions, five new activities were approved in 1992 as categorical exclusions. They were (1) site characterization and environmental monitoring (revised), (2) general maintenance, (3) the site water treatment plant effluent pipeline, (4) the modular office complex, and (5) the on-site laboratory.

The site water treatment plant effluent pipeline action also necessitated a floodplains/ wetlands assessment, which was completed in 1992. The associated *Federal Register* notices for the assessment and floodplains statement of findings were published on September 15, 1992 (57 FR 42564), and December 18, 1992 (57 FR 60178).

Resource Conservation and Recovery Act

Hazardous wastes at the Weldon Spring site are managed as required by the RCRA (as substantive applicable or relevant and appropriate requirements [ARARs]). This includes characterization, consolidation, inventory, storage, and transportation of hazardous and other wastes that remained on site after closure of the Weldon Spring Uranium Feed Materials Plant (WSUFMP) and wastes that were generated during remedial activities.

A RCRA Part B permit is not required at the site since remediation is being performed in accordance with decisions reached under the CERCLA. Section 121(e) of the CERCLA states that no Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely on site. More information is offered in the section on Issues and Actions.

Toxic Substances Control Act

Polychlorinated biphenyls (PCBs) are managed at the Weldon Spring site under the requirements of the TSCA as enforced by 40 CFR 761, *Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use in Prohibitions*. Quantities of PCBs are identified and managed as discussed in Section 2.6.6 of this report.

Clean Air Act

CAA compliance requirements pertaining to the site are found in Title I -Nonattainments, Title III - Hazardous Air Pollutants (including National Emission Standards for Hazardous Air Pollutants [NESHAPs]) and Title VI - Stratospheric Ozone Protection.

The Weldon Spring site is classified as a moderate nonattainment area for ozone under Title I. The Missouri State Implementation Plan was approved by the EPA in November 1992. This plan controls provisions that are dependent upon the degree to which an area has not

attained the national ambient air quality standards (NAAQS). As a moderate ozone nonattainment area, the requirements would affect source emitting nitrogen oxide (NO_X) and volatile organic compounds (VOCs). At present, sources described above do not exist at the WSSRAP.

Under Title III, asbestos and radionuclides are hazardous air pollutants (HAPs). The standards establish maximum levels for radionuclides and asbestos. WSSRAP plans for monitoring radionuclides and asbestos have been approved by the EPA and are described in detail in Section 5. The following table lists the major source categories that could potentially apply to the WSSRAP along with the respective schedules for promulgation of the corresponding emission standards.

Major Source Category	Schedule Date
Gasoline distribution	11/15/94
Solid waste treatment, storage, and disposal facilities	11/15/94
Site remediation	11/15/2000

Currently, the potential major source categories existing at the WSSRAP do not exceed the threshold limits of 9.07 metric tons per yr (tpy) (10 tpy) of any single hazardous air pollutant or 22.7 metric tpy (25 tpy) of a combination of hazardous air pollutants; nor does the project currently store over 3,780 l (1,000 gal) of gasoline per container on site. Therefore, the project is not subject to the requirement for vapor recovery systems for gasoline distribution. However, the Project Management Contractor (PMC) will continue to monitor the various sources for applicability. The categories of radionuclide emitters are not yet listed because the criteria for defining major and area sources of these pollutants have not been selected. Upon proposal of the Maximum Available Control Technology (MACT) standards, the WSSRAP will develop appropriate plans and budgets to comply with the standard for each of these source categories.

Sections 608 and 609 of Title VI are applicable to the WSSRAP. Section 608 establishes requirements for national recycling and emission reduction of Class I and II substances (chlorofluorocarbons and hydrochlorofluorocarbons, respectively). The section makes it unlawful to release, vent, or dispose of any Class I or II substances. Requirements in Section 608 apply to servicing, repairing, maintaining, and disposing of any refrigeration system (old or new) or air conditioning system (old or new). Section 609 specifies requirements that pertain to servicing motor vehicle air conditioners and applies to all WSSRAP vehicles. The

WSSRAP is complying with Sections 608 and 609 of Title IV of the 1990 CAA amendments by (1) implementing a phase-out policy of ozone-depleting substances by instituting controls in the purchasing and use of these substances; and (2) obtaining copies of the personnel training certifications and equipment approval records for personnel and subcontractors that service any WSSRAP ozone-containing equipment (i.e., refrigerators, heating, ventilating, and air conditioning [HVAC] units, abandoned refrigeration units, etc.) or any WSSRAP vehicle cooling system service.

Clean Water Act

Effluents discharged to waters of the United States are regulated under the CWA through regulations promulgated and implemented by the State of Missouri. The Federal government has granted regulatory authority for implementation of CWA provisions to those states with a regulatory program that is at least as stringent as the Federal program.

Compliance with the CWA at the WSSRAP includes meeting parameter limits set in three National Pollutant Discharge Elimination System (NPDES) permits. Both effluent and erosion-control monitoring are performed. In 1992, NPDES permit limits were exceeded during discharge of potable water used for hydrostatic testing of tanks for the site water treatment plant. The sump used to retain the water prior to discharge contained sediment; and the total settleable solids (TSS) limit was exceeded. Subsequently, samples were collected which did not exceed the permit limit. Following the incident, effluent was directly discharged without the use of a holding sump. The permitted storm water outfalls at the site were in compliance with the conditions of the National Pollutant Discharge Elimination System (NPDES) permit for the site.

Construction of a water treatment plant at the Weldon Spring quarry was completed in 1992. This plant is designed to remove chemical and radioactive components from the contaminated water in the quarry to, or below, levels established in the applicable NPDES operating permit for the quarry. The NPDES permit for the plant became effective in December 1992 when the plant was ready to discharge treated water. Once operational, batch analyses of treated effluent water will verify compliance with NPDES limits.

Construction of a water treatment plant at the chemical plant was completed in 1992. This plant has been designated as the Site Water Treatment Plant - Train 1. This Train 1 plant will treat water from the raffinate pits and on-site ponds, shower and decontamination water

generated during building dismantlement activities, and runoff from the temporary storage area (TSA). The plant is scheduled to begin operation in the spring of 1993. Once operational, batch analysis of treated water will verify compliance with NPDES limits.

Regulations passed in 1992 require that all persons who disturb approximately 5 acres of land and maintain existing storm water point sources must obtain permits. The WSSRAP applied for its land disturbance permit in November 1992; the permit was issued on December 7, 1992. Refer to Table 3-1 for a summary of NPDES permits.

Rivers and Harbors Act

Two nationwide permits under Section 10 of the *Rivers and Harbors Act* and Section 404 of the *Clean Water Act* were obtained from the U.S. Army Corps of Engineers prior to construction of the site water treatment plant effluent discharge pipeline and outfall structures. The permits require that, to protect the Missouri River, certain conditions be met prior to, and during, construction.

Safe Drinking Water Act

The SDWA was enacted by Congress in 1974 to authorize regulation of drinking water systems, require the EPA to set national standards for levels of contaminants in drinking water, and provide for protection of aquifers. Under the SARA, drinking water standards and goals set under the SDWA became groundwater standards for completed superfund cleanups.

Currently the SDWA is not an ARAR at the WSSRAP. The SDWA will be evaluated for its applicability during the decision-making process for the groundwater and quarry residuals operable units.

National Historic Preservation Act

In 1986, the Missouri Department of Natural Resources Historical Preservation Officer (HPO) determined that any archaeological resources in the chemical plant area would have been so severely damaged or destroyed during original plant construction that further investigation would not be warranted.

TABLE 3-1 Summary of WSSRAP NPDES and Construction Permits

Permit No.	a	Date Issued	Date Expired	b	Date Renewal or Extension Request Due	Scope and Comments
MO-0107701	O	10/01/90	07/28/93	N	01/28/93	Reapplication submitted 01/28/93. Covers storm water, sanitary, and SWTP discharges.
MO-0108987	O	05/05/89	05/04/94	N	12/04/93	Covers QWTP discharge.
MO-G680001	O	12/19/91	05/16/96	N	12/16/95	Covers hydrostatic test water from QWTP. QWTP tanks and effluent pond 2 are excluded since they have held contaminated water.
MO-G680002	O	02/07/92	05/16/97	N	12/16/95	Covers hydrostatic test water from SWTP tanks, basins, etc.
MO-G680004	O	02/07/92	Terminated 02/08/93	N	NA	Covered hydrostatic testing of QWTP effluent pipeline. The pipeline has carried treated water, so the permit is no longer applicable.
MO-G680005	O	11/06/92	05/16/96	N	11/16/95	Covers hydrostatic test water from SWTP effluent pipeline.
MO-R101389	O	12/07/92	12/12/96	N	06/12/96	Covers land disturbance storm water discharges from the SWTP pipeline excavation.
22-4245	C	08/01/91	08/01/93	Y	07/01/93	SWTP basins, siltation basins, effluent pump station, etc.
2523	C	04/10/92	04/10/93	N	03/10/93	SWTP Train 1
22-4113	C	06/07/90	06/06/92	Y	NA	QWTP basins, effluent pump station. Construction complete.
22-4233	C	04/17/91	10/16/92	Y	NA	QWTP, construction complete.
22-4411	C	08/12/92	08/11/93	N	07/11/93	Flow equalization on sanitary plant.
22-4450	C	09/28/92	09/27/93	N	08/27/93	SWTP effluent pipeline.

a - Permit type, O = Operating, C = Construction
b - Permit extended? N = No, Y = Yes

QWTP = Quarry Water Treatment Plant
SWTP = Site Water Treatment Plant

Six sites were identified in the vicinity of the quarry. These sites will not be disturbed during the quarry bulk waste excavation, but may be disturbed during quarry residuals activities in the future. In that case, a mitigation action plan will be prepared at that time.

One site on the quarry haul road which required data recovery was identified. The data recovery report was finalized in 1992.

In 1992, the HPO was consulted for proposed activities in three off-site areas. In one area, a 122 m (400 ft) metal process sewer discharge line, which extends from the site in the direction of the Southeast Drainage, will be removed. The HPO determined that this proposed undertaking could be initiated and completed with no adverse effect and no need for additional review.

A second area consisted of a buried pipeline from the site water treatment plant to the Missouri River, which will be used to convey treated water. A cultural resources survey indicated no sites within the proposed area.

An archeological review was conducted at a third area, the proposed soils borrow area and haul road to the chemical plant. The soils borrow area will provide construction materials required under the RI/FS remedial alternative for the chemical plant. Surveys were conducted and a Phase I report was completed in January 1992. The report recommends Phase II work for a few sites within the footprint of the borrow area. Phase II and possibly Phase III work will be conducted in 1993.

Endangered Species Act

The U.S. Fish and Wildlife Service (USFWS) was consulted under Section 7(a) of the *Endangered Species Act* for both the quarry (bulk waste removal) and the chemical plant operable units. The Missouri Department of Conservation (MDOC) was also consulted regarding State-listed threatened and endangered species. No threatened or endangered species or designated critical habitat is known to exist at the quarry (ANL 1990b). Therefore, no threatened or endangered species are expected to be impacted during removal of the bulk wastes and transfer to the chemical plant along the quarry haul road.

A biological assessment was prepared for the chemical plant area and has been included in the RI/FS-EIS documents (DOE 1992c). The MDOC has also been consulted pertaining to State-listed threatened or endangered species. The assessment concluded that no threatened or endangered species or critical habitats exist in the chemical plant area (DOE 1992a). Similar conclusions were made for off-site remedial alternative areas proposed for the chemical plant.

Ecological surveys were conducted for the three proposed off-site areas as discussed in the *National Historic Preservation Act* section of this report. In 1993 an environmental assessment will be prepared for the borrow area which will evaluate any impacts to Federal and/or State threatened and endangered species. No impacts to endangered species were determined for the two other off-site areas.

Executive Order 11988 Floodplain Management

The site water treatment plant effluent discharge pipeline consists of a buried pipeline to the Missouri River and an outfall structure in the river bank. Due to the construction activity in the floodplain of the river and the requirements of 10 CFR Part 1022 of the DOE *Floodplains/Wetlands Environmental Review Requirements*, a floodplains/wetlands assessment was prepared and a Notice of Floodplains/Wetlands Involvement and a Statement of Findings were published in the *Federal Register* in September (57 FR 4256) and December 1992 (57 FR 60178), respectively.

The *Feasibility Study for Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (DOE 1992a) contains a floodplain/wetlands assessment which concludes that temporary impacts from the interim action will be localized and minimal. The EIS availability notice in the *Federal Register* (see discussion in the NEPA section) serves as a notice for the floodplain/wetlands assessment. The substitution is allowable under 10 CFR 1022.14.

Executive Order 11990 Protection of Wetlands

Wetlands identification and delineation procedures were performed for the wetlands areas through which the site water treatment plant pipeline route crosses. The wetlands assessment was combined with the floodplain assessment (described above), as was the *Federal Register* notice.

The floodplain/wetlands assessment in the RI/FS-EIS for the chemical plant area concludes that the loss of on-site wetlands will not result in significant adverse impacts. In fact, remediation of the on-site wetlands will have a positive effect on the surrounding environment by eliminating contaminated wetlands. A wetlands mitigation plan will be developed with consultation from Federal, State, and local agencies.

3.1.2 DOE Order Compliance

3.1.2.1 DOE Order 5400.5, Radiation Protection of the Public and the Environment. DOE Order 5400.5 establishes nine primary standards and requirements for DOE operations to protect members of the public and the environment against undue risk from radiation. The DOE operates its facilities and conducts its activities so that radiation exposures to members of the public are maintained within established limits.

The annual dose to the maximally exposed member of the public as a result of activities at the Weldon Spring site was below the 100 mrem (1 mSv) guideline for all potential exposure modes. The 10 mrem (0.1 mSv) annual dose limit for public exposure to airborne emissions, excluding radon and its respective decay products as specified in 40 CFR Part 61, *National Emission Standards for Hazardous Air Pollutants*, was not exceeded in 1992. The appropriate dose evaluation techniques were used to assess 1992 environmental monitoring and surveillance data in compliance with this requirement.

ALARA practices were implemented to minimize exposures to the public as far below the limits as is reasonably achievable. The ALARA process was implemented at the site on a continual basis. Each time a different remediation activity was initiated on the site, ALARA objectives were established for all remedial activities to maintain potential exposures as low as reasonably achievable. Routine ALARA inspections were conducted to ensure that appropriate actions were being implemented during work activities. These methods are specified in standard operating procedure ES&H 1.1.5a, *WSSRAP ALARA Procedure*.

The site was not used as a disposal facility in 1992, and it did not contain the specified wastes; thus it was not subject to the requirements given in 40 CFR Part 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High Level and Transuranic Radioactive Waste*. In addition, the site did not operate a public drinking water

supply and therefore was not subject to the requirements of 40 CFR Part 141, *National Primary Drinking Regulations*.

Contaminated soil columns, drainage systems, and groundwater liquid discharges that have been discontinued were managed or decontaminated pursuant to the procedures and requirements of DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards*. The natural drainage systems at the Weldon Spring site were not governed by this paragraph. The terms "contaminated liquid discharges" and "liquid wastes" refer to discharges from operating facilities. The site facilities ceased operations in 1966. Storm water runoff did, on occasion, exceed the Derived Concentration Guideline (DCG) of 600 pCi/l (22.2 Bq/l) for natural uranium, but the annual averages for the runoff were below this criterion. Cleanup operations at the WSSRAP were under way to eliminate the source areas and to reduce the levels of contaminated discharge in accordance with the provisions of NEPA and CERCLA.

Twelve out-of-service vehicles were surveyed and released from the WSSRAP in September 1992. A comprehensive radiological survey was performed on each vehicle, and they met the DOE release guidelines as specified in this order for release of real property, personal property, and materials and equipment. Therefore, the vehicles were released for unrestricted use.

The public exposure reporting requirements specified in 5400.5 have not been utilized by the WSSRAP because there were no occurrences that would require such reporting. However, records and reports were maintained according to DOE Order 5400.1 and DOE Order 5484.1. Records of all environmental monitoring and surveillance activities conducted at the Weldon Spring site in 1992 are being maintained in accordance with the requirement of this order. All reports and records generated at the WSSRAP in 1992 pursuant to DOE Order requirements presented data in the units as specified by the applicable regulation or order.

3.1.2.2 DOE Order 5820.2A, Radioactive Waste Management. DOE Order 5820.2A establishes policies, guidelines, and minimum requirements by which the DOE manages its radioactive and mixed waste and contaminated facilities. The Weldon Spring site was in compliance with the applicable portions of Chapter III (low-level waste), Chapter V (decommissioning of radioactively contaminated facilities), and Chapter VI (administrative activities related to the Waste Management Plan). The types of wastes addressed in Chapters I, II, and IV were not present at the site.

The WSSRAP was in compliance with the waste management requirements for protection of the public health and safety, external exposure limits, and protection of groundwater resources. The WSSRAP has implemented a waste minimization program in an effort to reduce the quantity of radioactive and mixed waste generated. The program, which is described in the *Waste Minimization/Pollution Prevention Awareness Plan* (MKF and JEG 1991b), was developed as a requirement of DOE Order 5400.1. The requirement for waste segregation is documented in this plan and the *Waste Management Plan* (MKF and JEG 1993a).

The WSSRAP was in compliance with the requirements for characterizing waste materials in order to permit proper segregation, treatment, storage, and disposal. The *Waste Analysis Plan* (MKF and JEG 1992l) provided the means to obtain the characterization information necessary to classify, treat, store, and dispose of wastes. The *Environmental Monitoring Plan* (EMP) (MKF and JEG 1992o) provided the rationale and details for environmental monitoring of the storage areas. Since the WSSRAP did not receive waste from other facilities, waste acceptance criteria or performance assessment requirements were not applicable. The PMC is currently preparing a response to the DOE request for WSSRAP storage area requirements. The requirements for long-term storage were not applicable since waste was stored at the Weldon Spring site only as a step toward final disposal. The WSSRAP did not ship low-level waste; however, samples were shipped for radioactive and chemical analysis.

Management of low-level waste was conducted in accordance with the requirements of DOE Order 5700.6C, *Quality Assurance* and, where appropriate, ASME/NQA-1. All records and reports, including analytical data and waste manifests, were maintained as permanent records.

Chapter V of the Order outlines the requirements for decommissioning of radioactively contaminated facilities. The WSSRAP was in compliance with the requirements of this chapter by conducting the site remediation under the CERCLA process, which includes the requirements for characterization, environmental review, engineering, and site closure.

Chapter VI of the Order provides guidance on the development and maintenance of a waste management plan, including the format and content requirements of the plan. Although the Order requires that each site develop a waste management plan to serve as an annual report, the WSSRAP plan was developed to serve as a guidance document for day-to-day waste

management operations. The *Waste Management Plan* (MKF and JEG 1993a) is submitted to DOE Headquarters (HQ) for review and comment annually.

3.1.2.3 DOE Order 5400.1, General Environmental Protection Program. The WSSRAP conducted both radiological and nonradiological environmental monitoring programs at the site and vicinity properties. Environmental monitoring was conducted as required by DOE Order 5400.1 to measure and monitor effluents and to provide surveillance of effects on the environment and public health. Environmental characterization activities were also directed by the Order and, for remedial activities, under the CERCLA. This situation required a careful integration of WSSRAP activities that supported, when possible, all the environmental and public health requirements of the CERCLA and DOE and other relevant Federal and State regulations and orders.

The WSSRAP was in compliance with Order 5400.1 requirements for preparation of an *Environmental Protection Program Implementation Plan* (EPPIP) (MKF and JEG 1992f). The EPPIP details the programs in place at the WSSRAP to provide management direction, environmental protection goals and objectives, and the overall frame for the protection program at the WSSRAP. In 1992, the WSSRAP reviewed and revised the EPPIP to reflect the remedial status of the project. The project has prepared an *Environmental Monitoring Plan* (EMP) (MKF and JEG 1992o) which is reviewed annually and revised as necessary. The EMP was revised in 1992 to support the environmental protection program. These two main documents provided the basis for conducting environmental monitoring at the Weldon Spring site and meeting the requirements of the Order.

In addition to the plans developed for overall environmental monitoring and protection, the WSSRAP annually reviews and revises, as necessary, the *Groundwater Protection Management Plan* (MKF and JEG 1992h) and the *Waste Minimization and Pollution Awareness Plan* (MKF and JEG 1991b). The groundwater plan documents the policies and practices in place to assess the nature and extent of contaminants in the groundwater, to evaluate potential impacts to public health, and to gather data for remedial decisions. The waste minimization plan includes policies for waste control, training and awareness, and subcontractor work review. It also establishes a site recycling program.

3.1.2.4 DOE Order 5400.3, Hazardous and Mixed Waste Program. DOE Order 5400.3A mandates management of radioactive and hazardous wastes. At the WSSRAP,

radioactive hazardous and mixed wastes were managed in a manner that provided protection of the environment and protection of the health and safety of the public and site personnel. Implementation of the Order is described in the *Waste Management Plan* (MKF and JEG 1993a).

All waste management activities including generation, characterization, storage, packaging, minimization, transportation, and treatment or disposal were accomplished in a manner that was consistent with these broad objectives. Waste management activities were conducted in compliance with all applicable laws, requirements, regulations, and good practices governing the management of hazardous, radioactive, mixed and uncontaminated, nonhazardous waste. The WSSRAP Waste Management Program has been developed to ensure that the objectives of these orders are achieved and that waste generation is minimized.

3.1.2.5 DOE Order 5480.1B, Environment, Safety, and Health Program for Department of Energy Operations. DOE Order 5480.1B mandates (1) protection of the environment and the health and safety of the public, (2) assurance of safe and healthful workplaces and conditions of employment for all employees of DOE and DOE contractors, (3) protection of government property against loss and damage, (4) compliance with applicable statutory requirements, and (5) presence of a quality assurance program to ensure quality of design and standards.

Implementation of these requirements is described in the *Environmental Protection Program Implementation Plan* (EPPIP) (MKF and JEG 1992f). The EPPIP describes DOE activities and CERCLA requirements, activities, and functions concerned with controlling air, water, and soil pollution, and limiting the risks to personnel and the public. The activities include but are not limited to, environmental protection, occupational safety, industrial hygiene, health physics; emergency preparedness; radioactive, hazardous, and mixed waste management; and quality assurance.

3.1.2.6 DOE Order 5480.4, Environmental Protection, Safety, and Health Protection Standards. DOE Order 5480.4 requires the WSSRAP to comply with all applicable DOE Orders and guidelines and Federal, State, and local regulatory requirements. This section describes compliance activities and status.

3.1.3 Regulatory Issues

Below, outstanding regulatory issues as well as corrective actions are discussed. New issues are items originated in 1992; old issues appeared in calendar year 1991 and previous years.

3.1.3.1 New Issues

1. Federal Facilities Agreement

The *First Amended Federal Facilities Agreement* (FFA) (EPA 1992) between the DOE and EPA was signed in January 1992. The agreement establishes a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions in accordance with the CERCLA, the NCP, superfund guidance and policy, and the RCRA. It also requires implementation of the final remedial actions in accordance with the CERCLA and operation and maintenance of the selected remedial actions.

The WSSRAP has prepared a draft FFA implementation plan as part of the program to track scheduled FFA deliverables.

2. DOT Requirements for Stored Hazardous Wastes

Standards in the Missouri State Code of Regulations which are applicable to generators of hazardous wastes address pretransport, containerization, and labeling requirements (10 CSR 25-5.262(2)(C)1. Under these standards the hazardous wastes must be labeled, marked, and packaged according to 49 CFR Parts 173, 178, and 179 during the entire on-site storage period.

Corrective Action

The PMC believes that current waste container management methods provided adequate protection of the environment and site workers and that compliance with the new transportation requirements would not increase the level of protection during storage. A waiver from the packaging requirements was being sought. Until the waiver is

approved, as new wastes are identified, they will be placed in containers that meet the new DOT regulations package requirements according to the DOT schedule. Hazardous material containers currently stored in Building 434 were being relabeled to meet the requirements.

3.1.3.2 Old Issues

1. Disposal of PCB wastes beyond allowable time limits. On August 24, 1990, eight drums of nonradioactive PCB-contaminated oil and a nonradioactive PCB transformer were removed from a concrete pad (Substation 411) and placed in storage in Building 434.

   On August 20, 1991, the PCB oils and transformer were sent off site for treatment and/or disposal. Pursuant to 40 CFR 761.65(a), PCB containers and articles must be removed from storage and disposed of within one year from the date when first placed into storage. The required disposal date for the Substation 411 PCB items was August 24, 1991.

   The certificates of disposal for the drums and the transformer list August 27, and September 3, 1991, respectively, as the final disposal dates. An Occurrence Report was submitted in compliance with DOE Order 5000.3A because the one-year storage limitation was exceeded. The receiving facility notified the EPA of the late destruction of the PCBs per 40 CFR 761.215(c)(1).

   Corrective Action

   The PCB items were disposed of after the August 24, 1991, deadline due to delays caused by recent changes in the DOE nationwide policy for off-site release of nonradioactive material. The policy required the WSSRAP to develop procedures and obtain headquarters approval for off-site shipment and disposal of nonradioactive material. The procedures were submitted to DOE-HQ on September 20, 1991. DOE-HQ sent back the procedures with comments. The WSSRAP incorporated the comments and returned the procedures to DOE-HQ for final approval on January 1, 1992. An approval letter was received by the site DOE office on August 8, 1992.

2. Application of RCRA to residues on tanks and piping systems. The MDNR has taken a position, in the form of comments provided on the WSSRAP EE/CA for contaminated structures, that any RCRA-listed or characteristic residues on the surfaces of tanks and pipes must be managed in accordance with the RCRA. The MDNR defines residue as anything that cannot be removed by rinsate. The regulatory basis for the State's position is the closure of tank systems addressed in 40 CFR 264.197 and closure performance standards stated in 40 CFR 264.111. The ramifications of the State's position with regard to WSSRAP building dismantlement activities are that no removable hazardous waste residues should remain in tank systems (including ancillary components) that will be stored at the newly constructed material staging area (MSA). Of immediate concern was the possibility that the pipes and tanks removed to date could be contaminated with RCRA residues and thus would be improperly stored. Specific cases included the overhead piping removal conducted under Interim Remedial Action-6 (IRA-6) and dismantlement of the steam plant, Building 401.

Corrective Action

The WSSRAP identified the chemical species associated with overhead piping currently stored near Pads 109 and 110. Selected piping was examined to determine if visible residues were present. In addition, representative swipe testing was performed to detect removable residues. None of the samples showed any RCRA characteristics present.

At the steam plant, three chemical systems—the water softener (ion exchange resin and acid/base regenerates), the refrigeration units, and the feedwater treatment system (consisting of phosphate and sodium sulfite components)—were identified as potential sources of hazardous waste. During the dismantlement, samples of the ion exchange resin from the water softening system and coolant from the refrigeration units were analyzed for RCRA characteristics. None were detected. As a follow-up, the sodium sulfite mix tank was sampled to determine if residual hazardous wastes were present, and the results demonstrated that the tank was free of RCRA characteristics. An acid storage tank, which was a component of the water softener, was sampled and found to contain no RCRA characteristic waste.

Identification and characterization of residues in building tanks, equipment, and piping was ongoing. The WSSRAP determined that there are no listed waste residues in the building tanks, equipment, or piping. To date, a small quantity of RCRA characteristic residue has been found in the process piping in Building 108.

For proposed building dismantlement, the WSSRAP has agreed to coordinate and review the RCRA issue with the State on a building-by-building basis. The State and the WSSRAP agreed that the WSSRAP would submit a list of buildings and structures to be excluded from individual review based upon the nature and type of building and/or structure. This list of buildings was compiled and sent to the MDNR.

A site visit from the MDNR resolved State questions and supported the WSSRAP determination of buildings excluded from review. Approval from the MDNR was received in early 1992.

3. Storage of PCB wastes beyond allowable time limits (40 CFR 761.65[a]).

Approximately 28,120 liters (7,400 gal) of tributyl phosphate (TBP) contaminated with radionuclides and PCBs in excess of 50 parts per million (ppm) were contained in tanks on the Weldon Spring site. In addition, preliminary analyses indicated the TBP was also contaminated with mercury exceeding the regulatory level for toxicity characteristic (TC), thereby making it a RCRA hazardous waste. Also on site were small amounts of radiologically contaminated PCB wastes, including electrical capacitors and PCB-contaminated soil and oil.

All PCB wastes identified to date by investigative and remedial activities have been present since the plant was operational in the 1950s and 1960s. The WSSRAP continued to locate and identify all PCB-containing material and place it in proper storage.

Corrective Action

In December 1989, the WSSRAP-DOE sent a letter to EPA-Region VII notifying them that the one-year storage limitations had been exceeded. The WSSRAP is pursuing

an ARAR waiver in the *Record of Decision* (ROD) concerning storage limitations of PCB wastes.

The WSSRAP planned to send the TBP to the Oak Ridge Gaseous Diffusion Plant Incinerator for destruction and, during 1992 continued to await word on whether the State of Tennessee would allow the TBP to be shipped to Oak Ridge. No decision was made; however, the WSSRAP pursued an ARAR waiver in the site ROD for an alternative treatment technology.

An attempt by the WSSRAP to decontaminate the radiologically contaminated PCB capacitors failed. Therefore, the capacitors will remain on site and eventually be disposed of with other radiologically contaminated material when a viable disposal option is identified.

4. Storage of Land Disposal Restricted Waste Beyond Allowable Time Limits (40 CFR 268.50)

The Weldon Spring site was storing 20 containers of mixed waste in Building 434 that were classified under the Land Disposal Restrictions (LDRs) as California List Waste. This waste is prohibited from storage under 40 CFR 268.50, which prohibits storage of LDR waste unless solely for the purpose of accumulation of such quantities as are necessary to facilitate recovery, treatment, or disposal.

Corrective Action

The August 29, 1991, *Federal Register* announced the EPA policy of placing a low enforcement priority on the storage of certain mixed wastes that are prohibited from land disposal under the RCRA LDRs. The wastes affected included spent solvents, dioxins, and California List Wastes. The EPA recognized the lack of treatment and disposal options for these wastes and stated this policy will apply at least until December 31, 1993.

The Weldon Spring site will include in the chemical plant ROD an ARAR waiver for storage of LDR waste based on the fact that the schedule for final disposition of the

wastes is controlled by the decision-making process for remediation of the chemical plant area.

5. Surpassing the Missouri State maximum permissible exposure limit for radon at the quarry (19 CSR 20 - 10.040)

The Missouri Code of State Regulations limits quarterly averaged radon concentrations outside controlled areas to 1 pCi/l. This concentration was regularly exceeded at one quarry perimeter monitoring station and occasionally exceeded at other quarry perimeter monitoring stations.

Corrective Action

The long-term solution is the excavation and final disposal of the bulk waste (which is the primary radon source). This is addressed in the quarry ROD.

3.1.3.3 National Emission Standards for Hazardous Air Pollutants Compliance. The WSSRAP has developed an alternate method for NESHAPs point source monitoring and compliance as provided in 40 CFR 61.93 (b)(5), whereby air concentrations were monitored at five designated critical receptor locations on and around the Weldon Spring site. The WSSRAP plan is contained in the report *Plan for Monitoring Radionuclide Emissions Other Than Radon at Weldon Spring Site Critical Receptors* (MKF and JEG 1992i), which has been approved by the EPA. The EPA has also approved the WSSRAP plan to report annual monitoring results and effective dose equivalents at critical receptor locations via the annual site environmental report.

The air at each critical receptor location is continuously sampled for radionuclides. The air sampling filters from each location are separately composited and analyzed annually for the radionuclides that are major contributors to the effective dose equivalent; i.e., U-234, U-238, Th-228, Th-230, Th-232, Ra-226, and Ra-228. Air sampling filter collection, handling, and analysis methods are specified by the EPA such that radionuclide concentrations that would cause an effective dose equivalent of 10% of the standard (i.e., 1 mrem) are readily detectable and distinguishable from background. The quality assurance program described in Section 5 of the WSSRAP NESHAPs compliance plan meets the requirements of 40 CFR Part 61 Appendix B.

Detailed information, including calculations on radiation monitoring and dose calculations, are found in Section 4.

Two types of asbestos-containing material (ACM) are found at the WSSRAP: friable and nonfriable. Friable ACM includes asbestos insulation, fiberglass pipe, and equipment wrapping. Nonfriable ACM includes Transite siding, floor tile, and asphalt roofing material. The WSSRAP was in compliance with 40 CFR 61.145, the NESHAPs standard for demolition and renovation. Abatement activities were in compliance with Asbestos Hazard and Emergency Response Act (AHERA), and asbestos was collected and monitored in accordance with 29 CFR 1926.58. Removal, handling, and management of ACM is detailed in the *Waste Management Plan* (MKF and JEG 1993a) and was monitored according to procedure ES&H 3.1.4s, *Airborne Fibers - Area Monitoring*. Detailed information and results of the 1992 monitoring are discussed in Section 5.5.

3.1.3.4 Satisfaction of Reporting Requirements. Reporting requirements set by various agencies include release reporting under the CERCLA and SARA Title III, and reporting of audit deficiencies from functional appraisals conducted by the DOE at the WSSRAP.

3.1.3.4.1 Release Reporting. There were no reportable quantity releases from the Weldon Spring site that were not exempted as Federally permitted releases. Consequently, no release reports under CERCLA or SARA Title III were required.

3.1.3.4.2 SARA Title III Report. The WSSRAP was not a manufacturing facility according to the Standard Industrial Classification (SIC) Codes 20-39, and was therefore not required to submit the annual *Toxic Release Inventory* under Section 313 of the SARA.

3.1.3.5 Audit Summary. A functional appraisal of selected environmental, safety, health, and quality assurance programs, and Conduct of Operations (CONOPS) was conducted at the WSSRAP by the DOE Oak Ridge Field Office from March 2 to March 6, 1992. The appraisal was performed to assist the WSSRAP in its self-assessment program. No tiger-team audits were conducted in 1992 for environmental issues.

Table 3-2 summarizes the number of deficiencies resulting from the functional appraisal of selected environmental safety, health, and assurance programs. Forty-one of the 59 deficiencies have been closed out and are awaiting DOE approval and closeout.

TABLE 3-2 Results of Oak Ridge Functional Appraisal

	Deficiencies Cited	Internally Closed[a]	Externally Closed
National Environmental Policy Act (NEPA)	4	2	1
Water Pollution Control (WPC)	4	2	0
Hazardous Materials Waste Management (HMWM)	3	3	0
Environmental Quality Assurance (EQA)	10	9	6
Clean Air Act (CAA)	3	3	1
Health Physics (HP)	5	5	2
Industrial Hygiene (IH)	6	4	1
Industrial Safety (IS)	6	2	1
Transportation Safety (TS)	4	4	0
Fire Protection (FP)	2	1	1
Quality Assurance (QA)	3	2	1
Conduct of Operations (CONOPS)	9	4	3
TOTAL	59	41	17

(a) As of December 31, 1992, the finding was resolved.

3.1.4 Summary of Permits for 1992

Various permits were maintained by the WSSRAP for remedial activities including NPDES, excavation, and floodplain permits. Table 3-1 summarizes these permits. Other permits included:

- One excavation permit from the Missouri Highway Transportation Commission (MHTC) for installation of the effluent pipeline crossing Highway 94. This permit will expire in June of 1993.

- Two nationwide permits under the *Rivers and Harbors Act* and *Clean Water Act* issued by the Department of the Army for the effluent pipeline from the site water treatment plant to the Missouri River and for the accompanying outfall structure at the river.

- One floodplain development permit from the St. Charles County Planning and Zoning Commission for the quarry staging area and the quarry water treatment plant.

- One floodplain development permit from St. Charles County Planning and Zoning Commission for construction of a portion of one of the effluent ponds at the quarry.

3.2 Compliance Status for the Period January 1 - April 15, 1993

Compliance status remained unchanged under the RCRA, the TSCA, the CAA, the *Endangered Species Act*, the *National Historic Preservation Act*, Executive Orders 11988 and 11990, and DOE Orders.

Comprehensive Environmental Response, Compensation and Liability Act

The draft *Record of Decision for the Remedial Action at the Chemical Plant Area of the Weldon Spring Site* was submitted to DOE-HQ, EPA, and MDNR for review and comment on February 11, 1993. The close of public review for the RI, BA, FS, and *Proposed Plan* was February 19, 1993. DOE-HQ, EPA, and MDNR comments were received March 17, 1993. Meetings were held March 24 and 25 to discuss and finalize all ROD issues and CERCLA/NEPA integration. A draft final of the ROD was submitted to DOE-HQ, EPA, and MDNR for review on April 3, 1993.

National Environmental Policy Act

One categorical exclusion (CX) for the physical testing trailer was sent to DOE, Oak Ridge, for approval.

Clean Water Act

The first batch of contaminated quarry pond water was treated and released January 6, 1993.

Representatives of Federal, State, and local agencies and organizations were at the quarry water treatment plant to collect samples of potential effluent prior to discharge, including the EPA, MDNR, St. Charles County, St. Louis County Water Company and St. Louis County Health Department.

Two excavation permits from the Missouri Highway and Transportation Department were issued March 16, 1993 for installation of security fencing at the quarry and fencing and signs at the state right of way.

4 RADIATION DOSE ANALYSIS

One purpose of environmental monitoring is to detect the presence of atmospheric and liquid releases of radionuclides at the Weldon Spring site and ensure that such releases are not harmful to public health and safety. This section evaluates all monitoring results for airborne, surface, and groundwater discharges of radiological contaminants. It then utilizes the data to calculate potential dose equivalents to the general public and doses to aquatic biota. These calculations are evaluated against U.S. Department of Energy (DOE) guidelines contained in the *Radiological Control Manual* (DOE 1992c) and in DOE Order 5400.5.

Dose estimates were developed for a maximally exposed individual and for a collective population. Dose calculations were based upon several scenarios which are presented in this chapter. A review of the exposure pathways is also presented. An exposure pathway analysis evaluates possible human exposure conditions related to radionuclides released from the Weldon Spring site and determines which pathway are complete.

The U.S. Environmental Protection Agency (EPA) *National Emission Standards for Hazardous Air Pollutants* (NESHAPs) establishes criteria for release of airborne radioactive particulates. Airborne radionuclide concentrations are monitored at designated critical receptor locations and a dose is calculated for each receptor. Critical receptor locations are areas where members of the public abide or reside and there is potential exposure to airborne radioactive particulate contaminants.

In all, three major dose calculations are presented in this section; a maximally exposed individual, a collective population, and NESHAPs critical receptors. The exposure conditions used in the dose calculations are further discussed and presented in the respective environmental monitoring sections of this report.

4.1 Pathway Analysis

In order to develop the specific elements of the environmental monitoring program at the Weldon Spring site, the potential exposure pathways and health effects of the radioactive and chemical materials present at the site and the quarry are reviewed annually. These analyses of exposure pathways, required by DOE Order 5400.1, are based on the sources, release mechanisms, types, and locations of contaminants; the probable environmental fates of the

contaminants; and the locations and activities of potential receptors. Pathways are then reviewed to determine if a link can be shown between one or more contaminant sources, or one or more environmental transport processes to an exposure point where human or ecological receptors are present.

Table 4-1 lists the six complete pathways for exposure from contaminants evaluated by the Weldon Spring site environmental monitoring program. These pathways are used to determine radiological and nonradiological exposures from the site. Of the six complete pathways, only three were applicable in 1992 and used in calculations for dose estimates. These were Liquid (B), Liquid (C), and Airborne (B).

TABLE 4-1 Exposure Pathways for the Weldon Spring Site

		Applicable to 1992 Dose Estimate
Liquid(A)	Ingestion of groundwater from local wells downgradient from the site.	N
Liquid(B)	Ingestion of game and fish inhabiting wildlife area.	Y
Liquid(C)	Ingestion of surface water and sediments.	Y
Airborne(A)	Inhalation of particulates dispersed through wind erosion and remedial action.	N
Airborne(B)	Inhalation of radon emitted from contaminated soils.	Y
External	Direct gamma radiation from contaminated soils.	N

There was no contribution to effective dose equivalents (EDEs) from Pathway Liquid (A) (Table 4-1), ingestion of drinking water from local wells. Currently, no detectable concentrations significantly different from background concentrations occur in the production wells near the Weldon Spring Quarry. No drinking water wells are located in the chemical plant/raffinate pits area.

The airborne (A) pathway was not used since there are no detectable air particulate concentrations above background levels. In 1992, air monitoring results indicated that releases from the site were at background levels. Gross alpha results from air particulate monitoring were not found (at the 95% confidence level) to differ statistically from background results for all on-site and off-site monitoring stations (see Section 5.3.3). Therefore, no airborne radionuclide releases other than radon occurred at the site perimeter or off-site locations.

There was no contribution to effective dose from the external pathway. Statistical analysis of the results obtained from the external gamma monitoring program indicated that there was no reason to suspect that any of the locations monitored were greater than background at the 95% confidence level (see Section 5.2). The airborne particulate pathway was complete, i.e., a potential exposure route existed although there was no contribution to a hypothetical individual or the collective population dose from either the chemical plant/raffinate pits area or the quarry area. Airborne particulate concentrations indicated that at a 95% confidence level the measured results were not greater than the background results obtained (see Section 5).

The applicable public dose standards or limits for exposure that the Weldon Spring Site Remedial Action Project (WSSRAP) is required to meet are as follows:

- NESHAPs standard of 10 mrem (0.10 mSv) annually for airborne emissions other than radon at critical receptor locations.

- DOE guideline of 100 mrem (1 mSv) annual effective dose equivalent for all exposure pathways.

4.2 Radiological Release Estimates

Radiological release estimates were calculated for airborne radon and surface water releases. Table 4-2 shows the emissions to the environment for each radionuclide and their respective half-lives. The dashes in Table 4-2 indicate that the amount of radioactivity released to the environment was not distinguishable from background levels. However, above background radon gas concentrations were observed at six locations at the quarry and two locations at the chemical plant (see Section 5).

The average radon concentration at the quarry area perimeter was 0.4 pCi/l above background. A box model was utilized to predict the radon release rate for the year from the quarry. This model assumes that airborne contaminants are dispersed homogeneously within the modeled volume of air. The contaminated area within the quarry was used to estimate the radon release. In 1992, the estimated Rn-222 release was 9.2 Ci (3.3×10^{11} Bq). These calculations are provided in Appendix C.

Radon concentrations at the chemical plant perimeter were 0.1 pCi/l above background. A model was not used to predict total off-site releases from radon based on the above-background measurements at the chemical plant/raffinate pits perimeter. Models require identification of a source and an estimate of an emission rate. There have been no activities or changes in these areas which could be identified as potential sources of above-background radon emissions.

Intermittent surface water runoff was found to have transported uranium from the site during 1992 through five major discharge routes. These routes were monitored through monthly sampling of the runoff water, as required under the site National Pollutant Discharge Elimination System (NPDES) permit. The discharge of natural uranium from the NPDES outfalls is discussed in Section 6. It is assumed that uranium occurs naturally on an activity basis (49.1% U-234, 2.3% U-235, and 48.6% U-238) on WSSRAP properties. Using NPDES natural uranium values in conjunction with the activity ratios listed above, the U-234, U-235, and U-238 releases to water have been calculated and are presented in Table 4-2. Other radionuclides were not routinely monitored in surface water during 1992.

TABLE 4-2 Radionuclide Emissions to the Environment

Radionuclide	Activity of Radionuclide Released to Air (Ci)	Activity of Radionuclide Released to Water (Ci)	Activity of Radionuclide Released to Waters (gms)	Half-Life (Yrs)
U-238	–	7.44E-02	221000	3.47E09
U-235	–	3.52E-03	1630	7.04E08
U-234	–	7.52E-03	12	2.34E05
Th-232	–	NA	NA	1.40E10
Th-230	–	NA	NA	7.40E04

TABLE 4-2 Radionuclide Emissions to the Environment (Continued)

Radionuclide	Activity of Radionuclide Released to Air (Ci)	Activity of Radionuclide Released to Water (Ci)	Activity of Radionuclide Released to Waters (gms)	Half-Life (Yrs)
Th-228	–	NA	NA	1.910
Ra-228	–	NA	NA	5.76
Ra-226	–	NA	NA	1,600
Rn-222	8.9	NA	NA	3.82 days
Total Activity	8.9	0.1531[a]	222642	NA

NA Not analyzed for this radionuclide
[a] Total uranium value obtained from Table 6-7

4.3 Exposure Scenarios

Three scenarios from the exposure pathways (Table 4-1) were used to assess dose from the Weldon Spring Site. First, conditions were set to determine dose to a maximally exposed individual at each of the main site areas: the chemical plant/raffinate pits, the quarry, and the vicinity properties. A second dose, for a collective population, was calculated for users of the August A. Busch Wildlife Area. The results of these estimates were then compared to applicable standards to ensure the safety of members of the public and the environment. A dose was not calculated for the total population within an 80 km (49.6 mi) radius of the site as recommended in DOE Order 5400.5, for reasons explained below.

A third set of dose calculations was performed to meet NESHAPs monitoring requirements. These calculations were performed using results obtained from high volume samplers located at critical receptor locations. Extensive monitoring at the site perimeters indicated no above background radioactive particulate concentrations and no external gamma exposure resulting from WSSRAP activities. This conclusion is based on statistical analysis of low volume air particulate results (see Section 5). Although, several perimeter environmental radon sampling locations were greater than background, no above background concentrations were detected at off-site locations in the near vicinity of the site. Calculations of collective population doses utilizing perimeter and off-site monitoring data determined the dose to be less than 1 person-rem per year from all pathways to affected populations. Since all off-site low-

volume air particulate samplers and radon gas detectors other than background stations are within a 13 km (8.1 mi) radius and none have yielded above background concentrations of gross alpha or radon gas for any airborne pathway, the incorporation of calculation of a dose for the total population within 80 km (49.6 mi) of the site is unrealistic.

The scenarios and models used to evaluate these radiological exposures were conservative but appropriate. Although radiation doses can be calculated or measured for individuals, it is not appropriate to predict the health risk to a single individual. Estimates of health risks are based on statistical data collected from large groups of people exposed to radiation under various circumstances. Statistical models are not applicable to single individuals. Therefore, dose equivalents to a single individual are estimated by hypothesizing a maximally exposed individual and placing this individual in a reasonable, but very conservative scenario. This is appropriate when the magnitude of the dose to a hypothetical maximally exposed individual is small, as is the case at the WSSRAP. The scenarios and resulting estimated doses used in the calculations are outlined in Table 4-3. In addition, the percentage of the DOE guideline of 100 mrem is provided. A comparison to the EPA limit of 10 mrem was not done since this limit applies only to the airborne exposure pathway, excluding radon, and there was no contribution from this pathway other than radon in the dose calculation.

The collective population dose estimate is the product of the effective dose equivalent estimate at the exposure point and the number of persons exposed. Exposure points are locations where members of the public are potentially exposed to airborne radioactive particulate concentrations, radon gas concentrations, external gamma radiation, or radionuclide concentrations in water or food at above-background levels. The effective dose equivalent is calculated by estimating radionuclide concentrations in the air, water, food, and external gamma pathways at a given exposure point. These concentrations and reasonable exposure scenarios are used to estimate the amount of radioactivity ingested or inhaled and the amount of external gamma radiation received by the potentially exposed population.

The NESHAPs committed effective dose equivalent (CEDE) estimate is based on the isotopic analysis of the high volume samples collected from critical receptor locations. Although statistical analysis indicates there is not reason to suspect at the 95% confidence level that gross alpha analysis of low volume samplers results at perimeter and off-site locations, including the

TABLE 4-3 Exposure Scenarios for Weldon Spring Site Radiological Dose Estimates

Dose Scenario	Pathway	Activity	Media	Exposure Duration	Exposure/ Inhalation/ Ingestion Rate	Concentration pCi/g	Estimated Dose (mrem)	Percent of DOE Guidance	Percent of EPA Guidance
WSCP/WSRP Hypothetical Individual	Liquid(A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Liquid(B)	Fishing at Busch Lake 36	Fish	365 days	6.5 grams/day	0.017	0.01	0.01%	N/A
	Liquid(C)	Swimming at Busch Lake 36	Sediments	14.3 hours/year	200 mg/day	110	0.003	0.003%	N/A
			Water	14.3 hours/year	0.05 liters/hour	171[a]	0.03	0.03%	N/A
	External	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Airborne(A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Airborne(B)	Walking near perimeter	Air	50 hr/yr	1.25 meters^3/hour	0.14[a]	0.2	0.2%	N/A
WSQ Hypothetical Individual	Liquid(A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Liquid(B)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Liquid(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	External	N/A	-	N/A	N/A	N/A	N/A	N/A	N/A
	Airborne(A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Airborne(B)	Walking Near WSQ Perimeter	Air	50 hours/year	1.25 meter^3/hour	1.3[a]	1.9	1.9%	N/A

TABLE 4-3 Exposure Scenarios for Weldon Spring Site Radiological Dose Estimates (Continued)

Dose Scenario	Pathway	Activity	Media	Exposure Duration	Exposure/ Inhalation/ Ingestion Rate	Concentration pCi/g	Estimated Dose (mrem)	Percent of DOE Guidance	Percent of EPA Guidance
WSVP Hypothetical Individual	Liquid(A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Liquid(B)	Fishing at Slough	Fish	N/A	6.5 gms/day	0.0043	0.003	0.003%	N/A
	Liquid(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	External	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Airborne(A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Airborne(B)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Collective Population	Liquid(A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Liquid(B)	Fishing at Busch Lake 36 population = 7,232	Fish	N/A	200 g/person	0.017	0.007 person-rem	N/A	0.007
	Liquid(C)	Swimming at Busch Lake 36 (population = 3,838)	Sediments	1.43 hours/person	200 mg/day	171	0.013 person-rem	N/A	0.013
			Water	1.43 hours/person	0.05 liters/hour	110[a]	0.0014 person-rem	N/A	0.0014
	External	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Airborne(A)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Airborne(B)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A = Not applicable to the specific area for the 1992 dose calculation.
WSCP = Weldon Spring Chemical Plant
WSRP = Weldon Spring Raffinate Pits
WSQ = Weldon Spring Quarry
WSVP = Weldon Spring Vicinity Properties
[a] pCi/l

critical receptor locations, were greater than background, dose estimates were required to maintain compliance with NESHAPs.

All ingestion and inhalation calculations were performed using the methodology described in *International Commission on Radiation Protection* (ICRP) Reports 26 and 30 for a 50-yr committed effective dose equivalent (ICRP 1977 and 1978). Fifty-year committed effective dose equivalent conversion factors were obtained from the EPA *Federal Guidance Report* No. 11 (Eckerman 1988).

4.4 Dose Estimates

Dose estimates for the exposure scenarios are presented in Table 4-3 and were calculated utilizing 1992 monitoring data. Calculations for dose scenarios are provided in Appendix C. Dose estimates were far below the guidelines set by the DOE for annual public exposure and EPA limits with regard to NESHAPs.

The effective dose equivalent (EDE) for the hypothetical maximally exposed individual from all exposure pathways was 1.9 mrem. This value represents 1.9% of the DOE guideline of 100 mrem above background for all exposure pathways. For comparison, the annual average exposure to natural background radiation in the area of the site results in a CEDE of approximately 300 mrem. The collective population dose was 0.021 person-rem for recreational users at the Busch Wildlife Area.

The maximum calculated dose for NESHAPs critical receptors was 0.19 $\pm$ 0.33 mrem CEDE at AP-4006 for the individual who was assumed to reside there 365 days per year, 24 hours per day. Although analysis of the high volume filters collected for NESHAPs monitoring allowed a dose estimate calculation of 09 $\pm$ 0.33 mrem at AP-4006, there is some additional uncertainty associated with the analytical results because data quality objectives established in the NESHAPs Monitoring Plan were not met for either precision or accuracy. A corrective action report has been written in order to attempt and meet the data quality objectives in 1993.

Although to first state that there were no above background airborne particulate releases from the site and then to estimate a dose at critical receptor locations would seem to be contradictory, it is not. The statistical analysis of gross alpha results obtained at perimeter and off-site locations did provide data which indicated that there were no measurable above

background airborne particulate releases at the site. Although isotopic analysis of the high volume samples collected at critical receptors allowed estimates of very small doses, the error associated with all the results was near to, or greater than, 100% of the estimated dose. Such a large error is not unexpected when dealing with concentrations that are near analytical detection limits. In addition, the fact that none of the data quality objectives were met for the high volume sample data is also believed to be a result of measuring concentrations near the detection limits. As a result, although dose calculations are required for NESHAPs, it is correct to state that there were no above background airborne particulate emissions from the site.

4.4.1 Radiation Dose From the Chemical Plant/Raffinate Pits to a Hypothetical Maximally Exposed Individual

This section discusses the estimated committed effective dose equivalent to a hypothetical individual assumed to frequent the perimeter of the chemical plant/raffinate pits and to receive a radiation dose by the three pathways identified above. No private residences are adjacent to the site. Therefore, all calculations of dose equivalent due to direct gamma exposure, airborne radioactive particulate inhalation, and radon progeny inhalation assumes realistically less than 100% residence time. Recreational use of the Busch Wildlife area is considered in the assessment of the exposure to a maximally exposed individual at the chemical plant/raffinate pits area since some of the lakes in the area receive effluent from the site. None of these lakes are used as sources of drinking water, but recreational use of the wildlife area includes fishing and boating. Thus, the Liquid (B) pathway, fish ingestion, and the Liquid (C) pathway, incidental water and sediment ingestion, are potential pathways for exposure.

Two radon monitoring stations at the chemical plant, perimeter RD-2001 and RD-3002, were found to be greater than background at the 95% confidence level (Figure 5-1). The northern boundary of the chemical plant is accessible to members of the public. The scenarios are as follows:

- An individual is assumed to walk along the northwestern perimeter once per day, 250 day/yr.

- An individual is assumed to abide near the northwestern perimeter 12 min/day.

- Radon gas concentration were 0.1 pCi/l above normal background at the northern perimeter, based on monitoring results and the CAP-88 computer air dispersion model.

- The average fresh-water fish consumption rate was 6.5 g/day (0.23 oz/day) (EPA 1988a).

- The average U-238 concentration in fish was 0.017 pCi/g (0.0006 Bq/g), collected from Busch Lake 36, where the concentration was the highest of the three lakes receiving runoff from the site (see Section 8.3.1.1).

- An individual made 10 trips per year to the Busch Wildlife Area.

- The individual spent 5.7 hr boating per visit (MDOC 1991).

- While boating, the individual spent 25% of the time swimming.

- While swimming the individual ingested 0.05 liters/hr (0.05 qt/hr) of water (EPA 1988a).

- The concentration of uranium in surface water was 171 pCi/l, (6,327 Bq/m^3) from Busch Lake 36 (see Section 6), which had the highest average surface water concentration of the three lakes receiving runoff.

- The average uranium concentration of surface sediments was 110 pCi/g (4.1 Bq/g) from Busch Lake 34, which had the highest concentration.

Based on the exposure scenario and assumptions described above, a maximally exposed individual who frequented areas receiving surface water runoff from the chemical plant/raffinate pits and the chemical plant perimeter received a total effective dose equivalent of 0.21 mrem (0.0021 mSv) from inhalation of radon, ingestion of water and sediment, and ingestion of fish from contaminated waters.

4.4.2 Radiation Dose From the Weldon Spring Quarry to a Hypothetical Maximally Exposed Individual

This section discusses the estimated committed effective dose equivalent to a hypothetical individual assumed to frequent the perimeter of the Weldon Spring Quarry. No private residences are adjacent to the quarry site; therefore, all calculations of radon progeny inhalation (Airborne B) assume a realistic residence time of less than 100%. The scenario is based on a hypothetical individual who routinely walked along the northern boundary of the quarry on State Route 94.

Scenarios and assumptions particular to this dose calculation are summarized as follows:

- No contribution from pathways Liquid(B) or Liquid(C) of Table 4-1 was determined because access to the quarry was controlled by 24 hour security and a 2.4 m (8 ft) chain link fence topped with barbed wire. Fishing, swimming, and drinking water from the quarry pond were not realistic exposure pathways.

- The individual walked along State Route 94 twice per day, 250 day/yr.

- The average residence time near the quarry was 6 min/trip (ANL 1990b).

- The highest measured concentration of radon gas was 1.3 pCi/l (44.4 Bq/m^3) above normal background at station RD-1001 of the quarry perimeter (see Section 5.1.3).

- The equilibrium ratio between radon gas and its progeny was 50%.

- The effective dose equivalent conversion factor was 1.0 rem/working level month (WLM) (10 mSv/WLM) (ICRP 1981).

The dose to the hypothetical maximally exposed individual at the quarry was 1.9 mrem (0.019 mSv) from inhalation of radon daughters.

4.4.3 Radiation Dose From Vicinity Properties to a Hypothetical Maximally Exposed Individual

This section discusses the estimated effective dose equivalent to a hypothetical individual assumed to frequent the Femme Osage Slough, south of the quarry. This scenario provides a very conservative but plausible exposure assessment. No private residences are adjacent to the slough (it is situated on land currently managed by the Missouri Department of Conservation (MDOC) as part of the Weldon Spring Wildlife Area); therefore, all direct gamma exposure calculations assume a realistic less than 100% residence time. This scenario utilizes the exposure pathways and is based on a hypothetical individual who fished at the Femme Osage Slough.

Scenarios and assumptions particular to this dose calculation are summarized as follows:

- No contribution to the estimated dose was included from radon progeny concentrations, Airborne (B), because the slough is contaminated only with uranium. Consequently, above-background concentrations of radon were not found.

- The average U-234, U-235, and U-238 concentrations in fish samples taken from the Femme Osage Slough were 0.0043 pCi/g, (see Section 8.3.1.2).

- The fresh water fish consumption rate was 6.5 grams/day (0.23 oz/day) (EPA 1988a).

- No contribution from pathway Liquid (C) was included because the stagnant water conditions made it unlikely that the slough would be used for recreational swimming.

The dose to the maximally exposed individual at the vicinity property from consumption of fish tissue as discussed above was 0.003 mrem (0.00003 mSv) committed effective dose equivalent (CEDE).

4.4.4 Collective Population Dose

This section discusses the estimated collective effective dose equivalent to the populations assumed to frequent the Katy Trail located south of the quarry, and at the Busch Wildlife Area. This scenario provides a very conservative but plausible exposure assessment. Since the results

from all critical receptor monitoring locations were not significantly different from background concentrations at the 95% confidence level, no collective effective dose equivalent estimate was made for populations at or beyond the critical receptor locations. In addition, statistical analyses of the radon and external gamma measurements made near the quarry along the Katy Trail indicated that there was no reason to suspect at the 95% confidence level that the results were greater than background. As a result, no collective effective dose was calculated for the population on the Katy Trail. The scenario used for the Busch Wildlife Area is based on recreational use for fishing and boating activities.

Scenarios and assumptions particular to this dose calculation are summarized as follows:

- No contribution from radon and its progeny was included in the Katy Trail estimate. Results from the measurements near the trail indicated that there was no reason to suspect at the 95% confidence level that results were greater than background.

- The MDOC estimates that approximately 15,000 persons per year use the Busch Wildlife Area, which is adjacent to the chemical plant/raffinate pits area, while another 3,800 persons participate in recreational boating activities. Busch Lakes 34, 35, and 36 receive runoff from the chemical plant/raffinate pits site, and all three lakes are utilized for fishing and boating purposes. Therefore, a second point for potential exposure of a population through ingestion of fish, water, and sediment from these lakes was these 18,800 persons.

- On average, 7,232 fish per year are caught from the Busch lakes (MDOC 1991).

- If a different person consumes each fish, the affected population would be 7,232 persons.

- The highest average U-238 concentration in the fish collected from Lakes 34, 35, and 36 was 0.017 pCi/g (Section 8.3.1.1).

- The average time spent at the Busch Wildlife Area per boating trip was approximately 5.7 hr.

- Each of 3,800 visitors made only one visit to the area and spent 25% of the time swimming.

- Maximum water concentrations were 171 pCi/l (6.3 Bq/l) (Section 6) and sediment concentration 110 pCi/g (4.1 Bq/g) (ESE 1993).

The estimated population dose for the Busch lakes ingestion scenario were 0.007 person-rem (0.00007 person-SV) for fish, 0.013 person-rem (0.00013 person-SV) for water, and 0.0014 person-rem (0.000014 person-SV) for sediment. Consequently, the collective population dose estimate for all applicable scenarios for the Busch Wildlife Area exposure point was 0.021 person-rem (0.00021 person-Sv). This dose is considered insignificant as compared to the dose received from natural background sources.

4.5 NESHAPs Release Estimates

In 1990, the WSSRAP initiated an environmental airborne particulate monitoring program sensitive enough to detect airborne radionuclide concentrations other than radon at the levels specified in the NESHAPs (40 CFR 61 Subpart H, Appendix E). This regulation requires that radionuclide emissions other than radon be identified and that effective dose equivalents to members of the public be calculated using EPA approved procedures and computer models, or other procedures for which the EPA has granted prior approval. The WSSRAP has chosen to meet these requirements by measuring airborne radionuclide concentrations at designated critical receptor locations rather than using computer modeling. The WSSRAP monitoring plan is contained in the *Plan For Monitoring Radionuclide Emissions Other Than Radon at Weldon Spring Site Critical Receptors* (MKF and JEG 1992i) which has been approved by EPA Region VII.

Potential airborne emissions at the site result from wind dispersal of surface soils and fugitive dust generated during remedial actions. The most accurate method of dose estimation at critical receptor locations near the site is to measure airborne concentrations at these locations. Critical receptors are locations where members of the public abide or reside and have a potential to encounter off-site concentrations of radionuclides other than radon during remediation of the Weldon Spring site.

Five critical receptor locations have been identified around the site. The common boundary of the chemical plant and the Missouri Highway Maintenance Facility (AP-2001), the WSSRAP administration building (AP-2005), Francis Howell High School (AP-4006), the Weldon Spring Training Area on the Department of the Army property to the southwest (AP-4008), and 150 m (0.1 mi) from the nearest residence to the quarry (AP-4011). A background location was selected at AP-4007 and was moved to the new background station, AP-4012, in December 1992. Each station has a high volume air sampler as well as a low volume sampler. The locations of these monitoring stations are shown in Section 5, Figures 5-1, 5-2, and 5-3.

An exposure scenario was developed and a dose estimate was calculated for each critical receptor location as shown in Table 4-4. Other assumptions used in the dose calculation are:

- Breathing rate of 1.25 m^3/hr (44.1 ft^3/hr) (Cember 1983).
- Fifty-year committed effective dose equivalent conversion factors provided in EPA Federal Guidance Report No. 11 (Eckerman 1988).

The results of the NESHAPs dose calculations are presented in Table 4-4. Isotopic air monitoring results from high volume and low volume samplers provide emission concentrations for use in NESHAPs dose estimates that are shown in Tables 4-5 and 4-6, respectively. The high volume data was used for the dose calculation since the detection limits were more accurate with the larger volume of air sampled. The doses were all less than 0.2 mrem per year at each critical receptor location for both high and low volume results and were similar to the total committed effective dose equivalent calculated for NESHAPs in 1991.

Statistical evaluation of the high volume results indicated that stations AP-2001 and AP-2005 were statistically significant. However, when the fact that the data quality objectives were not met for either precision or accuracy, and that the laboratory did not provide the error associated with the total uranium analysis (i.e., the error from the total uranium analysis could not be included in the evaluation of statistical significance), the determination of statistical significance also contains uncertainty. Statistical evaluation of the low volume data indicates that none of the stations was statistically significant. However, the low volume data had a significantly greater percentage of error than the high volume data due to the higher minimum

TABLE 4-4 Exposure Scenarios and NESHAPs Dose Estimates for 1992

Critical Receptor	Sample ID	Total Individuals	Exposure Duration	Estimated Dose Equivalent
Missouri Highway Maintenance Facility	AP-2001	9	2,000 hrs/yr	6.79E-02 ± 8.07E-02
WSSRAP Administration Building	AP-2005	220	2,500 hrs/yr	1.73E-01 ± 9.42E-02
Francis Howell High School - Assessment 1	AP-4006	1800	2,250 hrs/yr	3.83E-02 ± 6.47E-02
Francis Howell High School - Assessment 2	AP-4006	1[a]	365 days/yr	1.49E-01 ± 2.52E-01
Weldon Spring Training Area	AP-4008	1[b]	2,000 hrs/yr	-1.87E-02 ± 7.09E-02
Quarry Residence	AP-4011	1[c]	365 days/yr	-1.18E-01 ± 2.38E-01

(a) One individual residing full-time on school properties
(b) One employee working full-time on Army property
(c) One individuel living at residence

TABLE 4-5 NESHAPs Isotopic Air Monitoring Results Effective Dose Equivalent Contributions, 1992

Radionuclide	Period	Net Concentration[b] (µCi/ml)	CEDE[b] (mrem)	Annual CEDE[b] (mrem)
AP-2001 Missouri Highway Maintenance Facility				
Total U[a]	1st Quarter	-1.23E-11	-8.86E-04	
	2nd Quarter	5.38E-12	3.87E-04	
	3rd Quarter	1.56E-10	1.12E-02	
	4th Quarter	1.06E-10	7.61E-03	1.83E-02
Ra-226	1st Quarter	-9.67E-12 ± 7.99E-11	-4.47E-05 ± 4.11E-04	
	2nd Quarter	3.87E-11 ± 1.07E-10	2.00E-04 ± 5.51E-04	
	3rd Quarter	-3.32E-11 ± 1.04E-10	-1.71E-04 ± 5.38E-04	
	4th Quarter	-7.33E-12 ± 1.08E-10	-3.78E-05 ± 5.54E-04	-5.37E-05 ± 1.03E-03
Ra-228	1st Quarter	-3.16E-11 ± 1.14E-10	-9.04E-05 ± 3.27E-04	
	2nd Quarter	-6.64E-11 ± 1.22E-10	-1.90E-04 ± 3.49E-04	
	3rd Quarter	1.01E-11 ± 1.13E-10	2.89E-05 ± 3.23E-04	
	4th Quarter	-4.73E-11 ± 1.17E-10	-1.36E-04 ± 3.35E-04	-3.87E-04 ± 6.67E-04
Th-228	1st Quarter	4.69E-12 ± 2.67E-11	9.62E-04 ± 5.47E-03	
	2nd Quarter	1.18E-11 ± 4.63E-11	2.42E-03 ± 9.50E-03	
	3rd Quarter	4.50E-11 ± 6.05E-11	9.23E-03 ± 1.24E-02	
	4th Quarter	1.25E-11 ± 2.79E-11	2.57E-03 ± 5.72E-03	1.52E-02 ± 1.75E-02
Th-230	1st Quarter	1.79E-11 ± 2.67E-11	3.50E-03 ± 5.21E-03	
	2nd Quarter	-2.03E-11 ± 6.32E-11	-3.97E-03 ± 1.04E-02	
	3rd Quarter	4.37E-12 ± 6.51E-11	8.53E-04 ± 1.27E-02	
	4th Quarter	4.21E-11 ± 3.48E-11	8.23E-03 ± 8.81E-03	8.61E-03 ± 1.85E-02
TH-232	1st Quarter	-1.57E-12 ± 2.66E-11	-1.55E-03 ± 2.61E-02	
	2nd Quarter	-1.11E-11 ± 4.63E-11	-1.10E-02 ± 4.55E-02	
	3rd Quarter	7.72E-12 ± 4.95E-11	7.59E-03 ± 4.87E-02	
	4th Quarter	3.16E-11 ± 2.75E-11	3.11E-02 ± 2.70E-02	2.62E-02 ± 7.65E-02
Total	Annual	N/A	N/A	6.79E-02 ± 8.07E-02

[a] Error was not report by analytical laboratory.
[b] Indicated error/range is at the 95% confidence level.
CEDE = committed effective dose equivalent

TABLE 4-5 NESHAPs Isotopic Air Monitoring Results Effective Dose Equivalent Contributions, 1992 (Continued)

Radionuclide	Period	Net Concentration[b] (µCi/ml)	CEDE[b] (mrem)	Annual CEDE[b] (mrem)
AP-2006 WSSRAP Administration Building				
Total U[a]	1st Quarter	1.76E-10 ± 0.00E+00	1.58E-02 ± 0.00E+00	
	2nd Quarter	2.93E-10 ± 0.00E+00	2.63E-02 ± 0.00E+00	
	3rd Quarter	2.45E-10 ± 0.00E+00	2.21E-02 ± 0.00E+00	
	4th Quarter	4.67E-10 ± 0.00E+00	4.20E-02 ± 0.00E+00	1.06E-01 ± 0.00E+00
Ra-226	1st Quarter	-3.57E-12 ± 8.54E-11	-2.30E-05 ± 5.50E-04	
	2nd Quarter	3.13E-11 ± 1.03E-10	2.01E-04 ± 6.62E-04	
	3rd Quarter	-3.48E-11 ± 9.10E-11	-2.24E-04 ± 5.86E-04	
	4th Quarter	2.88E-11 ± 1.19E-10	1.85E-04 ± 7.64E-04	1.40E-04 ± 1.29E-03
Ra-228	1st Quarter	-3.67E-11 ± 1.11E-10	-1.32E-04 ± 3.99E-04	
	2nd Quarter	-1.88E-11 ± 1.10E-10	-6.74E-05 ± 3.93E-04	
	3rd Quarter	4.90E-11 ± 1.12E-10	1.75E-04 ± 4.00E-04	
	4th Quarter	1.27E-11 ± 1.18E-10	4.53E-05 ± 4.23E-04	2.18E-05 ± 8.08E-04
Th-228	1st Quarter	5.63E-12 ± 2.59E-11	1.44E-03 ± 6.64E-03	
	2nd Quarter	4.69E-12 ± 4.47E-11	1.20E-03 ± 1.15E-02	
	3rd Quarter	3.83E-11 ± 5.06E-11	9.81E-03 ± 1.30E-02	
	4th Quarter	1.48E-12 ± 2.85E-11	3.80E-04 ± 7.30E-03	1.28E-02 ± 1.99E-02
Th-230	1st Quarter	3.08E-11 ± 2.84E-11	7.52E-03 ± 6.93E-03	
	2nd Quarter	-4.65E-11 ± 5.05E-11	-1.14E-02 ± 1.23E-02	
	3rd Quarter	2.31E-11 ± 6.00E-11	5.65E-03 ± 1.46E-02	
	4th Quarter	1.72E-11 ± 3.48E-11	4.19E-03 ± 8.51E-03	6.00E-03 ± 2.21E-02
Th-232	1st Quarter	7.30E-12 ± 2.81E-11	8.97E-03 ± 3.46E-02	
	2nd Quarter	1.84E-11 ± 4.92E-11	2.26E-02 ± 6.05E-02	
	3rd Quarter	-9.44E-14 ± 3.75E-11	-1.16E-04 ± 4.61E-02	
	4th Quarter	1.29E-11 ± 2.58E-11	1.59E-02 ± 3.17E-02	4.73E-02 ± 8.94E-02
All	Annual	N/A	N/A	1.73E-01 ± 9.42E-02

[a] Error was not report by analytical laboratory.
[b] Indicated error/range is at the 95% confidence level.
CEDE = committed effective dose equivalent

TABLE 4-5 NESHAPs Isotopic Air Monitoring Results Effective Dose Equivalent Contributions, 1992 (Continued)

Radionuclide	Period	Net Concentration[b] (µCi/ml)	CEDE[b] (mrem)	Annual CEDE[b] (mrem)
AP-4006 Francis Howell High School - Residence[c]				
Total U[a]	1st Quarter	-2.01E-11 ± 0.00E+00	-5.08E-03 ± 0.00E+00	1.06E-02 ± 0.00E+00
	2nd Quarter	2.35E-11 ± 0.00E+00	5.94E-03 ± 0.00E+00	
	3rd Quarter	2.21E-11 ± 0.00E+00	5.56E-03 ± 0.00E+00	
	4th Quarter	1.61E-11 ± 0.00E+00	4.07E-03 ± 0.00E+00	
Ra-226	1st Quarter	5.04E-11 ± 8.50E-11	9.10E-04 ± 1.53E-03	-2.03E-04 ± 3.40E-03
	2nd Quarter	-1.02E-10 ± 8.84E-11	-1.84E-03 ± 1.60E-03	
	3rd Quarter	5.25E-13 ± 9.29E-11	9.47E-06 ± 1.68E-03	
	4th Quarter	3.99E-11 ± 1.09E-10	7.20E-04 ± 1.97E-03	
Ra-228	1st Quarter	-4.19E-11 ± 1.11E-10	-4.20E-04 ± 1.11E-03	3.20E-04 ± 2.28E-03
	2nd Quarter	3.21E-11 ± 1.09E-10	3.23E-04 ± 1.09E-03	
	3rd Quarter	-1.34E-11 ± 1.16E-10	-1.35E-04 ± 1.15E-03	
	4th Quarter	5.50E-11 ± 1.20E-10	5.52E-04 ± 1.20E-03	
Th-228	1st Quarter	7.96E-12 ± 2.58E-11	5.73E-03 ± 1.85E-02	2.84E-03 ± 5.52E-02
	2nd Quarter	-7.32E-12 ± 4.80E-11	-5.27E-03 ± 3.45E-02	
	3rd Quarter	-1.02E-11 ± 4.78E-11	-7.32E-03 ± 3.44E-02	
	4th Quarter	1.35E-11 ± 2.54E-11	9.70E-03 ± 1.82E-02	
Th-230	1st Quarter	1.37E-11 ± 2.82E-11	9.36E-03 ± 1.93E-02	1.24E-01 ± 5.68E-02
	2nd Quarter	5.76E-11 ± 5.04E-11	3.94E-02 ± 3.45E-02	
	3rd Quarter	8.66E-11 ± 5.12E-11	5.93E-02 ± 3.51E-02	
	4th Quarter	2.40E-11 ± 3.03E-11	1.64E-02 ± 2.07E-02	
Th-232	1st Quarter	8.31E-13 ± 2.80E-11	2.86E-03 ± 9.64E-02	1.13E-02 ± 2.39E-01
	2nd Quarter	-4.94E-12 ± 4.46E-11	-1.70E-02 ± 1.54E-01	
	3rd Quarter	1.41E-11 ± 3.93E-11	4.86E-02 ± 1.35E-01	
	4th Quarter	-6.71E-12 ± 2.23E-11	-2.31E-02 ± 7.69E-02	
All	Annual	N/A	N/A	1.49E-01 ± 2.52E-01

(a) Error was not report by analytical laboratory.
(b) Indicated error/range is at the 95% confidence level.
(c) CEDE calculations are based on continuous exposure scenario for residence. A student scenario CEDE would give a result approximately 3.5 times smaller.

CEDE = committed effective dose equivalent

TABLE 4-5 NESHAPs Isotopic Air Monitoring Results Effective Dose Equivalent Contributions, 1992 (Continued)

Radionuclide	Period	Net Concentration[b] (µCi/ml)	CEDE[b] (mrem)	Annual CEDE[b] (mrem)
AP-4007 Background				
Total U[a]	1st Quarter	1.46E-10	NA	NA
	2nd Quarter	2.03E-10	NA	
	3rd Quarter	1.85E-10	NA	
	4th Quarter	2.31E-10	NA	
RA-226	1st Quarter	1.80E-11 ± 2.98E-11	NA	NA
	2nd Quarter	6.13E-11 ± 3.46E-11	NA	
	3rd Quarter	5.21E-11 ± 3.34E-11	NA	
	4th Quarter	8.85E-11 ± 4.19E-11	NA	
Ra-228	1st Quarter	7.45E-11 ± 4.16E-11	NA	NA
	2nd Quarter	7.84E-11 ± 4.10E-11	NA	
	3rd Quarter	3.01E-11 ± 3.28E-11	NA	
	4th Quarter	9.33E-11 ± 4.48E-11	NA	
Th-228	1st Quarter	0.00 ± 8.83E-12	NA	NA
	2nd Quarter	2.49E-11 ± 1.61E-11	NA	
	3rd Quarter	2.36E-11 ± 1.55E-11	NA	
	4th Quarter	1.43E-11 ± 1.05E-11	NA	
Th-230	1st Quarter	9.42E-12 ± 8.63E-12	NA	NA
	2nd Quarter	1.21E-10 ± 1.93E-11	NA	
	3rd Quarter	1.11E-10 ± 1.95E-11	NA	
	4th Quarter	5.90E-11 ± 1.24E-11	NA	
Th-232	1st Quarter	2.35E-12 ± 9.42E-12	NA	NA
	2nd Quarter	3.53E-11 ± 1.69E-11	NA	
	3rd Quarter	3.01E-11 ± 7.32E-12	NA	
	4th Quarter	2.86E-12 ± 8.57E-12	NA	

(a) Error was not report by analytical laboratory.
(b) Indicated error/range is at the 95% confidence level.
CEDE = committed effective dose equivalent

TABLE 4-5 NESHAPs Isotopic Air Monitoring Results Effective Dose Equivalent Contributions, 1992 (Continued)

Radionuclide	Period	Net Concentration[b] (µCi/ml)	CEDE[b] (mrem)	Annual CEDE[b] (mrem)
AP-4008 U.S. Army Weldon Spring Training Area				
Total U[a]	1st Quarter	4.46E-11 ± 0.00E+00	3.21E-03 ± 0.00E+00	
	2nd Quarter	-2.35E-11 ± 0.00E+00	-1.70E-03 ± 0.00E+00	
	3rd Quarter	-2.21E-11 ± 0.00E+00	-1.59E-03 ± 0.00E+00	
	4th Quarter	-1.61E-11 ± 0.00E+00	-1.16E-03 ± 0.00E+00	-1.24E-03 ± 0.00E+00
Ra-226	1st Quarter	-1.18E-11 ± 8.18E-11	-8.09E-05 ± 4.21E-04	
	2nd Quarter	1.02E-10 ± 1.15E-10	5.26E-04 ± 5.92E-04	
	3rd Quarter	-5.25E-13 ± 9.75E-11	-2.70E-06 ± 5.02E-04	
	4th Quarter	-3.99E-11 ± 1.05E-10	-2.06E-04 ± 5.42E-04	2.57E-04 ± 1.04E-03
Ra-228	1st Quarter	-6.89E-12 ± 1.18E-10	-1.97E-05 ± 3.32E-04	
	2nd Quarter	-3.21E-11 ± 1.15E-10	-9.21E-05 ± 3.29E-04	
	3rd Quarter	1.34E-11 ± 9.77E-11	3.85E-05 ± 2.80E-04	
	4th Quarter	-5.50E-11 ± 1.12E-10	-1.58E-04 ± 3.20E-04	-2.31E-04 ± 6.32E-04
Th-228	1st Quarter	1.24E-11 ± 2.78E-11	2.55E-03 ± 5.70E-03	
	2nd Quarter	7.32E-12 ± 4.55E-11	1.50E-03 ± 9.33E-03	
	3rd Quarter	1.02E-11 ± 4.71E-11	2.09E-03 ± 9.67E-03	
	4th Quarter	-1.35E-11 ± 2.45E-11	-2.77E-03 ± 5.03E-03	3.38E-03 ± 1.54E-02
Th-230	1st Quarter	4.27E-11 ± 2.90E-11	8.45E-03 ± 5.75E-03	
	2nd Quarter	-5.76E-11 ± 5.02E-11	-1.13E-02 ± 9.81E-02	
	3rd Quarter	-8.66E-11 ± 4.73E-11	-1.69E-02 ± 9.24E-03	
	4th Quarter	-2.40E-11 ± 3.03E-11	-4.68E-03 ± 5.93E-03	-2.44E-02 ± 1.58E-02
Th-232	1st Quarter	6.20E-12 ± 2.76E-11	5.95E-03 ± 2.65E-02	
	2nd Quarter	4.94E-12 ± 4.78E-11	4.86E-03 ± 4.70E-02	
	3rd Quarter	-1.41E-11 ± 3.36E-11	-1.39E-02 ± 3.30E-02	
	4th Quarter	6.71E-12 ± 2.34E-11	6.60E-03 ± 2.30E-02	3.53E-03 ± 6.73E-02
All	Annual	N/A	N/A	-1.87E-02 ± 7.09E-02

(a) Error was not report by analytical laboratory.
(b) Indicated error/range is at the 95% confidence level.
CEDE = committed effective dose equivalent

TABLE 4-5 NESHAPs Isotopic Air Monitoring Results Effective Dose Equivalent Contributions, 1992 (Continued)

Radionuclide	Period	Net Concentration[b] (µCi/ml)	CEDE[b] (mrem)	Annual CEDE[b] (mrem)
AP-4011 Quarry Residence				
Total U[a]	1st Quarter	-7.26E-12 ± 0.00E+00	-1.83E-03 ± 0.00E+00	
	2nd Quarter	-2.87E-11 ± 0.00E+00	-7.25E-03 ± 0.00E+00	
	3rd Quarter	-3.62E-11 ± 0.00E+00	-9.13E-03 ± 0.00E+00	
	4th Quarter	1.07E-11 ± 0.00E+00	2.70E-03 ± 0.00E+00	-1.55E-02 ± 0.00E+00
Ra-226	1st Quarter	-4.65E-12 ± 1.07E-10	-8.39E-05 ± 1.92E-03	
	2nd Quarter	-4.13E-11 ± 9.71E-11	-7.44E-04 ± 1.57E-03	
	3rd Quarter	3.11E-12 ± 9.31E-11	5.61E-05 ± 1.68E-03	
	4th Quarter	-7.35E-11 ± 1.02E-10	-1.33E-03 ± 1.84E-03	-2.10E-03 ± 3.52E-03
Ra-228	1st Quarter	-6.77E-12 ± 8.57E-11	-6.80E-05 ± 8.60E-04	
	2nd Quarter	1.07E-10 ± 1.22E-10	1.07E-03 ± 1.22E-03	
	3rd Quarter	-2.20E-11 ± 9.78E-11	-2.21E-04 ± 9.82E-04	
	4th Quarter	-3.49E-11 ± 1.15E-10	-3.50E-04 ± 1.15E-03	4.33E-04 ± 2.13E-03
Th-228	1st Quarter	3.15E-12 ± 2.56E-11	2.27E-03 ± 1.84E-02	
	2nd Quarter	2.74E-11 ± 4.90E-11	1.97E-02 ± 3.52E-02	
	3rd Quarter	-4.93E-12 ± 4.37E-11	-3.55E-03 ± 3.14E-02	
	4th Quarter	-9.27E-12 ± 2.58E-11	-6.67E-03 ± 1.85E-02	1.17E-02 ± 5.39E-02
Th-230	1st Quarter	1.50E-11 ± 2.45E-11	1.04E-02 ± 1.70E-02	
	2nd Quarter	-7.30E-11 ± 4.92E-11	-5.07E-02 ± 3.41E-02	
	3rd Quarter	-4.01E-11 ± 5.18E-11	-2.78E-02 ± 3.60E-02	
	4th Quarter	-3.94E-12 ± 3.29E-11	-2.74E-03 ± 2.28E-02	-7.08E-02 ± 5.72E-02
Th-232	1st Quarter	7.98E-13 ± 1.88E-11	2.68E-03 ± 6.33E-02	
	2nd Quarter	-1.85E-11 ± 4.55E-11	-6.36E-02 ± 1.57E-01	
	3rd Quarter	-4.14E-12 ± 3.56E-11	-1.43E-02 ± 1.23E-01	
	4th Quarter	9.66E-12 ± 2.39E-11	3.33E-02 ± 8.24E-02	-4.19E-02 ± 2.25E-01
All	Annual	N/A	N/A	-1.18E-01 ± 2.39E-01

[a] Error was not report by analytical laboratory.
[b] Indicated error/range is at the 95% confidence level.
CEDE = committed effective dose equivalent

TABLE 4-6 NESHAPs Isotopic Air Monitoring Results for Low-Volume Samplers 1992

Radionuclide	Net Concentration(b) (uCi/ml)	Annual CEDE(b) (mrem)
AP-2001		
Total U(a)	8.13E-12	2.34E-03
Ra-226	4.97E-11 ± 1.30E-10	1.02E-03 ± 2.68E-03
Ra-228	1.28E-10 ± 5.46E-10	1.47E-03 ± 6.26E-03
Th-228	-4.41E-13 ± 1.64E-10	-3.62E-04 ± 1.35E-01
TH-230	2.55E-11 ± 1.68E-10	1.99E-02 ± 1.31E-01
TH-232	0.00E-00 ± 1.52E-10	0.00E-00 ± 5.99E-01
Total CEDE	2.44E-02 ± 8.72E-01	
AP-2005		
Total U(a)	1.69E-12	4.88E-04
Ra-226	7.32E-12 ± 1.18E-10	1.51E-04 ± 2.44E-03
Ra-228	2.53E-11 ± 1.84E-10	2.90E-04 ± 6.06E-03
Th-228	2.75E-12 ± 1.80E-10	2.26E-03 ± 1.48E-01
TH-230	5.21E-11 ± 1.61E-10	4.08E-02 ± 1.42E-01
TH-232	0.00E-00 ± 1.60E-10	0.00E-00 ± 6.30E-01
Total CEDE	4.39E-02 ± 9.28E-01	
AP-4006		
Total U(a)	-1.39E-12	-3.19E-04
Ra-226	1.75E-11 ± 1.20E-10	2.88E-04 ± 1.98E-03
Ra-228	4.75E-11 ± 5.44E-10	4.36E-06 ± 4.98E-03
Th-228	-4.41E-13 ± 1.68E-10	-2.90E-04 ± 1.10E-01
Th-230	-3.08E-12 ± 1.58E-10	-1.93E-03 ± 9.85E-02
Th-232	0.00E-00 ± 1.55E-10	0.00E-00 ± 4.89E-01
Total CEDE	-2.24E-03 ± 7.04E-01	
AP-4008		
Total U(a)	1.55E-12	4.45E-04
Ra-226	-8.61E-12 ± 1.90E-10	-1.36E-04 ± 2.24E-03
Ra-228	6.11E-11 ± 5.56E-10	7.00E-04 ± 6.37E-03
Th-228	-4.41E-13 ± 1.66E-10	-3.62E-04 ± 1.36E-01
Th-230	5.52E-12 ± 1.60E-10	4.31E-03 ± 1.25E-01
Th-232	0.00E-00 ± 1.50E-10	0.00E-00 ± 5.90E-01
Total CEDE	4.96E-03 ± 8.60E-01	

TABLE 4-6 NESHAPs Isotopic Air Monitoring Results for Low-Volume Samplers 1992 (Continued)

Radionuclide	Net Concentration(b) (uCi/ml)	Annual CEDE(b) (mrem)
AP-4011		
Total U(a)	1.59E-12	3.63E-04
Ra-226	-1.41E-11 ± 9.88E-11	-2.33E-04 ± 1.63E-03
Ra-228	7.67E-11 ± 5.65E-10	7.03E-04 ± 5.18E-03
Th-228	-4.41E-13 ± 1.63E-10	-2.90E-04 ± 1.07E-01
Th-230	2.48E-12 ± 1.64E-10	1.55E-03 ± 1.03E-01
Th-232	0.00E-00 ± 1.62-10	0.00E-00 ± 5.11E-01
Total CEDE	2.09E-03 ± 7.28E-01	
AP-4007 Background		
Total U(a)	2.87E-12	N/A
Ra-226	1.41E-11 ± 3.99E-11	N/A
Ra-228	1.28E-11 ± 1.90E-10	N/A
Th-228	4.41E-13 ± 5.98E-11	N/A
Th-230	4.85E-12 ± 5.69E-11	N/A
Th-232	0.00E-00 ± 6.38E-11	N/A

(a) Error was not reported by analytical laboratory.
(b) Indicated error range is at the 95% confidence level.
(c) CEDE calculations based on continuous exposure scenario

detection levels. Because the analysis results were well below the detection limits, the error or uncertainty associated with the analysis results was great, and the results were not statistically significant.

The results of the data quality review of precision and accuracy for the NESHAPs high volume samples indicated that the data quality objectives established in the *Plan for Monitoring Radionuclide Emissions Other Than Radon at Weldon Spring Critical Receptors* (MKF and JEG 1992i) were not achieved. Only 46% of the spiked samples met the established accuracy requirements while the plan specifies that at least 85% must meet the requirements. In addition, only 36% of all samples analyzed met the precision requirements while, again, the plan calls for 85%. The analytical precision of the ratio of U-238 to U-234 could not be determined because the samples were analyzed for total uranium rather than isotopic uranium due to barium interference with isotopic uranium analysis of the glass fiber high volume filters. A corrective action plan has been prepared to meet the established accuracy requirements.

The plan specifies that accuracy, as determined by the results of spiked samples, must be considered acceptable if the analytical results of the samples are within ±50% of the known values. The plan also specifies that precision must be determined by averaging the results of three duplicate analyses. The degree of precision is considered acceptable if the standard deviation of duplicate analyses is within 50% of the average for 85% of the duplicate data sets. In addition, the plan specifies that precision must be calculated for the ratios of U-238 to U-234. The degree of precision is considered acceptable if the standard deviation of the ratios of U-238 to U-234 are within ±50% of the average for each composite sample.

Although the data quality objectives were not met, it is possible to conclude that the concentrations measured at the critical receptor locations were essentially at background. The analytical results of the samples were less than, or at, the minimum detectable concentration levels, and all the dose calculation results were less than 0.2 mrem.

4.6 Radiation Dose to Native Aquatic Organisms

Benthic invertebrates were collected from on-site and off-site locations (see Section 8.3.1.2) to calculate dose to native aquatic organisms as required in DOE Order 5400.5. The dose calculation was made using the highest concentration detected in a sample from Frog Pond which contained 32 pCi/g of total uranium.

The dose to native aquatic organisms was calculated for calendar year 1992 and compared to the DOE guideline of 1 rad/day. The absorbed dose rate to these organisms was found to be 0.04 rad/day.

4.7 Highlights

- The effective dose equivalent for the maximally exposed hypothetical individual from all pathways was 1.9 mrem. This value represents 1.9% of the DOE guideline of 100 mrem above background.

- The NESHAPs standard of 10 mrem annually for airborne emissions was not exceeded in 1992. The committed effective dose equivalents were calculated as <0.2 mrem for each of the critical receptor monitoring locations.

5 ENVIRONMENTAL RADIATION MONITORING PROGRAM

The Weldon Spring Site Remedial Action Project (WSSRAP) operates its environmental monitoring and surveillance program in accordance with the U.S. Department of Energy (DOE) Orders in the 5400 series and as designated in the *Environmental Monitoring Plan for Calendar Year 1992* (MKF and JEG 1992o). The substances present as wastes on the site require monitoring for both radiological and nonradiological constituents. This section describes radiological monitoring results for radon, external gamma radiation, and airborne radioactive particulates at various site perimeter and off-site locations. Provided below for each of the parameters mentioned is a program overview, summary of applicable standards, actual monitoring results, and an assessment of any associated environmental impacts.

5.1 Radon Gas Monitoring Program

5.1.1 Program Overview

Both U-238 and Th-232 are naturally occurring radionuclides in soil and rock. Radon, Rn-220 and Rn-222, is a naturally occurring radioactive gas found in both the uranium and thorium decay series. It is formed by the natural radioactive decay of Ra-224 and Ra-226, respectively. A fraction of the radon produced from the radioactive decay of naturally occurring U-238 and Th-232 diffuses from soil and rock into the atmosphere, accounting for natural background airborne radon concentrations. Radon is produced at the Weldon Spring site from these natural sources as well as from the Ra-224 and Ra-226 contained in contaminated waste materials.

Airborne radon concentrations fluctuate with both soil conditions and meteorological conditions. The amount of radon that actually enters the atmosphere varies depending on a number of parameters which include radium concentrations in soil, soil moisture content, soil porosity, soil density, and atmospheric pressure. Of these, the moisture content of the soil is the most variable and is primarily responsible for quarterly and annual changes in airborne radon concentrations.

The radon environmental monitoring program primarily utilizes a pair of radon detectors at each of 30 permanent monitoring locations; seven at the Weldon Spring Chemical Plant perimeter, eight at the Weldon Spring Quarry perimeter, seven at the raffinate pits perimeter,

and eight at off-site locations. Radon monitoring locations are identified with an "RD" prefix in Figures 5-1, 5-2, and 5-3. On-site monitoring locations are distributed around the perimeter to ensure adequate detection of radon dissipating from the site under various atmospheric conditions. Locations RD-4001, RD-4004, RD-4005, and RD-4006 monitor background radon concentrations.

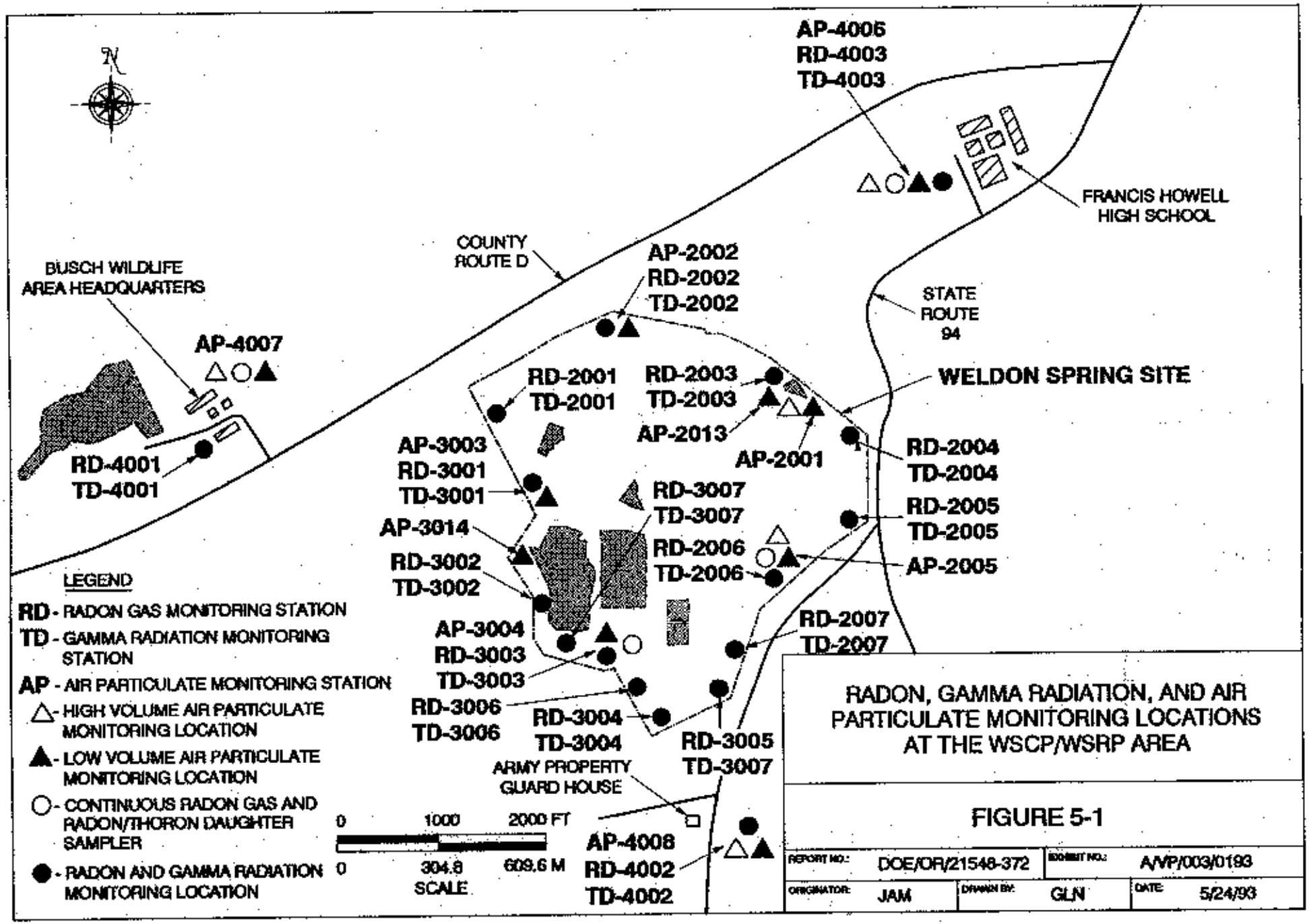
The radon detectors used in this program are Terradex Track Etch Type F detectors that are sensitive to all isotopes of radon. These detectors are deployed quarterly. In addition, the radon environmental monitoring program utilizes continuous radon and radon daughter monitors. Continuous radon and radon daughter monitors were placed at locations AP-4007 (moved to AP-4012, at the end of the year), AP-3004, AP-1009, and AP-4006 as shown in Figures 5-1 and 5-2. The continuous monitors are portable, fully automated instruments capable of continuously monitoring for radon, and radon and thoron daughters. The continuous radon and radon daughter monitors were placed in operation in January 1992 and removed for calibration in mid-March. The monitors were started again in mid-June. Comparativeness tests were performed from April to June to determine if the samplers were operating alike. Correction factors were developed from the testing and used to correct performance for each detector to yield comparable data that can be evaluated statistically.

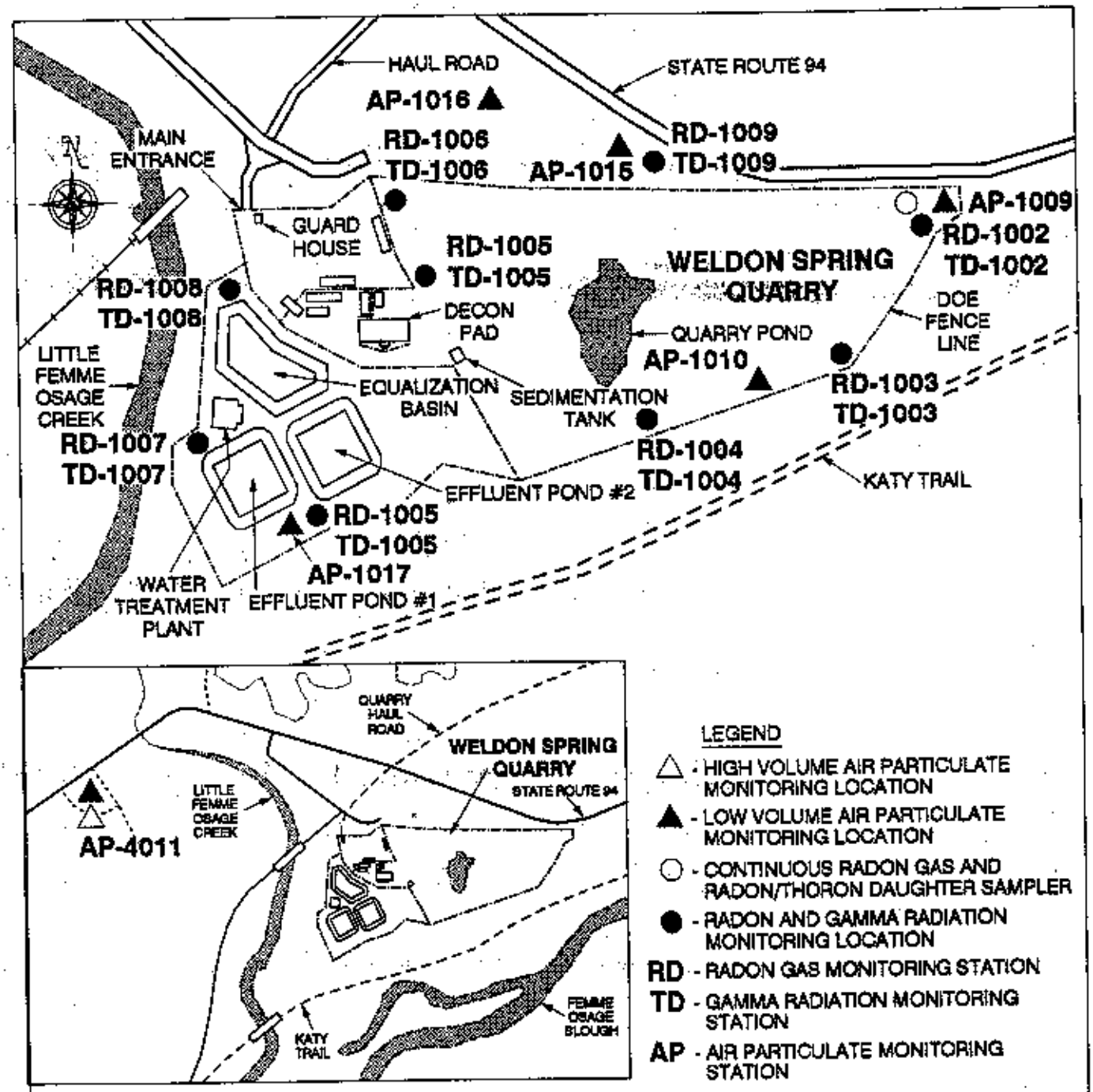
5.1.2 Applicable Standards

The primary applicable standard or guideline for radon concentrations is the derived concentration guideline (DCG) for unrestricted areas which is an annual average of 3 pCi/l (111 Bq/m^3) above background as specified in DOE Order 5400.5.

5.1.3 Monitoring Results

Table 5-1 summarizes the quarterly and annual average radon (Rn-220 and Rn-222) concentrations detected at all Weldon Spring site perimeter and off-site monitoring locations. For each monitoring location, quarterly radon concentrations were compared to the four background locations to determine if any significant differences existed at a 95% confidence level. Those locations that were statistically greater than background were compared to the DCG. For the DCG comparison, the average annual background concentration was subtracted from the annual average concentration, then compared (Table 5-1).

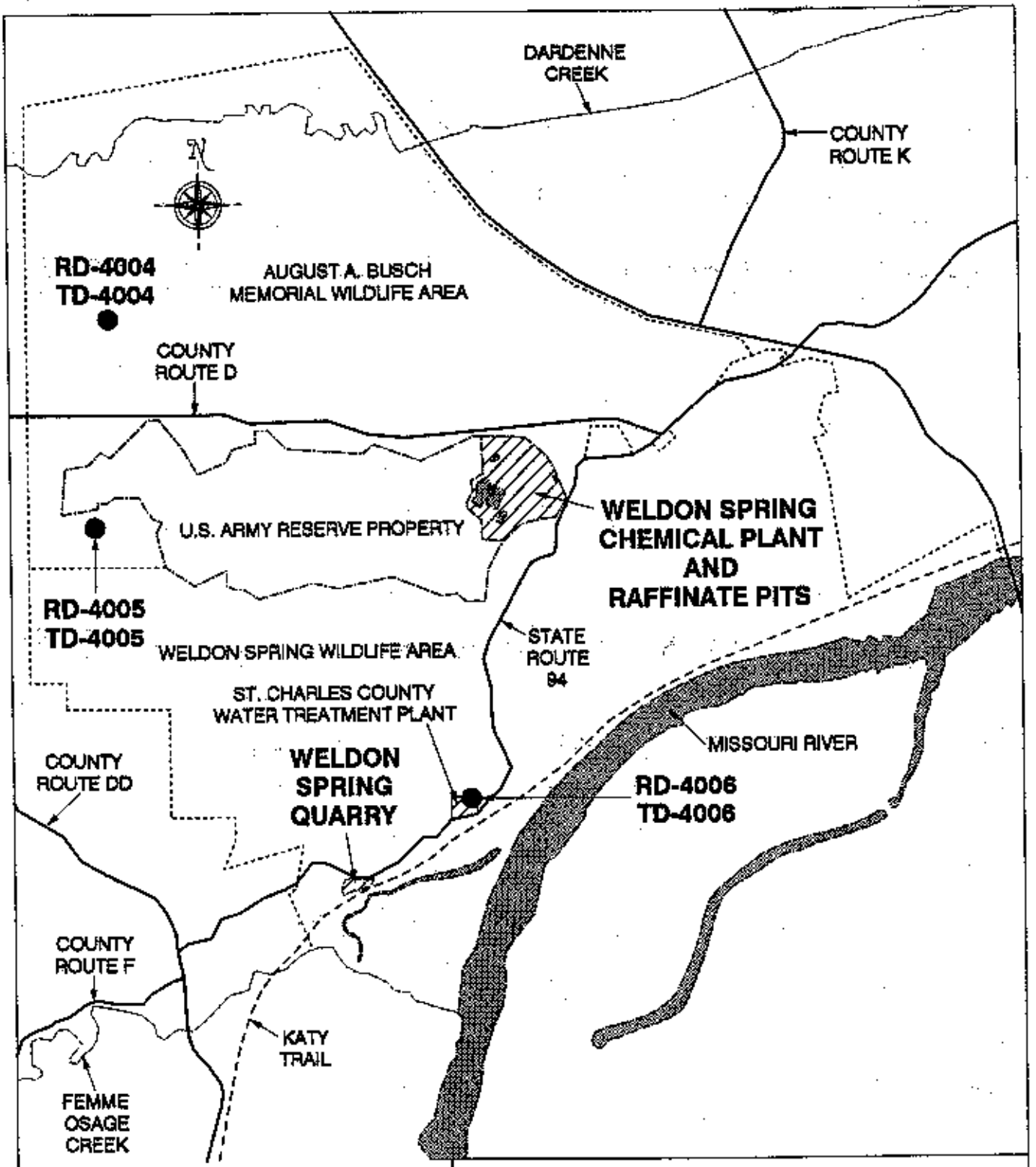

N
AP-4006
RD-4003
TD-4003
FRANCIS HOWELL HIGH SCHOOL
COUNTY ROUTE D
AP-2002
RD-2002
TD-2002
STATE ROUTE 94
BUSCH WILDLIFE AREA HEADQUARTERS
AP-4007
WELDON SPRING SITE
RD-2001
TD-2001
RD-2003
TD-2003
AP-2013
AP-2001
RD-2004
TD-2004
AP-3003
RD-3001
TD-3001
RD-3007
TD-3007
RD-2005
TD-2005
AP-3014
RD-2006
TD-2006
AP-2005
RD-4001
TD-4001
RD-3002
TD-3002
RD-2007
TD-2007
AP-3004
RD-3003
TD-3003
RD-3006
TD-3006
RD-3004
TD-3004
RD-3005
TD-3007
ARMY PROPERTY GUARD HOUSE
AP-4008
RD-4002
TD-4002
LEGEND
RD - RADON GAS MONITORING STATION
TD - GAMMA RADIATION MONITORING STATION
AP - AIR PARTICULATE MONITORING STATION
△ - HIGH VOLUME AIR PARTICULATE MONITORING LOCATION
▲ - LOW VOLUME AIR PARTICULATE MONITORING LOCATION
○ - CONTINUOUS RADON GAS AND RADON/THORON DAUGHTER SAMPLER
● - RADON AND GAMMA RADIATION MONITORING LOCATION
0 1000 2000 FT
0 304.8 609.6 M
SCALE
RADON, GAMMA RADIATION, AND AIR PARTICULATE MONITORING LOCATIONS AT THE WSCP/WSRP AREA
FIGURE 5-1
REPORT NO.: DOE/OR/21548-372
EXHIBIT NO.: A/VP/003/0193
ORIGINATOR: JAM
DRAWN BY: GLN
DATE: 5/24/93



RADON, GAMMA RADIATION, AND AIR PARTICULATE MONITORING LOCATIONS AT THE WSQ AREA

FIGURE 5-2

REPORT NO.: DOE/OR/21548-372		DGN/IT NO.: A/QY/002/0193	
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 5/24/93	



LEGEND

RD - RADON GAS MONITORING STATION

TD - GAMMA RADIATION MONITORING STATION

● - MONITORING LOCATION

0 1 MI
0 1.6 KM
SCALE

OFF-SITE RADON AND GAMMA RADIATION MONITORING LOCATIONS

FIGURE 5-3

REPORT NO.: DOE/OR/21548-372		EXHIBIT NO.: A/VP/004/0193	
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 1/93	

TABLE 5-1 1992 Track Etch Radon Results[a]

Location I.D.	1st Quarter pCi/l	2nd Quarter pCi/l	3rd Quarter pCi/l	4th Quarter pCi/l	Annual Average pCi/l	Standard Deviation pCi/l	Percent of Guideline (b)
WSQ							
RD-1001	1.1	1.3	1.7	0.7	1.2	0.3	31
RD-1002	1.9	1.4	1.6	1.1	1.5	0.4	42
RD-1003	0.7	0.5	0.7	0.8	0.7	0.2	14
RD-1004	0.4	0.3	0.3	0.4	0.3	0.1	4
RD-1005	0.4	0.4	0.3	0.4	0.3	0.1	4
RD-1006	0.4	0.3	0.3	0.4	0.3	0.3	3
RD-1007	0.5	0.2	0.2	0.3	0.3	0.1	-
RD-1008	0.4	0.3	N/A	0.2	0.3	0.1	-
WSCP							
RD-2001	0.3	0.4	0.3	0.3	0.3	0.1	2
RD-2002	0.2	0.2	0.4	0.2	0.2	0.1	-
RD-2003	0.3	0.3	0.1	0.2	0.2	0.1	-
RD-2004	0.3	0.3	0.2	0.2	0.2	0.1	-
RD-2005	0.3	0.2	0.2	0.1	0.2	0.1	-
RD-2006	0.3	0.2	0.3	0.1	0.2	0.1	-
RD-2007	N/A	N/A	N/A	0.2	0.2	0.0	-
WSRP							
RD-3001	0.3	0.4	0.4	0.1	0.3	0.1	-
RD-3002	0.4	0.4	0.4	0.2	0.3	0.1	4
RD-3003	0.3	0.5	0.2	0.2	0.3	0.1	-
RD-3004	0.2	0.4	0.2	0.1	0.2	0.1	-
RD-3005	N/A	N/A	N/A	0.3	0.3	0.0	-
RD-3006	N/A	N/A	N/A	0.4	0.4	0.0	-
RD-3007	N/A	N/A	N/A	0.3	0.3	0.0	-
OFF SITE							
*RD-4001	0.3	0.2	0.2	0.1	0.2	0.1	-
RD-4002	0.5	0.2	0.1	0.2	0.2	0.1	-
RD-4003	0.4	0.2	0.3	0.2	0.3	0.1	-
*RD-4004	0.3	0.3	0.3	0.1	0.2	0.1	-
*RD-4005	0.4	0.3	0.2	0.2	0.2	0.1	-
*RD-4006	0.4	0.3	0.3	0.1	0.3	0.1	-

TABLE 5-1 1992 Track Etch Radon Results[a] (Continued)

Location I.D.	1st Quarter pCi/l	2nd Quarter pCi/l	3rd Quarter pCi/l	4th Quarter pCi/l	Annual Average pCi/l	Standard Deviation pCi/l	Percent of Guideline (b)
RD-4007	N/A	N/A	0.2	0.2	0.2	0.1	-
RD-4008	N/A	N/A	0.2	0.4	0.3	0.1	-

(a) Results include natural background.

(b) Percent of guideline is calculated by taking the year-to-date average minus the average of the background stations divided by the DOE concentration guideline for RN-222 of 3 pCi/L (100 Bq/m^3) annual average above background for uncontrolled areas.

* Denotes background station

N/A Denotes missing track etch detector or a detector that was not deployed, such as previous quarters for new monitoring stations.

WSCP = Weldon Spring Chemical Plant

WSQ = Weldon Spring Quarry

WSRP = Weldon Spring Raffinate Pits

For each monitoring station, the results obtained from the pair of detectors were averaged to achieve a quarterly average radon concentration. These averages were used to calculate the annual average radon concentration at each location. The annual standard deviation was calculated by taking the square root of the sum of the squared quarterly standard deviations.

The annual background concentration was determined by calculating the arithmetic average of concentrations reported for the four background monitoring locations. These are RD-4001, RD-4004, RD-4005, and RD-4006. These data yielded an annual average background radon concentration (Rn-222 and Rn-220) in 1992 of 0.2 pCi/l (7.4 Bq/m^3). The average background radon concentration did not change significantly from the 1991 average of 0.3 pCi/l (11.1 Bq/m^3).

The results from continuous radon measurements were daily averages calculated from hourly concentration measurements for each location. Weekly averages were calculated from daily averages, and then a sliding average was computed. Sliding averages represent the average of all data collected at each monitoring station from the actual day the monitor began operation in calendar year 1992 to date.

Table 5-2 summarizes results obtained from the continuous radon and radon daughter monitors. At each monitoring station, the monitors recorded hourly concentration measurements. These measurements were reviewed weekly to identify any unexpected increases. Table 5-2 shows the quarterly and annual averages for each of the monitoring locations. The annual averages obtained with the radon gas monitors were also compared to the DCG after subtracting the background station AP-4007 result and are shown in the table.

It should be noted that the results obtained from the continuous monitors are consistently approximately 0.5 pCi/l greater than the results obtained from the radon track etch detectors. The continuous monitor results are believed to be biased high. This is probably a result of the annual calibration performed at the DOE facility in Grand Junction, CO. The detectors are calibrated at 5 pCi/l, 10 pCi/l, and 20 pCi/l airborne concentrations. The possibility of lowering these calibrated concentrations to more closely represent environmental concentrations is being investigated. In addition, the continuous monitors require a great amount of maintenance and do have a significant amount of downtime. This situation could have some effect on the averaged monitoring results.

5.1.4 Data Analysis

Statistical analysis of the results from the radon track etch detectors indicated at the 95% confidence level that the measured concentrations at six of the eight monitoring locations at the quarry perimeter were greater than the background monitoring location concentrations. In addition, the analysis indicated that measurements from one of the chemical plant locations and one of the raffinate pit locations were greater than the background station results. The analysis indicated that for all other stations there was no reason to suspect that the results were greater than background.

5.1.4.1 Chemical Plant/Raffinate Pits. Statistical analysis of the concentrations measured at monitoring location RD-2001 and RD-3002 indicated that the measured results were greater than background. Both of these monitoring stations are located at the perimeter boundary between the chemical plant/raffinate pits and the Weldon Spring Training Area. The average concentrations at both RD-2001 and RD-3002 exceeded background by 0.1 pCi/l. The statistical test used is largely based on the averages and standard deviations of the sample groups. When the standard deviations of the sample groups are small, the test is able to detect

TABLE 5-2 1992 Continuous Radon Monitoring Results[a]

Location ID	1st Quarter (pCi/l)		2nd Quarter (pCi/l)		3rd Quarter (pCi/l)		4th Quarter (pCi/l)		Annual		
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation	Percent of Guideline (b)
AP-3004	0.277	0.090	0.935	0.323	0.899	0.326	0.886	0.240	0.744	0.526	0
AP-4006	0.474	0.091	0.606	0.107	0.708	0.197	0.641	0.204	0.607	0.316	0
*AP-4007	0.701	0.148	0.799	0.151	0.788	0.225	0.744	0.267	0.758	0.408	N/A
AP-1009	1.661	0.573	1.687	0.659	2.350	1.829	2.356	1.521	2.014	2.534	42

(a) Results include natural background.

(b) Percent of guideline calculated by taking the year-to-date average minus the average of the background stations divided by the DOE concentration guideline for RN-222 of 3 pCi/l (100 Bq/m^3) annual average above background for uncontrolled areas.

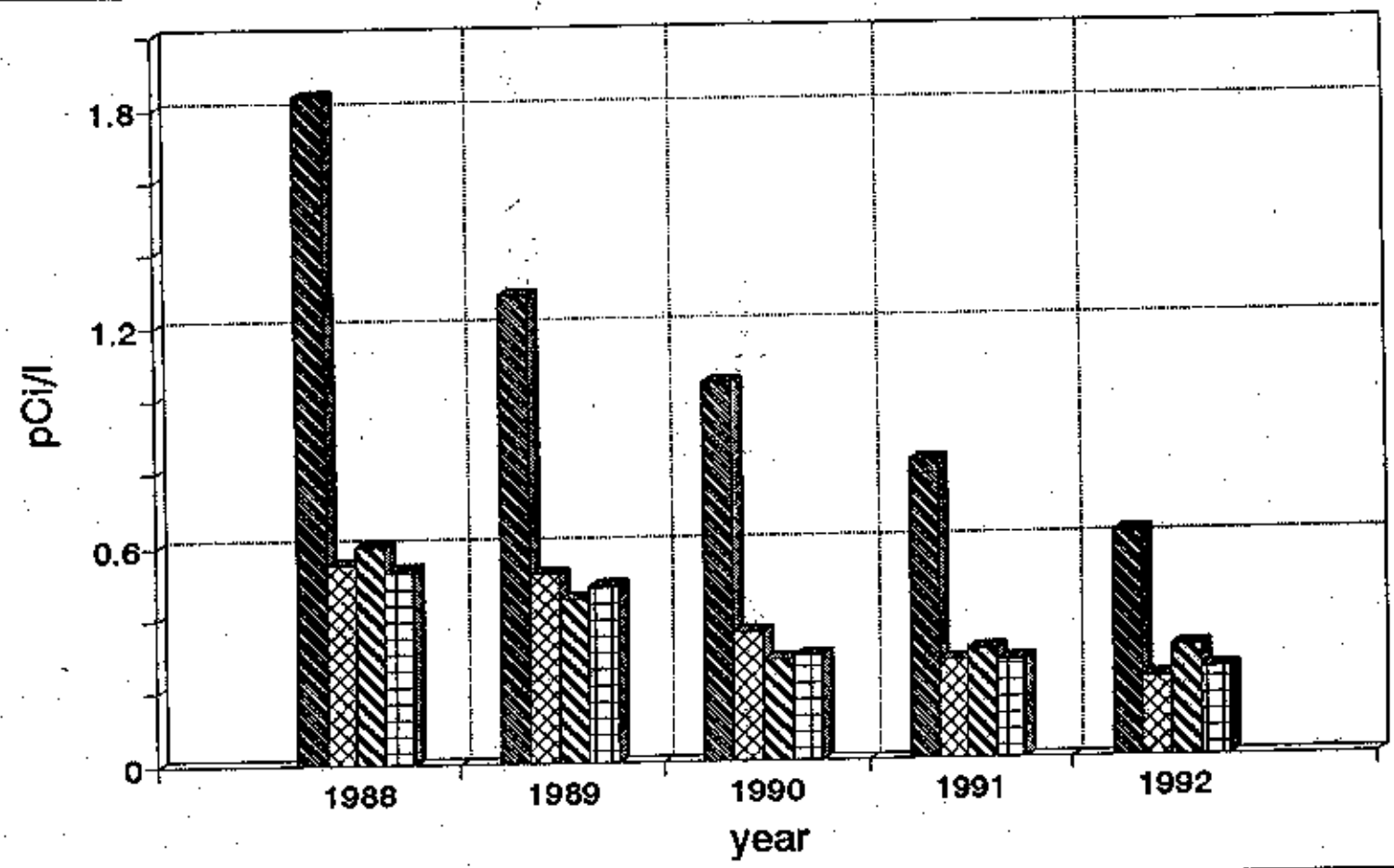
* Denotes background station

smaller differences between the two groups. Because the standard deviation between the quarterly analysis results for these two sample locations was small, the hypothesis test was able to conclude that the sampling locations were greater than background when the difference between the average concentration was only 0.1 pCi/l. Although the failure of these two stations may be the result of the potential for 5% false positive conclusions associated with the statistical test at the 95% confidence level, potential impacts were assessed for a hypothetical individual as discussed in Section 4. The quarterly measured radon concentrations from all stations ranged from 0.1 pCi/l to 0.5 pCi/l at the chemical plant/raffinate pits monitoring locations.

5.1.4.2 Quarry. The measured concentrations at the quarry indicated that six of the eight sampling locations were greater than background. These results were not unexpected based on previous years measurements and the fact that the quarry contains a significant amount of radium contamination. In addition, the quarry is surrounded by steep walls, and this tends to stagnate the air inside it. This inhibits dispersion and results in an increased concentration at the perimeter of the quarry. The impact of the above background radon concentrations to a hypothetical maximally exposed individual was assessed as described in Section 4.4.2. The measured results ranged from 0.1 pCi/l to 1.9 pCi/l.

5.1.4.3 Off Site. Statistical analysis of the results from off-site locations indicated that there was no reason to suspect at the 95% confidence level that any of the stations were greater than background. The radon concentration measurements at off-site locations ranged from 0.1 pCi/l to 0.5 pCi/l. These results are similar to results obtained during previous years.

5.1.4.4 Five Year Trend Analysis of Radon Gas. Figure 5-4 shows the annual average radon concentration for the monitoring stations at the quarry, chemical plant, raffinate pits, and off-site locations. The results shown include natural background radon concentrations. The results at the quarry in particular seem to indicate a significant downward trend. This trend appears to continue in 1992; however, it can partly be attributed to the addition of two stations at the quarry near the water treatment plant, which is further away from the contaminated soils than the other stations.



Quarry | Chemical Plant | Raffinate Pits | Off-site

RADON TRACK ETCH DETECTOR

5 YEAR TREND

FIGURE 5-4

REPORT NO.: DOE/OR/21548-372		EXHIBIT NO.: A/PI/087/0593	
ORIGINATOR: JR	DRAWN BY: SRS	DATE: 5/26/93	

5.2 Gamma Radiation Monitoring

5.2.1 Program Overview

Gamma radiation is emitted from radioisotopes in the U-238 and Th-232 decay series. Elevated concentrations of a number of these isotopes are present in many areas of the Weldon Spring site. Gamma rays are ionizing electromagnetic radiation emitted from the nuclei of atoms. The environment contains natural gamma radiation emitting substances, primarily potassium-40 and radioactive isotopes of the uranium and thorium series found in the earth. Cosmic radiation is high-energy radiation that originates in outer space and filters through the atmosphere to the earth's surface. Together, these two sources account for natural background gamma radiation. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 1982) estimates the typical external annual effective dose equivalent from all naturally occurring radiation to be 30 mrem/yr (0.3 mSv/yr) from cosmic sources and 35 mrem/yr (0.35 mSv/yr) from terrestrial radiation for a total of 65 mrem/yr (0.65 mSv/yr).

Gamma radiation is monitored at the Weldon Spring site using environmental thermoluminescent dosimeters (TLDs) deployed at 29 monitoring stations. Eight stations are located along the perimeter fence of the chemical plant (Figure 5-1); six are located in the vicinity of the raffinate pits; seven are located along the quarry perimeter fence (Figure 5-2), and eight are off site (Figures 5-1 and 5-3). Monitoring stations TD-4001, TD-4004, TD-4005, and TD-4006 measure natural background at locations unaffected by the site. Environmental TLDs are exchanged on a quarterly basis.

5.2.2 Applicable Standards

There is no specific standard or guideline for gamma radiation other than the DOE requirement of maintaining the dose to a member of the public below 100 mrem from all pathways including gamma radiation. This requirement is specified in DOE Order 5400.5.

5.2.3 Monitoring Results

To determine background levels of gamma radiation in 1992 as measured by TLDs, the quarterly gamma radiation measurements at the four background monitoring stations were

averaged to produce the annual average background gamma radiation dose rate. This yielded an average rate of 69 mrem/yr (0.69 mSv/yr) with a standard deviation of 3.4 mrem/yr (0.034 mSv/yr). This average background rate approximates the UNSCEAR (1982) estimate of 65 mrem/yr (0.65 mSv/yr) for this area.

Table 5-3 summarizes the quarterly and annual average gamma radiation monitoring results at the 16 chemical plant perimeter monitoring stations, Francis Howell High School, the Weldon Spring Army Reserve Training Area, and the four background monitoring stations. The results reported in the table include quarterly averages and annual totals for each monitoring station with the standard deviation for each. The standard deviations reported in this table reflect the error propagated by summing the square of the quarterly standard deviations and then taking the square root. TLDs were found missing at station TD-4004 during the second and fourth quarters and at Station TD-4001 during the third quarter. In order to calculate an annual total gamma exposure rate, the missing data were replaced with the average of the remaining quarterly TLD results for those monitoring stations.

5.2.4 Data Analysis

Statistical analysis of the results of the TLD detectors indicated that at the 95% confidence level there was no reason to suspect that radiation at any of the stations was greater than background. Based upon statistical analysis, there was no reason to believe that above background external gamma exposure to members of the public occurred as a result of activities at the WSSRAP.

5.2.4.1 Chemical Plant/Raffinate Pits. The annual total gamma exposure measurements from the TLDs at the chemical plant and raffinate pits ranged from 48 mrem to 78 mrem. These results are comparable to results obtained in previous years for these areas.

5.2.4.2 Quarry. The annual total gamma exposure measurements from the TLDs at the quarry ranged from 61 mrem to 78 mrem. These results are comparable to results obtained in previous years for this area.

5.2.4.3 Off Site. The annual total gamma exposure measurements at off-site locations ranged from 50 mrem to 86 mrem. These results are comparable to results obtained during previous years.

TABLE 5-3 1992 Environmental TLD Results[a]

Location I.D.	1st Quarter (mrem)	2nd Quarter (mrem)	3rd Quarter (mrem)	4th Quarter (mrem)	Annual Total(b) (mrem/yr)	Standard Deviation
WSQ						
TD-1001	18	9	19	15	61	5
TD-1002	18	29	16	14	77	6
TD-1003	17	35	13	13	78	8
TD-1004	18	29	14	13	74	6
TD-1005	12	30	-	13	73	5
TD-1006	17	28	12	12	69	3
TD-1007	18	31	14	14	77	3
TD-1008	15	33	13	13	76	3
WSCP						
TD-2001	17	30	12	11	70	5
TD-2002	18	30	12	12	72	4
TD-2003	14	30	12	13	68	4
TD-2004	17	32	16	13	78	6
TD-2005	17	29	-	10	74	4
TD-2006	17	30	12	12	71	4
TD-2007	-	-	-	12	48	-
WSRP						
TD-3001	16	37	13	11	78	4
TD-3002	13	25	8	7	53	7
TD-3003	17	31	13	12	74	4
TD-3004	14	29	10	-	71	7
TD-3005	-	-	-	14	54	-
TD-3006	-	-	-	16	64	-
OFF SITE						
*TD-4001	19	32	15	12	79	2
TD-4002	17	23	7	7	49	3
TD-4003	-	25	6	6	50	3
*TD-4004	15	32	13	12	72	2
*TD-4005	17	30	10	8	65	6
*TD-4006	17	29	11	11	68	2
TD-4007	17	32	10	8	67	2
TD-4008	18	32	-	15	86	2

5.2.4.4 Five Year Trend Analysis of TLDs. Gamma radiation exposure monitoring results from the last five years are represented graphically in Figure 5-5. The graph represents the yearly averages of results from monitoring stations at the quarry, chemical plant, raffinate pits, and off-site locations. The results shown include natural background dose rates. No significant trend was evident, which was expected since no large scale remediation was started at the site in 1992.

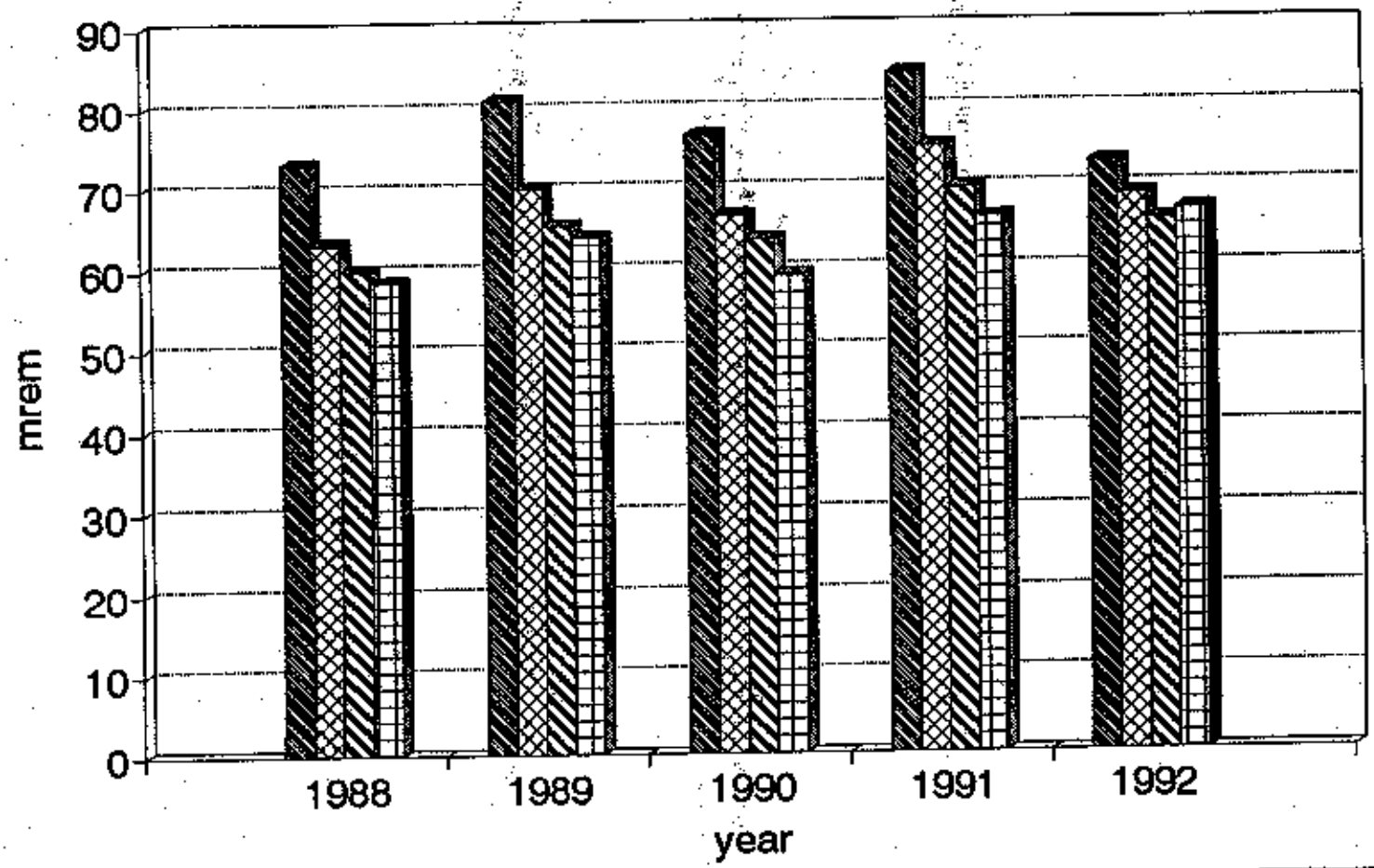
5.3 Radioactive Air Particulate Monitoring

5.3.1 Program Overview

Radioactive air particulates are airborne dust particles that carry radioactive contaminants. The radioactive isotopes that are the primary contributors to long-lived natural background radioactivity on dust particles are Po-210 and Pb-210, both of which are naturally occurring decay products of Rn-222 (radon). Background concentrations of radioactive air particulates vary depending on decay products of soil moisture, wind, and geological conditions. Many areas within the boundaries of the Weldon Spring site contain above-background concentrations of radionuclides in the soil, which could result in increased airborne radioactive particulate concentrations. Increased airborne radioactive particulate emissions from the site could also result from remedial work activities, such as movement of equipment or vehicles in contaminated areas, or from wind erosion.

The radionuclides present at the site are members of the U-238 and Th-232 decay series. These radionuclides emit alpha particles during decay which pose a potential respiratory hazard. In order to monitor these alpha particles, low volume air sampler filters were analyzed for long-lived gross alpha activity. These samplers collect airborne particulates by drawing ambient air through mixed cellulose ester filters with a 0.80 micron pore size. The filters are then analyzed on a gas flow proportional detector to determine the amount of gross alpha activity in the particulates collected on the filter surface.

5.3.1.1 Program Modification. In 1992, the WSSRAP initiated a number of changes in the radioactive airborne particulate monitoring program. These changes included installation of several new particulate monitoring stations, including a new background station.



Quarry | Chemical Plant | Raffinate Pits | Off-site

ENVIRONMENTAL TLD 5 YEAR TREND

FIGURE 5-5

REPORT NO.: DOE/OR/21548-372		EXHIBIT NO.: A/PI/088/0593	
ORIGINATOR: JR	DRAWN BY: SRS	DATE: 5/26/93	

At the beginning of 1992, the WSSRAP operated 11 low volume air particulate monitoring stations. Five of these (AP-2001, AP-2002, AP-3003, AP-3004, and AP-2005) were located around the chemical plant perimeter as shown on Figure 5-1. In 1992, two additional stations (AP-2013, and AP-3014) were added to this perimeter network. Also in 1992, the WSSRAP employed three previously existing low-volume stations at off-site locations. These were the Francis Howell High School (AP-4006), the Army training area (AP-4008), and two residences located approximately 0.7 km (0.4 mi) west of the quarry (AP-4011).

The monitoring station at the August A. Busch Wildlife Area (AP-4007) was used to monitor background levels in the vicinity of the chemical plant during most of 1992. This station is approximately 0.8 km (0.5 mi) from the chemical plant perimeter to the northwest. The terrain between the chemical plant and this station is hilly and forested, providing a significant physical barrier to airborne particulates originating from the chemical plant/raffinate pits. In addition, winds from the southeast are relatively rare in this region.

Just prior to the end of 1992 a new background station (AP-4012) was activated. This station was placed approximately 12 km (7.5 mi) from the Weldon Spring site in accordance with the background station location requirements specified in the *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991). During this same time period, the former Busch Wildlife Area background monitoring station was relocated to near the wildlife area headquarters, thus removing a portion of the physical barrier which had previously existed between the chemical plant/raffinate pits and the monitoring station. As a result, the Busch Wildlife Area station will be used as a regular off-site monitoring station in the future.

The off-site monitoring stations are shown on Figures 5-1 and 5-2. Three monitoring stations (AP-1015, AP-1016, and AP-1017) were also added to the two previously existing stations (AP-1009 and AP-1010) at the quarry perimeter at the end of 1992. The quarry monitoring stations are also shown on Figure 5-2.

The WSSRAP air particulate monitoring network now consist of 17 monitoring stations, which is an increase of more than 50% in monitoring capacity.

5.3.2 Monitoring Results

The annual average long-lived gross alpha concentrations and the calculated standard deviations for the 17 air monitoring stations are summarized in Table 5-4. The annual averages were calculated by averaging the uncensored weekly air particulate analysis results. Uncensored data refers to all reported values whether less than, or near, the minimum detectable amount. The use of uncensored data complies with the requirements of the DOE *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991). Utilizing uncensored data in all data manipulation minimizes any bias in the arithmetic averages and standard deviations.

TABLE 5-4 1992 Radioactive Air Particulate Gross Alpha Results

Monitoring Station Identification Number	Annual Average Long-Lived Gross Alpha Concentration ($\times 10^{-15}$ μCi/ml)[b]	Standard Deviation ($\times 10^{-15}$ μCi/ml)	Number of Sample Values Above MDC(c)/Total Number of Samples
AP-2001	1.22	0.70	42/52
AP-2002	1.36	0.62	47/52
AP-3003	1.07	0.48	32/36
AP-3004	1.20	0.65	44/52
AP-2005	1.17	0.50	44/50
AP-4006	1.08	0.42	47/52
AP-4007	1.28	0.51	52/52
AP-4008	1.08	0.46	47/50
AP-1009	1.33	0.64	47/51
AP-1010	1.34	0.64	33/44
AP-4011	1.11	0.48	47/52
AP-4012	1.18	0.35	2/2
AP-2013	1.04	0.47	38/41
AP-2014	1.22	0.73	27/29
AP-1015	0.95	0.58	2/3
AP-1016	0.86	0.44	2/3
AP-1017	1.03	0.51	19/24

The typical minimum detectable concentration (MDC) for low volume air particulate samples collected at the Weldon Spring site monitoring stations is 6.9×10^{-16} μCi/ml (0.026 mBq/m^3). This MDC is low enough to allow detection of Th-232, the radionuclide with the lowest derived concentration guideline (DCG) found at the site. The most restrictive inhalation DCG for Th-232 is 7×10^{-15} μCi/ml (0.26 mBq/m^3) (DOE 5400.5). Inhalation DCGs are airborne radioactive contaminant concentrations which, if inhaled by a member of the public continuously for 1 yr, would result in a committed effective dose equivalent of 100 mrem (1 mSv).

5.3.3 Data Analysis

Statistical analysis of the results from the low volume airborne particulate samplers indicate that the concentrations of airborne radioactive particulates are no greater than background levels.

5.3.3.1 Chemical Plant/Raffinate Pits. The average concentrations at the chemical plant/raffinate pits area perimeter ranged from 1.04×10^{-15} μCi/ml to 3.06×10^{-15} μCi/ml. These results are similar to those measured during previous years.

5.3.3.2 Quarry. The average concentration at the quarry area perimeter ranged from 0.85×10^{-15} μCi/ml to 1.34×10^{-15} μCi/ml. These results are similar to those measured during previous years.

5.3.3.3 Off Site. The average concentration at the off-site locations ranged from 1.06×10^{-15} μCi/ml to 1.28×10^{-15} μCi/ml. These results are similar to those measured in the past.

5.4 Unrestricted Area Radioactive Contamination Monitoring

5.4.1 Program Overview

The Weldon Spring site contains areas of radioactive contamination resulting from work practices during former uranium and thorium refining operations. Most of the processing involved refining uranium, thus uranium is the primary contaminant at the site. The unrestricted area radioactive contamination monitoring program includes radiological surveys of locations in

both the controlled and uncontrolled areas at the site. Site roadways are monitored to ensure that removable contamination is kept free from these accessible areas. In addition, the Katy Trail is surveyed because it is used by the public. The radiological surveys are usually performed monthly or at least on a quarterly basis. To date, these surveys confirm that radioactive contamination is not being carried into unrestricted areas.

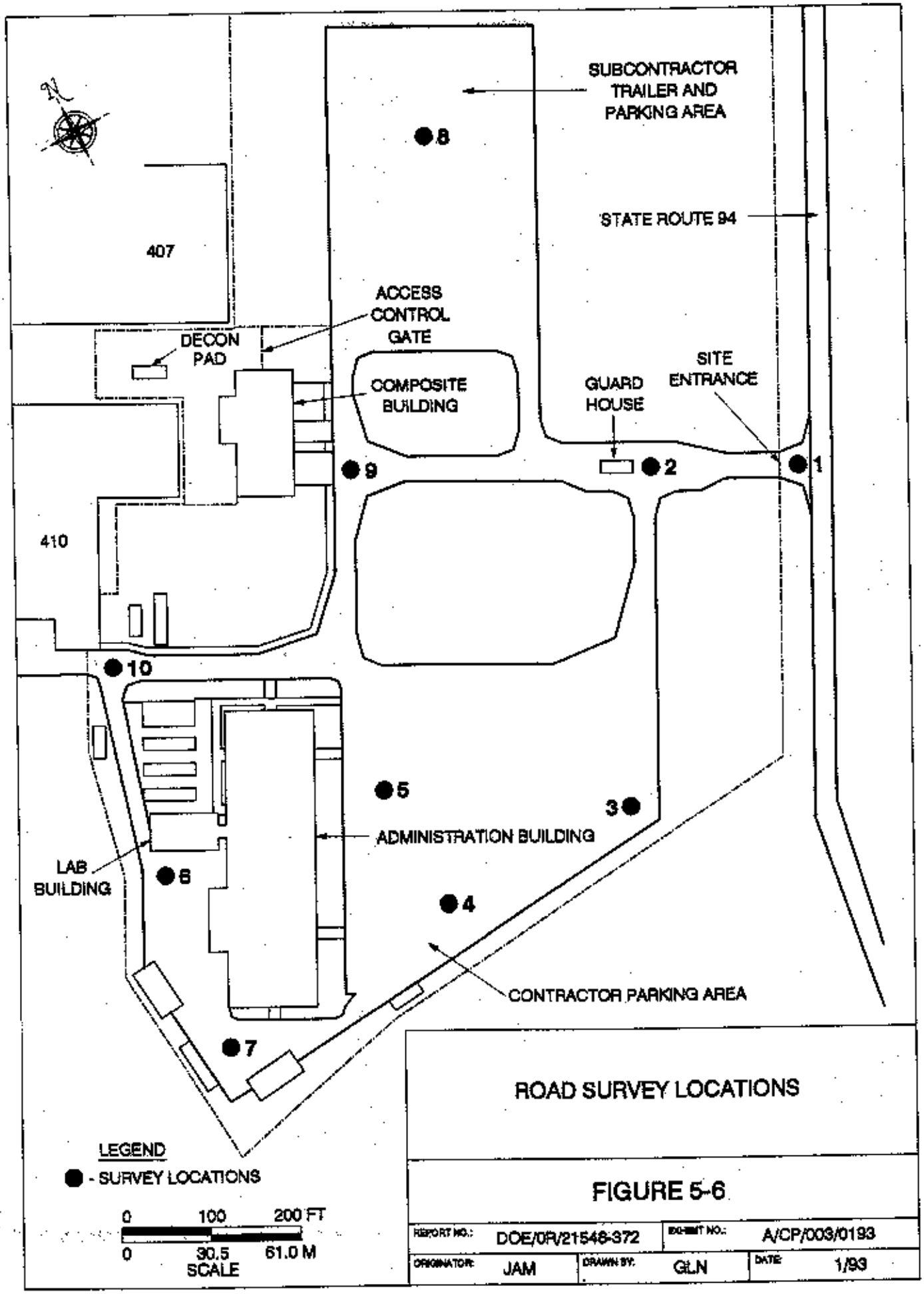
Since 1986, the WSSRAP has employed an unrestricted-area monitoring program to ensure that radioactive contamination is not migrating from the site as a result of remedial action operations in areas used by the general public. The unrestricted area contamination monitoring program focuses on taking in situ measurements and collecting swipe samples. In situ measurements are taken with either alpha detectors or beta-gamma detectors. Measurements are collected over a 1 minute counting interval and then converted to disintegrations per minute per 100 cm^2 (dpm/100 cm^2 or dpm/15.5 $in.^2$). These measurements determine the total radioactivity on the surface. The total radioactivity is interpreted as being the radioactivity contained within the material plus any removable or loose surficial radioactivity.

Removable surficial contamination levels are measured at each location using a dry cloth or paper swipe. The swipes are wiped (smeared) over a surface area of approximately 100 cm^2 (15.5 $in.^2$). Swipes are analyzed for 1 minute using an alpha scintillation detector. The count rate results are corrected for detector efficiency to yield measurement results in dpm/100 cm^2 (dpm/15.5 $in.^2$).

Figure 5-6 shows the monitoring locations for the roadways outside the controlled area and Figure 5-7 illustrates the approximate 1,130 m (1,243 yd) stretch of the Katy Trail that is included in the monitoring program. This section of the trail was selected for monitoring purposes due to its proximity to the quarry and the Femme Osage Slough. The 10 monitoring locations were selected along the trail to cover the area diagramed on Figure 5-7. Variations in monitoring locations were made in the general vicinity of the 10 locations to check for any possible contamination over the entire length of the investigated portion of the trail.

5.4.2 Monitoring Results

Table 5-5 lists the annual average beta-gamma and alpha monitoring results at each road survey location, and Table 5-6 gives the average beta-gamma and alpha monitoring results for



ROAD SURVEY LOCATIONS

FIGURE 5-6

REPORT NO.:	DOE/OR/21548-372	EXHIBIT NO.:	A/CP/003/0193		
ORIGINATOR:	JAM	DRAWN BY:	GLN	DATE:	1/93

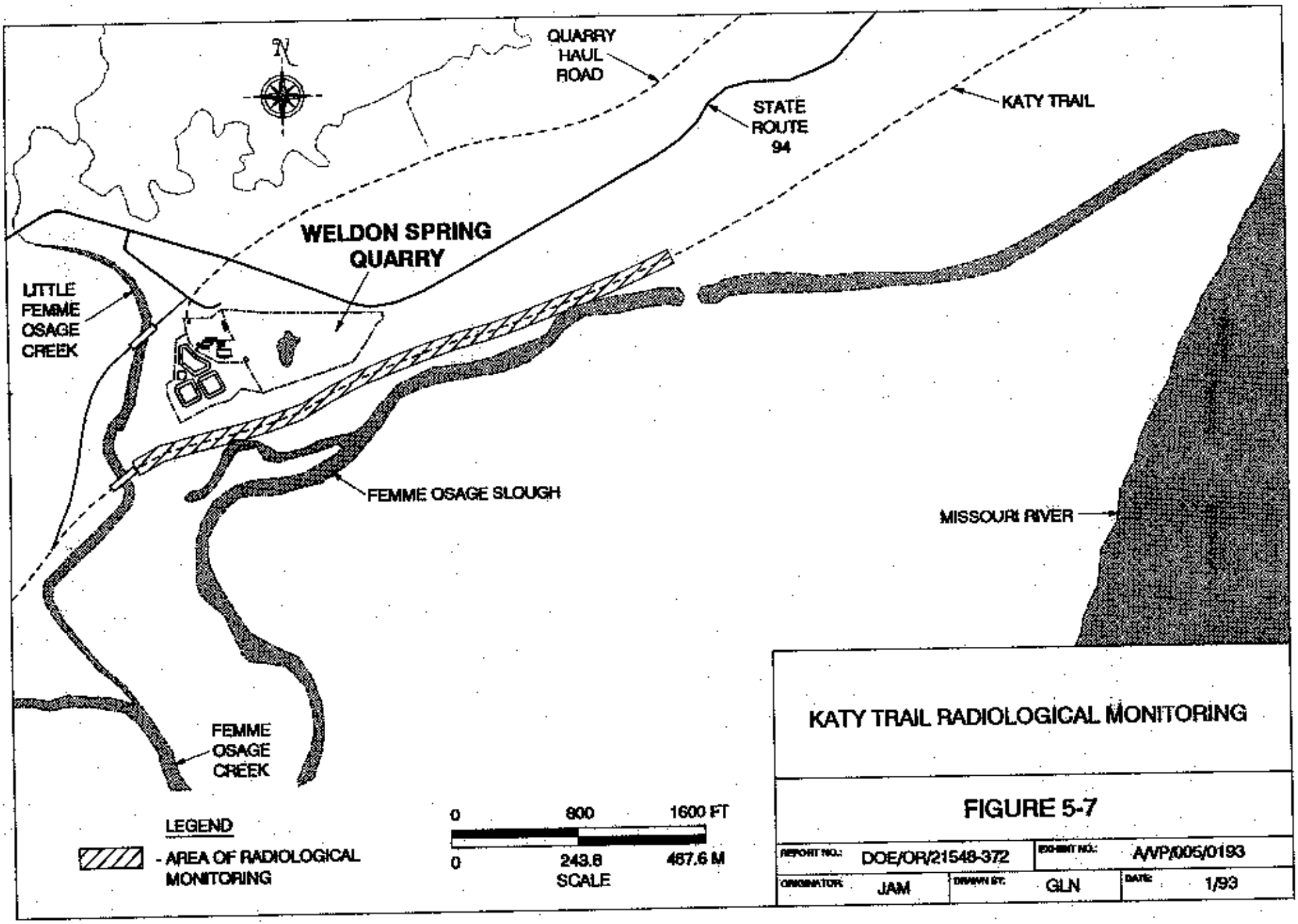

N
QUARRY HAUL ROAD
STATE ROUTE 94
KATY TRAIL
WELDON SPRING QUARRY
LITTLE FEMME OSAGE CREEK
FEMME OSAGE SLOUGH
MISSOURI RIVER
FEMME OSAGE CREEK
LEGEND
- AREA OF RADIOLOGICAL MONITORING
0 800 1600 FT
0 243.8 487.6 M
SCALE
KATY TRAIL RADIOLOGICAL MONITORING
FIGURE 5-7
REPORT NO.: DOE/OR/21548-372
EXHIBIT NO.: A/VP/005/0193
ORIGINATOR: JAM
DRAWN BY: GLN
DATE: 1/93

TABLE 5-5 1992 Site Roads Periodic Radiological Survey Results

Survey Location Number	Total Beta-Gamma Results(dpm/100 cm^2)[a]			Removable Alpha Results (dpm/100 cm^2)[b]		
	Annual Average	Standard Deviation	Number of Sample Values Above MDA/Number of Samples	Annual Average	Standard Deviation	Number of Sample Values Above MDA/Number of Samples
1	509	461	7/15	0.5	1.3	1/15
2	562	555	6/15	1.0	2.1	2/15
3	381	312	5/15	1.3	2.2	2/15
4	360	530	3/15	0.9	1.8	2/15
5	462	455	5/15	0.6	1.6	1/15
6	435	570	4/15	1.3	2.2	2/15
7	651	710	6/15	0.9	1.9	2/15
8	1734	1278	13/15	0.7	1.8	1/15
9	1033	714	12/15	0.9	1.9	1/15
10	899	772	10/15	0.6	1.6	1/15

(a) Minimum detectable activities (MDA) ranged from 421 dpm/100 cm^2 to 609 dpm/100 cm^2

(b) MDA ranged from 3 dpm/100 cm^2 to 6 dpm/100 cm^2

TABLE 5-6 1992 Katy Trail Periodic Radiological Survey Results

Survey Location Number	Total Beta-Gamma Results(dpm/100 cm^2)[a]			Removable Alpha Results (dpm/100 cm^2)[b]		
	Annual Average	Standard Deviation	Number of Sample Values Above MDA/Number of Samples	Annual Average	Standard Deviation	Number of Sample Values Above MDA/Number of Samples
1	206	217	2/10	0.3	1.4	0/10
2	198	210	0/10	0.3	1.9	0/10
3	111	355	1/10	0.3	2.2	1/10
4	154	153	0/10	0.2	2.3	1/10
5	260	279	1/10	-0.6	1.0	0/10
6	251	256	3/10	-0.9	0.3	0/10
7	196	296	1/10	0.8	4.0	2/10
8	199	189	0/10	0.3	2.4	1/10
9	162	191	1/10	2.0	3.1	4/10
10	265	290	1/10	-0.9	0.3	0/10

(a) Minimum detectable activities (MDA) ranged from 421 dpm/100 cm^2 to 604 dpm/100 cm^2
(b) MDA ranged from 3 dpm/100 cm^2 to 6 dpm/100 cm^2

each location along the Katy Trail. The tables reflect annual averages and standard deviations based upon actual net survey results. It should be noted that many of the values obtained throughout the year were below the minimum detectable activity (MDA) or the detection limit of the instruments. For the purpose of calculating arithmetic means and standard deviations, the DOE recommends reporting and use of actual net concentrations whether negative, positive, or zero (DOE 1991). Therefore, the negative results reported for removable alpha at some of the locations are acceptable and allow the use of uncensored data sets, which ensures that the annual averages and standard deviations remain unbiased parameters.

5.4.3 Data Analysis

The results of monitoring for the site show that fixed contamination is present at a few locations, but at levels well below the DOE uranium surface contamination guidelines for unrestricted use, which is 5,000 dpm/100 cm^2 (5,000 dpm/15.5 $in.^2$). The probable cause of the contamination is deposition of atmospheric releases of uranium during operation of the Weldon Spring Uranium Feed Material Plant (WSUFMP). Since the air monitoring program was initiated, there has been no increase in the levels of removable contamination on the uncontrolled area roadways at the Weldon Spring site.

The results from all monitoring locations along the Katy Trail indicate background radiation levels. These data show that no radioactive contamination is migrating from the quarry or the Femme Osage Slough onto the Katy Trail, and thus, there is no identifiable probability of radiological contamination to users of the trail.

5.5 Airborne Asbestos Monitoring

During periods when asbestos abatement was occurring on site, environmental monitoring for asbestos was conducted at the Francis Howell High School (FHHS) monitoring location and at site perimeter monitoring locations. In addition worker exposure and work area monitoring were conducted at the WSSRAP. FHHS samples were collected daily, and site perimeter samples were collected at a frequency of two samples, i.e., one upwind sample and one downwind sample, per week.

Two building dismantlement projects were initiated after July 23, 1992. A total of 102 environmental air samples was collected. Sixty-nine samples were collected from the FHHS station and 33 samples were collected from seven site perimeter stations.

Samplers were generally operated for 7 to 8 hours per day, corresponding to the period during which asbestos abatement operations were being conducted.

Two different methods for sample analysis were utilized in the asbestos monitoring program. Samples analyzed by Phase Contrast Microscopy (PCM) provided a measurement of total airborne concentrations for fibers having the size and shape characteristics typical of asbestos fibers. PCM methodology does not distinguish between airborne asbestos and nonasbestos fibers having similar morphology. Selected samples were analyzed by Transmission Electron Microscopy (TEM) to provide a measurement of total airborne asbestos fiber concentrations. No asbestos fibers were detected on any of the samples analyzed by TEM.

The PCM results of the environmental samples collected at the FHHS and site perimeter locations are provided in Tables 5-7 and 5-8. As determined by PCM analysis, results from the FHHS ranged from <0.0002 fibers per cubic centimeter of air (f/cc) to 0.01 f/cc with an average result of 0.001 f/cc. Results from the upwind locations of the site perimeter ranged from <0.001 f/cc to 0.003 f/cc with an average result of 0.001 f/cc. Results from the downwind locations of the site perimeter ranged from <0.001 f/cc to 0.002 f/cc with an average result of 0.001 f/cc.

The environmental air samples collected from the FHHS and the site perimeter are all considered to be within the range of normal background fiber concentrations, indicating that asbestos fibers were effectively contained during asbestos abatement operations. This conclusion is also supported by the results of the on-site asbestos work zone area monitoring program.

5.6 Highlights

- Statistical analysis indicated that six radon monitoring locations at the quarry perimeter and two locations at the chemical plant perimeter were statistically greater than background. The highest measured concentration was 42% of the DCG guideline for Rn-222.

TABLE 5-7 Summary of Asbestos Air Monitoring Results from Francis Howell High School

PCM Analysis			
Month/Year	Number of Samples	Range[a]	Average[a]
July 1992	7	<0.001 - 0.002	0.001
August 1992	15	<0.0005 - 0.004	0.001
September 1992	14	0.0009 - 0.006	0.002
October 1992	17	<0.0005 - 0.010	0.002
November 1992	5	<0.0005 - <0.001	0.001
Annual Average			0.001

(a) Units for the range and average values are in fibers per cubic centimeter (f/cc) of air. For purposes of averaging, the detection limits were treated as actual fiber concentrations for those samples reported as below detectable quantities.

TABLE 5-8 Summary of Asbestos Air-Monitoring Results for Upwind and Downwind Samples from the Weldon Spring Site Perimeter[a]

	Upwind Samples			Downwind Samples		
Month/Year	Number of Samples	Range[b]	Average[b]	Number of Samples	Range[b]	Average[b]
July 1992	2	<0.001	<0.001	2	<0.001-0.002	0.002
August 1992	4	<0.001-0.003	0.002	All 4 samples had the same result	All 4 samples were: <0.001	<0.001
September 1992	1	<0.001	<0.001	Both samples had the same result	Both samples are: 0.001	0.001
October 1992	3	All three samples were: <0.001-0.001	0.001	All 3 samples had the same result	All 3 samples are: 0.001	0.001
December 1992	3	0.001	0.001	All 3 samples had the same result	0.001-0.001	0.001
Annual Average			0.001	Annual Average		0.001

(a) All samples were analyzed using Phase Contrast Microscopy (PCM).
(b) Units for the range and average values are in fibers per cubic centimeter of air (f/cc). For purposes of averaging, the detection limits are treated as actual fiber concentrations for those samples reported as below detectable quantities.

- TLD results from the chemical plant, quarry, and off-site locations ranged from 48 mrem to 79 mrem. Statistical analysis of the monitoring results indicated that there was no reason to suspect at the 95% confidence level that these values were greater than background.

- Statistical analysis of gross alpha airborne particulate results indicated that there was no reason to suspect at the 95% confidence level that these values were greater than background.

6 SURFACE WATER PROTECTION

The environmental monitoring program for chemical and radiological constituents in surface waters includes National Pollutant Discharge Elimination System (NPDES) monitoring and surface water monitoring at streams, ponds, and lakes. The NPDES program is administered by the Missouri Department of Natural Resources and regulates storm water and wastewater discharges.

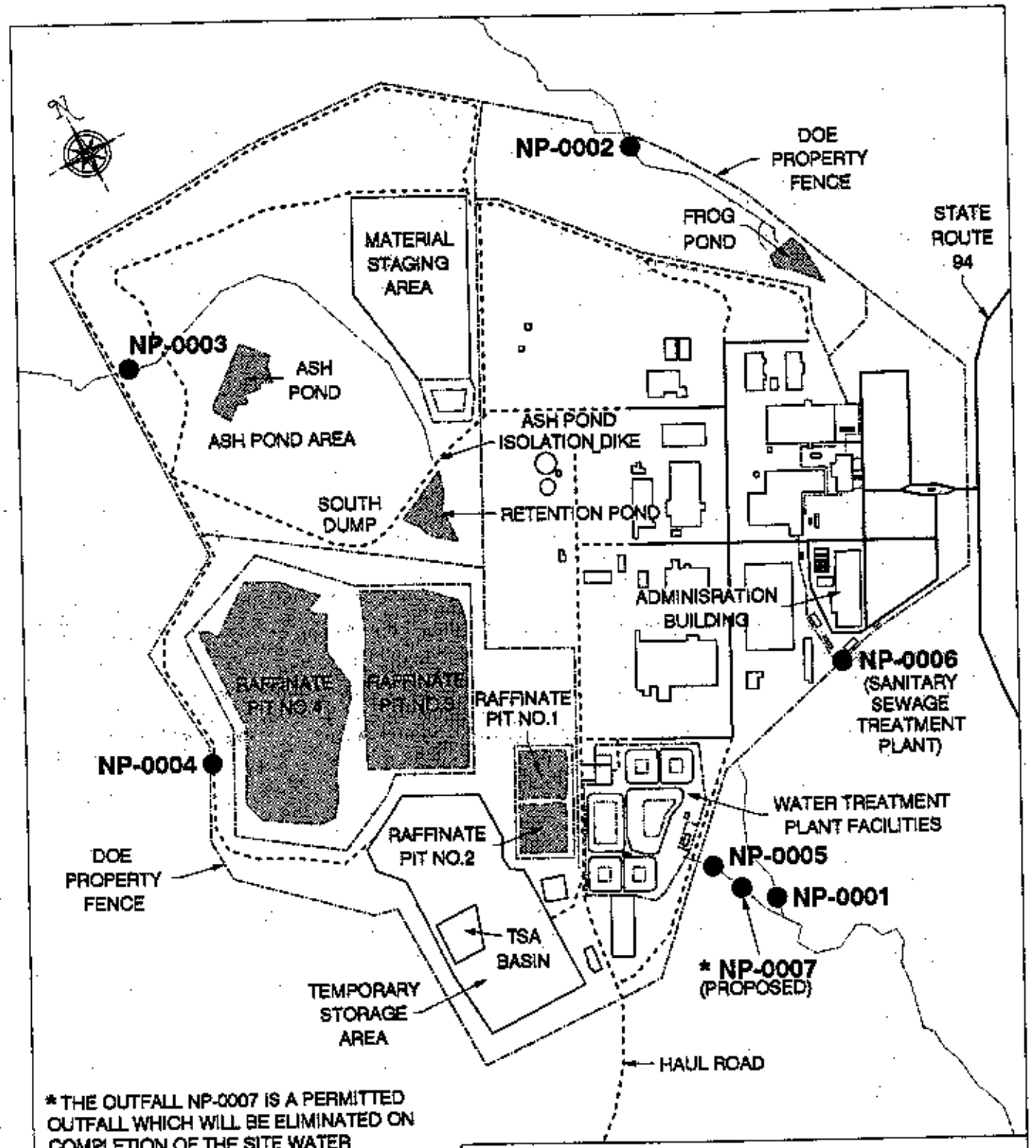
6.1 Program Overview

The surface water protection program at the Weldon Spring site consists of effluent monitoring and surface water monitoring. Effluent monitoring is conducted as defined by the NPDES permits. The surface water surveillance program is operated to maintain a sufficient database to allow the Weldon Spring Site Remedial Action Project (WSSRAP) to monitor on-site and off-site water conditions. This monitoring allows the project to gauge the impacts of on-site source areas on downstream receptors and evaluate the effects of remedial activities. The following sections describe these two program components in detail and discuss the results of the monitoring programs for the 1992 monitoring year. Section 6.4 describes the highlights for 1992.

6.1.1 Effluent Monitoring

The effluent or NPDES monitoring program at the Weldon Spring site establishes sampling requirements for eight discharge points, or outfalls, and hydrostatic test water discharges at both the Weldon Spring Quarry and the Weldon Spring Chemical Plant. The objective of the NPDES effluent monitoring program is to maintain compliance with NPDES permit requirements in order to protect the health of downstream water users and to protect the environment.

Five storm water outfalls (NP-0001 to NP-0005) and two wastewater treatment plant outfalls (NP-0006 and NP-0007) are located at the chemical plant/raffinate pits (Figure 6-1). Outfall NP-0006 is the outfall for the treated effluent from the administration building sanitary wastewater treatment plant. Outfall NP-0007 is the outfall for the site water treatment plant facility. While these seven NPDES outfalls all have "monitoring only" requirements, the two



* THE OUTFALL NP-0007 IS A PERMITTED OUTFALL WHICH WILL BE ELIMINATED ON COMPLETION OF THE SITE WATER TREATMENT PLANT EFFLUENT PIPELINE. NP-0007 WILL THEN DISCHARGE DIRECTLY INTO THE MISSOURI RIVER (SEE FIGURE 6-2).

LEGEND

● - SAMPLE LOCATION

0 500 1000 FT

0 152.4 304.8 M

SCALE

NPDES SURFACE WATER SAMPLING LOCATIONS AT THE WSCP / WSRP

FIGURE 6-1

REPORT NO.:	DOE/OR/21548-372	EXHIBIT NO.:	A/CP/004/0193		
ORIGINATOR:	JAM	DRAWN BY:	GLN	DATE:	1/93

treatment plant outfalls also have effluent limitations. In addition, hydrostatic test water associated with testing at the site water treatment plant was discharged under two separate permits.

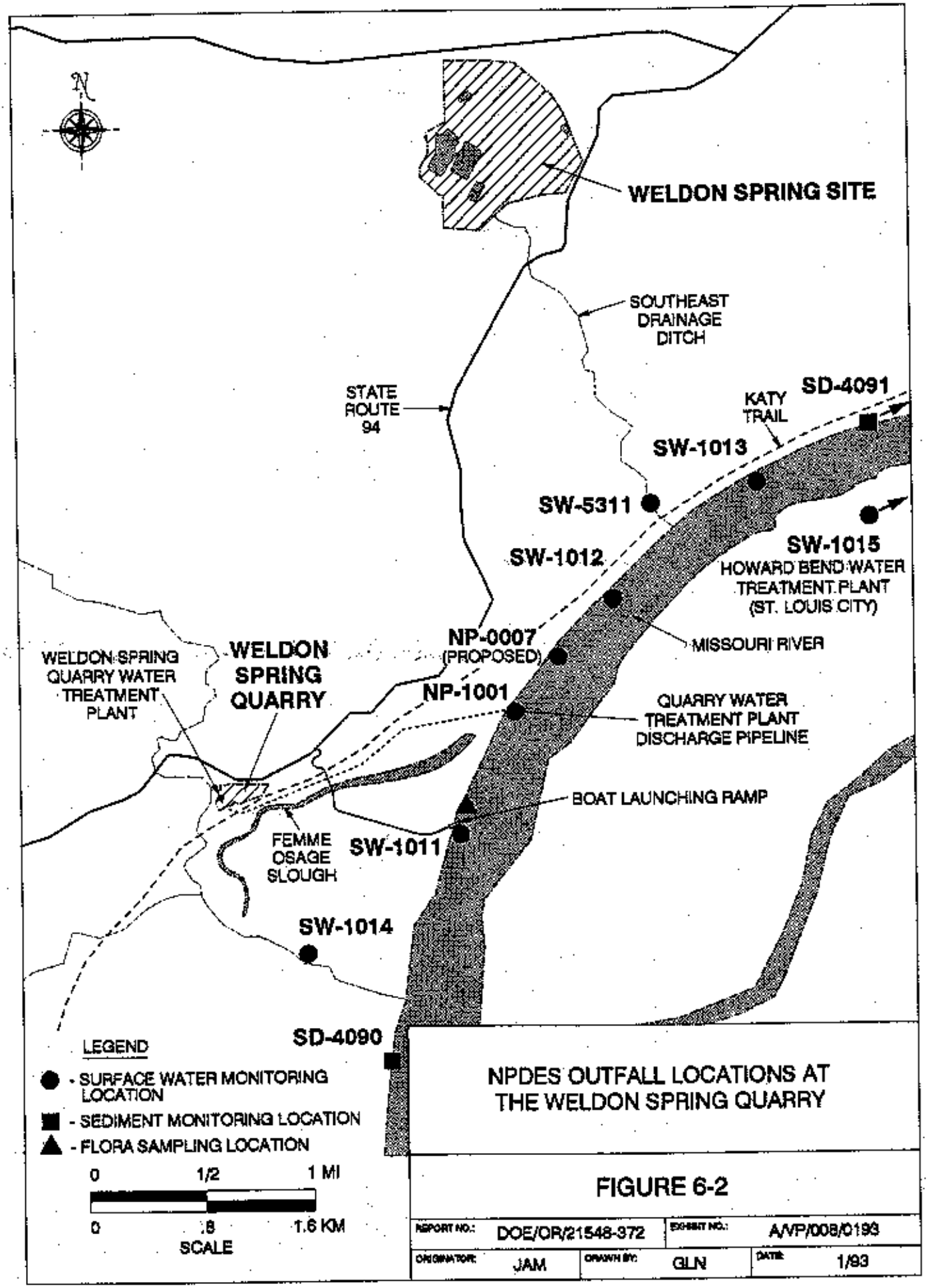
Storm water from the chemical plant/raffinate pits was discharged via wet weather tributaries south to the Missouri River and north to Schote Creek. The sanitary sewage treatment plant effluent and site water treatment plant hydrostatic test water were discharged via the Southeast Drainage to the Missouri River. The site water treatment plant pipeline hydrostatic test water was discharged to wet weather tributaries to the Missouri River. There was no discharge from the site water treatment plant in 1992.

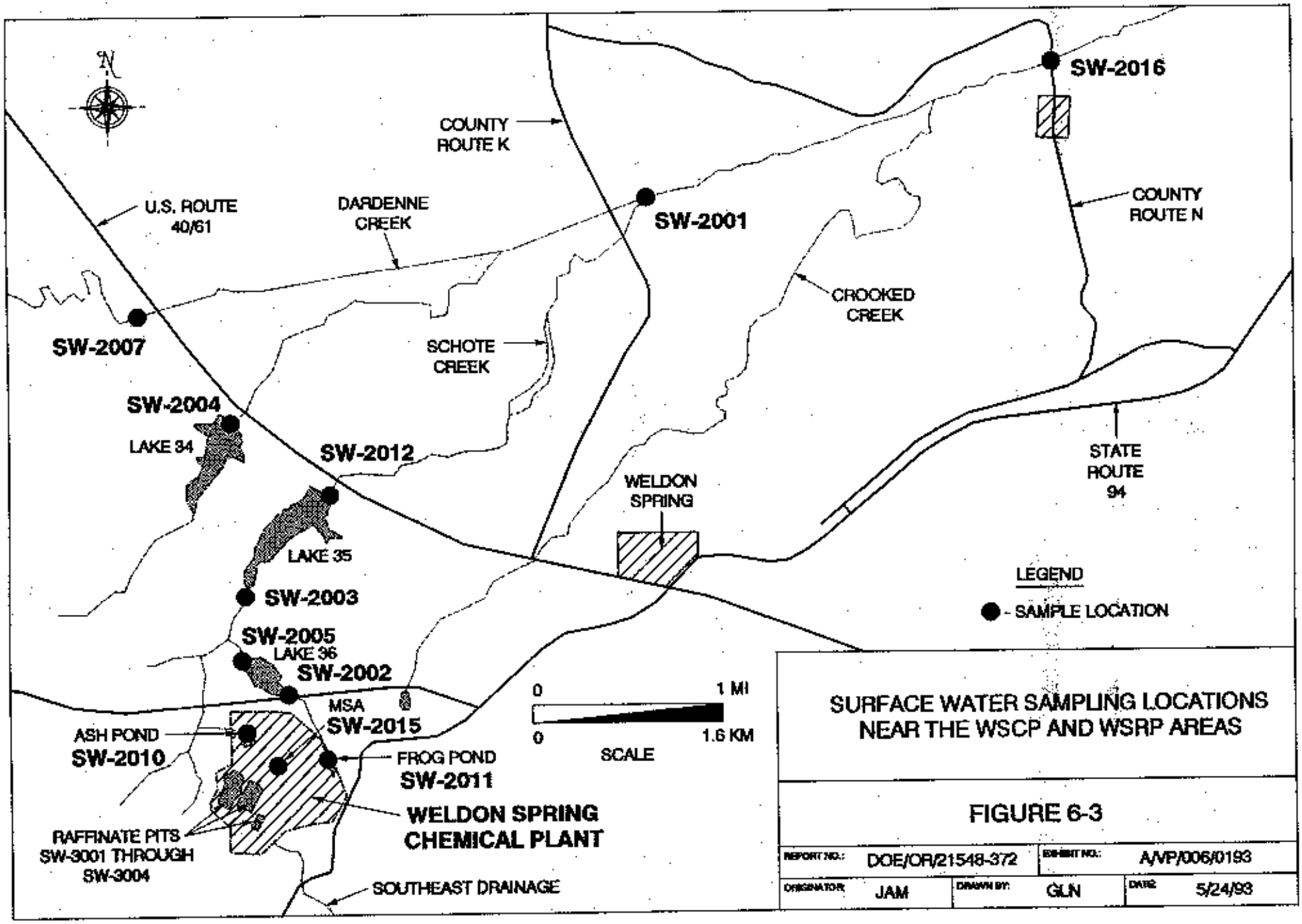
The Weldon Spring Quarry has one NPDES outfall, NP-1001, for treated water from the quarry water treatment plant, which was constructed to support remedial activities. This outfall is located on the Missouri River at approximately river mile 47.5 (Figure 6-2). Treated water from the plant was discharged directly to the Missouri River. Hydrostatic test water from the plant was discharged under two separate permits. Test water from the plant was discharged to Little Femme Osage Creek, and test water from the effluent pipe line was discharged directly to the Missouri River.

6.1.2 Surface Water

The surface water surveillance program was established to monitor the levels of radiological and chemical contaminants in surface water bodies at the Weldon Spring site and in downgradient rivers, streams, lakes, and surface water bodies affected by either surface run-off or groundwater seepage from the site.

6.1.2.1 Chemical Plant, Raffinate Pits, and Vicinity Properties. Eleven surface water locations were monitored to evaluate water bodies downgradient of the contaminated water sources at the chemical plant/raffinate pits (Figure 6-3). These locations included Ash Pond (SW-2010) and Frog Pond (SW-2011) at the chemical plant. At the August A. Busch Wildlife Area, Lake 34 (SW-2004), Lake 35 (SW-2003 and SW-2012), Lake 36 (SW-2002 and SW-2005), and Dardenne Creek (SW-2001, SW-2007, and SW-2016) were monitored. Surface water location SW-2015 is a holding pond at the material storage area (MSA) at the chemical plant. The holding pond receives rain water discharge from the MSA. Each location except the


N
WELDON SPRING SITE
SOUTHEAST DRAINAGE DITCH
STATE ROUTE 94
KATY TRAIL
SD-4091
SW-1013
SW-5311
SW-1015
HOWARD BEND WATER TREATMENT PLANT (ST. LOUIS CITY)
SW-1012
MISSOURI RIVER
NP-0007 (PROPOSED)
NP-1001
WELDON SPRING QUARRY WATER TREATMENT PLANT
WELDON SPRING QUARRY
QUARRY WATER TREATMENT PLANT DISCHARGE PIPELINE
BOAT LAUNCHING RAMP
FEMME OSAGE SLOUGH
SW-1011
SW-1014
SD-4090
LEGEND
- SURFACE WATER MONITORING LOCATION
- SEDIMENT MONITORING LOCATION
- FLORA SAMPLING LOCATION
0 1/2 1 MI
0 .8 1.6 KM
SCALE
NPDES OUTFALL LOCATIONS AT THE WELDON SPRING QUARRY
FIGURE 6-2
REPORT NO.: DOE/OR/21548-372
EXHIBIT NO.: A/VP/008/0193
ORIGINATOR: JAM
DRAWN BY: GLN
DATE: 1/93



SURFACE WATER SAMPLING LOCATIONS NEAR THE WSCP AND WSRP AREAS

FIGURE 6-3

REPORT NO.:	DOE/OR/21548-372	EXHIBIT NO.:	A/VP/006/0193		
ORIGINATOR:	JAM	DRAWN BY:	GLN	DATE:	5/24/93

raffinate pits was sampled quarterly for total uranium, and annually for nitrate, sulfate, metals including the toxicity characteristic metals (beryllium, thallium, and antimony), and radiological parameters including Ra-226, Ra-228, Th-230, and Th-232. Additionally, the four raffinate pits (SW-3001 through SW-3004) were sampled annually for nitrate, sulfate, total uranium, and the radiological parameters, Ra-226, Ra-228, Th-230, and Th-232.

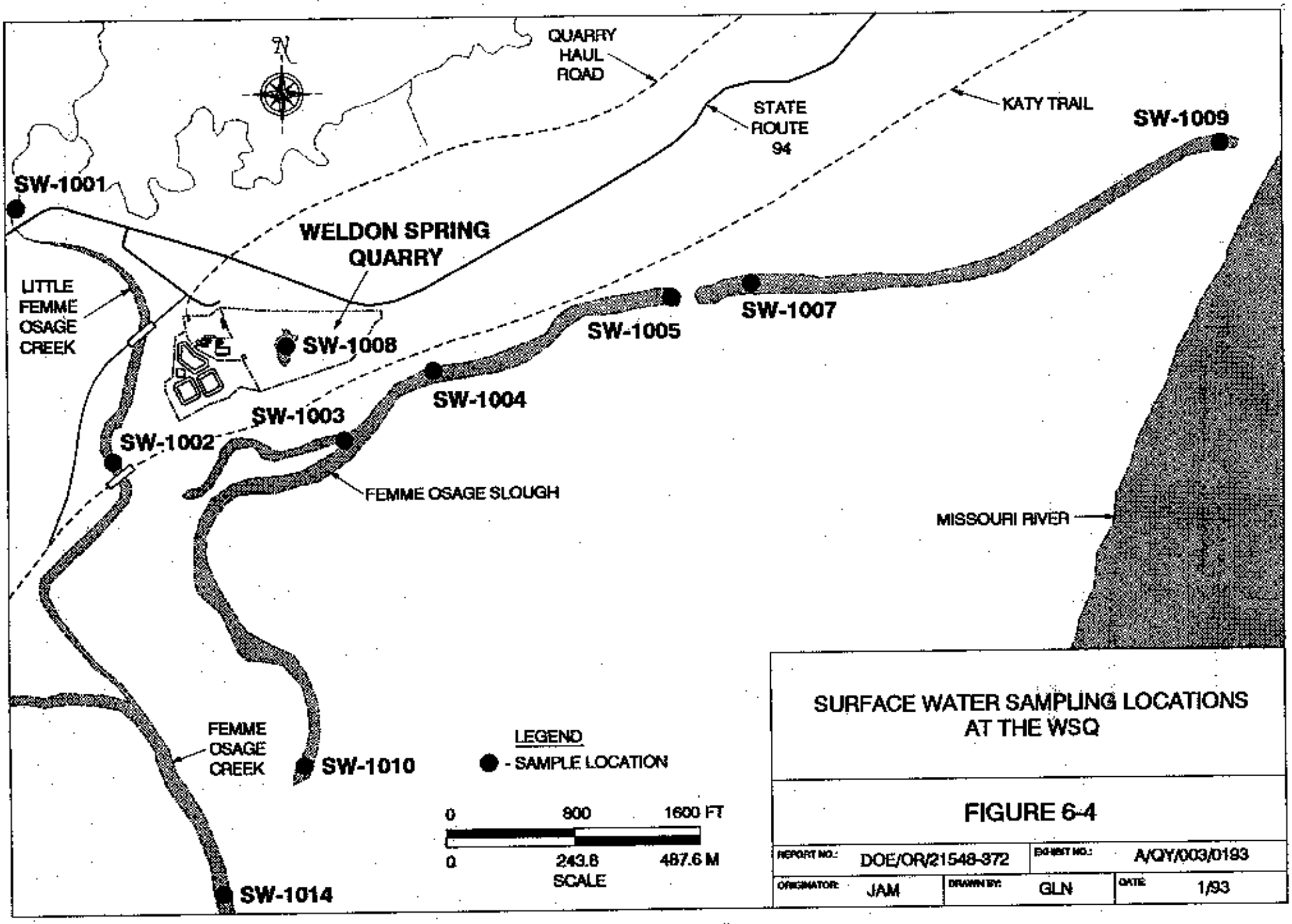
6.1.2.2 Weldon Spring Quarry. Thirteen surface water locations which have been, or could potentially be, impacted by groundwater seepage were monitored at the quarry and surrounding areas (Figures 6-2 and 6-4). Surface waters monitored were the Little Femme Osage Creek (SW-1001 and SW-1002), the Femme Osage Creek (SW-1014), the Femme Osage Slough (SW-1003 through SW-1005, SW-1007, SW-1009, and SW-1010), the Missouri River (SW-1011 through SW-1013) and the quarry pond (SW-1008). These locations were sampled bimonthly (every other month) for total uranium and annually for Ra-226, Ra-228, Th-230, Th-232, gross alpha, gross beta, nitroaromatics, nitrate, sulfate, arsenic, and barium. The quarry pond (SW-1008) was sampled bimonthly for all parameters noted above, except arsenic and barium were sampled once in 1992.

Beginning in August 1992, monitoring location SW-1007 (in the Femme Osage Slough) and several monitoring wells at the quarry were sampled more frequently due to elevated total uranium concentrations in a shallow groundwater monitoring well (MW-1011) adjacent to the Femme Osage Slough. Location SW-1007 was sampled to determine if there was a correlation between total uranium concentrations in the slough and the shallow groundwater.

6.2 Applicable Standards

6.2.1 Effluent Monitoring

The WSSRAP is subject to, and complies with, Executive Order 12088 which requires all Federal facilities to comply with applicable pollution control standards. Effluent discharges from the site are authorized by seven NPDES permits issued by the Missouri Department of Natural Resources (MDNR). The MDNR requires specific parameters to be sampled under the permits. Each parameter is assigned effluent limits or a "monitoring only" status. "Monitoring only" is a status where concentrations are reported but not limited by the permit. The sampling frequency and reporting requirements are also specified in the permits and are summarized in



SURFACE WATER SAMPLING LOCATIONS AT THE WSQ

FIGURE 6-4

REPORT NO.:	DOE/OR/21548-372	EXHIBIT NO.:	A/QY/003/0193		
ORIGINATOR:	JAM	DRAWN BY:	GLN	DATE	1/93

Tables 6-1 through 6-3. Priority pollutant monitoring is required at both the quarry and site water treatment plant NPDES locations on an annual basis. The list of priority pollutants required for analysis is shown in Appendix D.

Effluent is also regulated by DOE Order 5400.5 which requires a limit of 600 pCi/l for natural uranium. This limit is known as the derived concentration guideline (DCG). The DCG estimate is presented in Section 4.

6.2.2 Surface Water Monitoring

Surface water monitoring is performed under the requirements of the Federal environmental protection laws and requirements and internal DOE policies. DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, designates the DCGs for ingestion of drinking water as:

Natural Uranium	600 pCi/l
Thorium-230	300 pCi/l
Thorium-232	50 pCi/l
Radium-226	100 pCi/l
Radium-228	100 pCi/l

Selected parameters listed in the Missouri Water Quality Standards (Missouri Clean Water Commission Regulation 10 CSR 20-7.031) are also monitored (Table 6-4). The Proposed U.S. Environmental Protection Agency (EPA) drinking water standards for radionuclides that occur at the Weldon Spring site are also summarized in Table 6-4. These regulatory levels are used as a gauge to evaluate the contaminant levels in the surface water. MCLs and other drinking water standards are used as references by the WSSRAP, but are not directly applicable because the affected surface water does not represent a public drinking water supply, as defined in EPA 40 CFR, Section 141.1, Subpart A.

TABLE 6-1 Weldon Spring Chemical Plant Storm and Sanitary Water (NPDES Permit MO-0107701) Monitoring Requirements

Parameter	NP-0002, NP-0003, NP-0005 Frequency = once/month	NP-0001, NP-0004 Frequency = once/quarter	NP-0006 Frequency = once/quarter[e]
Flow	Monitor GPD	Monitor GPD	Monitor GPD
Settleable Solids	1.0 ml/l/hr[c]	1.0 ml/l/hr [c]	———
Total Suspended Solids (TSS)	Monitor mg/l[d]	Monitor mg/l [d]	15/20 mg/l [a]
Nitrate as N	Monitor mg/l	Monitor mg/l	———
Lithium	Monitor mg/l	Monitor mg/l	———
Uranium	Monitor mg/l	Monitor mg/l	———
Gross Alpha	Monitor pCi/l	Monitor pCi/l	———
pH	6 - 9 SU [c]	6 -9 SU[c]	6 - 9 SU
Fecal Coliform	———	———	400/1,000 colonies/ 100 ml [b]
Biochemical Oxygen Demand	———	———	10/15 mg/l[a]

(a) Monthly average/weekly average
(b) Monthly average/daily maximum
(c) Limits apply after date of Record of Decision, "monitoring only" requirements apply until that date.
(d) Limit is 50 mg/l if erosion control is not designed for 1 in 10 year, 24 hour storm.
(e) Frequency is once/month for NP-0006 flow monitoring.

TABLE 6-2 Treated Effluent Parameter Limits and Monitoring Requirements
Quarry Water Treatment Plant (NPDES Permit MO-0108987)
Site Water Treatment Plant (NPDES Permit MO-0107701)

Parameter	NP-0007, NP-1001, SW-5311[a]	River Water SW-1011, SW-1012, SW-1013, SW-1015[c]
Gross Alpha	Monitor pCi/l	Monitor pCi/l
Gross Beta	Monitor pCi/l	Monitor pCi/l
Uranium, Total [d]	Monitor pCi/l[b]	Monitor pCi/l
Radium-226	Monitor pCi/l	Monitor pCi/l
Radium-228	Monitor pCi/l	Monitor pCi/l
Thorium-230	Monitor pCi/l	Monitor pCi/l
Thorium-232	Monitor pCi/l	Monitor pCi/l
Flow	Monitor GPD	NR
Biochemical Oxygen Demand	Monitor mg/l	NR
Chemical Oxygen Demand	90/60 mg/l[e]	NR
Total Suspended Solids	50/30 mg/l[e]	NR
pH	6 - 9 SU	NR
Arsenic, Total	0.10 mg/l	NR
Barium, Total	1.50 mg/l	NR
Cadmium, Total	0.02 mg/l	NR
Chromium, Total	0.10 mg/l	NR
Copper, Total	1.00 mg/l	NR
Iron, Total	0.60 mg/l	NR
Lead, Total	0.10 mg/l	NR
Manganese, Total	0.10 mg/l	NR
Mercury, Total	0.004 mg/l	NR
Selenium, Total	0.02 mg/l	NR
Silver, Total	0.10 mg/l	NR
Zinc, Total	5.00 mg/l	NR
Cyanide, Total	0.0075 mg/l	NR
Asbestos	Monitor fibers/l	NR
2,4-DNT	0.22 µg/l	NR
Fluoride, Total	4.0 mg/l	NR

TABLE 6-2 Treated Effluent Parameter Limits and Monitoring Requirements Quarry Water Treatment Plant (NPDES Permit MO-0108987) Site Water Treatment Plant (NPDES Permit MO-0107701) (Continued)

Parameter	NP-0007, NP-1001, SW-5311[c]	River Water SW-1011, SW-1012, SW-1013, SW-1015[c]
Nitrate as N	20 mg/l / Monitor at Quarry	NR
Sulfate as SO_4	500 mg/l	NR
Chloride	Monitor mg/l	NR
Priority Pollutants	Monitor mg/l	NR
Whole Effluent Toxicity	10% Mortality	NR
Polonium 210 (Quarry only)	Monitor[e]	NR
Actinium 227 (Quarry only)	Monitor[e]	NR
Radon (Quarry only)	Monitor[e]	NR

(a) Daily maximum/monthly average
(b) Water will not be discharged if greater than 100 pCi/l
(c) Grab samples are analyzed once per batch
(d) Uranium in Missouri River sediments (SD-4090 and SD-4091) and terrestrial and aquatic flora are monitored up and downstream of QWTP Outfall on a semi-annual basis.
(e) Semi-annual monitoring.
NR No monitoring requirements

TABLE 6-3 Hydrostatic Test Water Effluent Limits and Monitoring Requirements for the QWTP, SWTP, QWTP Pipeline, SWTP Pipeline[a]

Parameter	Permit Limit Frequency = once/batch
Flow	Monitor-Total Gallons
Oil and grease	15 mg/l
Total suspended solids	50 mg/l

(a) NPDES permits MO-G680001, MO-G680002, MO-G680004 and MO-G680005, respectively.

QWTP = Quarry Water Treatment Plant

SWTP = Site Water Treatment Plant

TABLE 6-4 Regulatory Drinking Water Standards for Surface Water Monitoring

Parameter	Concentration mg/l	Standards
Antimony	0.006	MDWS
Arsenic[a]	0.05	MDWS
Barium[a]	1.0	MDWS
Beryllium	0.004	MDWS
Cadmium[a]	0.01	MDWS
Chromium[a]	0.05	MDWS
Cobalt	NS	MDWS
Copper[b]	1.0	MDWS
Iron[b]	0.3	MDWS
Nitrate (as N)[a]	10	MDWS
Sulfate[b]	250	MDWS
Chloride[b]	250	MDWS
Lead	0.05	MDWS
Manganese[b]	0.05	MDWS
Mercury	0.002	MDWS
Nickel	0.1	MDWS
Selenium	0.01	MDWS
Silver	0.05	MDWS
Thallium	NS	MDWS
Uranium	0.02	MDWS
Zinc[b]	5.0	MDWS
Fluoride	2.2	MDWS
TDS[b]	500	MDWS
2,4-DNT	0.00011	MDWS
Adjusted gross alpha	15 pCi/l	MDWS
Ra-226	20 pCi/l (proposed)	EPA
Ra-228	20 pCi/l (proposed)	EPA
Rn-222	300 pCi/l (proposed)	EPA
Uranium total (proposed)	20.0 µg/l (13.6 pCi/l)	EPA

(a) Primary maximum contaminant level
(b) Secondary maximum contaminant level
NS No drinking water standard
MDWS Missouri drinking water standards
EPA EPA Drinking Water Standards for Radionuclides

6.3 Monitoring Results

6.3.1 NPDES Monitoring Results

6.3.1.1 Radiological Analysis. Annual average uranium concentrations at the storm water discharge points ranged from 6.0 pCi/l (0.2 Bq/l), which is 1% of the DCG, at NP-0004 to 516 pCi/l (19.1 Bq/l), which is 86% of the DCG, at NP-0001. Annual average gross alpha concentrations range from 15 pCi/l (0.6 Bq/l) at NP-0004 to 435 pCi/l (16.1 Bq/l) at NP-0003. The annual average radionuclide concentrations for all the storm water outfalls are shown in Table 6-5.

On November 19, 1992, samples of treated water were collected from Effluent Pond 2 at the quarry water treatment plant. Uranium was not detected in the sample. The results of that sampling event are included here even though the water was not discharged in 1992 (Table 6-6). Water from the quarry water treatment plant is discharged at outfall NP-1001 to the Missouri River.

In addition to the above, hydrostatic test water was discharged from the quarry water treatment plant, basins, and effluent pipeline; from the site water treatment plant, basins and effluent pipeline; and from the temporary storage area (TSA) basin. Storm water was also discharged from the TSA basin. Hydrostatic test water was discharged from uncontaminated areas only and therefore radiological monitoring was not a requirement of these NPDES permits. The TSA basin water was discharged and monitored as storm water and hydrostatic test water. The MDNR gave permission in 1992 to discharge from the TSA basin to a drainage channel on the west side of the basin since it was impractical to discharge to a permitted outfall. The annual average uranium and gross alpha concentration of TSA effluent were 3.5 pCi/l (0.13 Bq/l) and 4.6 pCi/l (0.17 Bq/l), respectively.

Estimated quantities of total uranium released off site through surface water runoff are presented in Table 6-7. As a result of a review of watershed areas and runoff numbers, the parameters used for calculating the total uranium released are more conservative than those used in previous years; therefore, the figures are higher. The runoff curve numbers were calculated from data contained in *WSSRAP Chemical Plant Surface Water and Erosion Control Report*

TABLE 6-5 1992 Annual Average NPDES Results for Weldon Spring Chemical Plant Storm Water Outfalls

Location	No. of Samples	pH Range	Total Uranium (pCi/l)	Gross Alpha (pCi/l)	Nitrate (mg/l)	Lithium (µg/l)	Suspended Solids (mg/l)	Settleable Solids (ml/l/hr)	Oil and Grease (mg/l)
NP-0001	6	6.01 - 7.38	518 184-1090 275	406 150-732 174	0.49	<58	31	<0.1	NR
NP-0002	12	5.7 - 8.27	228 100-437 89	212 97-310 260	8.62	<49	18	<0.1	NR
NP-0003	13	6.3 - 7.98	478 32-1680 300	463 30-1590 513	1.75	<63	20	<0.1	NR
NP-0004	1[a]	7.10 - 8.56	6 -- --	10 -- --	360[b]	<39	51	<0.1	NR
NP-0005	13	5.46 - 8.13	296 55-510 139	275 70-460 115	18.3	<55	170	0.15	NR
NP-TSAB	8	5.8 - 8.33	3.5 0.95-6.4 1.8	4.6 N.D.(2)-12 4.2	1.3	11.3	84	<0.1	<5

(a) No flow meeting permit constraint of collecting water 4 - 10 days after storm event during three quarters.

(b) When suspect December 9, 1992, value is deleted the only remaining value is 0.570 mg/l.

SD = standard deviation

TABLE 6-6 Analytical Results for Limited Parameters and Radionuclides Quarry Water Treatment Plant Effluent Outfall NP-1001 - Batch No. 001 NPDES Permit MO-0108987

Parameter	Concentration µg/l[a]
COD	1.0 mg/l
TSS	<2.0 mg/l
Arsenic	<20.0
Barium	3.0
Cadmium	<5.0
Chromium	<8.0
Copper	<17.0
Iron	126
Lead	<2.0
Manganese	8.00
Mercury	<0.10
Selenium	<1.0
Silver	<1.0
Zinc	<15.0
Cyanide	<5.00
2,4-DNT	<0.019
Fluoride	<0.05 mg/l
Nitrate as N	<0.02 mg/l
Sulfate as SO_4	28.0 mg/l
Chloride	29.3 mg/l
Gross alpha	<2 pCi/l
Gross beta	7.0 pCi/l
Uranium	<0.2 pCi/l
Ra-226	<0.3 pCi/l
Ra-228	1.1 pCi/l
Th-228	<0.4 pCi/l
Th-230	<0.4 pCi/l
Th-232	<0.4 pCi/l

(a) Unless otherwise noted.

COD = Chemical Oxygen Demand

TABLE 6-7 1992 Estimated Annual Release of Natural Uranium from NPDES Outfalls

Outfalls	Drainage Area Acres[a]	% of precipitation as Runoff[e]	Average Concentration pCi/l	Total Rainfall Volume Mgal/yr	Total Runoff Mgal/yr	Total U[b] Release Ci/yr	Total U[c] Release Kg/yr (R)
NP-0001 and NP-0005	20.2	90 (50)[f]	351[a]	18.36	16.44	.02184	32.08
NP-0002	76.1 (57.3)[f]	79 (28.9)[f]	228	68.27	53.93	.04654	68.37
NP-0003	74.6 (60.1)[f]	69 (28)[f]	514	67.82	46.80	.084671	124.38
NP-0004	5.6	81 (51)[f]	6	5.09	4.12	.00009	0.14
NP-1001	--	--	.00015[d]	--	.512	2.9×10^{-8}	4.3×10^{-7}
Totals	175.5	--	–	159.54	121.29	.1531	224.97

(a) Assuming flow at NP-0005 is 3 times flow at NP-0001 (conservative).
(b) 3.785×10^{-6} x average concentration (pCi/l) x total runoff (Mgal/yr), constant is conversion factor.
(c) 5.56×10^{-3} x average concentration (pCi/l) x total runoff (Mgal/yr), constant is conversion factor.
(d) One half the detection limit.
(e) Runoff curve number.
(f) Values used in calculating 1991 total uranium releases.

(MKES 1991) and are higher than those used in previous years. The change is a result of recalculating the numbers and does not represent any physical change to the project. Also, the estimated watershed included the entire watershed contributing to the outfall which increased the figure for the annual storm water runoff. Previous estimates of watershed area did not include off-site areas or some of the minor on-site subwatersheds. The total uranium released from outfall NP-1001, the treated quarry water treatment plant effluent, was negligible (Table 6-7). It appears that the total uranium released has increased, but on the basis of the average uranium concentrations at the outfalls and precipitation, total uranium released for 1992 is similar to that released in 1991.

Annual average uranium concentrations in NPDES outfalls from 1988 through 1992 are shown in Table 6-8. Concentrations in 1992 increased at outfalls NP-0001 through NP-0003, decreased at outfall NP-0005, and did not change at outfall NP-0004 compared to 1991 concentrations. Each outfall is discussed below:

TABLE 6-8 Annual Average Uranium Concentrations at NPDES Outfalls 1988 - 1992

Uranium Concentrations pCi/l					
Outfall Location	1988	1989	1990	1991	1992
NP-0001	539	368	413	475	516
NP-0002	141	145	139	159	228
NP-0003	1,178	280	89	456	478
NP-0004	6	7	8	6	6
NP-0005	497	347	364	581	296
NP-1001	--	--	--	--	<0.0003

- The average uranium concentrations at NP-0001 increased slightly for 1992. The outfall is scheduled to be eliminated in 1993.

- The average uranium concentration has increased at outfall NP-0002, but remains below the DCG. Increased work activity in the watershed may account for the increased uranium levels.

- Uranium levels at outfall NP-0003 have increased. Three measurements in February and March were over 1,000 pCi/l, which contributed to the increase. The higher levels are the result of discharges from Ash Pond caused by snow melts, lower evaporation rates, and greater precipitation during these months.

- Uranium levels at NP-0004 have been consistent over the last 5 years at less than 10 pCi/l. The NPDES permit requires that samples be collected 4 to 10 days after a storm event. The low uranium levels indicate that the seepage from the raffinate pit at NP-0004 is not significant.

- Average annual uranium levels at NP-0005 have decreased to the lowest level since annual averages were recorded in 1987. The reduction is due to contaminated material and soil being removed from the area of the watershed where the site water treatment plant is located and the effective erosion control measures implemented in the area.

Radium and thorium were monitored one time at storm water outfalls NP-0002, NP-0003, NP-0004, and NP-0005 and for the single batch of treated water at the quarry water treatment plant. Radium and thorium measured highest at outfall NP-0005 with values of 9.1 pCi/l for Ra-226, 4.3 pCi/l for Ra-228, 2.0 pCi/l for the Th-228, 3.3 pCi/l for Th-230 and 1.2 pCi/l for Th-232. Thorium was not detected in the quarry water treatment plant effluent and radium was measured at 0.2 pCi/l for Ra-226 and 1.1 pCi/l for Ra-228. All radium and thorium data are presented in Appendix B as monthly averages.

6.3.1.2 Physical and Chemical Results. Physical analyses (settleable solids and total suspended solids) and chemical analyses (nitrate, pH, lithium, oil, and grease) were performed on storm water and hydrostatic test water samples. Additional parameters were monitored in the quarry water treatment plant effluent and in storm water samples collected for required permit application analyses.

6.3.1.2.1 Chemical Plant Storm Water. The annual averages for the physical and chemical parameters for storm water outfalls NP-0001 through NP-0005 and the TSA basin water are shown in Table 6-5. All other parameters are reported in Appendix D.

Settleable solids require "monitoring only" in the permit and will not have an established discharge limit until the *Record of Decision* (ROD) for the chemical plant area is reached. Fifty-three of 55 analyses for settleable solids in 1992 were 0.1 ml/l/hr or less. On February 6, 1992, settleable solids were 60.0 ml/l/hr at NP-0005 due to a water line break at an off-site area. Other than the water from the break, there was no natural runoff flow. On November 3, 1992, settleable solids were 1.1 ml/l/hr at outfall NP-0005. This was attributed to the construction activities at the site water treatment plant. Additional erosion control measures were added at that water treatment plant in response to the analytical results.

Total suspended solids (TSS) is also a "monitoring only" requirement in the NPDES permit for the five storm water outfalls, but only if erosion control is in place and designed for a 1 in 10 year, 24 hour storm. Otherwise, a TSS limit of 50 mg/l applies. Erosion control is designed and in place for a 1 in 10 year, 24 hour storm at the WSSRAP. TSS decreased in 1992 at outfalls NP-0001 through NP-0004 as compared to 1991 averages. TSS increased at outfall NP-0005 over the 1991 averages because of land disturbance during construction of the site water treatment plant. The average (without the 1,890 mg/l value due to the water line break on February 6, 1992) was 170.0 mg/l versus the 1991 average of 30 mg/l.

The pH of storm water is a "monitoring only" requirement in the NPDES permits if erosion control is in place and designed for a 1 in 10 year, 24 hour storm. Otherwise pH must be in the range of 6.0 to 9.0. The required erosion control is in place. After the ROD, the pH will have a permitted range of 6.0 to 9.0. In 1992, pH was in the range of 6.0 to 9.0 except for three instances where the values were slightly below 6.0 (5.7, 5.8, and 5.9). Two of the values were recorded for storm water measured on the same day (February 24, 1992), with a third pH on that day of 6.0. Since it is unlikely that storm water from three sources would be low in pH, a malfunction of the meter on that day is the suspected cause. Calibration records were checked and the meter was found to have been properly calibrated. Only one other pH level was below 6.0, a 5.8 pH was measured in water from the TSA basin on September 29, 1992.

Nitrate as nitrogen (N) is a "monitoring only" requirement for storm water in the NPDES permits. The annual averages for 1992 were slightly lower than the 1991 averages at NP-0001 and NP-0003. The averages at NP-0002 and NP-0005 were slightly higher, and the average at NP-0004 was significantly higher. The average at NP-0004 is suspect since nitrate values of 562 mg/l (grab) and 516 mg/l (composite) were recorded for samples collected on December 9, 1993. The historical high for nitrate at NP-0004 was on an order of magnitude lower. Another suspect sample was collected from a TSA basin discharge in the same month, and a nitrate value of 745 mg/l was reported. This result was later found by the laboratory to be in error. A nitric acid preserved sample had been analyzed for nitrate by mistake. These high values are currently being verified with the contract laboratory. Only one other sample was collected at NP-0004 with a nitrate as N value of 0.570 mg/l. No other circumstances were noted that could have resulted in these high nitrate values.

Lithium is a monitoring only parameter for storm water in the NPDES permit and was detected only at outfall NP-0005. In nine out of 14 samples at outfall NP-0005, no lithium was detected above a detection limit of 100 μg/l. The highest detected value was 142 μg/l on February 6, 1992, the day a water line broke and TSS was 9,890 mg/l. The next highest value was 39.0 μg/l.

6.3.1.2.2 Administration Building Sewage Treatment Plant. The sanitary sewage treatment plant serving the administration and composite building is discharged to outfall NP-0006. The NPDES permit authorizing the discharge requires quarterly monitoring. In 1992, NP-0006 was out of compliance once with TSS limits and once with biochemical oxygen demand

(BOD). TSS was 23.0 mg/l on February 12, 1992, which exceeded the monthly average limit of 15 mg/l and the weekly average limit of 20 mg/l. On March 4, 1992, BOD was 11.6 mg/l and on March 27, 1992, BOD was 13.0 mg/l which caused the monthly average limit of 10.0 mg/l to be exceeded. Operational controls were modified by the subcontractor to bring the treatment plant into compliance. No other noncompliances were noted. Beginning in late September, sewage was removed by a subcontractor, and the discharge temporarily eliminated while a flow equalization system was added to the plant to improve operations. The plant did not discharge for the remainder of 1992.

6.3.1.2.3 Preoperational Monitoring. Preoperational monitoring of the Missouri River surface water was conducted in 1992 at sample locations SW-1011 through SW-1013. Preoperational sediment samples were collected at locations SD-4090 and SD-4091 for total uranium. The results showed 1.4 pCi/g and 1.2 pCi/g for the sediment samples. These results may be found in Appendix B. Preoperational monitoring of radiological parameters was also conducted on surface water at the mouth of the Southeast Drainage (SW-5311) to monitor the effect of any future potential discharges from the site water treatment plant. The monitoring results are located in Appendix A.

The Missouri River was monitored for radionuclides in conjunction with the release of Batch 001 from the quarry water treatment plant. The batch was released in January 1993, and data will be presented in the 1993 site environmental report. The data will also be published in the Quarterly Environmental Data Summary - First Quarter of 1993.

6.3.2 Surface Water Monitoring Results

6.3.2.1 Surface Water at the Weldon Spring Quarry. The surface water monitoring locations at the Weldon Spring Quarry were sampled for total uranium, Ra-226, Ra-228, Th-228, Th-230, Th-232, gross alpha, and gross beta in 1992. The average uranium values continued to indicate that the highest levels for surface water are found in the quarry pond (SW-1008), which is within the quarry area, and the portion of the Femme Osage Slough (SW-1003, SW-1004, SW-1005, SW-1010) downgradient of the quarry. The annual averages for the surface water locations are summarized in Table 6-9. The uranium levels in the quarry pond remained within historical ranges. The uranium levels in the Little Femme Osage Creek

TABLE 6-9 Annual Averages for Total Uranium, Gross Alpha, Gross Beta and Isotopic Radionuclides (pCi/l) 1992

Monitoring Location	Total Uranium	Gross Alpha	Gross Beta	Ra-226	Ra-228	Th-228	Th-230	Th-232
SW-1001	0.91	< 2.00	8.90	< 0.20	< 0.90	< 0.20	4.80	< 0.20
SW-1002	1.50	NS	NS	NS	NS	NS	NS	NS
SW-1003	50.0	77.0	72.0	< 0.20	< 0.80	< 0.20	2.20	< 0.20
SW-1004	89.8	180	140	0.40	1.40	< 0.20	2.10	< 0.20
SW-1005	24.5	30.0	28.0	< 0.20	< 0.90	< 0.20	1.50	< 0.20
SW-1007	12.0	17.0	14.0	< 0.20	1.30	< 0.20	0.30	< 0.20
SW-1008	753	1048	484	0.73	4.43	0.29	0.75	< 0.44
SW-1009	8.74	12.0	19.0	0.60	< 0.90	< 0.20	< 0.20	< 0.20
SW-1010	43.6	NS	NS	NS	NS	NS	NS	NS
SW-1011	5.33	10	14	1.10	2.60	0.60	1.80	0.80
SW-1012	3.88	NS	NS	NS	NS	NS	NS	NS
SW-1013	4.57	NS	NS	NS	NS	NS	NS	NS
SW-1014	2.08	NS	NS	NS	NS	NS	NS	NS

NS = not sampled or not scheduled for sampling in 1992

(SW-1001 and SW-1002) and the Femme Osage Creek (SW-1014) remained close to the background level of 2.17 pCi/l for total uranium. The uranium levels in the Missouri River (SW-1011, SW-1012, and SW-1013) also remained within the background level of 4.10 pCi/l.

The DCG of 600 pCi/l for total uranium in discharge water is established in DOE Order 5400.5. This level is used as a referenceable criterion for the quarry pond because the pond is a source of potential contamination of the St. Charles County well field. The annual average for uranium from the quarry pond was 126% of the DCG (753 pCi/l).

The DCG for total uranium in drinking water systems is 24 pCi/l. This criterion was used for the Missouri River because the river is a source of drinking water. This value was not exceeded in any of the Missouri River samples.

The quarry surface water locations were sampled once for gross alpha and gross beta, except for the quarry pond (SW-1008), which was sampled bimonthly. The results for these locations were within historical ranges. Elevated levels are concentrated in the western portion of the Femme Osage Slough and the quarry pond. The annual averages are summarized in Table 6-9. The Missouri Drinking Water Standard of 5 pCi/l for gross alpha and 50 pCi/l for gross beta were exceeded in the quarry pond (SW-1008).

The DCGs for isotopic radium and thorium, as established by DOE Order 5400.5, were not exceeded at any of the surface water locations monitored during 1992. The Missouri Drinking Water Standard of 5 pCi/l for combined Ra-226 and Ra-228 was exceeded only one time within the quarry pond (SW-1008) adjacent to the source material with a value of 15.942 pCi/l.

Isotopic radium and thorium were analyzed once at surface water locations around the quarry and bimonthly at the quarry pond. The levels of these isotopes were within historic ranges with the highest concentrations reported from the western portion of the Femme Osage Slough and the quarry pond. The results for the monitoring locations are summarized in Table 6-9.

The quarry pond, SW-1008, was also sampled for other radionuclides. A summary of all the radiological isotopic concentrations in the quarry pond is presented in Table 6-10. These values indicate isotopic levels are within the expected ranges and ratios based on the isotopic levels in the quarry bulk wastes and the solubility of the isotopes in water. Radon levels are elevated due to the relatively short half-life of Rn-222 and its ability to migrate through the bulk wastes and become dissolved in the quarry pond water.

A study was performed to determine the variation in levels of radiological isotopes with respect to horizontal location at the pond, depth in the pond, and dissolved and undissolved contribution to the total concentration in the water. The analytical results are in Appendix A as SW-1008. The designations of "A," "B," or "C" indicate the location in the pond; the designations "03" or "08" indicate the depth below the surface; and the designation "F" indicates that the sample was filtered. The results of this study indicated that the contaminants in the quarry pond are homogeneous and are primarily dissolved in the water and not bound to suspended material within the water.

TABLE 6-10 Annual Averages of Isotopic Radionuclide in the Quarry Pond, SW-1008, 1992

Isotope	Concentration pCi/l
Actinium-227	< 3.54
Protactinium-231	< 0.43
Lead-210	42.2
Polonium-210	< 0.34
Ra-226	0.73
Ra-228	4.67
Rn-222	266
Th-228	<0.44
Th-230	0.81
Th-232	<0.44
U-234	378
U-235	38.0
U-238	500

Nitroaromatic compounds were at quarry surface water sampling locations. Two locations, the Little Femme Osage Creek (SW-1001) upstream from the quarry, and the quarry pond (SW-1008), indicated detectable concentrations of the six nitroaromatic compounds analyzed. The annual averages for these locations are summarized in Table 6-11. The concentrations within the quarry pond were within historic ranges for nitroaromatics. The only other instance where concentrations of nitroaromatics were detected at SW-1001 was in 1988. The origin of the nitroaromatics is linked to the former Weldon Spring Ordnance Works. The Little Femme Osage Creek was the drainage for the ordnance works area (Valley 5600), and previous sampling of several springs discharging to this valley have yielded detectable concentrations of nitroaromatic compounds. The Federal ambient water quality standard for surface water of 0.11 μg/l for 2,4-dinitrotoluene was exceeded only in the quarry pond.

All surface water monitoring locations at the quarry were sampled for nitrate and sulfate. The analyses indicated no notable nitrate concentrations. Nitrate concentrations were within

background in the Little Femme Osage Creek and the Femme Osage Creek. The annual averages for nitrate at the quarry are summarized in Table 6-12.

TABLE 6-11 Annual Averages at Monitoring Locations with Detectable Nitroaromatics Results (μg/l), 1992

Monitoring Locations	1,3,5 TNB	1,3 DNB	2,4,6 TNT	2,4 DNT	2,6 DNT	NB
SW-1001	<0.03	< 0.09	0.07	0.04	0.01	< 0.03
SW-1008	< 0.11	< 0.16	4.75	5.53	0.43	< 0.19

TABLE 6-12 Annual Averages for Inorganic Anions (mg/l), 1992

Monitoring Location	Nitrate	Sulfate	Monitoring Location	Nitrate	Sulfate
SW-1001	0.59	27.0	SW-1009	< 0.10	47.0
SW-1002	0.17	50.1	SW-1010	0.14	39.3
SW-1003	< 0.20	86.2	SW-1011	1.39	80.1
SW-1004	< 0.10	70.7	SW-1012	2.00	85.9
SW-1005	< 0.10	63.1	SW-1013	1.70	87.5
SW-1007	< 0.10	42.5	SW-1014	0.80	30.6
SW-1008	< 0.11	69.6			

Sulfate levels in surface water in the western portion of the Femme Osage Slough were elevated but within historic ranges. These elevated levels were likely due to the migration of water from the quarry sump via groundwater flow into the slough and are similar to the concentrations reported for the quarry pond. Sulfate levels in the Little Femme Osage Creek and the Femme Osage Creek remained similar to background levels. The annual averages for sulfate in surface waters at the quarry area are summarized in Table 6-12. The quarry pond was also sampled for chloride and fluoride in 1992. The results for chloride (11.3 mg/l) and fluoride (0.69 mg/l) were within historical ranges.

The maximum contaminant level (MCL) standards for nitrate (10 mg/l) and sulfate (250 mg/l) (Table 6-4) were not exceeded at any quarry locations in 1992. The MCL of 4 mg/l for fluoride and the secondary MCL of 250 mg/l for chloride were not exceeded in 1992 for the quarry pond.

The quarry surface water monitoring locations were also sampled for arsenic and barium in 1992. Arsenic levels were relatively uniform in the Femme Osage Slough and the quarry pond. The annual average concentrations in the Little Femme Osage Creek and the Femme Osage Creek were below detection limits. The annual averages for arsenic are summarized in Table 6-13.

TABLE 6-13 Annual Averages for Monitoring Locations with Detectable Metals Results (μg/l), 1992

Monitoring Location	Arsenic	Barium	Monitoring Location	Arsenic	Barium
SW-1001	< 2.00	90.1	SW-1009	< 2.00	123
SW-1002	< 2.00	80.9	SW-1010	< 2.00	60.7
SW-1003	2.29	89.4	SW-1011	4.79	302
SW-1004	< 2.00	65.7	SW-1012	< 2.00	261
SW-1005	3.79	120	SW-1013	4.50	219
SW-1007	2.20	125	SW-1014	< 2.00	77.8
SW-1008	3.70	85.2			

Barium levels in the western portion of the Femme Osage Slough were consistent with the annual average in the quarry pond. Elevated levels were reported for the eastern portion of the slough (SW-1007 and SW-1009) and at SW-1005 in the western portion, but all were within historic ranges. Barium annual averages are shown in Table 6-13. The annual averages for the Little Femme Osage Creek and the Femme Osage Creek were within background ranges. The MCLs for arsenic (50 μg/l) and barium (1,000 μg/l) (Table 6-4) were not exceeded at the quarry locations.

The quarry pond (SW-1008) was also sampled for cadmium, chromium, copper, iron, lead, manganese, mercury, selenium silver, and zinc in 1992. These metals were below detection limits as shown in Appendix B.

The quarry pond was sampled once for pesticides in 1992. Results indicate no detectable concentrations of pesticides are present.

The water quality characteristics of biochemical oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), and total suspended solids (TSS) were measured for the quarry pond. The results are summarized in Appendix B.

6.3.2.2 Surface Water at Weldon Spring Chemical Plant. The annual averages of the 1992 surface water monitoring program parameters for the Weldon Spring Chemical Plant and the raffinate pits and vicinity property are given in Appendix A. These data indicate that concentrations of the measured parameters generally remained within historical ranges.

Sampling locations SW-2001 and SW-2016, which are both downgradient from the chemical plant/raffinate pits, had metal, sulfate, and nitrate values similar to those of the background location (SW-2007) and to those of uncontaminated surface water within the region. Background values were also observed at locations SW-2002 through SW-2005 for nitrate, sulfate, and metals.

Uranium values are shown in Table 6-14. Uranium at SW-2001 and SW-2016 was similar to the background levels reported from SW-2007. Uranium values at SW-2002 through SW-2005 were significantly higher than background. Average values for 1992 ranged from 10.9 pCi/l at SW-2003 to 82 pCi/l at SW-2002. SW-2012 was not sampled in 1992 because of dry conditions.

The MSA basin (SW-2015) had uranium levels below the DCG level of 600 mg/l. Uranium levels at Frog Pond (SW-2011) were all above 200 pCi/l; the yearly average for this location was 247 pCi/l. Lead was detected in Frog Pond but was below the regulatory level of 0.05 mg/l. The former ordnance works site is a plausible source for the lead. Because lead is relatively insoluble under the surface water conditions at the site, this detection likely reflects the presence of lead sorbed onto suspended material. Surface water samples are not filtered per

TABLE 6-14 Annual Averages for Uranium and Anions in Surface Waters at The Weldon Spring Chemical Plant and Raffinate Pits in 1992

	Uranium, Total pCi/l	Nitrate mg/l	Sulfate mg/l
SW-2001	1.38	0.76	40.6
SW-2002	82.5	0.17	34.4
SW-2003	10.9	0.50	17/4
SW-2004	13.5	1.20	22.4
SW-2005	28.9	1.30	28.9
SW-2007	0.94	<0.10	24.8
SW-2010	2240	0.27	BKG
SW-2011	248	0.38	57.1
SW-2016	1.96	1.00	48.6
SW-3001	92.5	534	408
SW-3002	1110	103	800
SW-3003	205	1760	636
SW-3004	1600	0.12	67.3

BKG = at background levels

standard project procedures, thus concentrations of metals and uranium may vary as a function of the suspended sediment fraction in a surface water sample. Uranium values at Ash Pond (SW-2010) were extremely heterogeneous averaging 960 pCi/l and appear to be related to the length of time the water has been retained in the pond. Although uranium is elevated in Ash Pond and Frog Pond, nitrate, sulfate, and metals are below detection limits or within background ranges except for lead in Frog Pond.

Gross alpha and gross beta are bulk measurements of the total radiological content of surface water bodies (i.e., all radioactive elements that emit either alpha or beta particles contribute to these measurements). In all off-site surface water bodies, both gross alpha and gross beta were below detection limits. However, at Frog Pond (SW-2011) and Ash Pond

(SW-2010) these parameters were well above drinking water standards, reflecting the high levels of uranium in these ponds.

Surface water in the raffinate pits was monitored to provide data in support of operation of the site water treatment plant. All four raffinate pits were generally within historical ranges for nitrate, sulfate, uranium, and radiological parameters. Historically, measured values for each of these parameters display considerable scatter; new maximum values recorded in 1992 were unlikely to reflect significant changes in the raffinate pits. A new nitrate high of 103 mg/l was measured for Pit 2, which previously had values less than 5 mg/l. At present, it is unclear whether this value is an analytical artifact or reflects a change in Pit 2. This question will be re-examined when the 1993 nitrate data are available. The following radiological parameters exceeded DCGs in the raffinate pits: Ra-226 (164 pCi/l) in Pit 1, Th-230 (622 pCi/l) in Pit 1, and total uranium in Pit 2 (1300 pCi/l, 920 pCi/l) and Pit 4 (2200 pCi/l, 1000 pCi/l).

Although not Federally regulated for surface water, most parameters analyzed as a part of the chemical plant surface water monitoring program were below DCGs and regulatory drinking water standards presented in Section 6.2.2. The few exceptions occurred in on-site surface waters and included nitrate, sulfate, and uranium at the raffinate pits and uranium, gross alpha, and gross beta at Ash Pond (SW-2010) and Frog Pond (SW-2011).

6.4 Highlights

- Four additional NPDES outfalls were added to the 1992 monitoring program to support work at the chemical plant and the quarry water treatment plant facilities.

- NPDES permit limits were exceeded four times in 1992; once for total suspended solids and once for biochemical oxygen demand at outfall NP-0006; and two times for total suspended solids for hydrostatic test water discharges.

- Annual averages for uranium concentrations for 1992 as compared to 1991 decreased at outfall NP-0005, increased at outfalls NP-0001 through NP-0003, and remained consistent at NP-0004. The change in concentrations is attributable to increased remedial activities at the chemical plant.

- The first batch of contaminated water from the quarry pond was successfully treated in the quarry water treatment plant and passed all permit requirements.

- Radiological monitoring at the quarry continued to indicate high concentrations of radiological isotopes in the quarry pond (SW-1008), but these concentrations were within historic ranges.

- Nitroaromatic compounds were found in 1992 in the upgradient location, Little Femme Osage Creek. Monitoring in 1988 also detected nitroaromatics at this location, but their origin is linked to the former ordnance activities north of the quarry.

- Surface water concentrations at the chemical plant, raffinate pits, and vicinity properties area remain within historic ranges with the exception of SW-2005, which increased slightly in 1992.

7 GROUNDWATER PROTECTION

7.1 Program Overview

The groundwater monitoring and protection program at the Weldon Spring Site Remedial Action Project (WSSRAP) includes sampling and analysis of water collected from wells at the Weldon Spring Quarry, the Weldon Spring Chemical Plant and raffinate pits, and the vicinity properties. This program also includes monitoring of springs on the vicinity properties affected by WSSRAP operations. The groundwater protection program is formally defined in two documents: the *Groundwater Protection Program Management Plan* (MKF and JEG 1992h) and the *Environmental Monitoring Plan for 1992* (MKF and JEG 1992o). The Management Plan describes the management, structure, and scope of the program, whereas the *Monitoring Plan* defines the monitoring schedule and implementation of the program.

The general goals of the WSSRAP groundwater program are:

- Characterization of chemical and hydrological properties of the groundwater system.
- Monitoring existing contamination until final decisions regarding the remediation are made.
- Control of potential new sources of contamination.
- Protection of public water resources.

In addition, specific goals in 1992 for the groundwater program included:

- Development of a baseline for studying long and short term effects of source removal.
- Development of a baseline for studying effects of containment ponds associated with the quarry water treatment plant.
- Provision of sufficient data to perform spatial and temporal trend analysis.

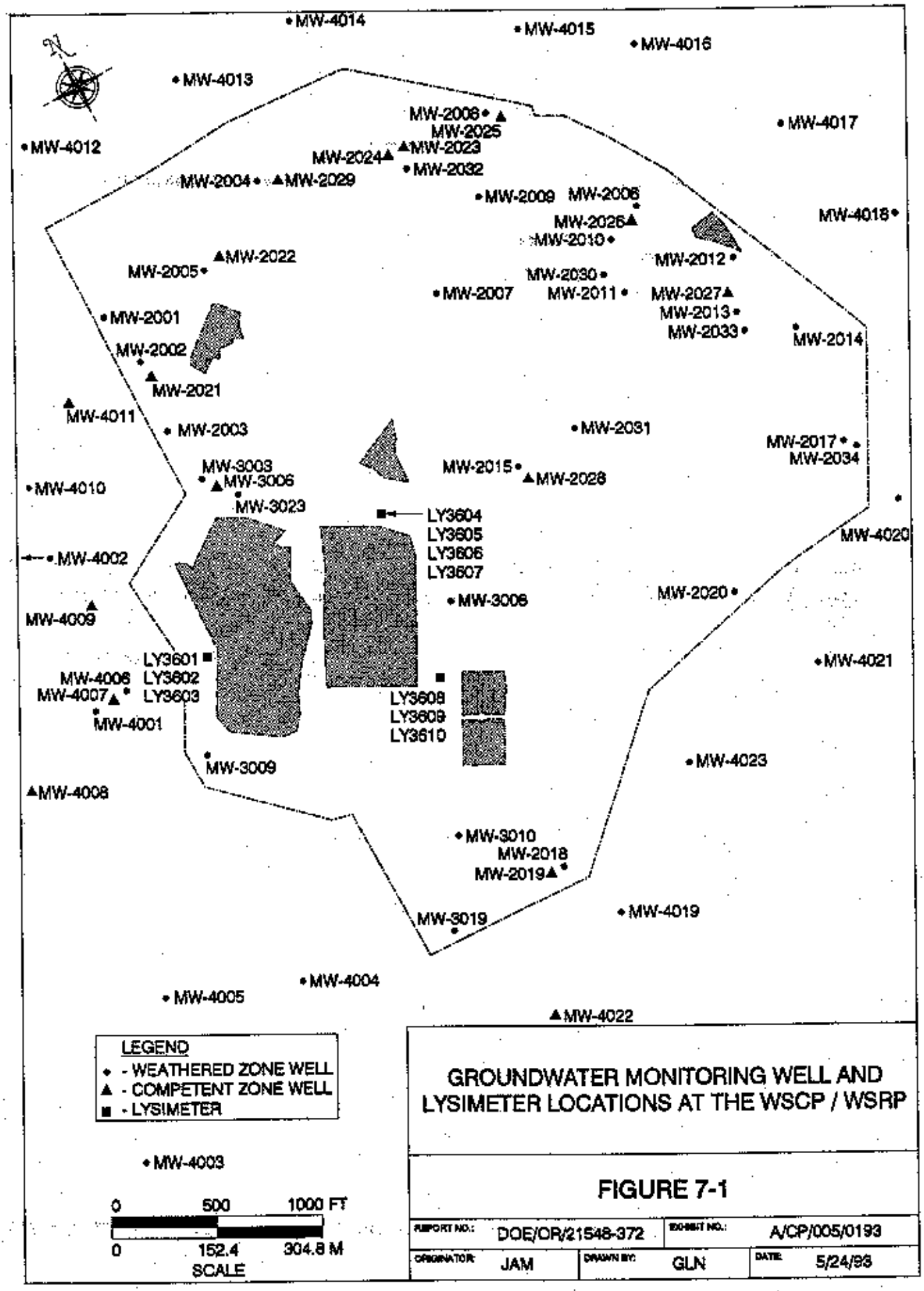
- Provision of information to support the Groundwater Separate Operable Unit activity planning in 1993.

Because of differences in the geology, nature of contamination, and proximity to drinking-water-production wells, specifics for fulfilling these objectives are different at the quarry on the one hand and the chemical plant, raffinate pits, and vicinity properties on the other hand. Therefore, these two areas have separate groundwater monitoring programs.

The groundwater monitoring programs of the WSSRAP are designed to detect the initial movement of contaminants or changes in concentration of existing groundwater contamination. At the chemical plant, this is accomplished by regularly sampling the array of on-site and off-site perimeter wells for contaminants of concern. At the quarry, groundwater contamination has been shown to have a preferred migration direction towards the Missouri River alluvium. These contaminants are monitored by a single line of perimeter wells around the quarry, and a series of lines of monitoring wells in the preferred direction of groundwater movement. Increasing trends have been indicated in the first two of the four lines of monitoring wells. The *WSSRAP Wellfield Contingency Plan* (MKF and JEG 1992t) identifies the levels of response required by various scenarios of contaminant detection in the more distant lines of wells.

The 1992 groundwater monitoring program at the chemical plant and raffinate pits provided for increased monitoring frequency at vicinity property wells (4000 series) to evaluate migration of contaminants to off-site locations, and the addition of geochemical parameters to facilitate the interpretation of groundwater data. Uranium, radiological parameters, nitroaromatic compounds, sulfate, and nitrate were monitored at all wells. Volatile and semivolatile organic compounds, PCBs, and pesticides were not monitored in 1992 because previous sampling indicated that these compounds were not present in the groundwater (MKF and JEG 1989c). The monitoring well locations are shown in Figure 7-1.

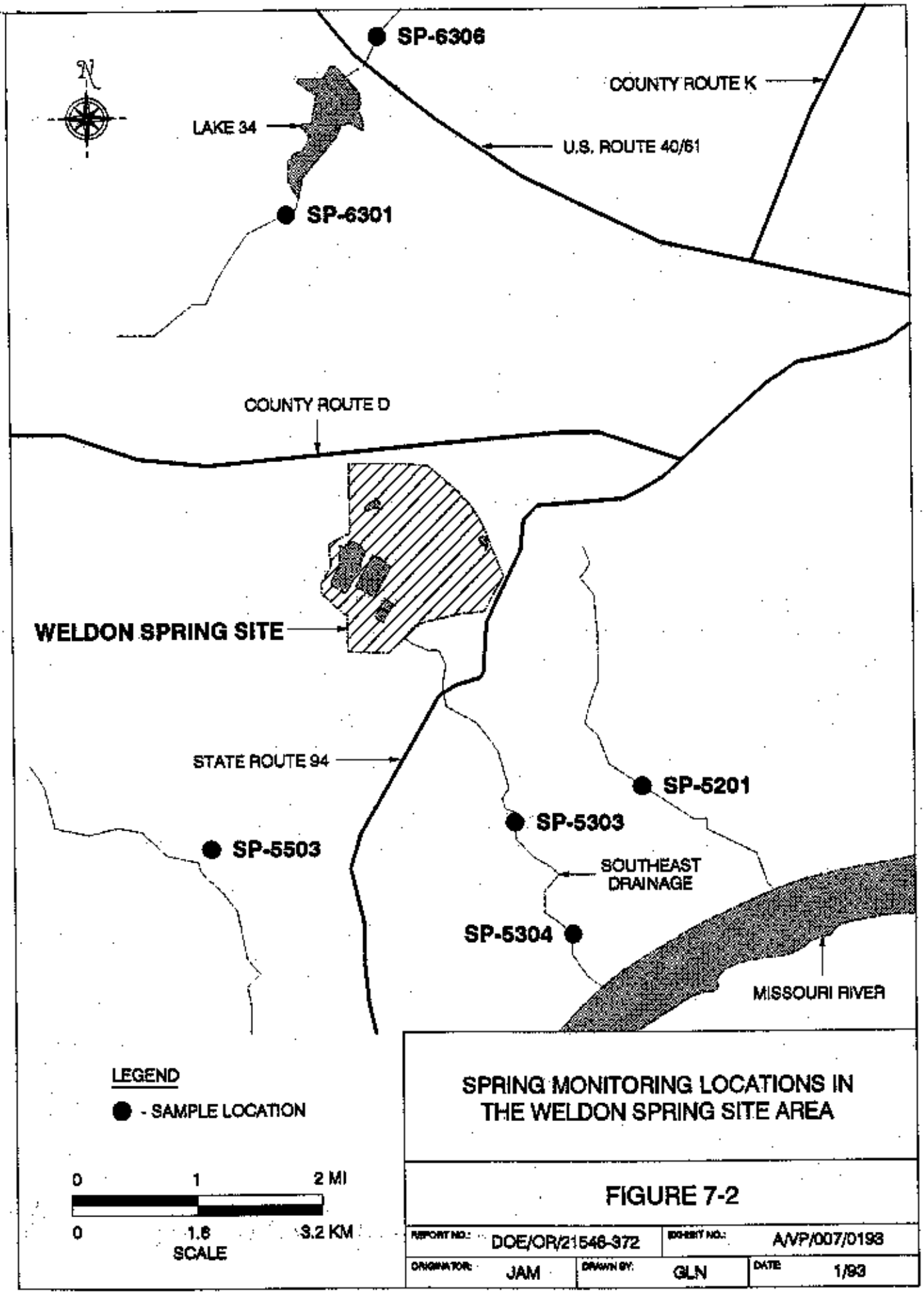
Because the groundwater flow system beneath the chemical plant comprises both diffuse and discrete flow components, springs are an important part of the monitoring program. Springs that were found to be minimally impacted by the chemical plant and raffinate pits or duplicated by other monitoring locations were eliminated from the 1992 monitoring schedule (MKF and JEG 1992o). The five springs that were retained (Figure 7-2) were scheduled for more extensive sampling to provide the level of data necessary to support public and environmental protection



GROUNDWATER MONITORING WELL AND LYSIMETER LOCATIONS AT THE WSCP / WSRP

FIGURE 7-1

REPORT NO.: DOE/OR/21548-372		SHEET NO.: A/CP/005/0193	
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 5/24/93	



SPRING MONITORING LOCATIONS IN THE WELDON SPRING SITE AREA

FIGURE 7-2

REPORT NO.:	DOE/OR/21546-372	SHEET NO.:	A/VP/007/0193		
ORIGINATOR:	JAM	DRAWN BY:	GLN	DATE:	1/93

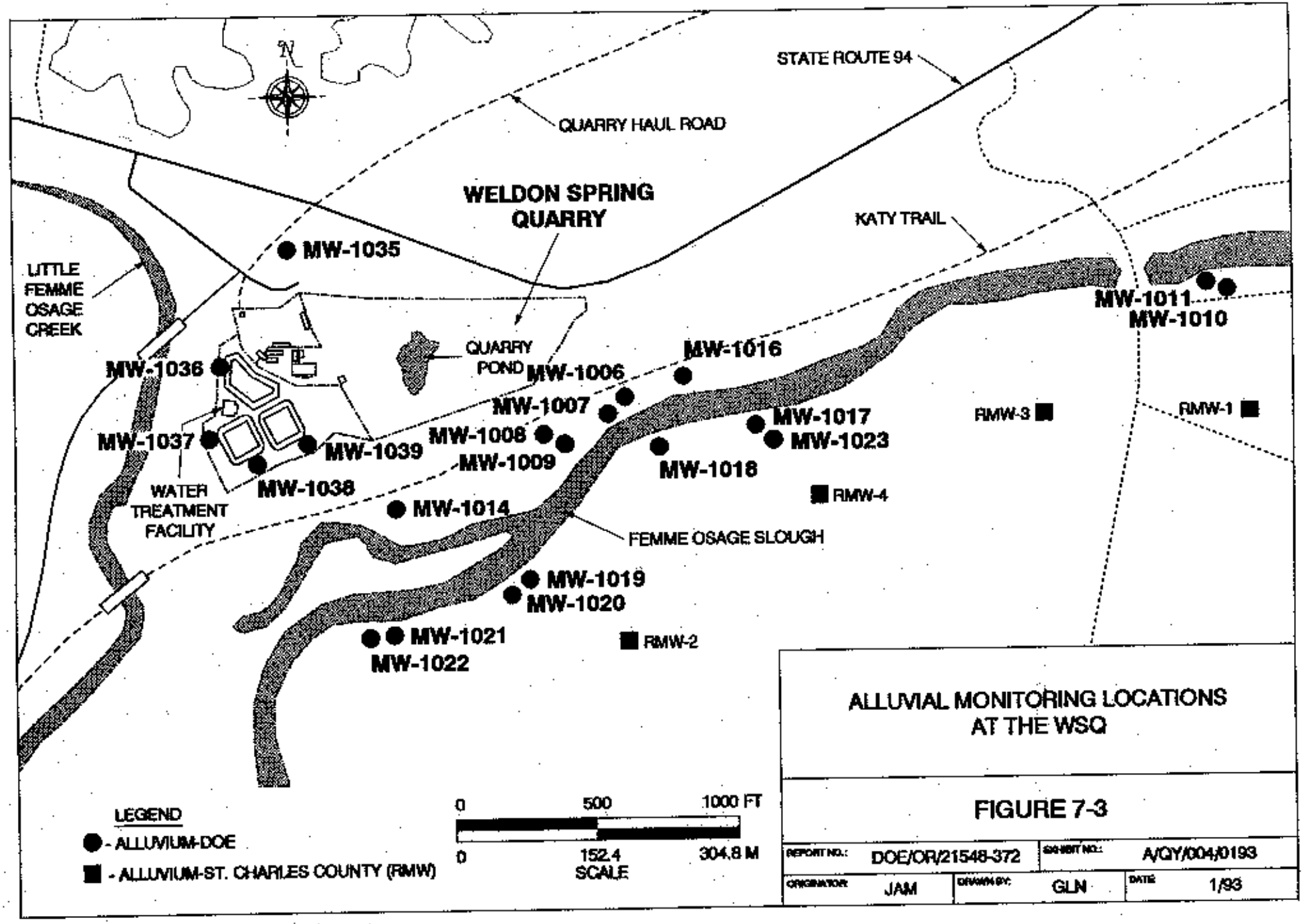
actions. High flow and low flow samples were collected at Burgermeister Spring (SP-6301) to test the hypothesis that high flow is dominated by a surface water component whereas low flow is dominated by a groundwater component. Results of these efforts are discussed in Section 7.5.1.

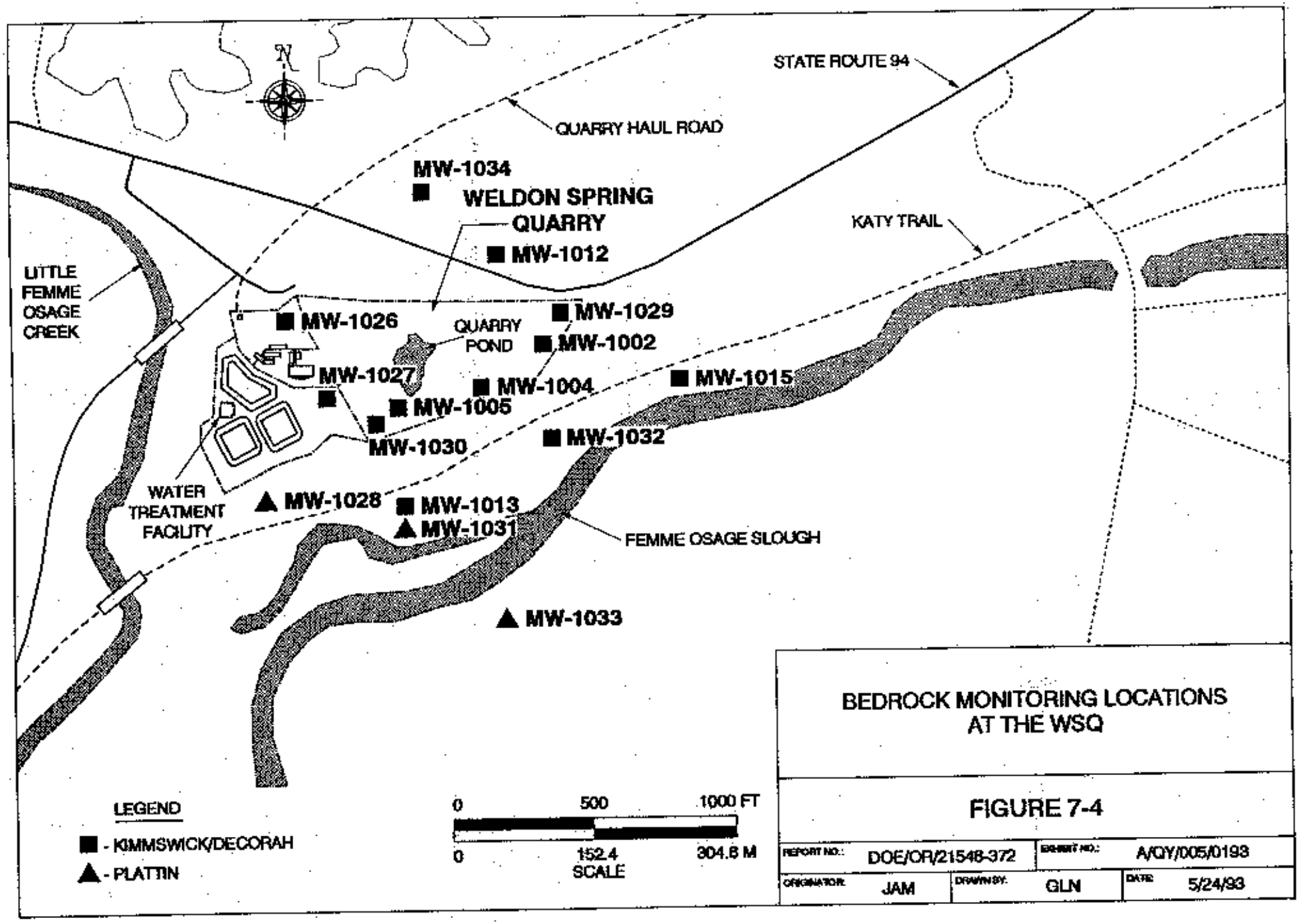
Groundwater monitoring occurs in both alluvial and bedrock materials at the quarry. These locations are shown in Figures 7-3 and 7-4. Two separate monitoring components were developed for the quarry in 1992. The first program consisted of bimonthly sampling of all wells north of the Femme Osage Slough (Figure 7-3) and wells MW-1010 and MW-1011 adjacent to the south bank of the slough. Included in this monitoring are wells MW-1035 through MW-1039, which are located around the quarry water treatment plant basins (Figure 7-3). This portion of the program was developed to detect unplanned releases during the temporary storage of pretreated and treated waters generated during quarry dewatering by establishing baseline conditions in the vicinity of the basins.

The second quarry program consisted of quarterly sampling of all monitoring and production wells south of the Femme Osage Slough (Figure 7-5), excluding the MW-1010 and MW-1011 wells. Pretreated (MW-RAWW) and treated (MW-FINW) waters from the St. Charles County Water Treatment Plant were also sampled quarterly. The four St. Charles County monitoring wells, DOE monitoring well MW-1024, the eight St. Charles County production wells, and treatment plant water were sampled quarterly for gross alpha in accordance with the requirements of DOE Order 5400.5 for protection of public drinking water supplies. This treatment plant is not operated by the DOE although it could potentially be affected by activities at the quarry. The program also included sampling of the St. Charles County production wells for volatile and semivolatile organics, mercury, lead, cadmium, PCBs, and pesticides in accordance with agreements made with St. Charles County, the Missouri Department of Natural Resources (MDNR), and the U.S. Environmental Protection Agency (EPA).

7.2 Applicable Standards

Two main criteria were used to develop the groundwater monitoring program: (1) the EPA *Water Quality Criteria for Drinking Water* (EPA 1986a), which protects public groundwater resources, and (2) the *Missouri Drinking Water Standards* (MDNR 1992). A list


STATE ROUTE 94
QUARRY HAUL ROAD
WELDON SPRING QUARRY
KATY TRAIL
LITTLE FEMME OSAGE CREEK
MW-1035
MW-1036
QUARRY POND
MW-1006
MW-1016
MW-1007
MW-1017
MW-1023
MW-1008
MW-1009
MW-1018
MW-1037
MW-1039
MW-1038
WATER TREATMENT FACILITY
MW-1014
FEMME OSAGE SLOUGH
MW-1019
MW-1020
MW-1021
MW-1022
MW-1011
MW-1010
RMW-1
RMW-2
RMW-3
RMW-4
LEGEND
- ALLUVIUM-DOE
- ALLUVIUM-ST. CHARLES COUNTY (RMW)
0 500 1000 FT
0 152.4 304.8 M
SCALE
ALLUVIAL MONITORING LOCATIONS AT THE WSQ
FIGURE 7-3
REPORT NO.: DOE/OR/21548-372
EXHIBIT NO.: A/QY/004/0193
ORIGINATOR: JAM
DRAWN BY: GLN
DATE: 1/93



BEDROCK MONITORING LOCATIONS AT THE WSQ

FIGURE 7-4

REPORT NO.:	DOE/OR/21548-372	DRAWING NO.:	A/QY/005/0193		
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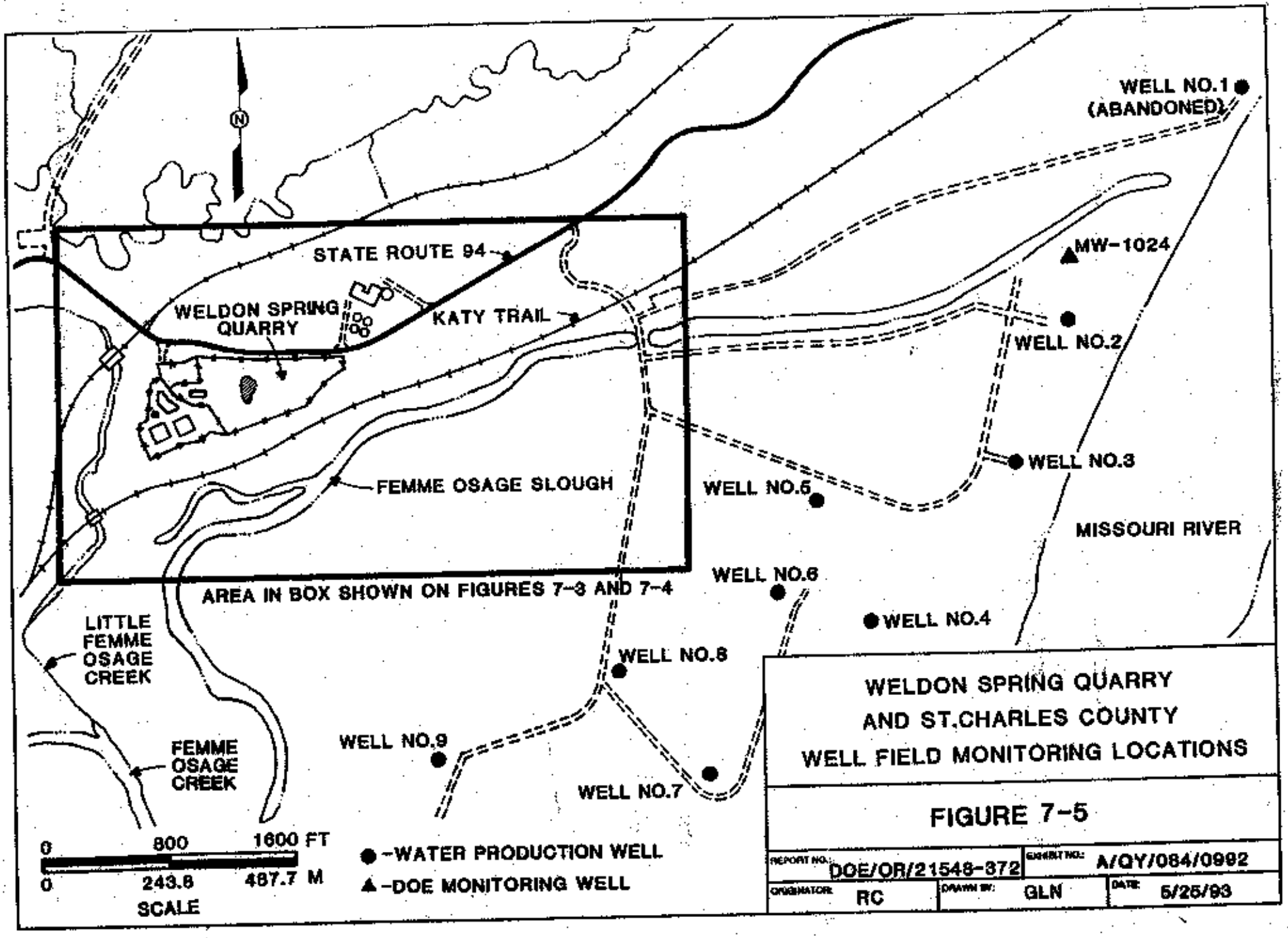

WELL NO.1
(ABANDONED)
MW-1024
WELL NO.2
WELL NO.3
MISSOURI RIVER
STATE ROUTE 94
WELDON SPRING
QUARRY
KATY TRAIL
FEMME OSAGE SLOUGH
WELL NO.5
WELL NO.6
WELL NO.4
AREA IN BOX SHOWN ON FIGURES 7-3 AND 7-4
LITTLE
FEMME
OSAGE
CREEK
WELL NO.8
FEMME
OSAGE
CREEK
WELL NO.9
WELL NO.7
0 800 1600 FT
0 243.8 487.7 M
SCALE
●-WATER PRODUCTION WELL
▲-DOE MONITORING WELL
WELDON SPRING QUARRY
AND ST.CHARLES COUNTY
WELL FIELD MONITORING LOCATIONS
FIGURE 7-5
REPORT NO. DOE/OR/21548-372
DRAWING NO. A/QY/084/0992
ORIGINATOR RC
DRAWN BY GLN
DATE 5/25/93

of the EPA water quality standards and Missouri Drinking Water Standards for contaminants that are routinely monitored in the groundwater program is in Table 7-1. Maximum contaminant levels (MCLs) and other drinking water standards are used as references by the WSSRAP but are not directly applicable because the affected groundwater does not represent a public drinking water supply as defined in EPA 40 CFR, Section 141.1, Subpart A.

Groundwater is also monitored under the requirements DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, which designates derived concentration guidelines (DCGs) for ingestion of water as:

Natural uranium	600 pCi/l	Ra-226	100 pCi/l
Th-230	300 pCi/l	Ra-228	100 pCi/l
Th-232	50 pCi/l		

As specified in DOE Order 5400.5, liquid effluents from DOE activities may not cause private or public drinking waters to exceed the radiological limit of an effective dose equivalent greater than 4 mrem per year or 4% of the DCG.

7.3 Hydrogeology

The general geologic and hydrologic features of the Weldon Spring area are described in Section 1.5. Presented below are specific features at the chemical plant and quarry that were used to develop the environmental monitoring program.

7.3.1 Weldon Spring Chemical Plant and Weldon Spring Raffinate Pits

The chemical plant/raffinate pit area is divided into two major geologic units based on gross lithologic characteristics. These units are the unconsolidated surficial material and the underlying carbonate bedrock. The unconsolidated surficial material consists of fill and topsoil, loess, glacially derived soil, till, and residuum. On average, the glacial soils are silty clays with minor amounts of gravel. The thickness of the these materials ranges from 6.1 m to 15.3 m (20 ft to 50 ft). With the exception of residuum-filled linear bedrock depressions, or paleochannels, and occasional perched water bodies at the base of fill layers, these materials are unsaturated. Lysimeters have been installed near the raffinate pits to sample soil solutions in these

TABLE 7-1 Regulatory Drinking Water Standards

Parameter	mg/l	Standards
Antimony	0.006	MDWS
Arsenic[a]	0.05	MDWS
Barium[a]	1.0	MDWS
Beryllium	0.004	MDWS
Cadmium[a]	0.01	MDWS
Chromium[a]	0.05	MDWS
Cobalt	NS	MDWS
Copper[b]	1.0	MDWS
Iron[b]	0.3	MDWS
Nitrate (as N)[a]	10	MDWS
Sulfate[b]	250	MDWS
Chloride[b]	250	MDWS
Lead	0.05	MDWS
Manganese[b]	0.05	MDWS
Mercury	0.002	MDWS
Nickel	0.1	MDWS
Selenium	0.01	MDWS
Silver	0.05	MDWS
Thallium	NS	MDWS
Uranium	0.02	MDWS
Zinc[b]	5.0	MDWS
Fluoride	2.2	MDWS
TDS[b]	500	MDWS
2,4-DNT	0.00011	MDWS
Adjusted gross alpha	15 pCi/l	MDWS
Ra-226[c]	5 pCi/l	MDWS
Ra-228[c]	5 pCi/l	MDWS
Rn-222	300 pCi/l	EPA
Uranium, total (proposed)	20.0 µg/l (13.6 pCi/l)	EPA

(a) Primary maximum contaminant level
(b) Secondary maximum contaminant level
(c) Standard for combined Ra-226 and Ra-228
NS No drinking water standard
MDWS Missouri drinking water standards
EPA EPA Drinking Water Standards for Radionuclides

unconsolidated materials but are not sampled on a routine basis. Monitoring wells have not been completed in the unconsolidated surficial materials.

Saturated conditions are generally first encountered in the upper levels of the Burlington-Keokuk Limestone, the uppermost bedrock unit. This unit is composed of two different lithologic zones: a shallow, weathered zone underlain by an unweathered or competent zone (MKF and JEG 1992o). Two flow systems are present in the saturated bedrock: diffuse flow along small fractures and bedding planes and discrete flow along preferred flowpaths such as bedrock depressions, paleochannels, and solution enlarged fractures. Diffuse flow is relatively slow (rates are on the order of centimeters to meters per year) and can be calculated using equivalent porous media principles, whereas discrete flow is rapid (rates are on the order of meters to kilometers per day) and are difficult to calculate with conventional hydrologic models. Within the confines of the site, the aquifer generally exhibits diffuse flow properties; however, discrete flow is thought to occur in areas of highly weathered bedrock and in residuum-filled paleochannels (MKF and JEG 1992p).

Within the unsaturated (or vadose zone) soil layers, granular or porous flow (i.e., flow along grain boundaries) prevails. Permeameter tests indicate that hydraulic conductivities in these soils range from 6.9E-09 to 1.7E-07 cm/s (2.7E-09 in./s to 6.7E-08 in./s) (MKF and JEG 1991a), which translate to relatively slow vertical seepage velocities through these layers. Where the downward-migrating seepage intersects the water table, typically within the weathered, upper part of the Burlington-Keokuk Limestone, the flow direction changes and becomes more horizontal (MKF and JEG 1992m). Within this regime, flow rates increase dramatically with the change to diffuse and potentially discrete flow. The presence of elevated uranium and nitrate levels at Burgermeister Spring, which is located 1.9 km (1.2 mi) north of the site, is strong evidence for discrete flow in the environs of the site. To address the complex hydrogeologic system at the site, both springs and wells are included in the groundwater monitoring program.

All monitoring wells are completed in the Burlington-Keokuk Limestone. Most are screened in or near the upper weathered portions of this formation. The remainder of the wells are screened at deeper levels in the unweathered (competent) zone to assess vertical migration of contaminants (Appendix E). Where possible, monitoring wells within the boundaries of the chemical plant are located close to potential contaminant sources to assess migration into the groundwater system. Additional wells are located on vicinity properties to evaluate movement

of contaminants off site. Well locations are shown in Figure 7-1. Of the 66 wells that were monitored in 1992, 33 are located within the chemical plant boundary (2000 series), five are adjacent to the raffinate pits (3000 series), and 23 are on bordering vicinity properties (4000 series).

Springs are a common feature in weathered carbonate terrain such as that in which the Weldon Spring site is situated. As part of site characterization, springs in the environs of the site have been inventoried (MDNR 1991). Those that were found to be hydraulically connected to the chemical plant or raffinate pit area or contained elevated levels of contaminants potentially derived from the chemical plant or raffinate pits were added to the monitoring program. In the 1992 *Environmental Monitoring Plan* (EMP) (MKF and JEG 1992o), the number of springs scheduled for routine monitoring was reduced to five. Three of the springs are in or near Valley 5300 (the Southeast Drainage) and the other two are in Valley 6300 (the Burgermeister Spring branch) (Figure 7-2).

Uranium is present in the water discharged from the springs along the Southeast Drainage; however, it is unclear whether contamination of the these springs reflects discharge of groundwater that was contaminated by sources upstream of the drainage or by the sediments within the drainage. Analysis of surface and near-surface sediments in the Southeast Drainage have shown uranium levels to be highly variable. Values range from 6 pCi/g to nearly 2,000 pCi/g; background for area soils is generally less than 4 pCi/g (MKF and JEG 1992p).

The Burgermeister Spring branch receives site-contaminated groundwater and surface water. Although the site is not located in Valley 6300, it is connected to this drainage by losing streams that travel along subterranean conduits and emerge at springs in the Burgermeister Spring branch. The most prominent location is Burgermeister Spring (SP-6301), a perennial spring, which discharges water impacted by site-contaminants during high and low flow periods.

Spring 6306, which is located below Busch Lake 34 and downstream of Burgermeister Spring, also exhibits detectable levels of uranium. Considerable evidence suggests that Lake 34, which has elevated uranium concentrations, is a plausible source for the uranium in Spring 6306. However, there is also evidence of a possible connection to Busch Lake 35, which is located in the same drainage as the Weldon Spring site and also has above background uranium levels.

7.3.2 Weldon Spring Quarry

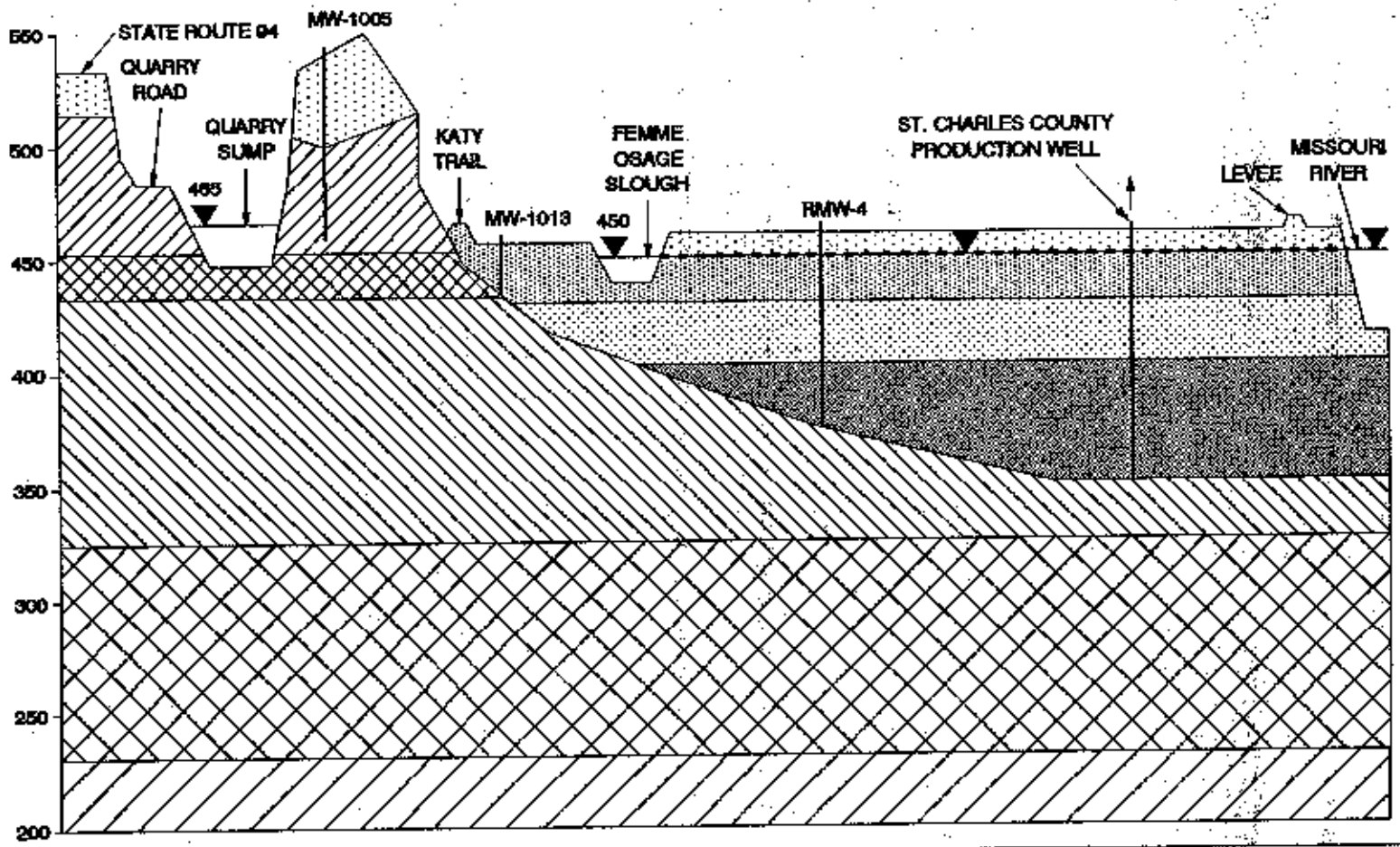
The geology of the quarry area is separated into upland overburden, Missouri River alluvium, and bedrock (Figure 7-6). The unconsolidated upland material overlying bedrock consists of up to 9.2 m (30 ft) of silty clay soil and loess deposits (MKF and JEG 1989b).

The bedrock at the quarry consists of three distinct Ordovician formations: the Kimmswick Limestone, the limestone and shale of the Decorah Group, and the Plattin Limestone (in descending order). The Kimmswick Limestone unconformably overlies the Decorah. It is a coarsely crystalline, white to light-gray, medium- to massively-bedded, fossiliferous limestone and is approximately 18.4 m (60 ft) thick. Nodular chert is irregularly scattered in the lower portion of the unit. The Kimmswick exhibits solution features apparently associated with the intersection of vertical joints and bedding planes. The cavities and joints may be open or filled with clay (MKF and JEG 1989b). The Kimmswick forms the bluff into which the quarry was worked.

The Decorah Group is a light, thinly bedded limestone interbedded with green shale. It is approximately 9.2 m (30 ft) thick in the vicinity of the quarry and exhibits horizontal partings or bedding planes which may be enlarged due to solutioning. The bottom of the quarry is excavated about 4.6 m (15 ft) into the Decorah and a thin bed of metabentonite separates the Decorah Group from the underlying Plattin Limestone (MKF and JEG 1989b).

The Plattin Limestone is a light to dark gray, finely crystalline, thinly bedded limestone about 31 m to 38 m (100 ft to 125 ft) thick. Thin light-green to greenish-gray shales are present in the upper portion, and small amounts of dark gray chert are present throughout the formation. The Plattin Limestone is the bedrock underlying the Missouri River alluvium (MKF and JEG 1989b).

The sediment composing the alluvium along the Missouri River varies from clays, silts, and sands to gravels at shallower depth and coarsens to cobbles and boulders above the bedrock. The alluvium thickness increases with distance from the bluff towards the river where the maximum thickness is approximately 31 m (100 ft). The alluvium is truncated at the erosional contact with the Paleozoic bedrock bluff along the Katy Trail. Organic silts and clays with underlying minor amounts of sand are the primary sediments between the bluff and the Femme



- SILTY CLAY
- SILT
- SAND
- SAND & GRAVEL
- KIMMSWICK LIMESTONE
- DECORAH GROUP
- PLATTIN LIMESTONE
- JOACHIM DOLOMITE
- ST. PETER SANDSTONE

MODIFIED AFTER BGA, 1988

NOT TO SCALE

GEOLOGICAL CROSS SECTION OF THE WSQ AREA

FIGURE 7-6

REPORT NO.:	DOE/OR/21548-372	DRAWING NO.:	A/PI/040/0393		
ORIGINATOR:	JAM	DRAWN BY:	GLN	DATE:	3/93

Osage Slough. An underlying soil layer of silty sand is present below a depth of about 6.1 m (20 ft) in the area of the slough (MKF and JEG 1989b).

The groundwater flow system at the quarry is composed of alluvial and bedrock aquifers. The alluvial aquifer is predominantly controlled by recharge from the Missouri River and the bedrock aquifer by precipitation and overland runoff. North of the Femme Osage Slough, the aquifer and bedrock are in contact. This is believed to be the primary route for migration of contaminants from the quarry into the alluvium.

In 1992, 36 wells, including eight municipal production wells, four county-owned monitoring wells, and 21 DOE monitoring wells, were screened within the alluvial material between the quarry and the Missouri River. Five of the wells, MW-1035 through MW-1039 were located west of the quarry to monitor the uppermost water bearing unit below the quarry water treatment plant equalization basin and effluent ponds. Six wells, MW-1006 through MW-1009, MW-1014, and MW-1016 were located between the quarry and the slough to monitor contaminant migration south of the quarry within the alluvium. Monitoring wells MW-1010, MW-1011, and MW-1017 through MW-1024 were located within the alluvium south of the slough and were monitored to detect contaminants south of the slough. St. Charles County monitoring wells RMW-1 through RMW-4 were monitored to ensure that the quarry contaminants were not migrating toward the county well field, and to provide an early warning for contaminant migration toward the well field, if this should occur. The eight county wells, PW-2 through PW-9, were also monitored to ensure that the quarry contaminants were not affecting the quality of the municipal well field water supply.

Fifteen DOE monitoring wells were screened within either the Kimmswick-Decorah or Plattin Formations to monitor contaminants near the quarry within the bedrock. Monitoring wells MW-1002, MW-1004, MW-1005, MW-1012, MW-1013, MW-1015, MW-1026, MW-1027, MW-1029, MW-1030, MW-1032, and MW-1034 were installed to monitor contaminants within the Kimmswick-Decorah Formations surrounding the quarry. Monitoring wells MW-1028, MW-1031, and MW-1033 were located south of the quarry within the Plattin Limestone to determine whether vertical contaminant migration through the fracture system has occurred.

In 1992, eight groundwater monitoring wells were installed in the Darst Bottom area approximately 0.6 km (1 mi) southwest of the St. Charles County well field. These wells were

installed by the U.S. Geological Survey to determine the upgradient characteristics of the Missouri River alluvium in the vicinity of the quarry. Analyses of the groundwater from these wells was used by the WSSRAP as background values for the St. Charles County well field.

Monitoring wells MW-1034 (Kimmswick/Decorah Formations) and MW-1035 (alluvium/unconsolidated materials) have been classified to be upgradient for the determination of the groundwater quality in bedrock at the quarry. No background well has been established for the Plattin Formation which is present at the base of the quarry.

A summary of the background values for the quarry is given in Table 7-2. This table includes the average background values followed by the ranges of values based on two standard deviations about the mean or the average radiological error about the analytical value.

7.4 Well Abandonment

All monitoring wells at the Weldon Spring site are constructed of stainless steel or polyvinyl chloride (PVC) and were installed and developed in accordance with accepted procedures at the time of their installation. These procedures include the U.S. EPA *RCRA Groundwater Monitoring Technical Enforcement Guidance Document* (EPA 1986b), which enforces the requirements of the *Resource Conservation and Recovery Act*; State of Missouri regulations; the *Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells* (EPA 1989), and the *Groundwater Protection Program Management Plan* (MKF and JEG 1992h).

In 1992, two groundwater monitoring wells (MW-3001, MW-3002) and two pumping wells (PW-1 and PW-3) and their associated observation wells at the chemical plant/raffinate pits, were abandoned. The monitoring wells were abandoned due to the construction of several interim action storage areas, specifically the Temporary Storage Area (TSA) the asbestos storage area, and the contaminated spoils storage area.

All abandonment activities were conducted in accordance with WSSRAP procedures ES&H 4.4.4, *Subsurface Monitoring Device Plugging and Abandonment*. This procedure requires overdrilling of the well casing and construction material (grout, bentonite seal) and tremie grouting of the hole to the surface. This process maintains the integrity of the associated aquifer by eliminating any conduit from the ground surface.

TABLE 7-2 Average Background Values and Statistical Ranges for Quarry Groundwater Monitoring Locations

Parameter	MW-1034[a]	MW-1035[b]	Darst Bottoms[c]
Total Uranium (pCi/l)	1.78[d] (0.06; 3.50)[e]	0.61 (-0.75; 1.97)	1.96 (-3.5; 7.42)
Radium-226 (pCi/l)	0.2 (± 0.3)	0.4 (+ 0.4)	0.70 (-0.24; 1.64)
Radium-228 (pCi/l)	< 0.9 (± 1.8)	< 0.9 (+ 1.9)	0.90 (-0.28; 2.08)
Thorium-228 (pCi/l)	< 0.2 (± 0.6)	< 0.2 (+ 0.6)	0.08 (0.04; 0.12)
Thorium-230 (pCi/l)	1.6 (± 1.0)	< 0.2 (+ 0.6)	0.11 (-0.07; 0.29)
Thorium-232 (pCi/l)	< 0.2 (± 0.6)	< 0.2 (+ 0.6)	0.07 (-0.01; 0.15)
Gross Alpha (pCi/l)	3.1 (± 3.9)	< 0.2 (+ 3.5)	2.56 (-0.74; 5.86)
Gross Beta (pCi/l)	5.8 (± 3.8)	5.9 (+ 2.5)	6.02 (0.88; 11.16)
Nitroaromatics (µg/l)	No detects	No detects	Not analyzed
Arsenic (µg/l)	< 4.0 (1.0; 6.0)	< 4.0 (1.0; 6.0)	3.72 (-1.0; 8.44)
Barium (µg/l)	153.1 (116.7; 189.5)	228.0 (170.2; 285.8)	456.6 (169.0; 744.2)
Nitrate (mg/l)	0.84 (-0.98; 2.66)	0.13 (-0.03; 0.29)	0.13 (-0.03; 0.29)
Sulfate (mg/l)	88.5 (25.9; 151.1)	41.5 (22.5; 60.5)	35.2 (3.0; 67.4)
Alkalinity (mg/l)	405.0 (295; 515)	228.3 (167.5; 289.1)	382.5 (342.9; 422.1)

(a) Kimmswick/Decorah Formation
(b) Alluvial/unconsolidated materials
(c) Missouri River alluvium
(d) Average background values. Values based on all available WSSRAP data.
(e) Range is based on two standard deviations about the mean.
(f) Average radiological error

7.5 Groundwater Monitoring Results

The results of the 1992 groundwater monitoring program are listed in Appendixes A and B. These appendixes contain tables of all monitoring results for groundwater locations at the chemical plant, quarry, vicinity properties, and springs located near the chemical plant. Annual averages have been calculated for all parameters analyzed in the monitoring program and are presented in Appendix A. Quarterly and bimonthly analytical results are presented as raw data in Appendix B. Appendix E contains results of statistical analyses and special groundwater studies.

7.5.1 Chemical Plant and Raffinate Pit Monitoring Results

In 1992, the measured concentrations for uranium, nitrate, sulfate, and nitroaromatic compounds (the primary contaminants of concern) generally remained within historical ranges in all monitoring wells and springs at the chemical plant, raffinate pits, and vicinity properties. Although new highs and lows were measured at some locations, these values were generally within the 95% confidence interval about the mean and likely reflected normal variation in the aquifer system rather than significant changes in groundwater conditions. As new samples are taken from a population, new highs and lows must be expected to occur as the range of variation (standard deviation) continues to be defined. Thus, new extreme values are not considered anomalous as long as they are similar to previous values and their temporal distribution about the mean is random. The temporal variability of the data does not appear to be related to seasonal influences (MKF and JEG 1992m) and may result from variable mixing within the aquifer. At present, these new extreme values do not appear to constitute recognizable statistical trends. The areal distribution of contaminants remains relatively unchanged from 1991 and is examined in greater detail in Section 7.6.1.

This section summarizes the monitoring data for contaminants and a comparison with background levels and water quality standards. Background levels for uranium, nitrate, and sulfate at the chemical plant/raffinate pits area were determined by the USGS (Table 7-3) based on averages from uncontaminated wells within the vicinity of the chemical plant and ordnance works. Drinking water standards for uranium, nitrate, sulfate and 2,4-dinitrotoluene are listed in Table 7-1.

TABLE 7-3 Background Values for the Chemical Plant, Raffinate Pits, and Vicinity Properties

Parameters	Groundwater/Springs	Streams
Calcium	82 mg/l	99 mg/l
Lithium	13 µg/l	9 µg/l
Sodium	30 mg/l	36 mg/l
Nitrate	1.6 mg/l	1.3 mg/l
Sulfate	32 mg/l	76 mg/l
Uranium	3 µg/l	2.7 µg/l

* Background values determined by U.S. Geological Survey from averages of uncontaminated wells in the vicinity of the chemical plant (see Kleeschulte, Appendix H).

Uranium is measured in all monitoring wells on a quarterly or semiannual basis. The highest uranium levels continue to occur near the raffinate pits. In 1992, uranium in 22 of the 61 monitoring wells exceeded the background level of 3 mg/l (2.04 pCi/l) (Table 7-4). Of these, only three locations (MW-3003, MW-3009, and MW-4020) exceeded the proposed MCL of 20 µg/l (13.6 pCi/l). New uranium highs were measured in 1992 at the following locations: MW-2030, MW-2032, MW-2033, MW-3003, MW-3023, MW-4001, MW-4003, and MW-4014. None of these new maximums represent a significant increase in uranium concentrations at these locations. All radiological parameters were below the water quality standards and DCGs (Table 7-1).

Sulfate and nitrate were also measured quarterly or semiannually in all monitoring wells at the chemical plant, raffinate pits, and vicinity properties. The calculated background value for nitrate (1.6 mg/l) was exceeded at 22 locations. The drinking water standard (10 mg/l) was exceeded at 14 locations. Above-background sulfate levels (32 mg/l) were measured at 28 locations. Four of these were above the water quality standard (250 mg/l). New nitrate highs were observed in MW-4005 and MW-4006; new sulfate highs were observed in MW-2032 and MW-4011.

TABLE 7-4 Annual Averages at Monitoring Locations with Total Uranium (pCi/l) Exceeding Background[a] Chemical Plant Area

Monitoring Location	Total Uranium	@	Monitoring Location	Total Uranium	@
MW-2017	8.65	0/2	MW-4005	2.32	1/3
MW-2019	2.65	0/2	MW-4007	2.28	0/4
MW-2020	3.00	0/2	MW-4009	4.06	0/4
MW-2030	11.60	0/4	MW-4010	3.29	0/4
MW-2032	7.05	1/4	MW-4011	5.33	0/4
MW-2034	12.3	0/2	MW-4012	2.11	0/4
MW-3003	19.8	0/4	MW-4016	3.43	0/4
MW-3008	4.34	0/4	MW-4019	2.63	0/4
MW-3009	42.7	0/4	MW-4020	14.0	0/4
MW-3023	8.85	0/4	MW-4021	5.39	0/4
MW-4004	4.07	0/3	MW-4022	7.03	0/4

[a] Background uranium = 2.04 pCi/l (3 mg/l).

@ = Ratio of nondetects to total number of samples.

Nitroaromatic compounds were analyzed quarterly or semiannually in all monitoring wells. Because these are not naturally occurring organic compounds, there are no background levels for nitroaromatics, and presently only 2,4-DNT has an ambient water quality standard. Twenty-seven locations yielded detectable concentrations of nitroaromatic compounds (Table 7-6); of these, 12 exceeded the ambient water quality standard of 0.11 μg/l for 2,4-DNT.

New high values were measured for the nitroaromatic compounds at the following locations:

- 1,3,5-trinitrobenzene at monitoring wells MW-2030, MW-2033, MW-3009, and MW-4015.
- 2,4,6-trinitrotoluene at monitoring wells MW-2018 and MW-2030.

TABLE 7-5 Annual Averages for Nitrate and Sulfate (mg/l) in the Groundwater Exceeding Background[a]

Monitoring Location	Nitrate	Sulfate	Monitoring Location	Nitrate	Sulfate
MW-2001	28.4	BKG	MW-3008	702	80.8
MW-2002	302	116	MW-3009	184	58.7
MW-2003	261	117	MW-3023	393	331
MW-2005	68.3	BKG	MW-4001	32.3	64.1
MW-2006	3.60	33.5	MW-4002	2.66	BKG
MW-2008	2.07	33.0	MW-4003	BKG	33.0
MW-2009	BKG	108	MW-4005	3.93	BKG
MW-2011	5.20	BKG	MW-4006	4.68	BKG
MW-2012	BKG	72.6	MW-4011	35.8	56.7
MW-2014	BKG	33.5	MW-4012	BKG	49.3
MW-2015	BKG	110	MW-4013	66.0	45.0
MW-2017	BKG	728	MW-4014	2.91	BKG
MW-2019	BKG	42.1	MW-4018	3.20	BKG
MW-2020	BKG	135	MW-4020	BKG	129
MW-2028	BKG	123	MW-4021	BKG	250
MW-2030	BKG	41.9	MW-4022	BKG	35.5
MW-2032	92.8	56.2	MW-4023	3.47	89.5
MW-2034	BKG	634			
MW-3003	342	158			

(a) Background nitrate = 1.6 mg/l, sulfate = 32 mg/l

BKG = value within background for this location

TABLE 7-6 Annual Averages for Monitoring Wells with Detectable Concentrations of Nitroaromatic Compounds in Groundwater

Monitoring Location	1,3,5-TNB	1,3-DNB	2,4,6-TNT	2,4-DNT	2,6-DNT	Nitrobenzene
MW-2001	0.04	BKG	BKG	0.09	0.06	BKG
MW-2002	BKG	BKG	BKG	0.07	0.40	BKG
MW-2003	BKG	BKG	BKG	0.17	0.84	BKG
MW-2005	BKG	BKG	BKG	0.08	0.13	BKG
MW-2006	9.27	BKG	1.10	BKG	2.11	BKG
MW-2008	0.63	BKG	BKG	0.08	0.93	BKG
MW-2009	BKG	BKG	BKG	0.07	0.27	BKG
MW-2010	0.16	BKG	0.34	0.08	0.50	BKG
MW-2011	0.59	BKG	BKG	0.10	1.95	0.04
MW-2012	2.40	BKG	0.66	0.19	1.75	BKG
MW-2013	4.80	0.13	0.67	0.28	7.46	BKG
MW-2014	2.90	BKG	BKG	0.15	0.94	BKG
MW-2020	BKG	BKG	BKG	0.04	BKG	BKG
MW-2030	6.01	BKG	9.93	0.15	8.03	BKG
MW-2032	1.20	BKG	4.03	0.14	3.90	BKG
MW-2033	6.06	BKG	1.82	1.12	10.2	BKG
M3-3003	BKG	BKG	BKG	0.06	0.13	BKG
MW-3008	BKG	BKG	BKG	0.13	0.32	BKG
MW-3009	0.21	BKG	BKG	0.22	0.10	BKG
MW-3023	BKG	BKG	BKG	7.88	8.50	BKG
MW-4001	57.8	0.14	1.48	4.68	4.55	BKG
MW-4002	0.11	BKG	0.13	BKG	0.09	BKG
MW-4006	15.0	BKG	BKG	0.13	3.73	BKG
MW-4013	38.5	BKG	0.04	0.06	0.92	BKG
MW-4014	0.39	BKG	BKG	BKG	0.08	BKG
MW-4015	0.69	BKG	BKG	0.10	1.00	BKG
MW-4023	0.17	BKG	BKG	0.08	0.05	BKG

BKG = well below background levels

- 2,4-dinitrotoluene at monitoring wells MW-2002, MW-2030, MW-3003, MW-3009, MW-3023, and MW-4015.

- 2,6-dinitrotoluene at monitoring wells MW-2002, MW-3003, MW-3008, MW-3009, MW-3023, and MW-4023.

Many of these new high values are lower than the pre-1990 detection levels, and therefore may not be historic maximums (Table 7-6).

Metals were analyzed quarterly in 34 of the monitoring wells. Although a number of metals have been identified as potential contaminants of concern in the remedial investigation for the chemical plant (MKF and JEG 1992p), only lead and chromium were detected at levels that exceeded water quality standards, which are 50 μg/l for both of these elements. Two locations recorded elevated lead values; however, these high values likely resulted from the analysis of unfiltered samples. This topic is further discussed in Section 10.2.7. Only one location, MW-4012, recorded chromium levels above the 50 μg/l standard; the 1992 average for this location was 57.02 μg/l.

Three groups of suction lysimeters are located in the vicinity of the raffinate pits. These lysimeter networks allow collection of water samples from vadose-zone soils (i.e., soils situated above the water table) and provide a monitor for migration of contaminated seepage from the raffinate pits into the groundwater system. Each group contains three or four lysimeters, which are installed at different depths. The number ranking within the group reflects the relative depth of the lysimeter, with the deepest lysimeter having the highest number. Lysimeters LY-3601 to 3603 are located west of Raffinate Pit 4, LY-3604-3607 are north of pit 3, and LY-3608-3610 are northwest of Raffinate Pit 1.

For uranium analyses during 1992, samples were collected from eight of the 10 lysimeters. The results of these analyses are in Table 7-7. Uranium values were below background levels (2.04 pCi/l) in all lysimeters adjacent to raffinate pits 1 and 3 but were above background in the lysimeters adjacent to Raffinate Pit 4.

The shallowest lysimeter near Raffinate Pit 4 (LY-3601) is located within the Ferrelview Formation 3.6 m (12 ft) below the surface. Its elevation is comparable to that of the base of Pit 4.

TABLE 7-7 Concentrations of Uranium (pCi/l) in Suction Lysimeters

Location	Concentration
LY-3601	17
LY-3602	4.3
LY-3603	6.1
LY-3604	1.7
LY-3605	<0.68
LY-3606	<0.68
LY-3607	<0.68
LY-3608	<0.68

LY-3602 lies at 5.8 m (19 ft) and is adjacent to a soil fracture. The deepest lysimeter, LY-3603, lies at 7.9 m (25.75 ft) and within the gravely chert residuum. The highest uranium value was recorded in LY-3601. The other two lysimeters had similar values slightly above background. The relationship of these uranium values suggests that seepage from Raffinate Pit 4 may be traveling laterally in the upper clay layer. The 1992 uranium values were slightly lower than those recorded by the USGS in 1990 (MKF and JEG 1990).

Five springs were monitored for uranium, nitrate, sulfate, metals, and nitroaromatic compounds. Levels of these contaminants remained within historic ranges at all five springs. Background levels were exceeded for uranium at four locations and water quality standards were exceeded at SP-5303, SP-5304, and SP-6301 (Table 7-8). Nitrate exceeded water quality standards at SP-6301, whereas sulfate was below these standards at all locations (Table 7-9). Nitroaromatic compounds were detected at SP-5303 and SP-6301 and exceeded the water quality standard for 2,4-DNT at SP-6301 (Table 7-10).

TABLE 7-8 Annual Averages for Uranium (pCi/l) Exceeding Background[a] in Springs

Monitoring Location	Total Uranium
SP-5303	125.8
SP-5304	103
SP-6301	78.6
SP-6306	3.44

[a] Background uranium - 2.04 pCi/l (3 mg/l)

TABLE 7-9 Annual Averages for Nitrate and Sulfate Exceeding Background[a] (mg/l) in Springs

Monitoring Location	Nitrate	Sulfate
SP-5201	0.19	61.4
SP-5303	0.48	63.0
SP-5304	0.79	51.5
SP-6301	32.3	58.0
SP-6303	0.21	7.9

[a] Background nitrate = 1.6 mg/l, sulfate = 32 mg/l

TABLE 7-10 Annual Averages for Monitoring Locations with Detectable Nitroaromatic Compounds (μg/l) in Springs for 1992

Monitoring Location	1,3,5 TNB	1,3 DNB	2,4,6 TNT	2,4 DNT	2,6 DNT	NB
SP-5303	0.09	BKG	20.0	0.24	0.43	BKG
SP-6301	BKG	BKG	0.27	0.04	0.61	BKG
SP-6301	BKG	0.27	0.04	0.61	BKG	BKG

BKG = value with background for this location.

Beginning in 1992, springs in Valley 5300 (the Southeast Drainage) were monitored at low flow to minimize contributions from surface discharge. Uranium concentrations at these springs (SP-5303 and SP-5304) displayed considerable variation, not unlike the range of values previously observed when flow volume was not considered as a criterion for sampling (MKF and JEG 1990 and 1991d). It has not been determined whether these variations reflect normal heterogeneity in the aquifer system or problems in defining low-flow conditions that minimize surface water input. The absence of high sulfate or nitrate values in the Valley 5300 springs indicates that the raffinate pits are unlikely sources for the elevated uranium concentrations found in these springs.

Burgermeister Spring (SP-6301) was monitored at high and low flow to evaluate the relationship between contaminant levels and discharge rates, as recommended by Quinlan (1989). Uranium levels did not correlate with flow based upon the 1992 data; however, nitrate levels showed an apparent decrease at high flow. Monitoring of low and high flow conditions will continue in 1993 to further examine the relationship between contaminant levels and discharge rates.

7.5.2 Quarry Monitoring Results

All groundwater monitoring wells at the quarry were sampled for radiological parameters, total uranium, Ra-226, Ra-228, Th-228, Th-230, Th-232, gross alpha, and gross beta. The uranium values continue to indicate that the highest levels above background (Table 7-2) occur in the bedrock downgradient from the quarry and in alluvial materials north of the Femme Osage Slough. The annual averages for the monitoring locations exceeding background are summarized in Table 7-11. The annual averages for monitoring locations south of the Femme Osage Slough and in the St. Charles County well field remain within background ranges.

The proposed EPA groundwater standard of 20 mg/l (13.6 pCi/l) was exceeded at 13 locations (MW-1004 through MW-1008, MW-1013 through MW-1016, MW-1027, MW-1028, MW-1031, and MW-1032) during 1992. The DCG for total uranium in discharge water is 600 pCi/l and was also exceeded at 10 of the above locations (MW-1004 through MW-1006, MW-1008, MW-1013 through MW-1016, MW-1027, and MW-1032); however, these wells are not directly used as drinking water sources. No production wells exceeded the DCG of 24 pCi/l for total uranium in drinking water systems.

TABLE 7-11 Annual Averages Total Uranium (pCi/l), Exceeding Background at the Quarry

Monitoring Location	Total Uranium	@	Monitoring Location	Total Uranium	@
MW-1004	4700	0/6	MW-1015	1356	0/6
MW-1005	1850	0/6	MW-1016	614	0/6
MW-1006	3260	0/6	MW-1027	690	0/6
MW-1007	454	0/6	MW-1028	167	2/6
MW-1008	5023	0/6	MW-1030	8.52	1/6
MW-1009	4.46	0/6	MW-1031	21.9	0/6
MW-1011	12.8	0/14	MW-1032	1407	0/6
MW-1013	872	0/6	MW-1036	5.37	0/6
MW-1014	953	0/6	MW-1038	2.58	0/6

@ = Number of nondetects to the total number of samples.
Refer to Table 7-2 for background values.

A more frequent sampling program was initiated for monitoring wells MW-1010 and MW-1011 because uranium concentrations exceeded 10 pCi/l at the MW-1011 location during 1992. Evaluation of these concentrations is required under WSSRAP procedure ES&H 1.1.7a, *Reporting Above Normal Values from Environmental Monitoring Networks*. The additional monitoring was undertaken to verify the values obtained from the analytical laboratory and to determine if there is an upward trend in uranium at that location. Subsequent trend analysis has indicated that uranium levels are stationary at these locations. In addition to these two monitoring locations, the Femme Osage Slough (SW-1007) and the St. Charles County monitoring well (MW-RMW1) were also sampled more frequently as a precaution if it was determined that an upward trend was present in MW-1011.

The St. Charles County production wells, the RMW-series wells, and pre-treated (MW-RAWW) and treated waters (MW-FINW) from the St. Charles County water treatment plant were sampled quarterly for gross alpha and gross beta. The annual averages for these locations are within background for the Missouri River alluvium. The remainder of the monitoring locations at the quarry were sampled once in 1992 for gross alpha and gross beta. The results indicated that levels were above background (Table 7-2) in the bedrock downgradient from the quarry and alluvial materials north of the Femme Osage Slough and in MW-1010 south of the slough. These averages are summarized in Table 7-12.

TABLE 7-12 Annual Averages for Gross Alpha (pCi/l) and Gross Beta (pCi/l), Exceeding Background at the Weldon Spring Quarry

Monitoring Location	Gross Alpha	Gross Beta	Monitoring Location	Gross Alpha	Gross Beta
MW-1002	7.00	12.0	MW-1016	480	300
MW-1004	3700	2840	MW-1024	7.10	11.1
MW-1005	1480	1070	MW-1026	25	18
MW-1006	4300	2230	MW-1027	680	280
MW-1007	2300	1320	MW-1028	6.80	13.0
MW-1008	6000	3400	MW-1029	13.0	12.0
MW-1009	15.0	11.0	MW-1030	98.0	190
MW-1010	BKG	6.40	MW-1031	22.0	13.0
MW-1011	22.0	22.0	MW-1032	860	780
MW-1012	23.0	13.0	MW-1036	8.50	9.60
MW-1013	1100	610	MW-1039	5.00	8.70
MW-1014	600	510	MW-RMW2	6.58	BKG
MW-1015	1400	810	MW-RMW3	6.28	10.8

Refer to Table 7-2 for background values.
BKG = value within background for this location

The Missouri Drinking Water Standard of 5 pCi/l for gross alpha was not exceeded at any of the St. Charles County production wells. The MCL of 50 pCi/l for gross beta was not exceeded in the St. Charles County well field. The St. Charles County treatment plant finished waters (MW-FINW) were in compliance with the gross alpha level of 15 pCi/l as established in 40 CFR 141 and endorsed in DOE Order 5400.5.

Ra-226, Ra-228, and isotopic thorium were analyzed once in 1992 at all groundwater monitoring locations at the quarry. The levels of these isotopes exceeded average background values (Table 7-2) along the Femme Osage Slough and in the RMW-series wells south of the slough. The annual isotopic levels for the monitoring locations exceeding background are summarized in Table 7-13. The variation in isotope levels is considered to be the result of the

natural variations in radiological levels in the environment. The DCG was not exceeded for any isotope at any of the sampling locations.

TABLE 7-13 Monitoring Location and Annual Averages of Isotopic (pCi/l) Radionuclides Exceeding Background at the Weldon Spring Quarry

Monitoring Location	Ra-226	Ra-228	Th-228	Th-230	Th-232
MW-1010	0.40	BKG	BKG	BKG	BKG
MW-1013	0.70	BKG	BKG	BKG	BKG
MW-1017	1.21	BKG	BKG	3.55	BKG
MW-1018	BKG	3.00	BKG	BKG	BKG
MW-1019	BKG	3.00	0.23	BKG	0.20
MW-1021	1.65	BKG	BKG	2.43	BKG
MW-1022	0.43	BKG	BKG	2.70	BKG
MW-1023	0.98	BKG	BKG	3.4	BKG
MW-1030	4.80	2.70	1.20	2.20	0.80

Refer to Table 7-2 for Background Values.
BKG = value within background for this location.

The Missouri Drinking Water Standard of 5 pCi/l for combined Ra-226 and Ra-228 was exceeded at DOE monitoring well MW-1030. Due to evidence of laboratory contamination, the results for MW-RMW1, MW-RMW3, MW-RMW4, and the pretreated and treated waters from the St. Charles County Treatment Plant were rejected for use and therefore are not included in this report. The quantitative limits for radium analysis did not allow for direct reference to the Missouri Drinking Water Standard for combined radium in groundwater.

In 1992, samples from all quarry monitoring wells and St. Charles County production wells were analyzed for nitroaromatic compounds. Thirteen monitoring locations yielded detectable concentrations of the six nitroaromatic compounds analyzed. The monitoring wells were situated either in the bedrock downgradient of the quarry (MW-1002, MW-1004, MW-1005, MW-1013, MW-1015, MW-1027, and MW-1032) or the alluvial materials north of the Femme Osage Slough (MW-1006, MW-1007, MW-1008, and MW-1016). A summary of

the annual averages for these locations is provided in Table 7-14. No detectable concentrations were indicated in the monitoring wells south of the slough or the St. Charles County production or monitoring wells.

The Missouri water quality standard for 2,4-dinitrotoluene (0.11 μg/l) was exceeded at 5 locations (MW-1002, MW-1004, MW-1006, MW-1027, and MW-1032). No MCLs have been established for other nitroaromatic compounds in groundwater.

All monitoring wells at the quarry and the St. Charles County production wells were sampled for nitrate and sulfate. Groundwater analyses in 1992 indicated no notable nitrate contamination at the quarry. The highest nitrate concentrations were found in bedrock and alluvial monitoring wells immediately south and adjacent to the quarry. Two monitoring wells, MW-1016 and St. Charles County well MW-RMW4, exceeded the average background values for nitrate. The MCL for nitrate (10 mg/l) was not exceeded at any of the locations at the quarry. The annual averages for these monitoring locations are summarized in Table 7-15.

Sulfate levels were elevated in the monitoring wells downgradient from the quarry but north of the Femme Osage Slough. Seventeen wells exceeded the average background levels for sulfate. The annual averages of these wells are summarized in Table 7-15. The sulfate levels were greater than background in the St. Charles County production wells adjacent to the Missouri River due to infiltration from the Missouri River.

TABLE 7-14 Annual Averages at Monitoring Locations with Detectable Nitroaromatics Results at the Weldon Spring Quarry (µg/l)

Monitoring Location	1,3,5 TNB	1,3 DNB	2,4,6 TNT	2,4 DNT	2,6 DNT
MW-1002	408	0.34	67.4	0.16	20.5
MW-1004	6.33	BKG	17.4	3.45	5.35
MW-1005	BKG	BKG	BKG	0.10	0.03
MW-1006	51.6	BKG	9.12	0.21	2.72
MW-1007	0.04	BKG	0.11	BKG	0.04
MW-1008	0.05	0.090	0.22	BKG	0.10
MW-1013	BKG	BKG	BKG	0.05	0.02
MW-1014	BKG	BKG	BKG	BKG	BKG
MW-1015	179	0.16	24.7	0.06	0.76
MW-1016	22.5	BKG	3.99	BKG	0.18
MW-1027	0.05	BKG	13.97	6.36	3.50
MW-1030	BKG	BKG	BKG	0.04	BKG
MW-1032	BKG	BKG	0.60	0.12	0.29

Refer to Table 7-2 for background values
BKG = value within background for this location.

TABLE 7-15 Annual Averages at Monitoring Locations With Nitrate and Sulfate Results Exceeding Background Weldon Spring Quarry

Monitoring Location	Nitrate (mg/l)	Sulfate (mg/l)	Monitoring Location	Nitrate (mg/l)	Sulfate (mg/l)
MW-1004	BKG	304	MW-1016	0.93	256
MW-1005	BKG	157	MW-1018	BKG	70.4
MW-1006	0.29	336	MW-1032	BKG	251
MW-1007	0.29	151	MW-PW02	BKG	114
MW-1008	0.16	257	MW-PW03	BKG	104
MW-1009	BKG	279	MW-PW04	BKG	107
MW-1012	0.94	BKG	MW-PW05	BKG	77.3
MW-1013	0.17	BKG	MW-PW06	BKG	97.9
MW-1014	BKG	111	MW-RMW4	0.50	BKG
MW-1015	1.87	311			

Refer to Table 7-2 for Background Values
BKG = value within background for this location.

The secondary MCL for sulfate is 250 mg/l; this standard was exceeded at seven locations north of the slough (MW-1004, MW-1006, MW-1008, MW-1009, MW-1015, MW-1016, and MW-1032).

In 1992, all quarry groundwater monitoring wells and St. Charles County production wells were analyzed for arsenic and barium. Arsenic levels exceeded background in locations adjacent to and south of the Femme Osage Slough. The annual averages for these locations are in Table 7-16. These elevated levels are the result of natural mechanisms, not past disposal practices at the quarry, because the arsenic values in the vicinity of the quarry proper remain within background ranges. The *Environmental Monitoring Plan for 1993* (MKF and JEG 1993c) outlines a geochemical groundwater monitoring program for the quarry which will focus on determining the mechanisms which cause these zones of differing concentrations.

Barium levels at the quarry have remained consistent, with the highest levels occurring at locations immediately south of the slough. These levels are also the result of natural geologic processes within the slough. The annual averages for these monitoring locations are summarized in Table 7-16.

TABLE 7-16 Annual Averages at Monitoring Location with Arsenic and Barium (μg/l) Results Exceeding Background Weldon Spring Quarry

Monitoring Location	Arsenic	Barium	Monitoring Location	Arsenic	Barium
MW-1007	17.1	324	MW-1024	9.00	BKG
MW-1009	4.35	416	MW-1026	20.9	396
MW-1010	104	361	MW-1028	BKG	290
MW-1017	149	983	MW-1030	BKG	239
MW-1018	114	652	MW-1033	BKG	389
MW-1019	72.4	838	MW-1036	BKG	291
MW-1020	25.7	BKG	MW-1039	BKG	475
MW-1021	69.4	828	MW-RMW2	14.2	BKG
MW-1022	150	552	MW-RMW3	32.0	660
MW-1023	66.6	BKG	MW-RMW4	16.9	BKG

Refer to Table 7-2 for background values
BKG = value within background for this location.

The MCL for arsenic in groundwater is 50 μg/l and was exceeded at seven locations south of the Femme Osage Slough (MW-1010, MW-1017 through MW-1019, and MW-1021 through MW-1023). The MCL for barium in groundwater is 1,000 μg/l and was not exceeded at any of the monitoring locations.

The St. Charles County production wells were sampled once in 1992 for cadmium, lead, and mercury. The levels for these metals did not exceed the average background values for the Missouri River alluvium and all values for these metals were within historic ranges. The St. Charles County RMW-series monitoring wells were sampled once for aluminum, calcium, chromium, iron, lead, lithium, magnesium, manganese, nickel, potassium, silver, sodium, and strontium. Several wells exceeded the average background values for specific metals, but all were within historic ranges for their respective locations.

The St. Charles County RMW-series monitoring wells, the St. Charles County production wells, untreated and treated waters form the St. Charles County water treatment plant, and DOE

monitoring wells MW-1024 were sampled in the first quarter for organics, volatiles and semivolatiles, pesticides, and polychlorinated biphenyls (PCBs). The results of the analyses indicated low concentrations of toluene at nine of the 14 sampling locations and the associated trip blank. The detection of toluene was attributed to sealing the sample vials and labels with clear adhesive tape. Resampling of several of the wells where toluene was reported indicated no detectable concentrations. This method of sealing organics sample vials for shipment is no longer employed at the WSSRAP. A concentration of methylene chloride (9 μg/l) was indicted in MW-RMW2. This concentration was attributed to laboratory contamination as a result of container cleaning practices. No detectable concentrations of pesticides or PCBs were indicated at any of the sampling locations.

7.6 Groundwater Analysis

In 1992, various data analysis techniques and special studies were conducted to evaluate contaminant migration and behavior at the Weldon Spring site. A summary of the 1992 studies and their application to future monitoring status is presented below.

7.6.1 Areal Distribution of Contaminants at the Weldon Spring Chemical Plant

Trend analysis conducted as a part of the 1991 environmental monitoring program indicated that neither statistically significant trends or seasonal effects were present in the groundwater data for the chemical plant, raffinate pits, and vicinity properties (MKF and JEG 1992m). Because the 1992 data are generally within historical ranges and the 1991 trend analyses did not reveal any systematic relationships, trend analysis was not conducted in 1992. Instead, the areal distribution of contaminants was analyzed in an effort to better understand the migration of the contaminants in the groundwater system.

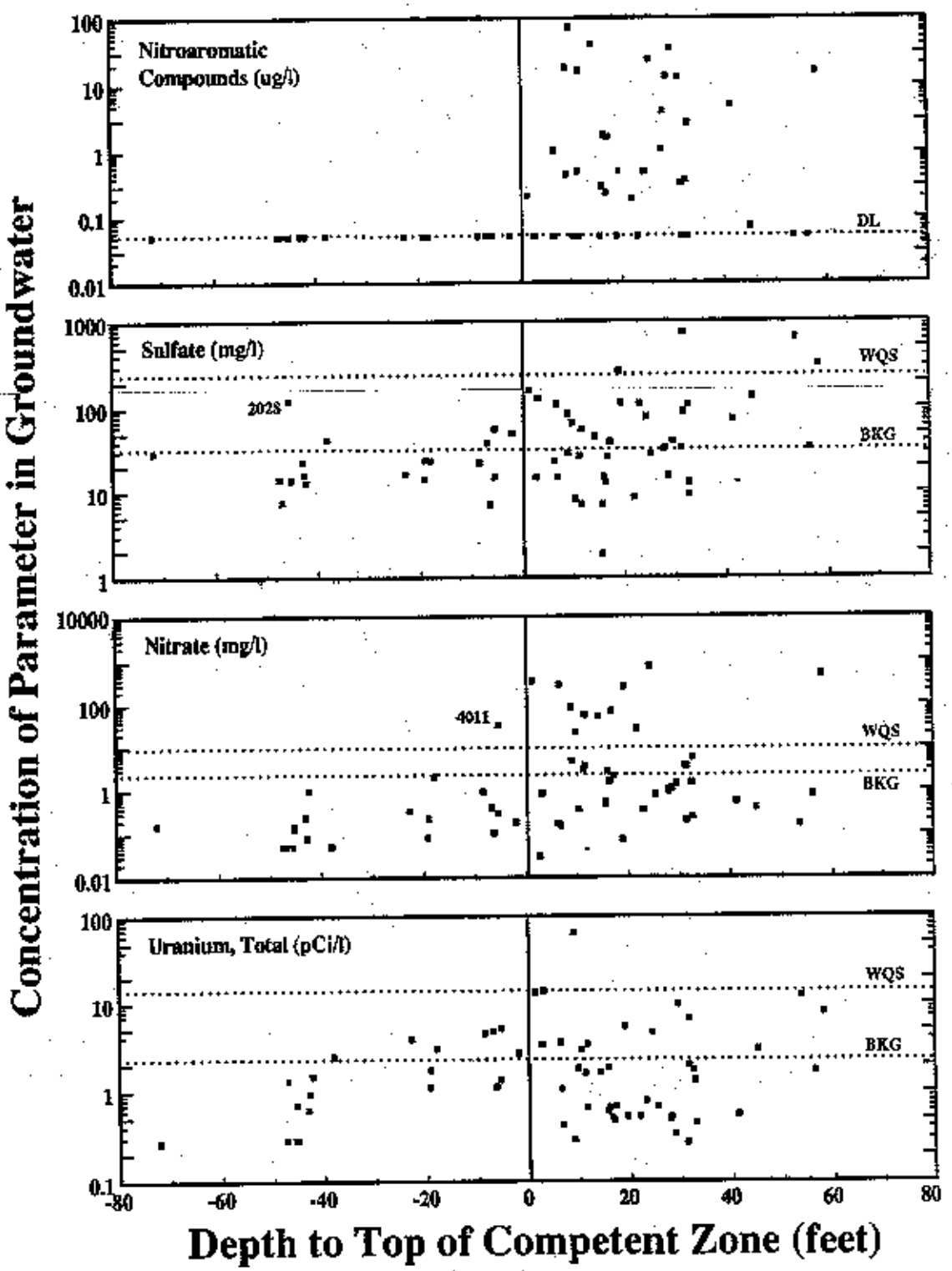
As stated in Section 7.3, the primary flux of groundwater at the chemical plant area is thought to be sub-horizontal and mainly confined to the highly permeable, upper weathered zone of the Burlington-Keokuk limestone. This hypothesis accounts for the presence of uranium and other contaminants in off-site springs at levels above those observed at most on-site monitoring wells. A vertical flow component must also be present because water levels (i.e., the potentiometric surfaces for the water table aquifer) in deeper wells are typically lower than in adjacent shallow wells. Because water can only move downgradient (i.e., from high to low potentials), the flow vector cannot be strictly horizontal. Hydraulic conductivities in the vertical

direction are significantly smaller than those in the horizontal direction, therefore vertical migration of contaminants in the saturated zone is not expected to be an important factor.

To examine this hypothesis, the wells were divided into those that received water only from the competent zone (deep wells) and those that were influenced by water traveling in the weathered zone. The distance from the top of the filter pack to the top of the weathered zone was used as a discriminant and was calculated for each well. The contaminants of concern were plotted against this distance. A subset of these diagrams is presented in Figure 7-7. In these diagrams, negative values indicate wells that were totally within the competent zone, and positive values indicate those that were partially or totally within the weathered zone. For each contaminant, high values were confined to the weathered-zone (+) wells; whereas most competent-zone-wells were at background levels or below detection limits. One exception was GW-4011, which had slightly elevated nitrate and uranium values and has historically been above background for these parameters. Although well logs indicate that this well is wholly within the competent zone, it is relatively shallow. The elevated sulfate level in GW-2028 is thought to reflect natural sulfate; this is a deep well and displays no other signs of contamination.

Based on the lithologic depth of the monitoring wells, the concentrations of seven contaminants (nitroaromatic compounds, uranium, sulfate, and nitrate) and lithium, a potential tracer element that is present at high levels in the raffinate pits, were contoured for the weathered-zone wells (Figures 7-8 through 7-11). Maximum raffinate pit concentrations and average background values are given in these diagrams (Schumacher 1990 and see Kleeschulte, Appendix H).

The contour diagrams provide a schematic representation of the distribution of compounds; the locations of minimum and maximum concentrations; and the spatial relationship among contaminants, tracer elements, and potential sources. They are included as a visual aid to the reader and are not intended to provide a true representation of the areal extent of contaminant plumes. The apparent location of a point source in the area of the raffinate pits may inaccurately portray the distribution of potential sources across the site.



LEGEND

WSQ - WATER QUALITY STANDARD (TABLE 7-1)

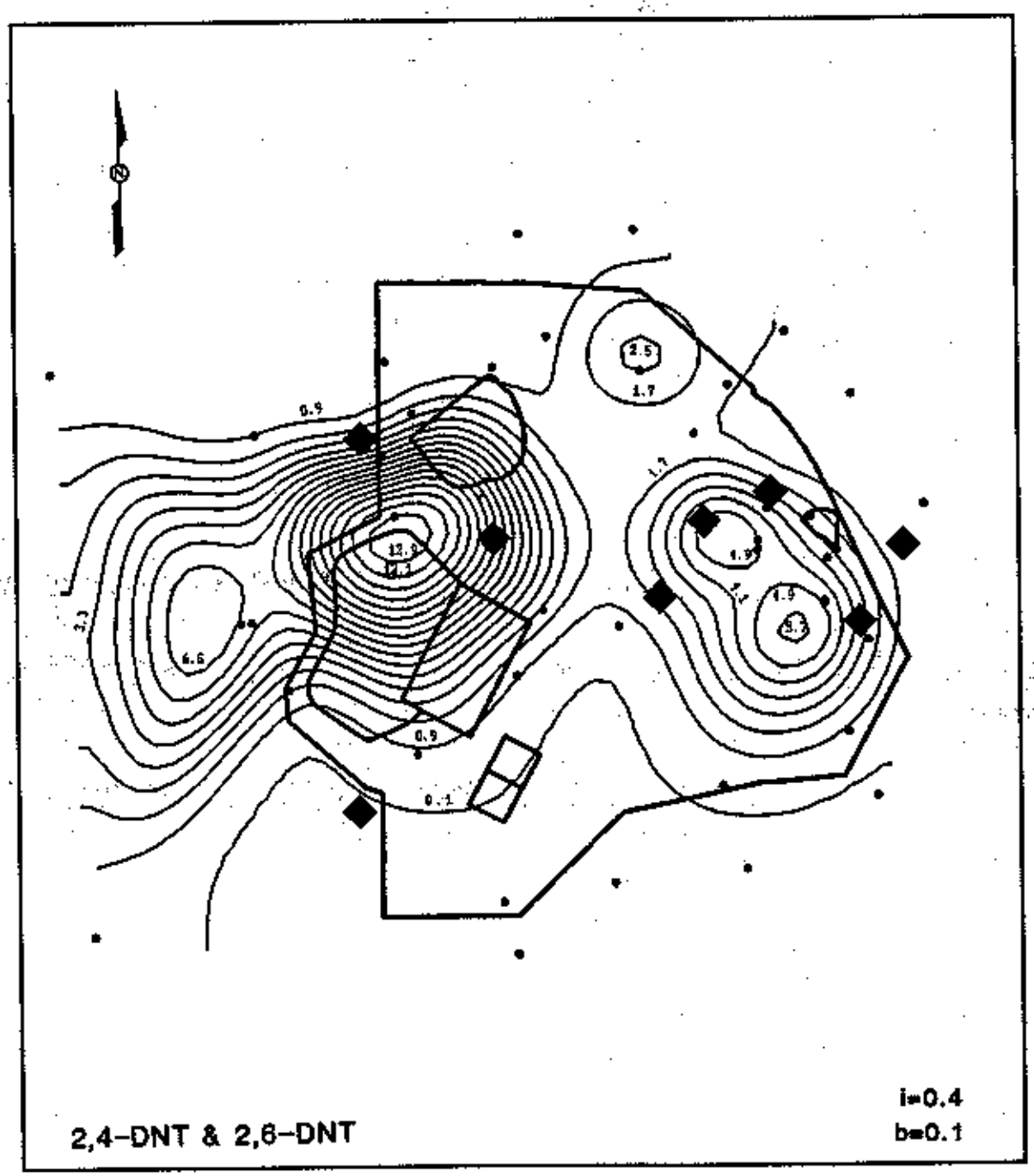
BKG - BACKGROUND VALUE

DL - ANALYTICAL DETECTION LIMIT

DISTRIBUTION OF CONTAMINANTS IN WEATHERED VS. COMPETENT ZONE MONITORING WELLS AT THE WSCP

FIGURE 7-7

REPORT NO.: DOE/OR/21548-372		EXHIBIT NO.: A/PI/088/0593	
ORIGINATOR: JR	DRAWN BY: SRS	DATE: 5/26/93	



NOT TO SCALE

LEGEND

i - INTERVAL

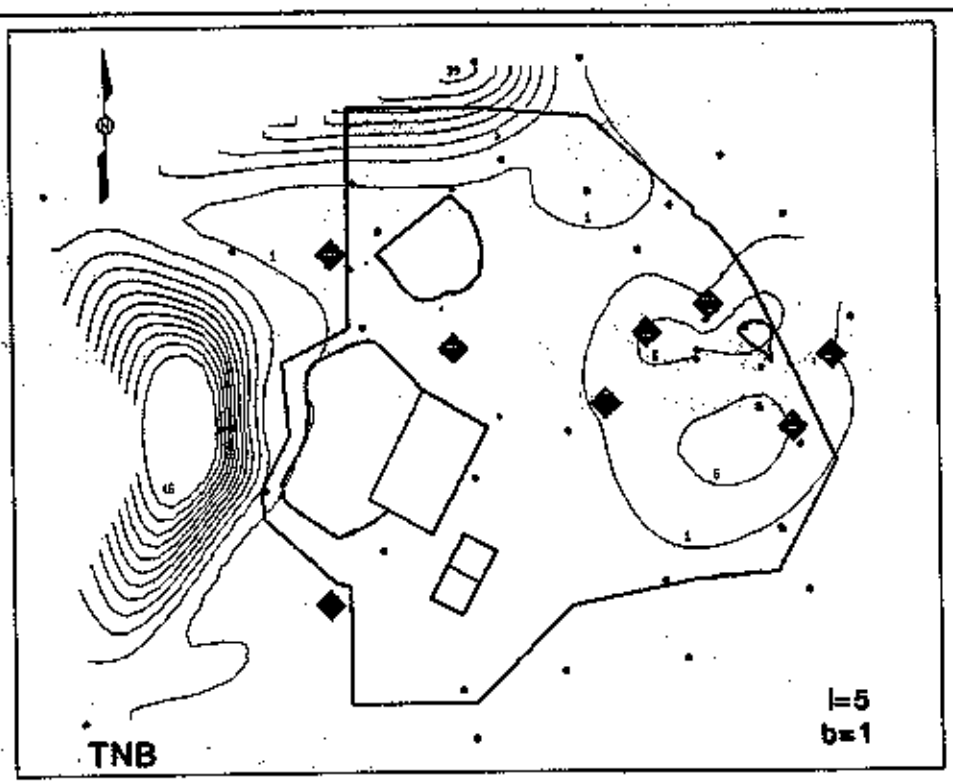
b - BASELINE

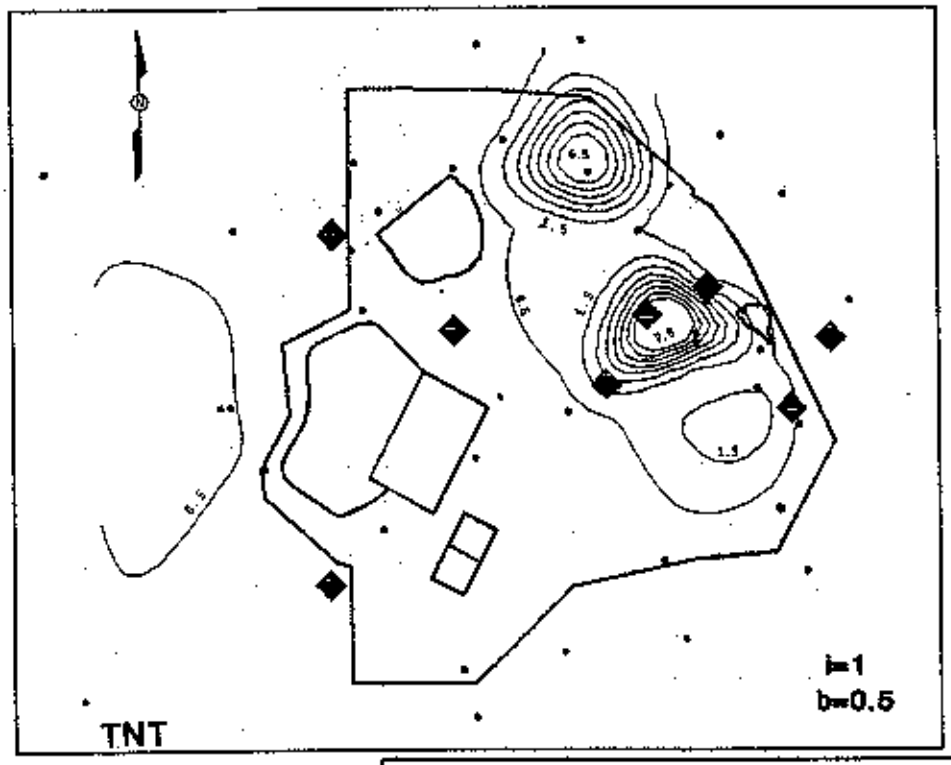
◆ - POTENTIAL SOURCE AREAS

AREAL DISTRIBUTION OF 2,4-DNT(µg/l) AND 2,6-DNT(µg/l) IN WSCP GROUNDWATER

FIGURE 7-8

REPORT NO.: DOE/OR/21548-372	EXHIBIT NO.: A/CP/047/0593	
ORIGINATOR: JR	DRAWN BY: SRS	DATE: 5/26/93





NOT TO SCALE

LEGEND

i – INTERVAL

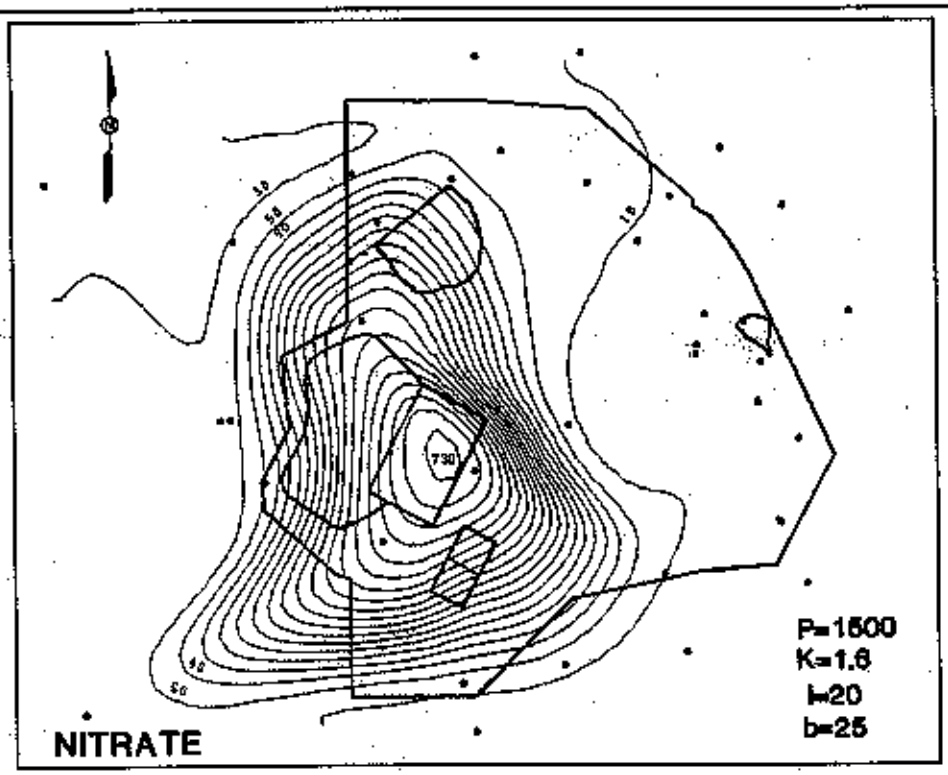
b – BASELINE

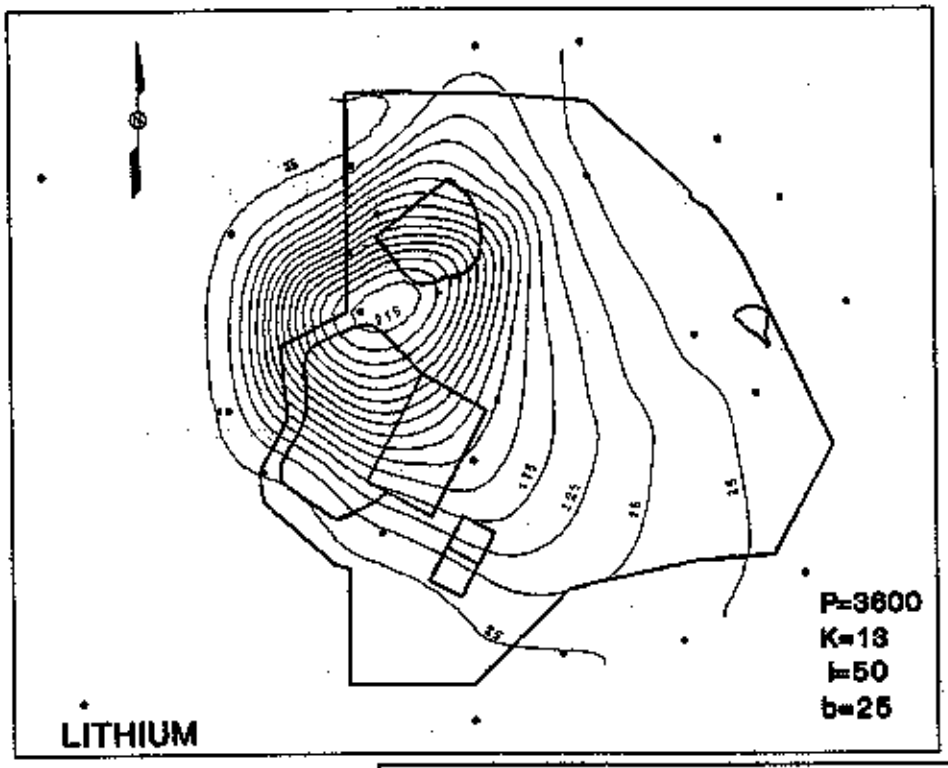
◆ – POTENTIAL SOURCE AREAS

AREAL DISTRIBUTION OF TNB(µg/l) AND TNT(µg/l) IN WSCP GROUNDWATER

FIGURE 7-9

REPORT NO.: DOE/OR/21548-372		EXHIBIT NO.: A/CP/048/0593	
ORIGINATOR: JR	DRAWN BY: SRS	DATE: 5/26/93	





NOT TO SCALE

LEGEND

I – INTERVAL

b – BASELINE

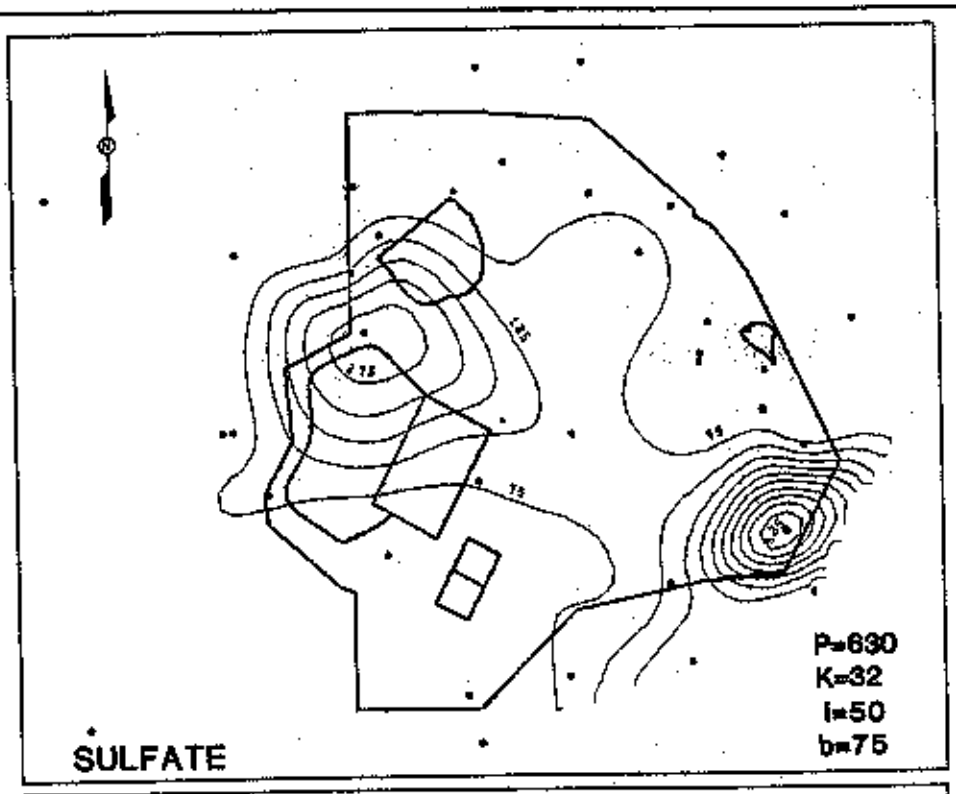
P – RAFFINATE PIT CONCENTRATION

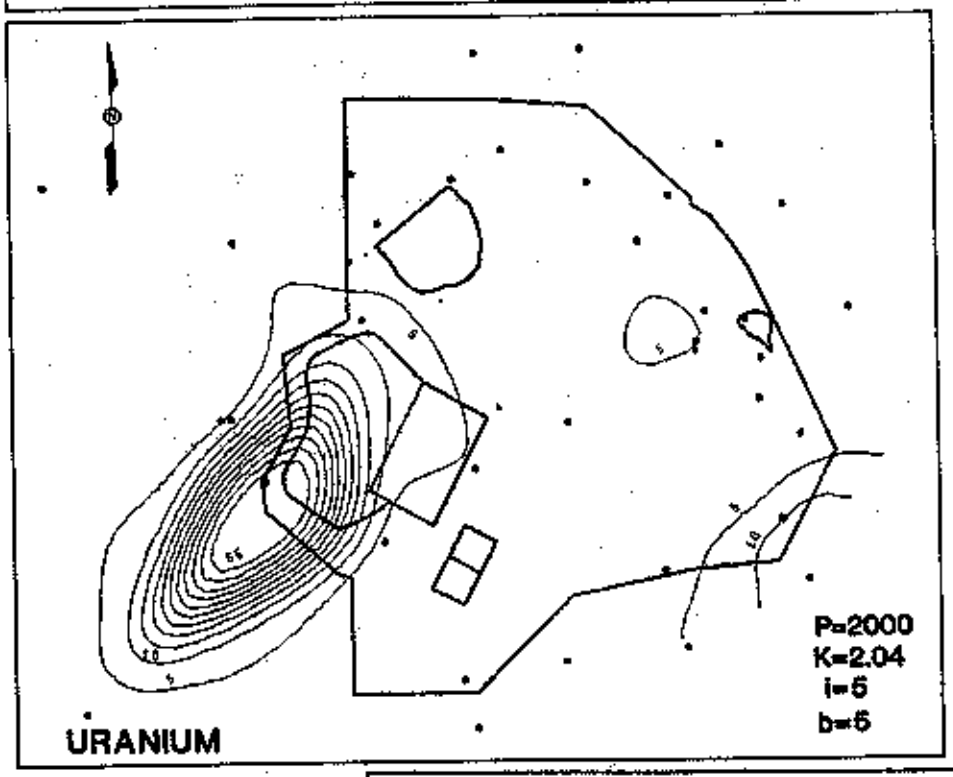
K – BACKGROUND CONCENTRATION

AREAL DISTRIBUTION OF NITRATE (mg/l) AND LITHIUM(µg/l) IN WSCP GROUNDWATER

FIGURE 7-10

REPORT NO.: DOE/OR/21548-372		EXHIBIT NO.: A/CP/049/0593	
ORIGINATOR: JR	DRAWN BY: SRS	DATE: 5/26/93	





NOT TO SCALE

LEGEND

I – INTERVAL

b – BASELINE

P – RAFFINATE PIT CONCENTRATION

K – BACKGROUND CONCENTRATION

AREAL DISTRIBUTION OF SULFATE (mg/l) AND URANIUM (pCi/l) IN WSCP GROUNDWATER

FIGURE 7-11

REPORT NO.: DOE/OR/21548-372		EXHIBIT NO.: A/CP/050/0593	
ORIGINATOR: JR	DRAWN BY: SRS	DATE: 5/26/93	

The distribution of the nitroaromatic compounds is depicted in Figures 7-8 and 7-9. These diagrams show multiple nitroaromatic highs, which may indicate as many as five or as few as two discrete sources. The location of nitroaromatic highs near the raffinate pits is coincidental; no source for these compounds is present there. The highs generally coincide with process buildings and lines from the former ordnance works (MKF and JEG 1988, MKF and JEG 1992p). The nitroaromatic contamination on the eastern side of the site, however, may also be derived from a nearby lagoon where waste water was held during ordnance works operations. This lagoon has been filled but still contains high levels of nitroaromatic compounds (IT 1992). The major potential source areas are indicated by diamonds in Figures 7-8 and 7-9.

The dinitrotoluene (DNT) compounds have similar areal distributions and so are combined in Figure 7-8. A trinitrotoluene (TNT) impacted area overlaps the DNT pattern on the eastern edge of the site, and a trinitrobenzene (TNB) area partially overlaps the DNT patterns on the western edge of the site. TNB is also present at high levels along the northern boundary of the site. According to the USGS (Schumacher et al. 1992; IT 1992), DNT is not a breakdown product of TNT, but TNB is derived from TNT by photolytic degradation. This suggests that the TNT sources for the TNB impacted areas should lie at the surface above, or upgradient from, the TNT areas. The presence of TNT-contaminated surface soils upgradient of the western TNB high (Schumacher et al, 1992; IT 1992) supports this hypothesis.

Lithium, sodium, and nitrate are generally conserved in the groundwater environment, although lithium and sodium are weakly sorbed onto clay, and nitrate concentrations may be reduced by redox reactions and biological fixation of nitrogen. Calcium and sulfate also act as conserved elements at low concentration levels; however, their concentrations are also limited by sorption and by precipitation of calcite and barite, respectively.

The patterns for lithium and nitrate are quite similar, with the highest values occurring in the area of raffinate pits 3 and 4 and Ash Pond (Figure 7-10). The areal extent of above-background values for these elements suggests that the groundwater under a large fraction of the site has been impacted by operations at the chemical plant. Whether the sources lie solely within the areas of the raffinate pits and Ash Pond is presently uncertain. A road salt storage area for the Missouri Highway and Transportation Department lies on the eastern boundary of the site near Highway 94, and is a potential source of sodium, and perhaps calcium. Nevertheless, both of these parameters are near background concentrations in this area.

In contrast to these patterns, uranium and sulfate display limited distributions (Figure 7-11). Areas of elevated uranium loosely coincide with high sulfate areas. The major area impacted uranium lies near the raffinate pits; a small area of above background uranium levels is present at the southeast corner of the site near Highway 94 and west of Frog Pond. In contrast, the highest sulfate values occur in the southeast corner of the chemical plant and more moderate values are present in the vicinity of the raffinate pits. The uranium high west of Frog Pond lies near the area where uranium ore was off loaded and prepared for processing during the operational period of the chemical plant. The sulfate and uranium high values near the raffinate pits are reasonably assumed to reflect seepage from the base of these contaminated ponds; however, the elevated values near the southeast corner of the chemical plant are not clearly understood. The absence of high nitrate levels in this area suggests a source other than the raffinate pits. A potential source for the uranium may lie beneath Building 301, whereas the sulfate may be residual from the ordnance works. The apparent association of uranium and sulfate in this location could be coincidental.

The contour diagrams suggest that a large area of the site has been impacted by previous operations at the chemical plant; however, the distribution of contaminants arising from these operations is relatively limited. This indicates that movement of contaminants in the subsurface is controlled in part by biological or geochemical processes. Geochemical controls are evaluated in Section 10.2.8. Nitroaromatic contamination resulting from operations of the ordnance works is present in several discrete areas of the site, and areas of DNT and TNT contamination plausibly mark the location of buried source-areas for these compounds.

In 1993, geochemical parameters will be measured for all wells at the chemical plant. The additional calcium, sodium, and lithium data will provide additional information on the areas actually impacted by the chemical plant operations. The geochemical data will also facilitate identification of potential sources, such as seepage from the raffinate pits, contaminated soils beneath the chemical plant buildings, and off-site salt deposits, and the areas impacted by these sources.

7.6.2 Trend Analysis for the Quarry

Statistical tests for seasonal and time dependent trends were performed on the historical and current data from those groundwater wells that exhibited an upward trend in similar analyses which were performed for the *Site Environmental Report* for 1991 (MKF and JEG 1992m) and/or exhibited an upward trend from the review of the 1992 environmental monitoring data. For this reason, trending was performed on total uranium and nitroaromatic data only. No significant trends for inorganic anions or metals were identified from previous trend analyses (MKF and JEG 1992m).

The monitoring locations that were trended were required to meet the following criteria;

- The monitoring location exhibited an upward trend in total uranium concentration as determined by trend analysis conducted with 1991 data (MKF and JEG 1992m).
- The monitoring location exhibited a recent upward trend in total uranium and/or nitroaromatic compounds during 1992 environmental monitoring.
- The historical average of total uranium and/or nitroaromatic compound concentrations was greater than five times the detection limit.

The computer program TREND, developed at Pacific Northwest Laboratory, was used for this testing. The method employed was the nonparametric Mann-Kendall test, which best accounts for nondetect values and missing data. The trend slope estimation used Sen's Nonparametric Slope Estimator method. Seasonality hypothesis testing was conducted with Minitab statistical software using the Mann-Whitney U-Test. These analyses evaluated the influence of seasonal effects on groundwater behavior.

The results of the trend analysis are discussed below and presented in Tables 7-17 and 7-18. Trend direction and slope are estimated in picocuries per liter per year. A 95% confidence interval was calculated to indicate the variability in the values about this trend line and to indicate that these values should be interpreted as indicators, not for the prediction of future concentrations, but for areas which should be more closely monitored in the future.

TABLE 7-17 Weldon Spring Quarry Groundwater Total Uranium Trend Analysis

Well ID	Location	No. of Points	Trend	Slope (pCi/l/yr)	Confidence Intervals (pCi/l)
MW-1004	Bedrock-Rim	20	Upward	435	238 - 685
MW-1005	Bedrock-Rim	21	Upward	274	121 - 391
MW-1006	Alluvium	21	Upward	407	-215 - 557
MW-1007	Alluvium	20	Stationary	—	—
MW-1008	Alluvium	20	Upward	910	711 - 1108
MW-1011	Alluvium	31	Stationary	—	—
MW-1013	Bedrock	24	Stationary	—	—
MW-1014	Alluvium	24	Stationary	—	—
MW-1015	Bedrock	23	Upward	215	88 - 308
MW-1016	Alluvium	22	Upward	132	58 - 224
MW-1027	Bedrock-Rim	17	Stationary	—	—
MW-1031	Bedrock	10	Stationary	—	—
MW-1032	Bedrock	12	Upward	846	36 - 1202

Based on the above criteria, 13 of the 36 DOE monitoring locations were selected for seasonality and trend analyses. The locations consisted of six bedrock monitoring wells (MW-1004, MW-1013, MW-1015, MW-1027, MW-1031, and MW-1032) and seven alluvial monitoring wells (MW-1005 through MW-1008, MW-1011, MW-1014, and MW-1016). All of these wells were located north of the Femme Osage Slough with the exception of well MW-1011 located on the south bank of the slough. The results of the uranium trend analysis is presented in Table 7-17.

Based on the results of the analysis of the uranium data, upward trends were present in bedrock wells on the southeast rim of the quarry (MW-1004 and MW-1005) and in the alluvial monitoring wells southeast of the quarry (MW-1006, MW-1008, and MW-1016). These wells were located along the orientation of the predominant fracture system in the quarry area which appears to be the major pathway for migration of contaminants. Seasonality was not found to be a factor at any of these locations and no upward trends were evident south of the Femme Osage Slough.

TABLE 7-18 Quarry Groundwater Nitroaromatic Trend Analysis

Well	Area	Compound	No. of Points	Seasonality	Trend	Slope (µg/l/yr)	CI
GW-1002	Bedrock-Rim	2,4-DNT	22	No	S	---	---
		2,6-DNT		No	U	2.7	1.8 - 4.9
		1,3,5-TNB		No	U	62	40 - 110
		1,3-DNB		No	S	---	---
		2,4,6-TNT		No	U	10	4.9 - 17
GW-1004	Bedrock-Rim	2,4-DNT	22	No	U	0.7	0.6 - 0.9
		2,6-DNT		No	U	0.8	0.4 - 1.2
		1,3,5-TNB		No	U	1.2	0.7 - 1.8
		1,3-DNB		No	D	0.03	-0.04 - 0
		2,4,6-TNT		No	U	0.8	0.4 - 1.2
GW-1006	Alluvium	2,4-DNT	22	No	S	---	---
		2,6-DNT		No	S	---	---
		1,3,5-TNB		No	S	---	---
		1,3-DNB		No	D	0.04	-0.05 - -0.01
		2,4,6-TNT		No	S	---	---

TABLE 7-18 Quarry Groundwater Nitroaromatic Trend Analysis (Continued)

Well	Area	Compound	No. of Points	Seasonality	Trend	Slope (µg/l/yr)	CI
GW-1015	Bedrock	2,4-DNT	24	No	S	---	—
		2,6-DNT		No	S	---	—
		1,3,5-TNB		Yes	U	28	6.7 - 100
		1,3-DNB		No	S	---	---
		2,4,6-TNT		Yes	S	---	—
GW-1016	Alluvium	2,4-DNT	22	No	D	0.01	-0.02 - 0
		2,6-DNT		No	S	---	---
		1,3,5-TNB		Yes	U	4.5	-3.8 - 20
		1,3-DNB		No	D	0.01	-0.02 - 0
		2,4,6-TNT		Yes	S	---	—

Slope

S stationary (no trend)
U upward trend
D downward trend
CI confidence interval

No previous trending had been performed on nitroaromatic data at the quarry. Five out of 36 DOE monitoring locations were selected for nitroaromatic trend analysis in a manner similar to the selections for total uranium trend analysis. The summary of the nitroaromatic trend analysis is presented in Table 7-18. Nitrobenzene was not included in the statistical analysis because the levels were consistently below detection limits.

Based on the results of the nitroaromatic compound trending analysis, upward trends were present in monitoring wells MW-1002 and MW-1004 in the bedrock at the quarry rim and monitoring wells MW-1015 and MW-1016 southeast of the quarry in the bedrock and alluvium. The strongest upward trends were observed for TNB, which is a photolytic decay product of TNT (Schumacher 1990). The source of the increasing TNB trends may be the nitroaromatic contaminated soils within the quarry. Leaching of TNB produced by photolytic degradation of TNT could release TNB to the groundwater system. Downward trends in DNB and DNT are negligible and are likely the result of the microbial degradation of those compounds in the subsurface.

7.6.3 Baseline Groundwater Quality Determination for Quarry Water Treatment Plant Monitoring Wells

Monitoring wells MW-1035 through MW-1039, which monitor shallow groundwater in the vicinity of the quarry water treatment plant, have been sampled since their installation in 1991. A goal of the *Environmental Monitoring Plan for Calendar Year 1992* (MKF and JEG 1992o) was to establish baseline groundwater quality values for parameters frequently monitored at the quarry. Monitoring well MW-1035 had previously been established as a background well for the unconsolidated materials north of the Femme Osage Slough, and the results for this well are summarized in Table 7-19. The result of this baseline determination are summarized in Appendix A and will be used for comparison purposes after the quarry water treatment plant begins operation.

7.7 Highlights

- Radiological results for the St. Charles County well field remained within background levels for the Missouri River alluvium in 1992.

TABLE 7-19 Average Baseline Values for the Quarry Water Treatment Plant Monitoring Wells

Parameters	MW-1036	MW-1037	MW-1038	MW-1039
Total uranium (pCi/l)	4.28	2.29	2.78	1.8
Ra-226 (pCi/l)	0.2	0.3	0.2	0.1
Ra-228 (pCi/l)	<0.9	0.1	0.5	0.9
Th-228 (pCi/l)	<0.2	<0.2	<0.5	<0.2
Th-230 (pCi/l)	<0.2	0.2	<0.2	0.1
Th-232 (pCi/l)	<0.2	<0.2	<0.2	<0.2
Gross alpha (pCi/l)	8.5	3.9	0.6	5.0
Gross beta (pCi/l)	9.6	5.9	8.1	8.7
Nitroaromatics	No detects	No detects	No detects	No detects
Arsenic (µg/l)	<2.0	<2.0	<2.0	<2.0
Barium (µg/l)	286.4	573.6	240.8	487.1
Nitrate (mg/l)	0.10	0.14	<0.10	0.10
Sulfate (mg/l)	59.6	19.0	47.8	50.9
Alkalinity (mg/l)	501.7	456.8	447.0	546.5

- No detectable concentrations of the six nitroaromatic compounds of concern were indicated in groundwater south of the Femme Osage Slough.

- A more frequent monitoring program for monitoring well MW-1011, south of the Femme Osage Slough, was initiated because uranium concentrations exceeded 10 pCi/l in the second bimonthly period. Statistical analysis of data uncovered no upward trend at this monitoring location.

- Trend analysis for the quarry groundwater data indicated an upward slope for uranium in seven of the 13 monitoring wells meeting selection criteria and for four nitroaromatic compounds in four of the five wells selected.

- At the chemical plant and raffinate pits, uranium, sulfate, nitrate, and nitroaromatic compounds in monitoring wells and springs remained within historic ranges during 1992.

- Nitroaromatics were present at detectable levels in 27 of the 66 monitoring wells at the chemical plant and raffinate pits and uranium, nitrate, and sulfate exceeded regulatory levels in no more than than 15 of the 66 monitoring wells. Historically high uranium concentrations in groundwater wells were recorded near Raffinate Pit 4 of the chemical plant and raffinate pits and at the southeast corner of the site.

- Contaminant transport continues to be confined to the upper weathered zone of the bedrock aquifer at the chemical plant and raffinate pits. Conduit flow appears to play a major role in off-site contaminant transport as evidenced by the presence of elevated uranium levels in Burgermeister Spring.

8 BIOLOGICAL MONITORING PROGRAM

8.1 Program Description

The biological monitoring program complies with regulatory requirements including U.S. Department of Energy (DOE) Orders, the *National Environmental Policy Act* (NEPA), the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA), and Federal and State regulations. Many of the sampling activities directed by DOE Orders 5400.1 and 5400.5 such as preoperational monitoring, effluent monitoring, and environmental surveillance are used to support the NEPA and CERCLA biological monitoring program and include the collection and analysis of water, soil, foodstuffs, and biota.

The NEPA requires baseline characterization information to support regulatory documents such as environmental assessments and environmental impact statements. CERCLA site activities also required the collection of characterization data in 1992 to assess risk to ecological resources for the Remedial Investigation/Feasibility Study (RI/FS) activities related to the Weldon Spring Chemical Plant Operable Unit.

Activities for the biological monitoring program are selected from the results of pathway analysis. Exposure pathways identified for human and ecological receptors are identified in Section 2.1 of the *Environmental Monitoring Plan for Calendar Year 1992* (MKF and JEG 1992o). Pathways identified as complete are those that show linkage between one or more contaminant sources, through one or more environmental transport processes, to an exposure point where human or ecological receptors are present. These exposure pathways direct biological sampling activities and determine the type of data that needs to be gathered, documented, and presented.

Complete pathways applicable to biological monitoring for the Weldon Spring site are:

- Human ingestion of game and fish inhabiting wildlife areas.
- Human ingestion of foodstuffs grown in the Weldon Spring site area.
- Ingestion of invertebrates and vegetation by aquatic biota.
- Ingestion of surface water and sediments by terrestrial biota.
- Ingestion of vegetation, crops, and soils by terrestrial biota.
- Uptake of water and sediments by aquatic biota.

Biological monitoring supports human dose calculations, as presented in Section 4, by providing data for the human ingestion pathways. The remaining pathways are monitored to support biological risk assessment studies and compliance with environmental surveillance requirements.

Two types of data were gathered in 1992: survey and analytical. Survey data were collected in the field, including information such as species presence, number of individuals, and abundance. Analytical data on samples from the Weldon Spring site were received from a subcontractor laboratory. Biological samples were analyzed for radionuclides and some specific metals. The biological monitoring program was expanded greatly over previous years with a number of new activities added in 1992 including bird, turtle, and mammal surveys.

8.2 Applicable Standards

DOE Orders and U.S. Environmental Protection Agency (EPA) regulations provide the standards of compliance for the biological monitoring program. In 1992, the Weldon Spring Site Remedial Action Project (WSSRAP) performed prescreening assessments on terrestrial foodstuffs to establish a surveillance level. This surveillance level was determined on the basis of DOE guidelines for established annual effective dose equivalents for humans consuming terrestrial foodstuffs. If 1991-1992 preliminary analysis of the public dose indicated the annual effective dose equivalent from ingestion of terrestrial foods was 5 mrem or greater, sufficient sampling and analysis will be performed to ensure that foodstuffs and radionuclides contributing at least 90% of the ingestion dose are evaluated. If the annual effective dose is between 1 mrem and 5 mrem, sufficient sampling and analysis is expected to be carried out to provide reasonable assurance that the doses are within this range. When the annual effective dose equivalent is between 0.1 mrem and 1 mrem, surveillance is expected to be performed to show whether the radionuclides are behaving as expected (DOE 1991).

The biological monitoring program also provided data for the dose estimates on which the discussion in Section 4 on the ingestion of biota by humans is based. This calculation was based on the guideline that members of the public should not be exposed to radiation sources as a consequence of all routine DOE activities that in any one year could cause an effective dose equivalent greater than 100 mrem (1 mSv).

DOE Order 5400.5 also addresses the protection of native aquatic organisms from the potential bioaccumulation of radionuclides. The Order states that the absorbed dose shall not exceed 1 rad per day from exposure to the radioactive material in liquid wastes discharged to natural waterways.

The EPA has established Federal ambient water quality criteria for various pollutants, including metals and nitroaromatic contaminants found at the Weldon Spring site. Although monitoring for nitroaromatics in surface water is conducted at the site, the levels found do not indicate a need for further monitoring to protect aquatic life and human health as related to the ingestion of biota. Table 8-1 lists the water quality criteria for metals for both aquatic life and

TABLE 8-1 EPA Water Quality and Human Health Criteria for Metals

Parameter	Fresh Water Aquatic Life/Maximum Level µg/l	Human Health at 10^{-5} Incremental Risk Level-Ingesting Aquatic Organisms Only µg/l
Arsenic	190	0.175
Cadmium	1.1	10
Chromium (+3)	210	3.4×10^{6}
Chromium (+6)	11	50
Copper	12	1,000
Lead	3.2	50
Mercury	0.012	0.146
Nickel	96	100
Selenium	260	10
Silver	4.1	50
Zinc	320	5,000

(Source EPA 1986a)

human health. On the basis of surface water monitoring from 1987 through 1992 at August A. Busch Wildlife Area Lakes 34, 35, and 36, and Femme Osage Slough, the only metals of concern for aquatic life are lead, mercury, silver, and zinc. Human health requires protection from ingestion of biota containing elevated arsenic levels. Mercury is also under consideration

since previous detection limits for surface water monitoring were not low enough to meet the EPA criteria levels. The EPA criteria for human health risk are used in developing surveillance levels for fish and game programs. The EPA criteria also serve as a guide in the surveillance of benthic invertebrates, waterfowl, and zooplankton.

8.3 Monitoring Results

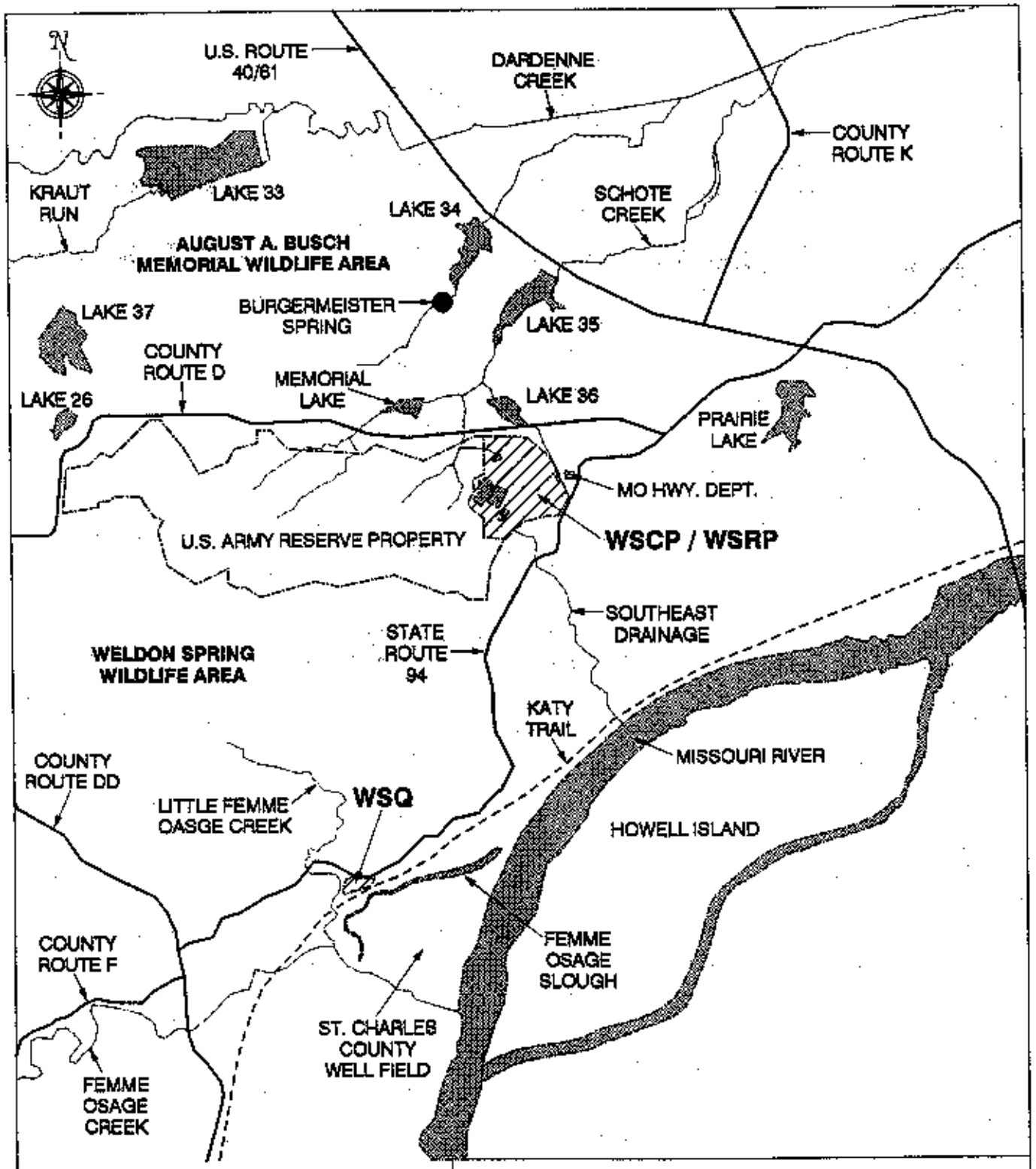
The biological monitoring program was divided into two study units: aquatic and terrestrial. Studies were carried out at predetermined survey locations as detailed in the *Environmental Monitoring Plan for Calendar Year 1992* (MKF and JEG 1992o). General study locations can be found on Figure 8-1.

8.3.1 Aquatic Monitoring

Biota are primarily exposed to radionuclides and other contaminants of concern at the Weldon Spring site by aquatic pathways. Contaminated surface water bodies and surface water runoff from the site to off-site lakes and streams provide the main route of exposure to biota. Characterization studies have been conducted to determine the effects of contaminants on biota at on-site and off-site properties. Biouptake studies conducted on fish were based on human consumption of game species.

8.3.1.1 Fish. Fish samples were collected in 1992 to refine future monitoring requirements by developing conclusive statements on the conditions and contaminant levels in fish consumed by humans. In order to statistically define contaminant levels and differences, if any, between fish in lakes that receive contaminated surface water from the site and those that do not, a larger number of samples were collected in 1992 than in previous years. The number of samples was increased to provide an adequate data set for statistical analysis and to formulate conclusions.

In 1992, the WSSRAP and the Missouri Department of Conservation (MDOC), sampled fish from off-site properties, including Lakes 34, 35, and 36 at the Busch Wildlife Area and from Femme Osage Slough where elevated levels of uranium are known to exist. Lakes 33 and 37 at the Busch Wildlife Area were used as background sampling locations. These background lakes have been shown to have no hydraulic connection to the site.



ECOLOGICAL SURVEY LOCATIONS IN WELDON SPRING SITE AREA

FIGURE 8-1

REPORT NO.: DOE/OR/21548-972		DOCUMENT NO.: A/VP/010/0193	
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 1/93	

Samples taken consisted primarily of game species such as large mouth bass, crappie, sunfish, and catfish. Samples were prepared as whole, fillets, and fish cakes (crappie and sunfish only), and analyzed for isotopic uranium, arsenic, and lead. All data below the detection limit are presented and were used in calculations as half of the detection limit according to EPA guidance (EPA 1989) unless uncensored data were available (Section 9.1.5).

The two highest uranium concentrations were found in whole sunfish from Lake 36 (0.204 pCi/g) and Lake 35 (0.558 pCi/g) (Table 8-2). Higher concentrations would be expected in whole samples, since radionuclides tend to accumulate in the bones and organs. All other samples were less than 0.050 pCi/g. Background concentrations ranged from less than 0.001 pCi/g to a high of 0.009 pCi/g. The data are presented as total uranium with detection limits ranging from 4.8E-03 pCi/g to 4.86E-05 pCi/g.

Lead and arsenic analyses were added to the 1992 fish sampling program. Lead was analyzed in fish in order to address levels detected in study lakes during the 1991 aquatic biological screening investigation (Section 8.3.1.2). Elevated levels of lead were detected in surface water at Lakes 35 and 36 and exceeded the fresh water aquatic life maximum level of 3.2 μg/l. Due to historic arsenic values in fish, it was necessary to include arsenic to determine if the concentrations in fish were of concern (MKF and JEG 1989a). Although Lakes 34, 35, and 36 are connected hydraulically to the site, the elevated lead levels were found in the background lakes as well as the study lakes. Busch Lakes 34, 35, and 36 and the site are hydraulically connected by Ash Pond drainage, Frog Pond drainage, and Burgermeister Spring. No elevated levels of arsenic and lead have been detected leaving the chemical plant and raffinate pits by these routes during National Pollution Discharge Elimination System (NPDES) sampling. The source of elevated levels of lead in the study lakes is not known, although it could be from the Weldon Spring Ordnance Works or from natural sources. Results of arsenic and lead analyses of fish samples are presented below.

Arsenic and lead concentrations are also presented in Table 8-2. All results showed that arsenic concentrations were less than the detection limit 0.046 μg/g to 3.4 μg/g, with the exception of 1.475 μg/g found in sunfish cakes from Lake 34 and 0.19 μg/g found in sunfish fillets from Lake 36. Lead was detected in most of the samples taken from both the study lakes and background lakes. Lead values from study lakes ranged from <0.046 μg/g to 8.9 μg/g and ranged from <0.048 μg/g to 1.4 μg/g in the background lakes. The highest concentration

TABLE 8-2 Average Uranium and Metal Concentrations in Fish

Background Locations	Species/sample type	Uranium (pCi/g)	@	Arsenic (µg/g)	@	Lead (µg/g)	@
Lake 34	Bass Fillet	0.001	0/1	<0.49	1/1	<0.049	1/1
	Bass Whole	0.001	1/2	<1.23	2/2	0.50	0/2
	Catfish Fillet	0.017	0/2	<0.50	1/1	0.48	0/1
	Catfish Whole	0.002	0/1	<0.48	1/1	0.56	0/1
	Sunfish Fillet*	<0.10	1/1	<3.4	1/1	<2.8	1/1
	Sunfish Cakes	0.001	0/2	1.475	1/2	0.92	0/2
	Sunfish Whole	0.003	0/2	<1.24	2/2	0.72	0/2
Lake 35	Bass Fillet*	<0.10	1/1	<3.4	1/1	<2.8	1/1
	Bass Whole	0.007	0/1	<0.48	1/1	0.29	0/1
	Catfish Fillets	0.004	0/1	NA	-	NA	-
	Crappie Cakes	0.011	0/2	<0.27	2/2	0.08	0/2
	Crappie Whole	0.027	0/1	<2.0	1/1	0.20	0/1
	Sunfish Cakes	0.189	0/2	<1.18	2/2	0.42	0/2
	Sunfish Whole	0.558	0/3	<0.5	3/3	1.06	0/3
Lake 36	Bass Fillets	0.005	0/1	<0.049	1/1	0.30	0/1
	Bass Whole	0.035	0/1	<0.049	1/1	0.084	0/1
	Carp Fillets	0.032	0/1	<0.046	1/1	<0.046	1/1
	Sunfish Fillets	0.023	0/1	0.19	0/1	<0.050	1/1
	Crappie Cakes	0.176	0/1	<0.46	1/1	0.44	0/1
	Sunfish Whole	0.204	0/4	<0.08	4/4	0.665	0/4
Femme Osage Slough	Bass Fillets	0.005	0/1	<0.49	1/1	0.11	0/1
	Carp Fillets	0.005	0/1	<0.048	1/1	0.12	0/1
	Carp Whole*	0.11	0/1	<3.4	1/1	<2.8	1/1
	Catfish Whole	0.120	0/1	<0.048	1/1	0.20	0/1
	Buffalo Whole	0.002	0/1	<1.9	1/1	0.35	0/1
	Sunfish Whole	0.006	0/1	<2.0	1/1	8.9	0/1

TABLE 8-2 Average Uranium and Metal Concentrations in Fish (Continued)

Background Locations	Species/sample type	Uranium (pCi/g)	@	Arsenic (µg/g)	@	Lead (µg/g)	@
Lake 33	Bass Fillets*	<0.10	1/1	<3.3	1/1	<2.8	1/1
	Bass Whole	0.002	0/1	<0.048	1/1	0.078	0/1
	Carp Fillets	0.022	0/2	<0.48	2/2	0.89	0/2
	Carp Whole	0.019	0/1	<0.46	1/1	1.1	0/1
	Catfish Fillets	0.006	0/1	<0.50	1/1	<0.25	1/1
	Catfish Whole	0.031	0/2	<0.253	2/2	1.4	0/2
	Crappie Cakes	0.001	0/2	<0.049	1/1	<0.048	1/1
	Crappie Whole	0.009	0/1	<0.48	1/1	0.21	0/1
	Sunfish Whole	0.004	0/3	<0.5	3/3	1.3	0/3
	Sunfish Cakes	0.004	0/1	<0.49	1/1	0.44	0/1
Lake 37	Bass Fillets	0.001	0/1	<0.048	1/1	0.048	0/1
	Bass Whole	0.002	0/2	<0.047	2/2	0.28	0/2
	Catfish Fillets	<0.001	1/1	<0.048	1/1	<0.048	1/1
	Sunfish Whole	0.004	0/1	<1.9	1/1	1.4	0/1

* Samples could not be reanalyzed at the lower detection limit due to insufficient sample material.
@ = Number of nondetects to total number of samples.

(8.9 µg/g) was found in whole sunfish taken from Femme Osage Slough. The highest concentrations found for edible portions were 0.89 µg/g found in carp fillets from background Lake 33 and 0.92 µg/g in sunfish cake samples from Lake 34.

8.3.1.2 Benthic Invertebrates and Zooplankton. Benthic invertebrates and zooplankton were collected in 1992 as part of the aquatic biological screening investigation required by DOE Order 5400.5. Benthic invertebrate biomass samples were also collected for biouptake of uranium in order to assess the exposure to aquatic biota by ingestion of invertebrates. The 1992 study compared species diversities and population densities for benthic invertebrates and zooplankton at contaminated areas and background locations.

Benthic invertebrates and zooplankton were sampled from Frog Pond, Busch Lakes 34, 35, 36, and Femme Osage Slough, with Busch Lakes 26 and 33 serving as background locations.

Invertebrates were also sampled from pool and riffle habitats at Little Femme Osage Creek, Dardenne Creek, the Southeast Drainage, Burgermeister Spring, and at a background location.

Additionally, limnological samples were taken to characterize lake and stream habitats. Surface water was analyzed for uranium, toxicity metals (As, Ag, Ba, Cr, Zn, Pb, Hg, and Se), total suspended solids, nitrate, phosphate, chlorophyll a, pH, temperature, conductivity, dissolved oxygen, and Secchi disk depths. Sediments were analyzed for uranium, toxicity metals, and sediment type. Complete results for the 1992 sampling event will be available in a 1993 final report, which will discuss sampling locations and methods, results, interpretation, and a comparison to the 1991 results. Preliminary results for biomass and for invertebrate and zooplankton diversity and density are presented below.

Lake, stream, and spring locations sampled in 1992 exhibited significant differences between contaminated and background sites (ESE 1993).

Biomass samples from lake locations consisted of the benthic families: Chironomidae, Oligochaete, Hexigenia, Corbicula, and Sphaeriidae. Average 1992 concentrations in the lake study areas ranged from 2.90 pCi/g in Oligochaete collected from Frog Pond to 25.0 pCi/g in Hexigenia taken from Lake 36. Background concentrations ranged from 0.29 pCi/g in Chironomidae from Lake 26 to 1.20 pCi/g in a composite sample from Lake 33.

Biomass samples collected from spring and stream locations were primarily composed of Asellidae, Gammaridae, Chironomidae, Physidae, Decapoda, and Hydropsychidae. Average detectable concentrations ranged from 0.45 pCi/g in Chironomidae from the Little Femme Osage Creek to 29.0 pCi/g in a composite sample taken from Burgermeister spring. Average uranium concentrations for biomass samples are presented in Table 8-3.

Diversity and density results indicated that zooplankton were primarily affected by the sizes and depths of the lakes. Larger, deeper lakes contained limnetic and large zooplankton rotifers, whereas the smaller, shallower lakes contained notably lower numbers of larger zooplankton and different communities of rotifers. No significant difference was found in densities or diversities of zooplankton between contaminated lakes and background lakes (ESE 1993).

TABLE 8-3 Average Uranium Concentrations (pCi/g) in Benthic Invertebrates Sampled during 1991 and 1992

Location	Benthic Family	1991 Uranium Concentration	1992 Uranium Concentration
Femme Osage Slough	Chironomids	<1.30	<0.68
	Others	2.6	3.01
Frog Pond	Others	0.57	9.40
	Chironomids	-	21.0
	Oligochaetes	-	2.90
	Physidae	-	13.0
Lake 33 (background)	Others	-	1.20
Lake 34	Chironomids	0.56	<2.30
	Ephemoptera	2.66	-
	Oligochaetes	-	<2.30
	Others	0.23	-
Lake 35	Chironomids	6.80	7.70
	Oligochaetes	12.2	-
	Others	16.3	3.3
Lake 36	Ephemoptera	8.18	-
	Hexagenia	-	25.0
	Others	49.6	4.68
Lake 26 (background)	Chironomids	-	0.29
	Ephemoptera	0.184	-
	Hexagenia	-	<0.76
	Others	<0.048	<3.40
Lake 37 (background)	Chironomids	0.143	Not Sampled
	Ephemoptera	0.075	
	Naidadae	<0.204	
	Others	0.218	
Dardanne Creek	Others	R*	17.4

TABLE 8-3 Average Uranium Concentrations (pCi/g) in Benthic Invertebrates Sampled during 1991 and 1992 (Continued)

Location	Benthic Family	1991 Uranium Concentration	1992 Uranium Concentration
Little Femme Osage	Chironomids	-	0.45
	Decapods	-	<7.60
	Oligochaetes	-	<34.0
	Others	<3.10	0.777
Burgermeister Spring	Asellidae	-	2.4
	Gammarids	R*	0.66
	Oligochaetes	-	9.30
	Others	0.489	29.0
Southeast Drainage	Asellidae	-	5.35
	Chironomids	-	10.0
	Physadae	-	<8.50
	Others	29.2	4.7
Background Spring	Amphipods/ Ephemoptera	.014	
	Oligochaetes/ Chrinomids	.70	
	Decapods	<0.15	
	Gammarids		0.155
	Others		0.80

"-" - Family not represented from sampling location
R* - Rejected by validation process
Other - Sample not represented by at least 75% of any one family

There will be two changes in the 1993 aquatic biological investigations. First, due to the culvert connection between the north and south arms of Femme Osage Slough, a background location will be identified for future comparison studies. During previous studies, the samples collected from Femme Osage Slough were interpreted as a gradient from the source of contamination to the most distant sampling location in the slough. Second, because of problems in evaluating the Southeast Drainage, a habitat evaluation will be conducted to determine the

quality of habitat, and to determine whether results from the Southeast Drainage are indicative of an impacted drainage. EPA protocols (Plafkin 1989) will be used for this evaluation.

8.3.1.3 Aquatic Vegetation. Aquatic vegetation was sampled in 1992 to support three data objectives: (1) to determine whether fauna feeding on this vegetation are potentially exposed to radionuclides above background levels, thereby addressing the human exposure pathway by ingestion of game; (2) to support dose calculation for the *Baseline Risk Assessment for the Chemical Plant Area of the Weldon Spring Site* (DOE 1992c) for biological risk; and (3) to fulfill preoperational monitoring requirements for the quarry water treatment plant at the Missouri River outfall location.

Aquatic vegetation samples were collected from Frog Pond and analyzed for total uranium. Vegetation samples were collected from the exposed sediments of Ash Pond where deer are frequently sighted, and from Memorial Lake, which served as a background location. Samples were analyzed for uranium, radium, and thorium.

The aquatic vegetation (macrophytes) collected from Frog Pond showed uranium concentration of 37.0 pCi/g. Semi-aquatic vegetation samples (sedge-rosettes) collected from Ash Pond had uranium concentrations of 0.730 pCi/g. The background location, Memorial Lake had uranium concentrations of 0.014 pCi/g. The samples from Ash Pond and Memorial Lake were not rinsed in order to reflect what a deer grazing on this vegetation would consume. Radium and thorium results are presented in Appendix F, Table F-1.

A radiological dose to waterfowl was calculated on the basis of ingestion of aquatic vegetation, benthic invertebrates, and surface water. Ducks were assumed to consume 100 grams of aquatic vegetation, 15 grams of insects, and 500 ml of water per day. Geese were assumed to consume twice as much per day (DOE 1992c). The highest uranium concentrations were used for aquatic vegetation (37 pCi/grams from Frog Pond), benthics (50 pCi/g from Frog Pond), and surface water (4,420 pCi/l from Ash Pond).

Aquatic vegetation samples were not collected from Raffinate Pit 4 and the Femme Osage Slough, as stated in the *Environmental Monitoring Report for Calendar Year 1992* (MKF and JEG 1992o) based upon the *Baseline Assessment for the Chemical Plant Area of the Weldon Spring Site* stating there is minimal dose to waterfowl foraging on aquatic vegetation from on-site water bodies (ANL 1992). Additional aquatic sampling of vegetation from Femme

Osage Slough will be addressed in the work plan for the Weldon Spring Quarry residuals remedial investigation.

Aquatic and terrestrial vegetation samples which were to be taken from the Missouri River were required for preoperational monitoring by the National Pollution Discharge Elimination System (NPDES) permit. Aquatic vegetation samples could not be collected at the quarry water treatment plant pipeline discharge point due to high water levels caused by frequent flooding in 1992. Algae were not established along the river edges and were never abundant enough to allow the collection of samples. Terrestrial vegetation samples consisting primarily of cottonwood and willow saplings, trumpet creeper, and grape vine were collected in May, August, and October, and analyzed for uranium. Uranium concentrations were 0.32 pCi/g, 0.31 pCi/g, and 0.045 pCi/g, respectively. These results will be used as background samples to compare with samples collected while the quarry water treatment plant is in operation.

Wetland determination surveys were continued in 1992 at Ash Pond, Frog Pond, and the raffinate pits. Further documentation is presented as part of the RI/FS documentation for the chemical plant. A determination was made in 1991 that wetlands at the chemical plant are not regulated under the U.S. Army Corps of Engineers, although they may require mitigation under the NEPA. Wetland surveys at the chemical plant were completed in 1992, and information is currently being used to develop a mitigation plan for chemical plant wetlands. This plan will be presented as part of the *Record of Decision* (ROD) for the chemical plant in late 1993.

8.3.1.4 Waterfowl. Waterfowl were surveyed at the Weldon Spring site and at background ponds and lakes to identify the species and determine the time each spent on site. These surveys were performed to support baseline risk assessment studies for the chemical plant RI/FS and to provide data to calculate the radiological dose to humans from consumption of game biota utilizing on-site waters.

In addition to on-site surveys, waterfowl counts were taken at the Femme Osage Slough and Missouri River to provide data for the Weldon Spring Quarry Residual Operable Unit as described in Section 2.4.3. Prairie Lake served as the background location. Surveys were conducted on an average of four days per month from April through October and on two days per month in January, February, November, and December. Resident species were the focus of the surveys since these individuals have the greatest probability of spending time on these

waterbodies. Resident species for east-central Missouri include Canada geese, mallards, and wood ducks.

Sightings during 1992 indicated that the site aquatic habitats were used by waterfowl for resting, foraging, and nesting. Raffinate Pit 4 attracted most of the waterfowl, because it has the largest surface area and plenty of aquatic vegetation, offers protection from winds, and is relatively protected from construction activities due to the high berms of the pit. The highest number of resident species was found in November 1992 and averaged 24 individuals. The greatest number of individuals of all species observed occurred in November of 1992 with a monthly total of 174 and a survey-day average of 35. A total of 10 goslings (with three pairs of adult Canada geese), two Mallard ducklings, and 12 wood ducklings were observed at Pit 4 during the spring and early summer. The individuals were sighted several times in June through August. A list of species found at the site ponds and raffinate pits can be found in Table F-2 in Appendix F.

The highest monthly total of waterfowl at Femme Osage Slough was recorded in May with 85 individuals. The survey day average was 21 individuals. The blue-winged teal was the only non-resident species observed at the slough in 1992.

The Missouri River had its highest number of waterfowl during April, with a total of 121 and a survey-day average of 30 individuals. This high count occurred on a single occasion when a flock of 100 green-winged teals were observed on the Missouri River. The green-winged teal, American coot, and snow goose were non-resident species observed on the Missouri River.

Prairie Lake (the background location) is in the Weldon Spring Wildlife Area and was used by migratory and resident waterfowl. March showed the greatest number of individuals with a total of 130 and a survey-day average of 65. In addition, three pairs of Canada geese were observed with a total of 11 goslings from May through July 1992. Table F-2 in Appendix F provides a complete list of species observed.

The species observed at both on-site and off-site locations were indicative of resident species and migrating species for east central Missouri. Raffinate Pit 4 and Prairie Lake were similar in the number of species observed and in breeding occurrences. Few individuals were observed on Raffinate Pits 1, 2, and 3 during surveys. This is probably due to increased construction activities associated with the site water treatment plant and temporary storage area

(TSA). Ash Pond was dry in August through October. Frog Pond had very little activity, which is attributable to its small surface area.

Resident species generally accounted for most of the individuals observed. Water bodies on site were occupied year round by mallards, wood ducks, and Canada geese. Prairie Lake showed similar results with occupation by mallards and Canada geese during 9 months. Femme Osage Slough was predominately used by wood ducks from April through July, with only limited use by Canada geese and mallards. The Missouri River was utilized infrequently by resident species, with Canada geese being observed for the longest period of time, four consecutive months (Appendix F, Table F-3). The pied-billed grebe (State rare) is the only listed waterfowl species and was not observed at any survey location in 1992.

Waterfowl samples were not collected in 1992, although planned for in the *Environmental Monitoring Plan*. The radiological risk from human ingestion of waterfowl was well below the EPA's target risk range (DOE 1992c). Measured values in these calculations were from the 1990 sampling, although the duration of time spent on site by sampled waterfowl was not known. The measured concentrations in the samples were compared to modeled concentrations using 365 days as the amount of time the chemical plant ponds were used by waterfowl. It was determined that the radiological risk was within the EPA target risk range for both the measured and modeled estimates. In addition, the dose calculated for waterfowl was less than the 1 rad/day specified in the regulatory guide (DOE 1992c). Therefore, no further surveys or sampling is planned for waterfowl at the chemical plant.

8.3.1.5 Turtles. Blanding's turtle, *Emydoidea blandingii*, is a semi-aquatic turtle on the Missouri Rare and Endangered Species List as a State endangered species (MDOC 1992). Blanding's turtle is more frequently sighted in northeastern Missouri and in the northern part of the United States, and was not previously known to exist in this area. However, in 1991, individuals of this species were sighted in the Busch Wildlife Area, and there is habitat at the chemical plant which could support this species.

The alligator snapping turtle, *Macroclemys temminckii*, is a candidate for Federal listing and is a Missouri State rare species. This species would not be expected at the chemical plant and raffinate pits, but suitable habitat does exist at Femme Osage Slough. In order to determine the presence or absence of these listed species, surveys were conducted at the chemical plant and raffinate pits and surrounding areas.

Turtle surveys were conducted during August, September, and October of 1992. The surveys consisted of trapping turtles in a variety of locations at the Weldon Spring site, Busch Wildlife Area, and the Weldon Spring Wildlife Area. The locations were Raffinate Pit 4 and Frog Pond; Femme Osage Slough and Pond 2A on the Weldon Spring Wildlife Area (see Section 10.2.1), and Lake 36 and Memorial Lake in the Busch Wildlife Area.

Standard turtle nets with a nylon mesh hoop and a diameter of 0.76 m (2.5 ft) and a mesh size of 6.4 cm to 8.9 cm (2.5 in. to 3.5 in.) were used. Traps were placed 0.3 m (1 ft) below the surface of the water and baited with fish. Typically, traps were placed and rebaited for three successive days. All captures were released after field data were documented.

Raffinate Pit 4 was trapped five nights and Frog Pond was trapped four nights. A total of 10 turtles were captured at the on-site locations with an average of two individuals in Raffinate Pit 4 and less than one per day in Frog Pond. Two species were trapped at these on-site locations: the common snapping turtle and the red-eared slider.

At the Busch Wildlife Area, Lake 36 was trapped five nights, but no individuals were captured. This was probably due to the foraging behavior of a large number of grass carp stocked at the lake which resulted in the loss of vegetated areas for turtles. Memorial Lake was trapped 18 nights producing a total of 72 turtles with an average of four individuals per day, including three species: the common snapping turtle, red-eared slider, and western painted turtle.

Trapping at Femme Osage Slough resulted in the highest number of turtles captured. In 10 nights 148 individuals were captured for an average of 15 individuals per day. The highest number trapped in one night was 26 individuals. A total of five species were captured (see Appendix F, Table F-4). The large population in the slough was probably due to proper habitat, food supply, and proximity to the Missouri River.

No species listed on the Federal or State endangered list were found during site surveys. Five species were captured during 1992 surveys. These species are all commonly found in habitats of eastern Missouri. Results are presented in Appendix F, Table F-4. The turtle surveys were conducted to support the ecological assessment for the chemical plant in support of the ROD. No further investigations will be conducted under the DOE environmental monitoring plan.

8.3.2 Terrestrial Monitoring

The primary route of exposure from contaminated terrestrial systems is by air deposition. Since above-background concentrations of airborne radionuclides have not been observed off site, activities were designed to document current conditions and to characterize the terrestrial habitats. Terrestrial fauna utilize contaminated surface waters or consume potentially contaminated flora and fauna. Characterization studies were conducted to identify exposure pathways and to determine whether further activities were necessary.

8.3.2.1 Birds. In order to support RI/FS baseline risk assessments and assess site conditions prior to remediation activities, bird surveys were conducted at 15 locations on the Weldon Spring site, Busch Wildlife Area, and the Weldon Spring Wildlife Area. Additional information was required to determine if any threatened or endangered species were utilizing the chemical plant area. Surveys consisted of 15-minute observation periods conducted on a bimonthly basis. Audio and visual observations were recorded.

The most common species found in the chemical plant and raffinate pits areas were those that can utilize a number of different types of habitats and would be considered generalists, such as the northern cardinal, American robin, and blue jay. The raffinate pits attracted water species such as the spotted sandpiper and the barn swallow. In the wooded areas near Ash Pond, the north dump, and Frog Pond, species that utilize deciduous forest habitats were found, including the pileated woodpecker, wood thrush, and yellow-billed cuckoo. The list of species observed for all locations can be found in Appendix F, Table F-5.

During the on-site surveys, three State-listed species were observed: Swainson's hawk, *Buteo swansoni* (endangered); the brown creeper, *Certhia americana* (status undetermined), and Cooper's hawk, *Accipiter cooperii* (rare).

The surveys at the quarry recorded species typical in urban areas and tolerant of disturbance. This was to be expected given the remedial activities being performed in the area. Species found included northern cardinals and black-capped chickadees.

Results of surveys conducted at vicinity locations showed species representative of each area's habitat. The drainage areas, such as the Southeast Drainage, had species like the worm-eating warbler and the ovenbird which tend to prefer a more dense deciduous forest habitat. The

agricultural fields, in contrast, recorded species that prefer open habitats and fence rows including the orchard oriole and the song sparrow.

Two Federally listed species were sighted in 1992, the bald eagle, *Haliaeetus leucocephalus*, and the loggerhead shrike, *Lanius ludovicianus*. The bald eagle is a Federally endangered species, and was observed several times along the Missouri River in January and February 1992. Howell Island, located across the Missouri River from the St. Charles County well field, is a known overwintering location for bald eagles. The loggerhead shrike, a candidate on the Federal listing, was observed in fields 1 and 5 of the Weldon Spring Wildlife Area, located northeast of the chemical plant and in the St. Charles County well field. Loggerhead shrikes are found typically in agricultural habitats. Bird species observed during site surveys and listed on Federal and State endangered species list are shown in Table 8-4.

Quarterly owl surveys were also conducted in and around the site at five locations to determine if State and Federal species are using these areas. Additional owl surveys were conducted to support special biological studies in the areas of the water treatment plant pipeline, the quarry haul road, and the borrow area. Surveys were done after dusk during full moons. Taped owl calls were used to elicit responses at each location. Both audio and visual encounters were recorded for the total number of individuals. The great-horned owl, barred owl, and eastern screech owl recordings were played at all locations. Depending upon habitat and time of year, three State listed species, the barn owl, *Tyto alba*, (State rare); short-eared owl, *Asio flammeus*, (State endangered); and long-eared owl, *Asio otus*, (status undetermined) calls were also played. Results of these surveys are presented in Appendix F, Table F-6.

The barred owl was the most common species encountered at all survey locations and is a typical species in eastern Missouri. The great-horned owl and eastern screech owl were also observed. No long-eared, short-eared, or barn owls were recorded during surveys, although the Busch Wildlife Area reported observations of long-eared owls in pine forested areas. Long-eared owls were likely not found during site surveys due to the lack of coniferous forest habitat. The most recent sightings of the barn owl and short-eared owl in St Charles county were from Marais Temps Clair, which is approximately 39 km (24 mi) northeast of the site.

Avifauna surveys were conducted in support of the ecological assessments for the chemical plant and quarry. No further investigations will be conducted under the DOE environmental monitoring program.

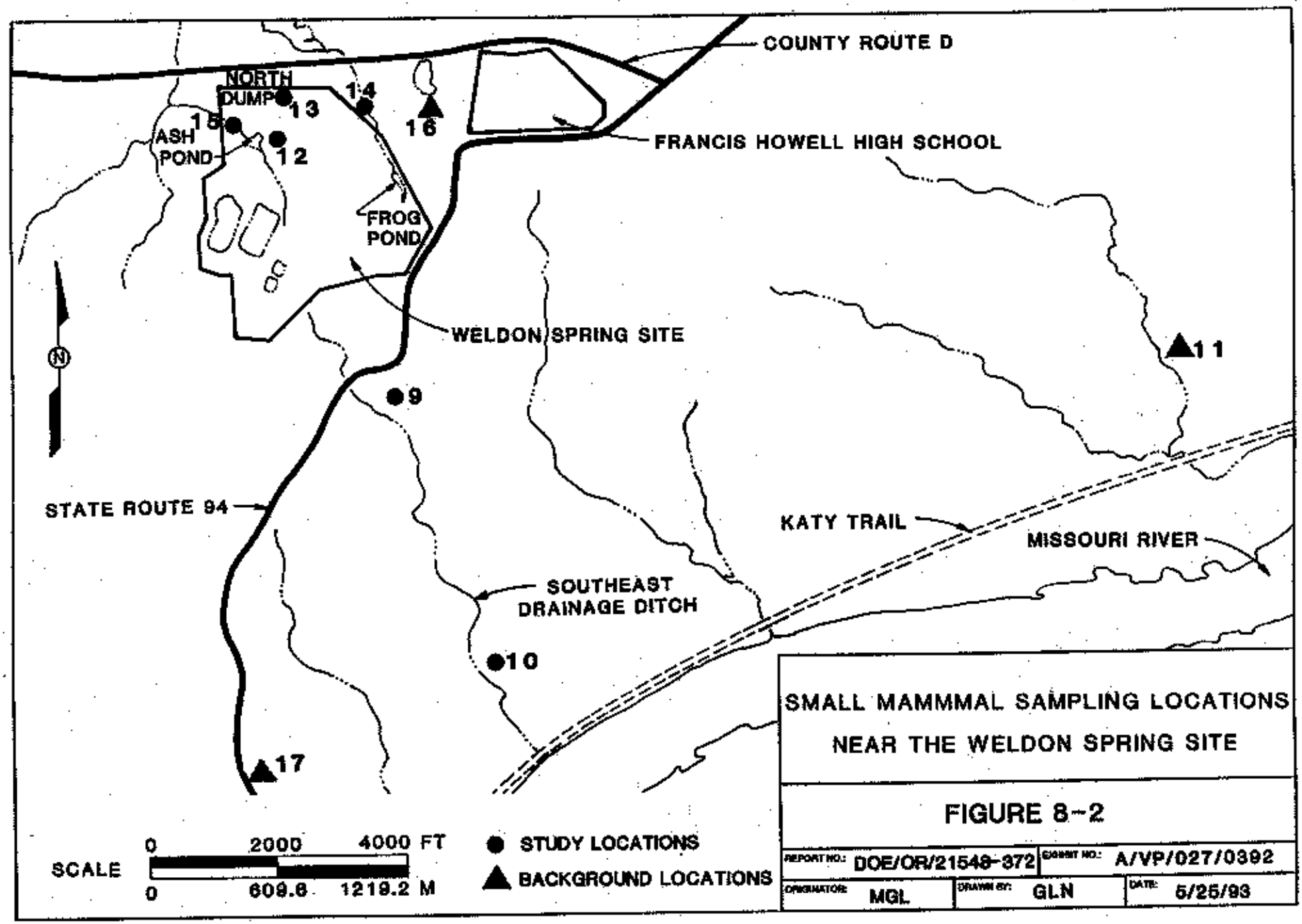
TABLE 8-4 Rare and Endangered Species Sighted at the Weldon Spring Site and Surrounding Areas

Species	Federal Status	State Status	Location(s) Observed
Bald Eagle	Endangered	Endangered	Missouri River
Brown creeper	-	Status Undetermined	WSCP/WSRP Southeast drainage Burgermeister spring
Cooper's hawk	-	Rare	WSCP/WSRP and WSWA - fields 1 and 5
Loggerhead shrike	C2[a]	Watch list	WSWA - fields 1 and 5 St. Charles County Well field/Slough
Mississippi kite	-	Rare	WSWA - fields 1 and 5
Northern harrier	-	Endangered	St. Charles County Well field
Osprey	-	Extirpated	Burgermeister Spring
Swainson's hawk	3C[b]	Endangered	St. Charles County Well field/Slough WSCP/WSRP

[a] Candidate for Federal listing
[b] Proved to be more abundant and therefore not Federally listed

8.3.2.2 Small Mammals. Small mammals were selected as indicator species to represent potential exposure to terrestrial biota from ingestion of vegetation, crops, and soils. Small mammals are prey for top carnivores such as hawks, coyotes, and many threatened and endangered species. Small mammals were selected as indicator species because they are locally abundant, easily collected, have a limited range, and have the potential for high exposure. Small mammals are exposed to contaminated soil and surface waters by their close proximity to soils and through burrowing behavior, and therefore serve as appropriate indicator species. Although dermal absorption is not considered a complete pathway, it is still a factor as a possible exposure route to terrestrial organisms, since small mammals tend to burrow.

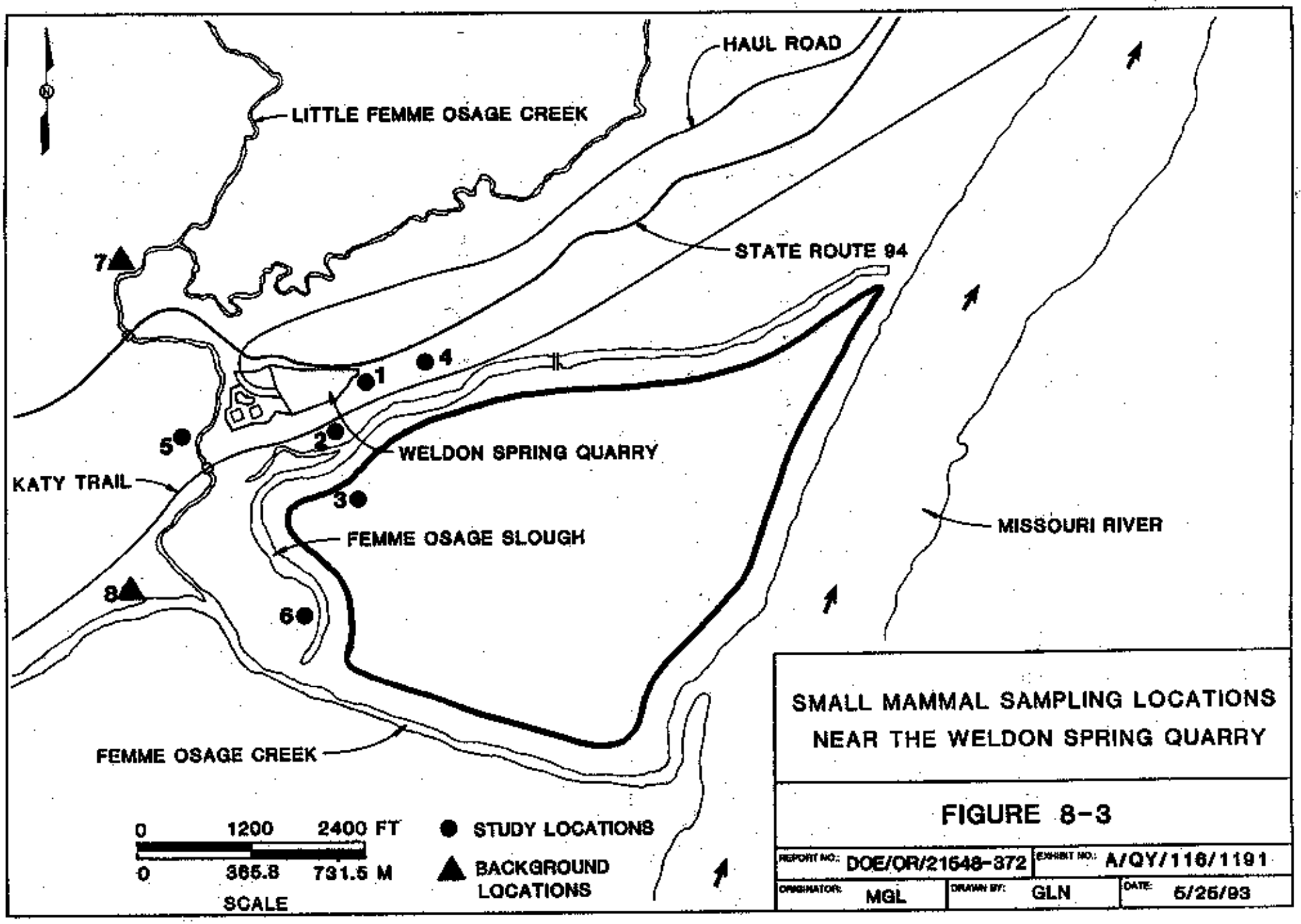
Small mammals were surveyed at 16 locations over 12 trap nights (MKF and JEG 1992j). Locations were established on the site and surrounding areas. Reference locations were also established based on similar habitats. Figures 8-2 and 8-3 show the small mammal study locations at and near the chemical plant and quarry. Each individual captured was identified as



SMALL MAMMMAL SAMPLING LOCATIONS NEAR THE WELDON SPRING SITE

FIGURE 8-2

REPORT NO.: DOE/OR/21548-372		EXHIBIT NO.: A/VP/027/0392	
ORIGINATOR: MGL	DRAWN BY: GLN	DATE: 5/25/93	


HAUL ROAD
LITTLE FEMME OSAGE CREEK
STATE ROUTE 94
7
1
4
5
2
WELDON SPRING QUARRY
KATY TRAIL
3
FEMME OSAGE SLOUGH
MISSOURI RIVER
8
6
FEMME OSAGE CREEK
0 1200 2400 FT
0 365.8 731.5 M
SCALE
STUDY LOCATIONS
BACKGROUND LOCATIONS
SMALL MAMMAL SAMPLING LOCATIONS
NEAR THE WELDON SPRING QUARRY
FIGURE 8-3
REPORT NO.: DOE/OR/21548-372
EXHIBIT NO.: A/QY/116/1191
ORIGINATOR: MGL
DRAWN BY: GLN
DATE: 5/25/93

to species, sex, and age; measured for total length; weighed; ear tagged; and released. Mammals and soil samples were also collected from each location and analyzed for total uranium, Th-228, Th-230, Th-232, Ra-226, and Ra-228. In addition, soils were analyzed for toxicity metals. Location 6 was eliminated from the study due to farming disturbance. No animals were trapped at the upper area of the Southeast Drainage during the study period due to predation of the traps by other mammals. Predation was noted to a lesser extent at background Location 8, the north dump, and Frog Pond drainage.

The most common species encountered was the deer mouse, *Peromyscus maniculatus*, making up 83% of the total captures. The white-footed mouse, *Peromyscus leucopus*, was the second most abundant species (7%). The remaining 10% consisted of four other species: the harvest mouse, *Reithrodontomys megalotus*; the prairie vole, *Microtus ochrogaster*; the house mouse, *Mus musculus*; and the shorttail shrew, *Blarina brevicausa*.

Although the deer mouse and white footed mouse utilize similar habitats, the deer mouse tends to prefer open areas such as cultivated fields and fence rows, while the white-footed mouse is usually found in more wooded areas (Schwartz 1981). The ranges of the two species of *Peromyscus* rarely overlap. The results confirm this with *Peromyscus maniculatus* dominant at all sites. Population results from the background and contaminated sites were inconsistent and variable. In general, no significant differences were found in the sex ratios of *P. maniculatus* from control and contaminated sites (Bethel et al. 1993).

Radiological results for small mammals were obtained from all locations except the upper Southeast Drainage, background drainage, Ash Pond, and Frog Pond drainage (locations 9, 11, 12 and 14). No individuals were caught on the days mice were collected for laboratory analyses.

Average uranium concentrations ranged from <0.068 pCi/g to 0.17 pCi/g at Vicinity Property 9 (Location 2). Ra-226 and Ra-228 values were all less than the detection limits. Although the Ra-228 values are reported, they were rejected by the validation process. Th-228 concentrations are less than the detection limits. Th-230 values ranged from <0.01 pCi/g to 0.10 pCi/g. Th-232 values were all less than the detection limits, with one exception from the St. Charles County well field adjacent the Femme Osage Slough of 0.02 pCi/g.

Radiological results for soils showed elevated levels of uranium at sites 10, 12, 13, 14, and 15, with the highest concentration of 36.08 pCi/g at Site 12, Ash Pond. Slightly elevated Ra-226 concentrations were also found at Sites 10 and 12. No elevated levels of Th-228 or Th-232 were found. Radiological results are presented in Appendix F, Table F-7.

Metal results for soil showed no elevated levels above background at the study locations, with the exception of Location 4. This location had above background concentrations of cadmium, lead, and zinc. Analytical results for metals can be found in Appendix F, Table F-8.

8.3.2.3 Large Mammals. A deer study was conducted to support dose calculations to humans from ingestion of terrestrial biota. Population size, composition, and the concentration of radionuclides were determined for deer residing at the chemical plant and raffinate pits site. The estimate of the total number of individuals was based upon observations from vehicle, spotlight, and fixed-point surveys. The observations were used to characterize the on-site population in terms of size, movement patterns, health of herd, and site usage.

A total of 27 surveys were made from vehicle and fixed-point locations. Most observational periods were conducted at sunrise and sunset for an hour and a half.

Surveys indicated that approximately 20 individuals comprise the chemical plant population. Of these, four are adult males, six are adult females, five are yearling females, and five are fawns. An average of 15 deer per night were observed during four spotlight surveys. It was determined that the deer spend most of the day near wooded or covered areas in the north and west portions of the chemical plant and avoid construction areas. In contrast, at night most deer are observed closer to construction areas, in the open field areas near the raffinate pits, and near the buildings. Their activity was shown to be significantly heightened at night.

Samples were collected from deer killed accidentally at locations both on and off site. Four deer were collected on site; three adults and one juvenile. Samples were also collected from Highway 94 near the Francis Howell High School 1.6 km (1 mi) north of the chemical plant. A second background sample was collected from Macon County, Missouri, from hunter donations.

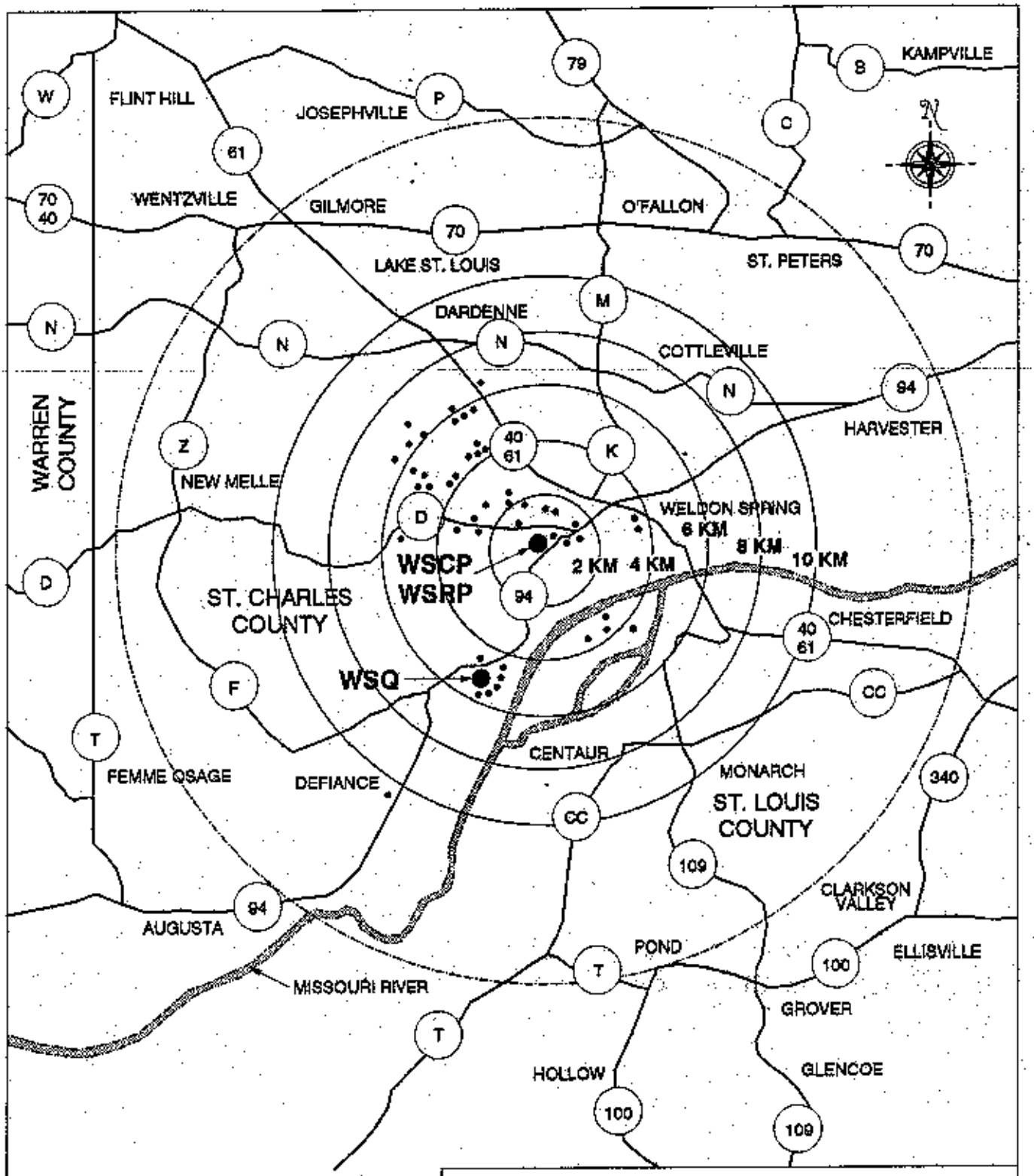
Bone, flesh, and organ samples were analyzed for uranium, radium, and thorium. Overall, the radionuclides concentrations found in deer samples were low. The greatest

concentrations were reported for Ra-226 at 1.84 pCi/g and Ra-228 at 1.11 pCi/g which were found in bone samples from the chemical plant area. Radium, as well as uranium and thorium, tends to accumulate primarily in bone tissues and is expected to be found at the highest concentration. The concentrations found in muscle samples from deer at off-site properties were 0.005 pCi/g for uranium and <0.28 for Ra-228. All results are presented in Appendix F and Table F-9.

8.3.2.4 Vegetation. Vegetation surveys were conducted to characterize plant species and habitat type and condition, and to identify habitats that support, or could support, State and Federal rare or endangered species. These surveys documented the presence of tree and herbaceous species and the percent of vegetative and canopy cover. Survey efforts during 1992 were concentrated within the chemical plant and raffinate pits area.

Surveys were conducted by using quadrants established along transects for each location. The transects were placed evenly along a baseline for each area. Trees and herbaceous vegetation were surveyed by using 100 m^2 quadrants and 1 m^2 quadrants respectively; both were placed at set increments along the transects in accordance with WSSRAP procedure ES&H 4.4.6, *Vegetation Surveys*. Qualitative notes were also completed for grass species. A list of vegetation at the chemical plant and raffinate pits can be found in Appendix F, Table F-10.

8.3.2.5 Agricultural. The *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991) and DOE Order 5400.5 requires the analysis of "foodstuff" (crops and daily products) within a 16 km (10 mi) radius of all DOE facilities (Figure 8-4). The DOE has also established a decreasing order of importance for foodstuffs ranging from milk as the most important, through vegetables, meat, eggs, and grain to fruit as the least important. Since there is only one commercial dairy farm within the study area, and no known commercial poultry farms, only agricultural crops were sampled. Seventeen percent of the surrounding Busch, Weldon Spring, and Howell Island Wildlife areas consists of cropland (MDOC 1991). These areas most commonly produce such agricultural products as corn, soybeans, milo, wheat, and sunflowers. The crops grown on MDOC property are not produced for direct human consumption, but are used for livestock feed or left in the field for wildlife.



• - SAMPLING LOCATION

0 5 MI
0 8.05 KM
SCALE

AGRICULTURAL SAMPLING AREA

FIGURE 8-4

REPORT NO.: DOE/OR/21548-372		EXHIBIT NO.: A/VF/020/0393	
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 3/93	

Agricultural crops were selected for Tier-1 sampling. If elevated concentrations were found in these products, then meat, eggs, and milk products produced by animals consuming these crops would be sampled. Additionally, trends in environmental contamination would be monitored to determine possible long-term accumulation of radionuclides. This information will help to determine the need for second tier sampling, which includes milk, beef, eggs, poultry, pork and wild game.

Agricultural sampling was conducted during September, October, and November, 1992. Crop samples consisted of corn, soybeans, and milo. Soil samples were also collected at each agricultural sampling location. Both agricultural and soil samples were analyzed for total uranium, isotopic thorium, Ra-226 and Ra-228.

Average uranium concentrations for all agricultural products from the study area ranged from 0.001 pCi/g within the 6-8 km (3.7-4.9 mi) interval to 0.005 pCi/g within the 4-6 km (2.4-3.7 mi) interval. Average concentrations from the background locations ranged from 0.008 pCi/g to 0.037 pCi/g. Average soil concentrations ranged from 1.3 pCi/g within the 10-12 km (6.2-7.5 mi) interval to 2.18 pCi/g in the 0-2 km (0-1.2 mi) interval. Average background soil concentrations ranged from 1.1 pCi/g to 1.8 pCi/g. A summary of the agricultural and soil data can be found in Appendix F, Tables F-11 and F-12.

Initial statistical analysis of the data indicated that the concentration of uranium in agricultural products is not dependent upon the type of crop, but upon the sample type: kernel, grain, cob, or stalk. Uranium concentrations were found to be significantly higher in background samples when compared with samples taken within the 16 km (10 mi) radius. The concentration of uranium was also compared to distance from the chemical plant and quarry at 2 mile intervals. No significant difference was found in sample concentrations based on distance from source.

Preliminary review indicated that samples collected from background locations with the significantly higher concentrations of uranium were probably attributable to sampling methods. Most of the background corn fields were harvested prior to sampling and therefore samples were collected from the ground. Although sampling methods require visible dirt to be rinsed from the samples, the results indicated that some soil may have remained on the samples. Complete results and interpretation will be available in a report to be published in 1993.

Although the corn sampled was not produced for human consumption (but for livestock feed), a committed effective dose equivalent was calculated at 0.03 mrem/yr. This dose was based on an individual consuming 186.6 g (6 oz) of corn once a week over one year and using the highest uranium concentration found in corn kernels, 0.111 pCi/g. This dose was less than the annual effective dose of <1 mrem/yr. Therefore, based upon DOE guidance for dose from foodstuffs of <1 mrem/yr, surveillance sampling instead of annual sampling will be conducted in the future. The surveillance program will concentrate on collecting better background samples and samples from fields in the St. Charles County well field.

8.4 Highlights

- Uranium concentrations ranged from 0.001 pCi/g to 0.558 pCi/g in edible portions of fish sampled in 1992.

- Aquatic monitoring of invertebrates in lakes surrounding the site indicated that there was little significant difference in population densities or species diversity that could be attributed to uranium contamination in the lakes.

- Several Federal and State threatened and endangered species were observed during bird surveys conducted in the vicinity, including the bald eagle, loggerhead shrike, Swainson's hawk, brown creeper, Cooper's hawk, Mississippi kite, northern harrier, and osprey.

- Uranium concentrations in agricultural samples were less than 0.05 pCi/l. Initial statistical analysis and evaluation of the data indicated that additional sampling is required to establish background concentrations.

- Deer samples were obtained from site and off-site locations to support surveillance monitoring activities. Uranium concentrations found in muscle tissue were 0.005 pCi/g.

9 ENVIRONMENTAL QUALITY ASSURANCE PROGRAM INFORMATION

9.1 Program Overview

The Environmental Quality Assurance Program includes management of the quality assurance/quality control programs, plans, and procedures governing environmental monitoring activities at the Weldon Spring Site Remedial Action Project (WSSRAP) and at the subcontracted off-site laboratories. This section discusses the environmental monitoring standards at the WSSRAP and the goals for these programs, plans, and procedures.

The purpose of the Environmental Quality Assurance Program is to provide the WSSRAP with reliable, accurate, and precise monitoring data. The program furnishes guidance and directives to detect and prevent quality problems from the time a sample is collected until the associated data is evaluated and utilized. Key elements in achieving the goals of this program are compliance with Quality Assurance Program and Environmental Quality Assurance Program procedures, personnel training, compliance audits, use of quality control samples, complete documentation of field activities and laboratory analyses, and review of data documentation for precision, accuracy, and completeness. Lists of the major programs, plans, and procedures in place at the WSSRAP are in Sections 9.1.1 through 9.1.7.

9.1.1 Quality Assurance Program

The *Project Management Contractor Quality Assurance Program* (QAP) (MKF and JEG 1992q) establishes the quality assurance program for activities performed by the Project Management Contractor (PMC). The QAP requires compliance with the criteria of DOE Order 5700.6C as specified in the PMC contract DE-AC05-860R21548. The QAP has been reviewed and approved by PMC management, the PMC Project Quality Manager, and the DOE Project Manager.

Compliance with the DOE Order 5700.6C criteria is ensured through quality assurance (QA) audits, QA surveillance, and implementation of the WSSRAP Self Assessment Program. The QAP is the overall guide for controlling and documenting the quality of work at the WSSRAP. This document requires that specific plans and procedures be generated to address Quality Level 1 and Quality Level 2 work activities and inspection criteria. These plans and procedures specify the requirements of all applicable documents, codes, standards, and

regulations. Quality Level 1 activities are items, processes, or services whose failure would cause an unacceptable impact or risk to the safety or health of the public of the environment. Quality Level 2 activities are items, processes, or services whose failure would degrade the performance or reliability of operations, data or deliverables.

9.1.2 Environmental Quality Assurance Project Plan

Environmental compliance issues applicable to the WSSRAP are addressed in the WSSRAP *Environmental Quality Assurance Project Plan* (EQAPjP) (MKF and JEG 1992g) which outlines the specific U.S. Environmental Protection Agency/Quality Assurance Management Staff (EPA/QAMS) 005-80 Quality Assurance requirements for characterization and routine monitoring at the WSSRAP. The EQAPjP does not supersede the QAP, but rather expands on the specific requirements of environmental monitoring and characterization activities.

The primary purpose of this document is to provide a complete and accurate framework of information for assessing the amount and extent of hazardous materials present at the site. The EQAPjP is also supported by standard operating procedures (SOPs), the *Environmental Safety and Health Plan* (MKF and JEG 1992s), the *Environmental Monitoring Plan* (EMP) (MKF and JEG 1992o), and sampling plans written for specific environmental tasks.

9.1.3 Environmental Data Administration Plan

The *Environmental Data Administration Plan* (EDAP) (MKF and JEG 1992d) summarizes SOPs and data quality requirements for collecting and analyzing environmental data. The EDAP describes administrative procedures for managing environmental data and governs sampling plan preparation, data verification and validation, database administration, and data archiving. Guidance on developing data quality objectives (DQOs) for specific investigations is also detailed. The EDAP does not supersede the EQAPjP, but details its specific requirements.

9.1.4 Environmental Monitoring and Quality Assurance Standard Operating Procedures

SOPs have been developed for routine activities at the WSSRAP. Environmental monitoring SOPs are generally administered by the Environmental Safety and Health (ES&H) Department, and Quality Assurance SOPs are administered by the Project Quality Department. These two departments are responsible for most SOPs used to administer the environmental

quality assurance program described in this section. Controlled copies of SOPs are maintained in accordance with the document control requirements of American Society of Mechanical Engineers (ASME) NQA-1 (1989). All SOPs are reviewed at least annually and revised as appropriate.

All SOPs have been developed from U.S. EPA and DOE guidance and standard industry practices (applicable ASME NQA-1 criteria) and are specific to the WSSRAP. SOPs applicable to environmental monitoring and quality assurance activities at the WSSRAP are listed in Table 9-1. These procedures cover all activities from groundwater sampling through chain-of-custody and provide detailed instructions to environmental monitoring personnel. All procedures that require data or sample acquisition include requirements for ensuring the quality of the data or samples.

9.1.5 Use and Presentation of Data

Analytical data are received from subcontracted analytical laboratories. In 1992, and since 1987 when routine environmental monitoring began, data have been reported as not-detected ("ND") when concentrations were measured as less than the required detection limit of the analytical methods or instrumentation. Few less-than-detection-limit values (or uncensored values) were reported by the laboratories and no "less-than" values were maintained in the WSSRAP data management system. Where uncensored data were available, they were maintained in the "comments" field of the electronic data base. The U.S. Department of Energy (DOE) document, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*, (DOE 1991) recommends that uncensored data be used for environmental monitoring and dose estimate reporting. In 1992, the procedures were changed as a corrective action for the functional appraisal finding EMON-90-10-19-F.

Uncensored data have been used in all reporting and calculations for this *Annual Environmental Report* where available. This type of data is designated by parentheses around the data value, for example "(1.17)". If uncensored data were not available, nondetect data were used in calculations of averages at a value of one-half the detection limit (DL/2). The EPA recommends the use of the DL/2 value for statistical manipulation of data when the percentage of nondetects in the data set is small, and uncensored data are not available (EPA 1989). In addition, all averages and summary calculations include the ratio of nondetect data versus the total number of samples (e.g., 1:4) as required under the corrective action plan.

TABLE 9-1 Procedures Applicable to Environmental Monitoring Activities

Procedure Number	Procedure Title
ES&H 1.1.7	Reporting Above Normal Values from Environmental Monitoring Networks
ES&H 4.1.1	Environmental Numbering System
ES&H 4.1.2	Chain of Custody
ES&H 4.1.3	Sampling Equipment Decontamination
ES&H 4.1.4	Quality Control Samples for Aqueous and Solid Matrices
ES&H 4.3.1	Surface Water Sampling
ES&H 4.4.1	Groundwater Sampling
ES&H 4.4.2	Groundwater Level Monitoring and Well Integrity Inspections
ES&H 4.4.5	Soil/Sediment Sampling
ES&H 4.4.6	Vegetation Surveys
ES&H 4.5.1	pH and Temperature Measurements in Water
ES&H 4.5.2	Specific Conductance Measurement in Water
ES&H 4.5.7	Measurement of Settleable Solids
ES&H 4.5.8	Water Sampling Filtering
ES&H 4.6.1	Area TLD Deployment for Environmental Sampling
ES&H 4.6.2	Radon Concentrations Measurement in Ambient Air
ES&H 4.6.4	Constant Flow Air Sampler Operation and Sample Filter Handling
ES&H 4.6.6	Constant Flow High Volume Air Sampler Operation and Sample Filter Handling
ES&H 4.9.1	Environmental Monitoring Data Verification
ES&H 4.9.2	Environmental Monitoring Data Validation
CM&O-15	Task-Specific Safety Assessments
RC-30	Monitoring Well Waste Management
SQP-1	Site Wide Audit Tracking System
SQP-2	Quality Assurance Surveillance
SQP-7a	Quality Assurance Records
SQP-9	Inventory, Validation, and Transfer of Quality Assurance Records for Retention
SQP-10	Collection, Review, and Temporary Storage of Quality Assurance Records
SQP-14a	Nonconformance and Corrective Action
SQP-18a	Independent Assessments

Laboratory contracts are being modified where possible, to provide uncensored data. New laboratory specifications require the reporting of uncensored data, where possible. These contracts are scheduled to be awarded in mid-1993.

9.1.6 Training and Audits

Training of all personnel utilizing SOPs, programs, and plans is tracked by the Project Training and Improvement (PTI) Group. Training includes procedure review, classroom training, and "hands on" training under the supervision of qualified individuals. The training is tracked on a training matrix for each individual. Managers identify SOPs, plans, and programs on which each individual must be trained. As procedures are revised, these matrixes are updated and personnel are retrained.

The environmental programs are audited by the Project Quality Department. Audits include self assessments, surveillances, and formal audits. They evaluate compliance with environmental programs and generate audit reports to track deficiencies and corrective actions. The WSSRAP is also audited routinely by external organizations including DOE Headquarters and the DOE Oak Ridge field office. The external audits assess compliance with applicable regulations, DOE Orders, and site plans and procedures. All audit reports, deficiencies, and corrective actions are tracked using the Site Wide Audit Tracking System (SWATS).

9.1.7 Subcontracted Off-Site Laboratories Programs

Subcontracted off-site laboratories that performed analyses used in the preparation of this report used Contract Laboratory Program (CLP) methodologies. For certain analyses (such as radiochemical and wet chemistry) the laboratories are using EPA 600 (drinking water), EPA 900 (radiochemical analysis of drinking water), or methods that are reviewed and approved by the PMC prior to analysis of each sample. Each of the subcontracted off-site laboratories has submitted a site-specific *Quality Assurance Project Plan* (QAPjP) to the WSSRAP and controlled copies of their standard operating procedures (SOPs). The QAPjPs and SOPs are reviewed and approved by the PMC before any samples are shipped to the laboratory. Changes to the standard analytical protocols or methodology are documented in the controlled SOPs. All of the laboratories currently being used by the WSSRAP have had a preliminary assessment of their facilities to make sure that they have the capability to perform work according to the specifications of their contracts. Quality Assurance audits are performed annually to inspect the

laboratory facilities and operations, to ensure that the laboratories are performing analyses as specified in their contracts, and to check that WSSRAP data documentation and records are being properly maintained.

The site-specific QAPjPs from laboratories identify standard practices that ensure that the laboratories are performing high quality work. The laboratories must demonstrate compliance with additional QA/QC requirements as specified in their contracts. These include sample preparation and analytical methods; calibration of instrumentation; periodic inspection, maintenance, and servicing; statistical procedures to control precision and accuracy; corrective action programs; participation in the external DOE and EPA Performance Audit Program; maintenance and storage of WSSRAP records; hard copy and electronic formatting; and notification of nonconforming issues.

The laboratory SOPs provide detailed information about internal policies on standard analytical protocol and methods. These SOPs tell analysts exactly how to perform the work and how to calculate, reduce, and record pertinent information.

9.2 Applicable Standards

Applicable standards for environmental quality assurance include: (1) use of the appropriate analytical and field measurement methodologies; (2) collection and evaluation of quality control samples; (3) accuracy, precision, and completeness evaluations; (4) and preservation and security of all applicable documents and records pertinent to the environmental monitoring programs. Each of these standards is briefly explained in Sections 9.2.1 through 9.2.4.

9.2.1 Analytical and Field Measurement Methodologies

Analytical and field measurement methodologies used at the WSSRAP comply with applicable standards required by the DOE, EPA, and the American Public Health Association. Analytical methodologies used by subcontracted laboratories for environmental monitoring follow the EPA CLP requirements (metal and organic methodologies) and the EPA drinking water and radiochemical methodologies. Field measurement methodologies typically follow the American Public Health Association Standard Methodologies for the Examination of Water and Wastewater (APHA 1992).

9.2.2 Quality Control Samples

Quality control samples for environmental monitoring are collected in accordance with WSSRAP SOPs that specify the frequencies of quality control sample collection. Quality control samples are taken in accordance with the EPA CLP (EPA 1988b) and DOE guidance documents.

Following are descriptions of the QC samples collected at the WSSRAP.

Distilled Water Blank: A blank that monitors the purity of distilled water used for field blanks and decontamination of sampling equipment.

Field Blank: A blank that monitors potential contaminants, such as dust or volatile compounds, that may be introduced at the site of sample collection. Field blanks are collected in the field at the time of sample collection activities.

Equipment Blank: A blank that monitors the effectiveness of procedures used to clean sampling equipment prior to collecting a sample. Equipment blanks include both rinsate and filter blanks.

Trip Blank: A blank that monitors volatile organic compounds that may be introduced during transportation or handling at the laboratory.

Field Replicate: A replicate that monitors field conditions that may affect the reproducibility of samples collected from a given location.

Blind Duplicate: A replicate with a modified sample identification. The duplicate is used to monitor field conditions that may affect the reproducibility of samples collected from a given location.

The samples listed below are split at the laboratory from large volume samples.

Matrix Spike: A spike that monitors the accuracy of laboratory measurements for a given matrix type. The results of this analysis and the routine sample are used to compute the percent recovery for each parameter.

Matrix Duplicate: A duplicate that monitors the precision of laboratory measurements for inorganic parameters in a given matrix type. The results of the matrix duplicate and the routine sample are used to compute the relative percent difference for each parameter.

Matrix Spike Duplicate: A duplicate that monitors the precision of laboratory measurements for organic compounds. The matrix spike duplicate is spiked in the same manner as the matrix spike sample. The results of the matrix spike and matrix spike duplicate are used to determine the relative percent difference for organic parameters.

9.2.3 Accuracy, Precision, and Completeness

The WSSRAP data validation group determines the analytical accuracy, precision, and completeness of 10% of environmental data. Data validation is required under DOE Order 5400.1.

9.2.4 Preservation and Security of Documents and Records

Requirements for preservation and security of documents and records are specified in DOE Order 5700.6C and ASME NQA-1 (1989). All documents pertinent to environmental monitoring are preserved and secured by the departments that produce them.

9.3 Quality Assurance Sample Results

The effectiveness of the quality assurance program is assessed by reviewing the analytical results of the duplicate sample analyses and sample blank analyses. Following is a description of how QA samples were evaluated in 1992 and compared to actual samples.

9.3.1 Duplicate Analyses Results

Two kinds of duplicate analyses were performed in 1992. One was performed at the subcontracted laboratories from aliquots of original samples collected at the Weldon Spring site. The second was replicate or blind duplicate analysis of samples split by the WSSRAP into separate containers and identified by separate identification numbers. Laboratory duplicates were used to assess the precision of analyses and also aid in evaluating the homogeneity of

samples or analytical interferences of sample matrixes. Blind duplicate (replicate) analyses were used to assess the precision of sample locations, to evaluate sample reproducibility, and to identify possible field sampling problems.

Generally, laboratory duplicate samples were analyzed for the same parameters as the original samples at the rate of approximately one for every 20 samples. Blind duplicate (replicate) samples were collected as specified in the EMP (MKF and JEG, 1992o). Typically, duplicate samples were analyzed for the more common parameters: uranium, nitroaromatic compounds, inorganic anions, and metals.

When laboratory and blind duplicate samples were available, the average relative percent difference was calculated. This difference represents an estimate of precision. The equation used (as specified in the *USEPA Contract Laboratory Program, Inorganic Scope of Work*, [EPA 1988b]) was:

$$RPD = (S-D)/((S+D)/2) \times 100$$

where S = the normal sample
D = the duplicate analysis

The relative percent difference was calculated only for samples whose analytical results exceeded five times the detection limit. When analytical results are less than five times the detection limit, the tolerance limits (variability) are higher, and generally, the relative precision is greater. The CLP (EPA 1988b) specifies that analytical results less than five times the detection limit should not be used.

Table 9-2 summarizes the data on relative percent differences for groundwater (including springs) and surface water (including National Pollutant Discharge Elimination System [NPDES]) samples for the parameters of sufficient data size to permit averaging. Both the laboratory duplicates and the blind duplicates are summarized. When the relative percent difference data could not be averaged, they were not evaluated because these parameters were not commonly analyzed for and/or were not contaminants of concern.

TABLE 9-2 Summary of Calculated Relative Percent Differences

	Groundwater [a]				Surface Water[b]			
	Laboratory Duplicates		Blind Duplicates		Laboratory Duplicates		Blind Duplicates	
Parameter	RPD[c]	Count No.[e]	RPD[c]	Count No.[e]	RPD[c]	Count No.[e]	RPD[c]	Count No.[e]
Alkalinity	2.40%	48 (51)	5.96%	20 (20)	10.32%	3 (3)	1.51%	4 (4)
Nitrate-N	12.90%	18 (51)	4.15%	3 (20)	21.24%	7 (11)		0 (5)
Sulfate	5.70%	47 (54)	6.84%	19 (20)	16.69%	5 (5)	2.48%	5 (5)
Chloride	5.10%	10 (16)	2.41%	5 (6)	(d)	(0)	(d)	(0)
Arsenic	7.87%	9 (40)	5.05%	6 (6)	(d)	0)	(d)	0 (4)
Barium	5.61%	34 (40)	7.35%	19 (19)	(2.19%)	4 (5)	8.79%	4 (4)
Calcium	5.60%	15 (15)	4.75%	6 (6)	(d)	(0)	(d)	(0)
Magnesium	4.77%	15 (15)	4.70%	6 (6)	(d)	(0)	(d)	(0)
Manganese	15.20%	6 (16)	10.26%	5 (6)	(d)	(0)	(d)	(0)
Potassium	16.50%	11 (15)	10.11%	6 (6)	(d)	(0)	(d)	(0)
Sodium	4.50%	14 (15)	6.06%	6 (6)	(d)	(0)	(d)	(0)
Strontium	4.40%	14 (16)	5.21%	6 (6)	(d)	(0)	(d)	(0)
Silica, dissolved	11.20%	15 (15)	9.56%	6 (6)	(d)	(0)	(d)	(0)
Uranium, total	11.80%	22 (48)	4.27%	10 (23)	18.87%	15 (23)	13.10%	5 (8)

(a) Groundwater samples include spring samples
(b) Surface water samples include NPDES samples
(c) RPD = Relative Percent difference
(d) RPD could not be calculated for these parameters
(e) The first number is the number of samples used to calculate RPD; the second number (in parentheses) is the total number of duplicate sets analyzed in 1992.

The results shown in Table 9-2 indicate that for all parameters reviewed, the relative percent difference was less that 20% (except nitrate data in laboratory duplicates on surface water). The 20% criterion demonstrates that duplicate sample results were reproduced and of acceptable quality. This criterion is recommended in the CLP (EPA 1988b).

The only failure to meet the 20% criterion was nitrate data in laboratory duplicates for surface water. Here, the relative percent difference was 21.2%. Evaluation of the nitrate samples showed that the high relative percent difference (RPD) may be attributable to low level contamination as noted in field blanks (Section 9.3.2.2). This may have affected the RPD for nitrate sample with low detection limits. These data points had high relative percent differences because they were less than 1.0 mg/l. If these data points were not used, the relative percent difference was 12%.

9.3.2 Blank Sample Results Evaluation

Various types of blanks are collected by the WSSRAP to assess the conditions and/or contaminants that may be present during sample collection and transportation. These conditions and contaminants are monitored by collecting samples to ensure routine samples are not being contaminated. Blank samples assess the:

- Environments that the samples (i.e., volatile analyses) were shipped in (trip blanks).
- Ambient conditions in the field that may effect a sample during collection (field/trip blanks).
- Sampling equipment used to collect samples, when applicable (equipment blanks).
- Quality of water used to decontaminate sampling equipment and/or assess the ambient air conditions (water blanks).

Sections 9.3.2.1 through 9.3.2.4 discuss the sample blank analyses and the summary of analytical results that were above the analytical detection limits. Field blank samples for groundwater, surface water, spring and seep water, and NPDES water were evaluated together as a set. Table 9-3 summarizes the blank samples collected in 1992.

TABLE 9-3 Summary and Average of Field Blank Parameter Results

Parameters	Number of Detects/Number of Analyses	Evaluation and Summary of Detects	Comments
Uranium, total	4 out of 11 (36%)	3 of 4 (75%) <5X DL; 1 of 4 @ 12.5 X DL	
Nitrate-N	9 out of 14 (64%)	7 of 9 (78%) <5X DL; 2 of 9 (22%) >5X DL	No nitrate above 0.53 mg/l (low level contamination)
Chloride	1 out of 4 (25%)	1 of 1 <2X DL	
Sulfate	1 out of 14 (7%)	1 of 1 <2X DL	
Alkalinity	3 out of 14 (21%)	3 of 3 (100%) <2X DL	
Lead	2 out of 4 (50%)	1 of 2 rejected; 1 of 2 <2X DL	One rejected by the validation group
Iron	2 out of 4 (50%)	2 of 2 <2X DL	
Sodium/Strontium	1 out of 3 (33%)	1 of 1 <2X DL	
Calcium	1 out of 4 (25%)	1 of 1 <5X DL	
Phosphorus	2 out of 3 (66%)	1 of 2 <2X DL; 1 of 2 >5X DL	
Thorium-230	1 out of 5 (20%)	See comments	Laboratory problem/ contamination
Toluene	1 out of 1 (100%)	See comments	Rejected by the validation group
Arsenic/Barium	0 out of 13 (0%)	NA	
Nitroaromatic	0 out of 14 (0%)	NA	

Note: DL = Detection limit; <2X = Less than two times; >5X = greater than five times

9.3.2.1 Trip Blank Evaluation. Trip blanks are collected to assess the impact of sample collection and shipment on groundwater and surface water samples analyzed for volatile organic compounds. Trip blanks are sent to the laboratory with each shipment of volatile organic samples.

In 1992, 13 trip blank samples were analyzed for volatile organic compounds. Low levels of methylene chloride (one sample) and toluene (two samples) were found. Further evaluation showed that the methylene chloride concentration was just at the detection limit and that this compound is a common laboratory contaminant. The concentration did not exceed the

CLP criterion. Of the two samples in which toluene was detected, one was rejected by the WSSRAP validation group due to laboratory contamination problems and the other was less than five times the detection limit. Further investigation showed that the presence of toluene was probably not due to shipping or laboratory contamination, but rather to improper preparation of sampling containers (use of clear adhesive tape on sampling vials). Corrective action has been taken to prevent this problem from recurring. This consisted of training samplers and shippers on proper handling techniques for volatile organic samples.

9.3.2.2 Field Blank Evaluation. Field blank samples are collected at monitoring sites just prior to, or immediately after, actual samples are collected. The field blanks are collected to assess the ambient air conditions at the sample locations. They are analyzed for the parameters being sampled which, therefore, are generally the parameters of concern, such as uranium, anions, metals, and nitroaromatics. In the first seven months of 1992, field blank samples were collected at a frequency of one blank for every 20 samples. In July 1992, ES&H procedure 4.1.4, *Quality Control Samples for Aqueous and Solid Matrices: Definitions, Identification Codes, and Collection Procedures*, was implemented. This procedure changed the frequency of field blank sample collection to one per month.

Nineteen field blank samples were collected in 1992. The data is summarized in Table 9-3. This table presents the ratio of detects to total number of samples collected for each parameter having results above the detection limits. Overall, most of the contaminants were low level (less than five times the detection limit) and/or the parameters were in the water blank samples (see Section 9.3.2.4). These conditions suggest that most of the concentrations found in field blank samples are probably not associated with field conditions, but are due either to the tolerance limits of data near the detection limit or the contamination of the water used for field blanks. None of the analytical results for field blank samples had a major impact on routine analyses performed in 1992.

Several parameters that were greater than five times the analytical detection limits were further investigated.

Uranium was detected in 36% of the field blank samples, but was also found in 46% of the water blank samples at similar concentrations. Seventy-five percent of the detected uranium was less than five times the detection limit. Further evaluation of the data showed that most of the uranium in the field and water blank samples was from the laboratory that performed

uranium analyses during the first six months of 1992. Laboratory analytical problems were determined by validation of uranium data and through an audit of the laboratory. The concentrations did not have a major impact on the uranium data for the routine samples because they were less than five times the detection limit and routine sample data is not impacted by these low level concentrations.

Thorium-230 was detected in one of five field blanks. Review of data indicated that the laboratory blank was also contaminated, an indication that the source of contamination was the laboratory.

Nitrate was found in 64% of the field blank samples and 18% of the water blank samples. Seventy-eight percent of the nitrate in the field blank samples was less than five times the detection limit. Some of the nitrate data may be the result of problems with data near the detection limit and the result of using nitric acid in the field for preserving other parameters collected at the same time. Samplers have been trained on how to prevent nitric acid fumes from contaminating nitrate samples. The nitrate in the field blank samples did not have a major impact on the nitrate data for the routine samples because it was less than five times the detection limit and routine sample data are not impacted by these low level concentrations.

Several other parameters summarized in Table 9-3 had a high number of detected concentrations in the field blank samples, but further evaluation showed that almost all of these data points were reported as uncensored data and were less than two times the detection limit. The detected concentrations for these parameters did not have an impact on routine analyses performed in 1992.

9.3.2.3 Equipment and Bailer Blank Evaluation. Equipment and bailer blanks are collected by rinsing distilled water over decontaminated equipment and bailers to determine the effectiveness of cleaning sampling equipment and whether the equipment used to collect the samples was contaminated. At the WSSRAP, most of the groundwater samples are collected from dedicated equipment, and surface water is collected by placing the sample directly into a sample container. Therefore, only one bailer blank and three equipment blanks were collected and analyzed.

The three equipment blanks were analyzed for radiochemical parameters only, and the results were less than two times the detection limit. When the associated error was applied, the

detected parameters were below the detection limit.

The one bailer blank had most of the contaminants of concern, including the geochemical parameters. Most of these parameters were below the detection limit, but several metal parameter results (calcium, iron, magnesium) were greater than five times the detection limit. Concentrations of these parameters did not affect the analytical data of the samples collected from the bailer because these parameters were found at concentrations at least 100 times higher than the concentrations found in the bailer blank.

Further investigation revealed that the bailer was probably not thoroughly decontaminated before the blank was collected since these metals are commonly found in suspended material found in groundwater at the Weldon Spring site. To prevent this from recurring, sampling personnel have been retrained in decontamination procedures.

9.3.2.4 Water Blank Evaluation. Water blank samples are collected to evaluate the quality of the distilled water used to decontaminate sampling equipment and to assess whether contaminants are present in the water used for field and trip blanks. Water blank samples also serve as laboratory blanks. Water blanks were collected quarterly until July when ES&H 4.1.4 was initiated. ES&H 4.1.4 states that water blank samples shall be collected on a monthly basis. Generally, the water blanks were analyzed for contaminants of concern and were collected at the same time as field blanks.

In 1992, 17 water blanks were collected. Table 9-4 presents the ratio of detects to the total number of samples collected for each parameter that had results above the detection limit. Overall, most of the contaminants found in water blank samples were low level (less than five times the detection limit). Concentrations near the detection limit may have been the result of slightly tainted water, but more than likely these results were caused by the higher tolerance limits of data near the detection limit. Low level concentrations found in water blank samples impacted the analytical results for field blank samples because low level contamination was also found in most of the field blank samples.

Although low level concentrations in the water blank samples did not impact the analysis of samples collected in 1992, corrective actions are being taken to eliminate future problems.

TABLE 9-4 Summary of Water Blank Parameter Results

Parameter	Number of Detects/Number of Analyses	Evaluation and Summary of Detects	Comments
Uranium, total	6 out of 13 (46%)	4 of 6 at DL; 2 of 6 <5X DL	
Nitrate-N	2 out of 11 (18%)	1 of 2 <5X DL; 1 of 2 >5X DL	
Chloride	1 out of 5 (20%)	1 of 1 <2X DL	
Alkalinity	3 out of 8 (38%)	3 of 3 <3X DL	
Chemical Oxygen Demand	2 out of 3 (67%)	2 of 2 at DL	
Iron	1 out of 5 (20%)	1 of 1 <2X DL	
Lead	1 out of 5 (20%)	1 of 1 <2X DL	
Magnesium	1 out of 2 (50%)	1 of 1 <2X DL	
Mercury	1 out of 3 (33%)	1 of 1 <2X DL	
Phosphorus	3 out of 4 (75%)	2 of 3 <2X DL; 1 of 3 >5X DL	
Sodium	1 out of 2 (50%)	1 of 1 <2X DL	
Strontium	1 out of 2 (50%)	1 of 1 >5X DL	
Thorium-230	4 out of 6 (67%)	See comments column	Laboratory problem/ contamination
All other[a]	No detections		

a. Nitroaromatic, other metals and radiochemical parameters

9.4 1992 Data Validation Program Summary

Data validation programs at the WSSRAP involve reviewing and qualifying at least 10% of the data collected during a calendar year. The information summarized below includes all WSSRAP data collected and is not limited to environmental monitoring data. The data points represent the number of parameters analyzed (e.g., toluene), not the number of physical analyses performed (e.g., volatile organics analyses).

Table 9-5 identifies the number of 1992 quarterly and total data points that were selected for data validation, and what percentage of those selected were completed.

Table 9-6 identifies validation qualifiers assigned to the selected data points as a result of data validation. To date, 98% of 1992 data validation has been completed.

Table 9-7 identifies the average percent of accuracy and precision for all matrixes (not including environmental and waste management) for anion, metal, nitroaromatic, radiochemical, and miscellaneous parameters. Other analyses (e.g., volatile organics) are not presented because the data is limited. The accuracy values are based on the percent of recoveries of the laboratory control samples, and the precision values are based on the relative percent of difference between duplicates. The data population size associated with each accuracy and precision value is listed as "n." Several of the precision values in Table 9-7 do not reflect the results duplicate analyses discussed in Section 9.3.1 because the data validation precision results included all matrixes collected at the WSSRAP.

9.5 Interlaboratory Comparison Program Results

This section summarizes the interlaboratory comparison program data recieved from the subcontracted laboratories. Data presented in this section are from three programs: (1) the DOE quality assessment program, (2) EPA organic and inorganic performance evaluation studies and (3) the EPA intercomparison radionuclide control program.

The interlaboratory comparison programs are intended to allow participating laboratories to analyze spiked control standards to verify how their SOPs and QA/QC programs are performing. Interlaboratory comparison programs provide laboratories with information regarding their control standards. Interlaboratory comparison program results presented in this section do not impact any of the analytical data used to prepare this report, but are discussed here to provide information about laboratories' capability to perform accurate analyses of spiked control samples.

Results of the DOE Environmental Measurement Laboratory Quality Assessment Program are presented in Table 9-8. This table provides information on the parameter, matrix type, laboratory name, date analyzed, DOE value, reported value, and percent recovery. Only the

TABLE 9-5 WSSRAP Validation Summary for Calendar Year 1992 (as of January 1993)

Calendar Quarter 1992	No. of Data Points Collected	No. of Data Points Selected for Validation	No. of Validated Data Points	% Completed
Quarter 1	10,813	2,969	1,339	45.1%
Quarter 2	17,413	2,183	66	3.0%
Quarter 3	10,180	1,186	730	61.6%
Quarter 4	13,249	2,773	1,238	44.6%
1992 Total	51,655	9,111	3,373	37.0%

uranium data results from this program are presented because all of the other radionuclides associated with this program are for enriched uranium and their associated daughters.

Results of the EPA intercomparison radionuclide control program are presented in Table 9-9. This table provides information on the parameter, matrix type, laboratory name, date analyzed, DOE value, reported value, and the percent recovery. Uranium and uranium daughter data from this program are presented because most of the radionuclides associated with this program are for enriched uranium and their associated daughters.

Results of the EPA organic and inorganic performance evaluation program are not summarized or presented in this section. However, this information is evaluated during the routine audits of each of the laboratories. Results of the 1992 performance evaluation samples for TCT-St. Louis and Weston (Lionville laboratory) have been reviewed, and no major problems with the results from these programs were observed.

TABLE 9-6 Annual Data Validation Qualifier Summary - 1992 (as of January 1993)

	Anions	Metals	Miscellaneous	Nitroaromatics	Pest/PCB	Radiochemical	Semi-VOA	VOA	Total
No. of Data Points									
Accepted	96	679	85	26	313	91	1237	777	3304
Rejected	13	33	7	0	0	1	0	15	69
On Hold	25	78	27	0	504	229	0	100	963
Not Validatable	0	0	0	0	0	0	0	0	0
Pending	94	1487	119	162	371	560	1032	950	4775
Total	228	2277	238	188	1188	881	2269	1842	9111
Percentages									
Accepted	42.1	29.8	35.7	13.8	26.3	10.3	54.5	42.2	36.3
Rejected	5.7	1.4	2.9	0.0	0.0	0.1	0.0	0.8	0.8
On Hold	11.0	3.4	11.3	0.0	42.4	26.0	0.0	5.4	10.6
Not Validatable	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pending	41.2	65.3	50.0	86.2	31.2	63.6	45.5	51.6	52.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Avg. % Completeness for 1992: 98.0%
Accepted/Accepted

TABLE 9-7 Validation Accuracy and Precision Summary for Calendar Year 1992

Parameter	% Acc.[a]	n[b]	% Prec.[c]	n[b]
ANIONS				
Fluoride	96.6	7	0.0	7
Chloride	99.8	7	1.6	7
Nitrate	99.1	25	1.4	25
Sulfate	97.9	25	4.4	25
METALS				
Aluminum	111.0	1		0
Antimony	133.8	1		0
Arsenic	99.3	70	28.0	60
Barium	101.7	36	0.7	26
Beryllium	100.0	1		0
Cadmium	107.2	27	0.1	17
Calcium	96.8	1		0
Chromium	106.3	26	0.0	16
Cobalt	109.2	1		0
Copper	105.1	8	0.0	7
Iron	115.7	8	4.2	7
Lead	100.3	60	10.0	49
Lithium	102.0	1		0
Magnesium	107.0	1		0
Manganese	102.6	40	44.8	39
Mercury	96.3	58	0.0	56
Molybdenum	109.8	1		0
Nickel	106.6	1		0
Potassium	119.5	1		0
Selenium	99.4	58	0.0	48
Silver	105.4	26	0.0	16
Sodium	95.6	1		0
Thallium	102.4	33	0.0	32

TABLE 9-7 Validation Accuracy and Precision Summary for Calendar Year 1992 (Continued)

Parameter	% Acc.[a]	n[b]	% Prec.[c]	n[b]
METALS (continued)				
Vanadium	97.6	1		0
Zinc	103.4	10	0.4	8
MISCELLANEOUS				
Alkalinity	94.9	18	1.4	18
Total Dissolved Solids	85.3	2	0.0	2
Total Suspended Solids	99.2	9	0.0	9
Cyanide, Total	92.6	11	0.0	11
Biochemical Oxygen Demand	84.3	7		0
Chemical Oxygen Demand	95.1	7	0.0	7
NITROAROMATICS				
1,3,5-Trinitrobenzene	102.9	2		0
1,3-Dinitrobenzene	95.0	2		0
Nitrobenzene	91.2	2		0
2,4,6-Trinitrotoluene	94.0	9	3.6	7
2,4-Dinitrotoluene	88.4	9	0.0	7
2,6-Dinitrotoluene	119.3	2		0
RADIOCHEMICAL				
Uranium, Total	106.2	15	6.5	16
Th-228	104.4	1		0
Th-230	114.0	11	32.1	11
Th-232	115.2	4	92.0	3
Ra-226	104.4	10	7.9	10
Ra-228	110.9	10	10.9	10
Gross Alpha	101.0	7	2.7	7
Gross Beta	97.0	7	3.4	7

a The accuracy values are based on the percent of recoveries of the associated laboratory control samples.
b Sample Population
c The precision values are based on the relative percent of differences between associated sample duplicates.

TABLE 9-8 Summary of DOE Interlaboratory Comparison Program

Parameter (matrix)	Laboratory (Date)	DOE Value	Reported Value	Percent Recovery
Uranium, total pCi (water)	Core (3/92)	0.838	0.3	36%
Uranium, total µg (water)	Core (9/92)	0.00906	0.004	44%
Uranium, total pCi (soil)	Core (3/92)	59.3	37	62%
Uranium, total µg (soil)	Core (9/92)	2.32	2.0	86%
Uranium, total pCi (air)	Core (3/92)	0.2	0.21	105%
Uranium, total µg (water)	Barringer (9/92)	0.00906	0.008	88%
Uranium, total µg (air)	Barringer (9/92)	1.28	1.54	120%
Uranium, total µg (soil)	Barringer (9/92)	2.32	2.1	91%
Uranium, 234 pCi (water)	Barringer (9/92)	0.115	0.137	119%
Uranium, 238 pCi (water)	Barringer (9/92)	0.115	0.115	100%
Uranium, 234 pCi (air)	Barringer (9/92)	0.0166	0.0204	123%
Uranium, 238 pCi (air)	Barringer (9/92)	0.016	0.0204	127%
Uranium, 234 pCi (soil)	Barringer (9/92)	29.2	18.5	63%
Uranium, 238 pCi (soil)	Barringer (9/92)	29.6	14.8	50%
Uranium, total pCi (water)	Ecotek (3/92)	0.838	0.8	95%
Uranium, 234 pCi (water)	Ecotek (9/92)	0.115	0.630	548%
Uranium, total pCi (air)	Ecotek (3/92)	0.2	0.16	80%
Uranium, 234 pCi (air)	Ecotek (9/92)	0.0166	0.11	663%
Uranium, 234 pCi (soil)	Ecotek (9/92)	29.2	50.7	174%

TABLE 9-9 Summary of EPA - EMSL Intercomparison Radionuclide Control Program

Parameter (Matrix)	Laboratory (Date)	EPA EMSL Value	Average Reported Value	Percent Recovery
Uranium, total (water)	Barringer (3/92)	25.3	23.67	94%
Uranium, total (water)	Barringer (10/92)	10.2	9.97	98%
Gross Alpha (water)	Barringer (3/92)	15.0	15.33	102%
Gross Alpha (water)	Barringer (10/92)	29.0	19.67	68%
Gross Beta (water)	Barringer (3/92)	44.0	44.67	102%
Gross Beta (water)	Barringer (10/92)	53.0	33.0	62%
Radium-226 (water)	Barringer (3/92)	10.1	9.67	96%
Radium-226 (water)	Barringer (10/92)	7.4	9.47	128%
Radium-228 (water)	Barringer (3/92)	15.0	15.57	104%
Radium-228 (water)	Barringer (10/92)	10.0	10.53	105%
Uranium, total (water)	Ecotek (3/92)	25.3	23.63	93%
Uranium, total (air)	Ecotek (4/92)	4.0	3.33	83%
Uranium, total (water)	Ecotek (7/92)	4.0	3.93	98%
Uranium, total (water)	Ecotek (10/92)	10.2	10.2	100%
Uranium, total (water)	Ecotek (11/92)	15.2	12.7	84%
Gross Alpha (water)	Ecotek (1/92)	30	28.33	94%
Gross Alpha (water)	Ecotek (4/92)	40	41	103%
Gross Alpha (water)	Ecotek (5/92)	15	21.33	142%
Gross Alpha (water)	Ecotek (9/92)	45	29.67	66%
Gross Alpha (water)	Ecotek (10/92)	29	28.33	98%
Gross Beta (water)	Ecotek (1/92)	30	18.33	61%
Gross Beta (water)	Ecotek (4/92)	140	11.67	8%
Gross Beta (water)	Ecotek (5/92)	44	43.33	98%
Gross Beta (water)	Ecotek (9/92)	50	45.67	91%
Gross Beta (water)	Ecotek (10/92)	53	41.67	79%
Radium-226 (water)	Ecotek (4/92)	14.9	18.23	122%
Radium-226 (water)	Ecotek (10/92)	7.4	7.07	96%
Radium-226 (water)	Ecotek (11/92)	7.5	6.9	92%
Radium-228 (water)	Ecotek (4/92)	14	12.5	89%
Radium-228 (water)	Ecotek (10/92)	10	11.8	118%
Radium-228 (water)	Ecotek (11/92)	5	5.43	109%

10 SPECIAL STUDIES

This section highlights significant activities and efforts at the Weldon Spring Site Remedial Action Project that support and assist in the implementation of environmental protection policies. In addition, short term environmental studies are described that support regulatory requirements not specifically covered by U.S. Department of Energy (DOE) Order 5400.1 or that were not planned in the *Environmental Monitoring Plan for Calendar Year 1992* (MKF and JEG 1992o).

10.1 Special Programs

The special programs described in this section were initiated to determine the effectiveness of engineering practices put in place as a result of remedial activities at the site. In addition, research activities were developed to support overall environment monitoring.

10.1.1 Embankment Safety Program

Federal regulations require that embankments higher than 7.6 m (25 ft) and those that could pose significant downstream hazards be regulated by an embankment safety program. The Federal Energy Regulatory Commission (FERC) has the overall responsibility for embankments owned by the DOE and performs formal inspections at least every five years. The Weldon Spring Site Remedial Action Project (WSSRAP) is responsible for developing and implementing an embankment safety program, maintaining the embankments, and performing routine surveillance of these structures.

The WSSRAP has implemented a program which it developed in 1991. This program outlines the training necessary to effectively survey and assess the embankments at the Weldon Spring site and requires mandatory inspections as outlined in procedure ES&H 4.2.3s. All regulatory and surveillance requirements, including documentation, are also defined by this program. The *Emergency Preparedness Plan* (MKF and JEG 1991c) outlines actions to be taken in the event of possible or actual embankment failures.

All embankments at the site were assessed in 1992 in accordance with the requirements of these documents. Only minor deficiencies were noted, and the integrity of the embankments

was determined to be sound. Also in 1992, an extensive maintenance program, consisting of removal of weeds and woody vegetation, was initiated.

10.1.2 Storm Water Runoff Monitoring Program

As a result of increased remedial and construction activity at the chemical plant, erosion and sediment control measures have been implemented to reduce the sediment load in storm water runoff from the site. These measures are regulated by the National Pollution Discharge Elimination System (NPDES). As an internal measure only, storm water runoff samples were collected and analyzed for settleable solids and total uranium in order to determine the effectiveness of current erosion and sediment control around storage and construction areas at the site.

Sampling was performed monthly, during or immediately after measurable storm events. The effectiveness of the controls was determined by sampling runoff on the down slope side of sediment barriers and comparing parameter concentration levels to maximum allowable limits and to the historical data for each sampling point. Changes were made to control systems if the concentration levels exceeded allowable limits or were significantly higher than historical data. To assess the effectiveness of erosion and sediment control work practices, this program will continue while soil disturbance activities are in process.

10.1.3 Environmental Internship

In 1991, the WSSRAP initiated an environmental internship program to encourage and cultivate young environmental professionals who, in many cases, will dedicate extended careers to environmental protection, waste management, and remedial cleanup. Another goal of this program was to provide the opportunities to local public and private colleges. The internship program provides 24 hour or 40 hour hazardous materials training, radiation safety, and other appropriate instruction to the interns.

In 1992, the program supported two environmental internships. The industrial hygiene internship included work activities to support field activities including respirator fit testing, calibration of instruments, noise monitoring, hazardous atmosphere determination, and heat stress monitoring. The ecological internship also included field activities including vegetation

surveys, deer surveys, collection and preparation of biological samples, and data interpretation tasks.

10.2 Special Studies

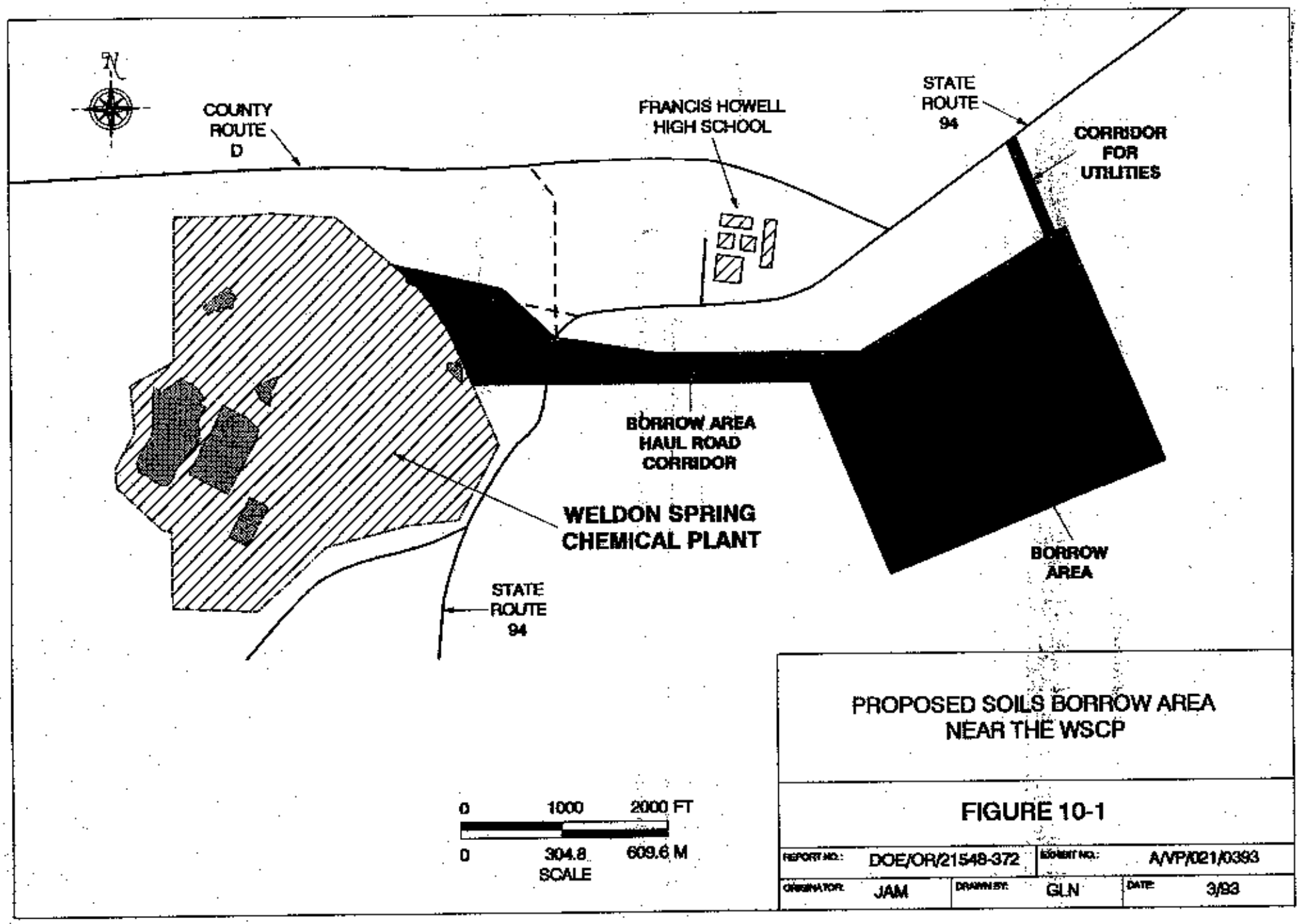
The special studies described in this subsection are short-term or one-time studies that support regulatory requirements not specifically covered by DOE 5400.1 or which were not planned in the Environmental *Monitoring Plan for Calendar Year 1992* (MKF and JEG 1992o). These studies are applicable to the monitoring requirements of DOE Order 5400.1 for preoperational monitoring and baseline characterization.

10.2.1 Proposed Borrow Area

If the decision is made to construct a disposal cell at the Weldon Spring site, the borrow area will be the source for low-permeability soils (Figure 10-1). A biological survey was conducted to meet the requirements of the *National Environmental Policy Act* (NEPA) and *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA). The NEPA requires that surveys be conducted prior to any major construction activity at a Federal facility to locate any possible threatened or endangered species or their critical habitat that may be impacted by Federal activities. The CERCLA requires biological surveys to support ecological risk assessments. The *Clean Water Act* (CWA), Section 404, regulates dredging and filling of areas that drain into natural waters of the U.S. and activities in Federal jurisdictional wetlands.

A biological survey was performed in 1992 to characterize flora and fauna within and surrounding the borrow area; to determine if any Federal or State threatened or endangered species are using the borrow area; and to delineate wetlands in the proposed area. Biological surveys were conducted for birds, owls, herpetofauna, fish, and vegetation. All surveys were conducted during July and August with the exception of bird surveys which were conducted twice monthly for the entire year.

The borrow area is primarily comprised of cropland and old field habitat. This area was last planted with wheat in 1990 and harvested in 1991. Within the overall area there are small forested areas such as hedgerows and drainages, and four ponds. The primary tree species


N
COUNTY ROUTE D
FRANCIS HOWELL HIGH SCHOOL
STATE ROUTE 94
CORRIDOR FOR UTILITIES
BORROW AREA HAUL ROAD CORRIDOR
WELDON SPRING CHEMICAL PLANT
BORROW AREA
STATE ROUTE 94
0 1000 2000 FT
0 304.8 609.6 M
SCALE
PROPOSED SOILS BORROW AREA NEAR THE WSCP
FIGURE 10-1
REPORT NO.: DOE/OR/21548-372
EXHIBIT NO.: A/VP/021/0393
ORIGINATOR: JAM
DRAWN BY: GLN
DATE: 3/93

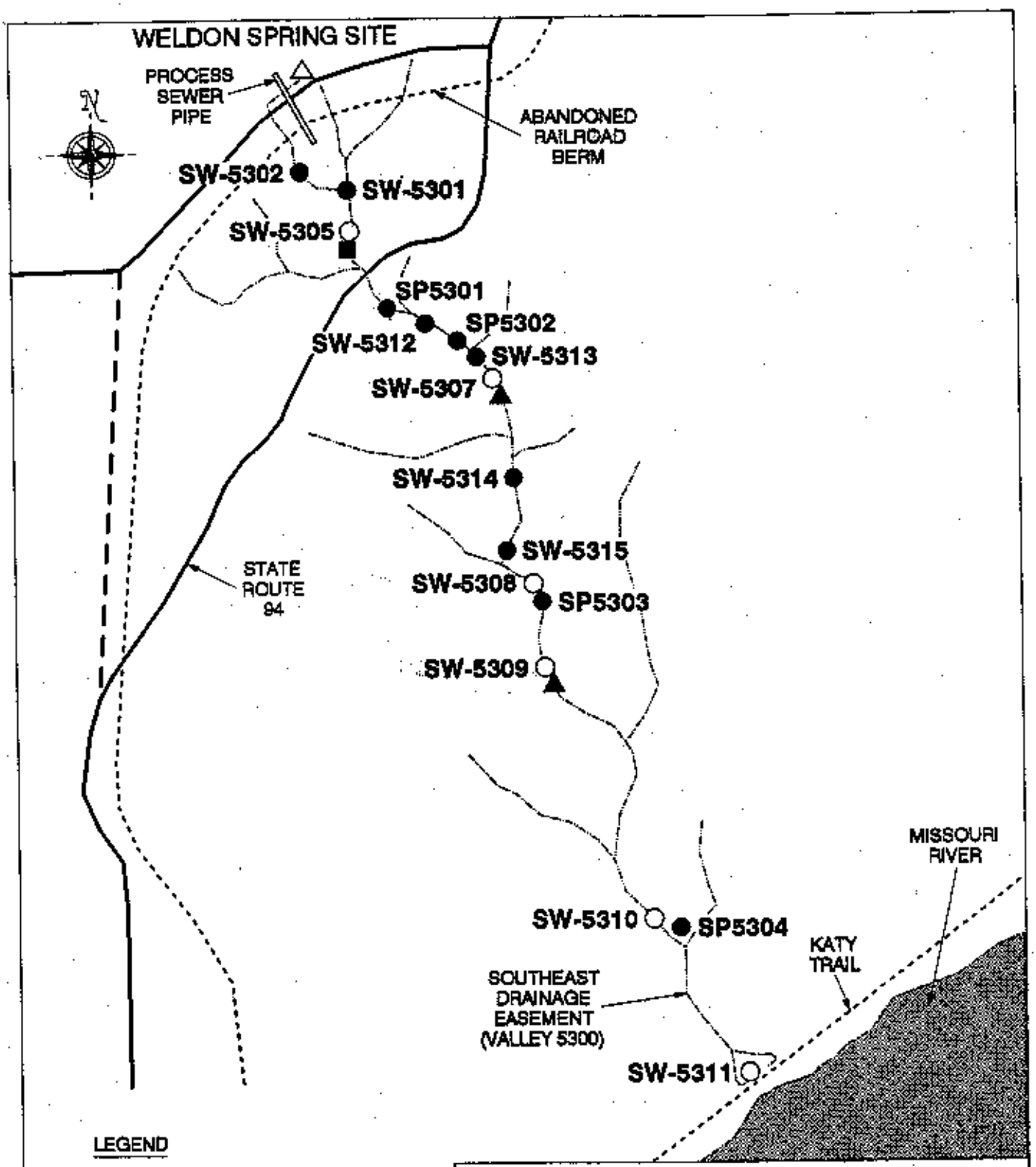
include black willow in the pond area, cottonwood in the drainages, and eastern red cedar and common persimmon in the old fields. Old field vegetation includes such opportunistic species as goldenrod, common mullein, common thistle, and poison ivy. Fauna associated with this area includes cotton-tailed rabbits, white-tailed deer, eastern meadowlarks, and American goldfinches. Three listed species have been sighted within the borrow area: the loggerhead shrike (Federal candidate species and State watch list), Mississippi kite (State rare) and Cooper's hawk (State rare).

The ponds in the borrow area are identified as wetlands on the National Wetlands Inventory Map (USDI 1990) and are classified as a palustrine unconsolidated bottom wetland system. Palustrine systems are nontidal wetlands dominated by trees, shrubs, and persistent emergent (Cowardin et al. 1979). Preliminary surveys indicate the presence of wetland vegetation, soils, and hydrology; therefore, further studies will be conducted in 1993 to support the environmental assessment.

10.2.2 Southeast Drainage Flow Study

In 1990, the WSSRAP planned to use a natural drainageway, the Southeast Drainage as the discharge route for treated effluent from the site wastewater treatment plant at the Weldon Spring Chemical Plant. The Southeast Drainage receives groundwater discharge through various springs along the drainageway. During low flow conditions, the surface water has an average uranium concentration of 150 pCi/l. Sediments in the drainage were contaminated when the chemical plant was in operation and as a result, small contaminated areas are found along the drainage. During storms, the surface water flow in the drainage increases greatly, and sediments become resuspended in the storm water.

In order to gain an understanding of how the contaminated sediments in the drainage might be impacted by this effluent under various discharge rates from the site water treatment plant, the WSSRAP conducted a study to measure contaminant mobilization and uptake under induced flow conditions. The scope of this study included (1) introduction of "clean" water from a fire hydrant into the drainage basin at varying flow rates, and (2) collection and analysis of samples at designated locations along the drainage route. Water was released at three approximate flow rates: (1) 378 liters per minute (lpm) (100 gpm);(2) 756 lpm (200 gpm); and (3) 1,134 lpm (300 gpm). Each release step was maintained for at least 24 hours. Samples were collected at the locations shown in Figure 10-2. Samples were analyzed for radiochemical



LEGEND

- ● - SPRING LOCATION AND NUMBER
- ■ - SWALLOW HOLE
- ▲ - TOTAL WATER LOSS TO STREAM BED
- △ - FIRE HYDRANT

0 1000 2000 FT
0 304.8 609.6 M
SCALE

SOUTHEAST DRAINAGE FLOW STUDY

FIGURE 10-2

REPORT NO.:	DOE/OR/21548-372	EXHIBIT NO.:	A/VP/024/0393		
ORIGINATOR:	JAM	DRAWN BY:	GLN	DATE:	3/93

parameters, metals, and nitroaromatics. The study also measured the differences between the total (dissolved plus suspended) and dissolved-only fractions of the parameters of interest. Data results from this study are summarized in Appendix G. Following is a summary and interpretation of the results.

When clean water was introduced into the drainage at 378 lpm (100 gpm) and 756 lpm (200 gpm) the flow rate concentration of uranium at the lower portion of the drainage was 128 pCi/l and 150 pCi/l, respectively. Additional data were then obtained by collecting samples sequentially at one location. The results showed that concentrations of uranium were higher during the first part of the surge. This condition demonstrates that resuspension and/or entrainment of contaminants (storm surge) was occurring.

The 1,134 lpm (300 gpm) flow rate showed results similar to those of the first and second steps. Additional sampling locations were again added to further evaluate the drainage. The results showed a gradual increase in uranium concentration along most of the drainage, but decrease downgradient of spring SP-5304 (Figure 10-2), which contributes substantially to the total flow along the Southeast Drainage. The concentration of uranium at the lower portion of the drainage was 104 pCi/l.

Additional analyses for metals, nitroaromatics, and radiochemical constituents other than uranium were collected during the second and third steps of the study. These parameters were detected above analytical detection limits, but were well below applicable permit levels for the site water treatment plant. No significant amounts of resuspension and/or entrainment for these parameters were observed.

In conclusion, the study demonstrated that the concentrations of uranium mobilized by the induced discharge of water were very similar in the three steps of the study. The concentration measured at the highest flow rate appeared to be slightly lower than the concentrations at the lower flow rates, although, not statistically significant. Uranium concentrations showed there is a possibility that resuspension and/or entrainment of uranium may exceed the NPDES release limit. Other parameters tested did not show substantial increases in concentrations and did not exceed the NPDES permit limits. As a result of this flow study, alternate methods for discharge of the treated water were reviewed in 1992.

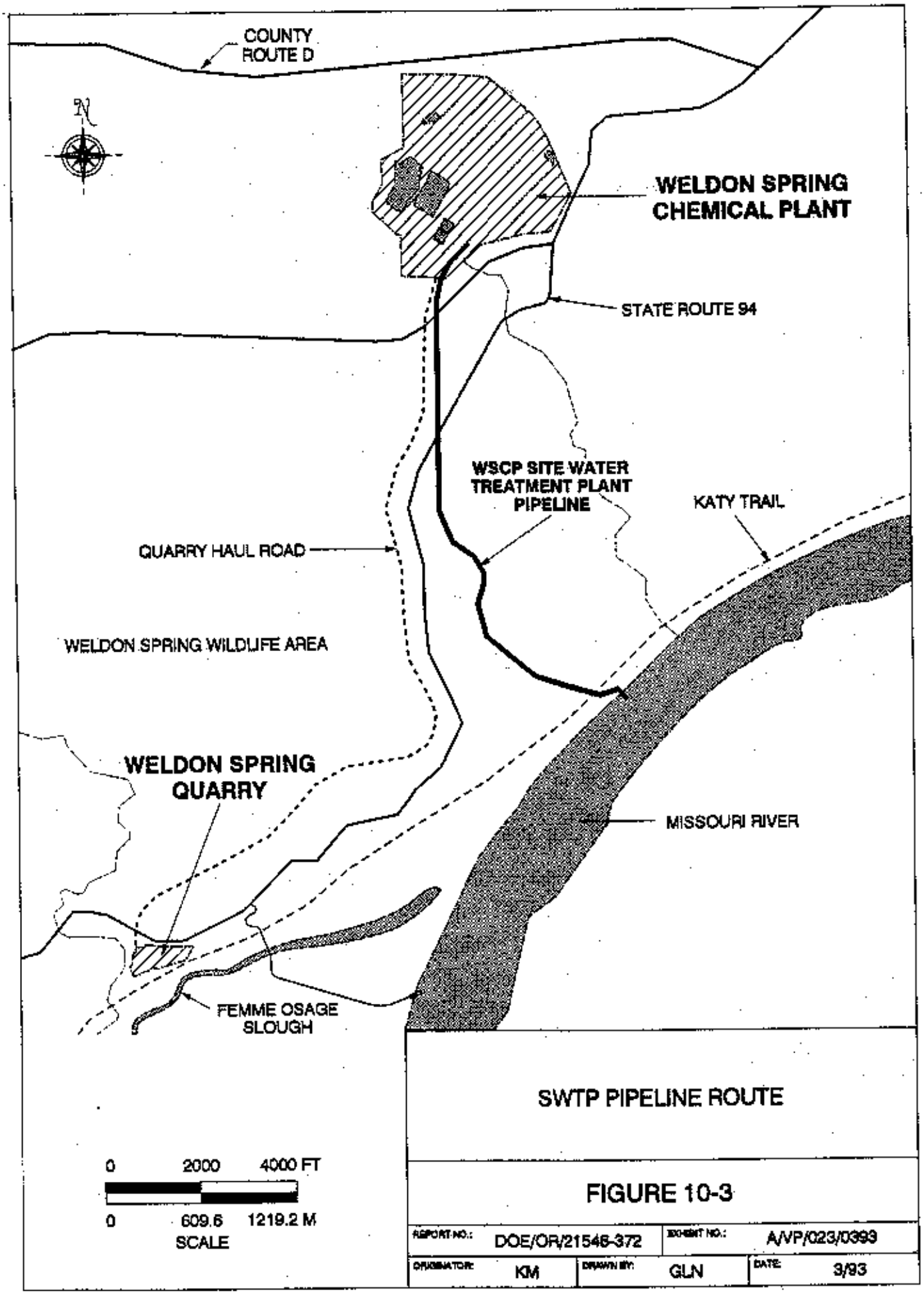
10.2.3 Site Water Treatment Plant Pipeline Survey

Water used in the operation of the temporary storage area (TSA) will require treatments at an on-site treatment facility. Originally, the plan was to discharge effluent from this facility along with other treated surface waters to the Southeast Drainage. However, the Southeast Drainage flow studies indicated that additional flow in the drainage causes uranium in sediments to be resuspended. The concentration of uranium showed that levels established by the NPDES permit may be exceeded. Therefore, the WSSRAP initiated an engineering study to evaluate different options for discharging the water. This study concluded that it would be feasible to built a discharge pipeline to the Missouri River. An underground pipeline would eliminate the potential of resuspending and/or entraining uranium along the Southeast Drainage. The route selected follows an abandoned railbed and State maintenance route (Figure 10-3).

From May through June 1992, document research, surveys, and sampling were conducted. Previously, surveys and/or characterizations had been performed along the pipeline route to identify radiological and chemical contaminants. Radiological analyses were conducted on soil samples obtained from borings along the Hamburg Quarry road. Information from the previous surveys indicated that chemical analyses were not needed.

Document research identified one area of radiological surface soil contamination (MKF and JEG 1992t). The report concluded that no activities or concentrations above release criteria were present along the railroad grade with the exception of radioactive surface soils adjacent to the chemical plant fence line. The site water treatment plant effluent pipeline will be located on the opposite side of the haul road where contaminant concentrations are below levels which would pose personnel exposure problems or waste management concerns during construction.

The location of a trinitrotoluene (TNT) raw waste water line identified in information obtained from the Department of the Army was verified and staked out. The documentation indicated the line was buried approximately 0.6 m to 1.5 m (2 ft to 5 ft) below ground in the vicinity of Substation 411 in the former railroad marshalling yard. This line was considered an explosive hazard because pure TNT/dinitrotoluene (DNT) residue could be in the line. No excavation was permitted in this area.


COUNTY ROUTE D
N
WELDON SPRING CHEMICAL PLANT
STATE ROUTE 94
WSCP SITE WATER TREATMENT PLANT PIPELINE
KATY TRAIL
QUARRY HAUL ROAD
WELDON SPRING WILDLIFE AREA
WELDON SPRING QUARRY
MISSOURI RIVER
FEMME OSAGE SLOUGH
0 2000 4000 FT
0 609.6 1219.2 M
SCALE
SWTP PIPELINE ROUTE
FIGURE 10-3
REPORT NO.: DOE/OR/21546-372
DOCUMENT NO.: A/VP/023/0393
ORIGINATOR: KM
DRAWN BY: GLN
DATE: 3/93

The ecological evaluations confirmed that there are no critical habitats along the proposed route. Minimal clearing and cutting of vegetation will occur since the pipeline follows previously disturbed areas. No impact to distribution, breeding, or survival of Federal or State species would occur from pipeline activity (MKF and JEG 1993b). No long term impact would occur along the pipeline route.

10.2.4 Characterization of Imhoff Tank and Process Sewer Pipe

The Imhoff tank (Structure 427) and an adjacent process sewer pipe that extends off site approximately 122 m (400 ft) have been scheduled for removal in 1993. The Imhoff tank was the primary sewage treatment plant for the Weldon Spring Chemical Plant. It is an underground structure extending down to bedrock (approximately 7.6 m [25 ft]) and is located near the south boundary line of the chemical plant. The process sewer system transferred wastewater from the process buildings and overflow from the raffinate pits to the Southeast Drainage. The section to be removed ranges in depth from 3.05 m (10 ft) at the site boundary to ground surface at the outfall.

The subsurface soil was characterized in 1992 to estimate the quantity of contaminated soil requiring excavation during removal of the Imhoff tank and process sewer line. Samples were collected adjacent to the Imhoff tank from approximately 4.57 m (15 ft) below the ground surface to auger refusal (top of bedrock). Along the process sewer line, samples were collected at a depth equivalent to the center line of the pipe to approximately 1.83 m (6 ft) below the pipe.

The samples were analyzed for Hazardous Substance List (HSL) metals, nitrates, polychlorinated biphenyl (PCB), Ra-226, Th-228, Th-230, Th-232, and total uranium. The analytical results indicated that none of the samples exceeded the proposed cleanup criteria. However, a 0.61 m (2 ft) envelope of soil surrounding the process sewer line will be excavated and stored on site as a proactive measure.

10.2.5 Lung Solubility Studies

Lung solubility studies began in 1991. Based on radiological characterization of the contaminated material remaining at the site, the most significant radionuclides from an internal radiation dosimetry perspective are U-238, U-234, Th-228, Th-230, and Th-232. The chemical nature of the compounds in which the uranium and thorium are bound is a very important

parameter for accurate estimation of the radiation dose equivalent received by inhalation. For example, in its dosimetric model for the respiratory system, the International Commission on Radiation Protection (ICRP 1978) defines three different solubility classes for uranium deposited in the lung. Uranium-containing chemical compounds which fall in the least soluble class (i.e., Class Y) deliver about 48 times more committed effective dose equivalent than does an equal amount (on a radioactivity basis) of uranium-containing compounds which belong to the most soluble class (i.e., Class D).

In order to accurately determine the solubility classifications of uranium and thorium compounds at the Weldon Spring site, bulk samples and area air samples were collected in 1991 from the chemical plant, raffinate pits, and quarry, and sent to an off-site laboratory for special analysis. In the analysis procedure, the samples are placed in a fluid which is chemically similar to human lung fluid. The fluid temperature is maintained at the human body temperature of 37°C (98.6°F). The fluid is collected at various times and analyzed for uranium and thorium isotopes. Fresh fluid is then added and the samples are maintained at the same temperature until another fluid extraction is made.

The last extraction was completed in September 1992. Preliminary data reduction and analysis have revealed that the thorium components on the site are mostly Class Y materials. The uranium components in the site process buildings were also found to be primarily Class Y components, whereas the uranium in the non-process buildings was found to be Class D material. Final data analysis will be completed by August 1993 and documented in the 1993 environmental report.

10.2.6 Particle Sizing Studies

Particle sizing studies began in 1991 and were continued in 1992. A knowledge of particle size within different areas or buildings on the site is vital to assessing the potential health effects associated with exposures to airborne particulates. Particle size distributions are essential in order to determine the probable point of respiratory deposition, particle behavior in the air, and the best methods of dust control, and to conduct an overall evaluation of chemical and radiological hazards. Thus, the particle sizing study should reproduce, to a reasonable degree, the dust collecting characteristics of the human respiratory system so that lung penetration by airborne particles can be predicted from sampling data.

The more penetrable particles (smaller particles) possess a greater potential to deliver radiation dose and other hazardous effects. The ICRP dosimetric models apply a default value of one micron to the determination of dose conversion factors. However, average particle sizes are expected to be larger than this default value. Collection of particle sizing data was initiated in July 1992 in the two process buildings where remediation activities were concentrated during 1992. Early data analysis has yielded particle sizes of >5.0 micron in both process buildings. These particle sizes are five times the ICRP default value and would result in approximately three times less committed effective dose equivalents for any given inhalation intake. Data collection will continue on a biannual basis at all locations where work activities create a potential to receive a committed effective dose equivalent in excess of 100 mrem.

10.2.7 Effect of Filtration on Groundwater Analysis at the Chemical Plant

Groundwater at the Weldon Spring site is filtered during sample collection to remove fine clays and other colloidal particles which are greater than 0.45 microns in diameter and may become suspended during the pumping process. If not removed, these particles may release naturally occurring metals to the water during sample preservation and/or analysis, resulting in measured concentrations that differ markedly from filtered samples.

Among unfiltered samples, concentrations of impacted parameters are a function of the amount of sediment or solid material suspended in the sample. Suspended sediment levels are related to conditions within the aquifer and pumping rates, which may not be constant from one monitoring period to the next.

In 1992, water collected from some wells was not filtered due to sampling problems at those locations. Samples collected from most of these wells were filtered during the second half of 1992. Comparison of the filtered and unfiltered samples from a given well offers an opportunity to evaluate transport mechanisms for the contaminants of concern. In addition, these samples provide preliminary information that may guide sampling strategies for the Groundwater Separate Operable Unit, which will require some unfiltered samples for risk assessment calculations. Since the 1992 filtered and unfiltered samples were collected during different quarters, natural variability in addition to filtration is a potential source of sample differences. Table 10-1 compares the results. Numerical values are given only for those parameters that are significantly affected by filtration.

TABLE 10-1 Filtered versus Unfiltered Sample Results

Well	2019	2025	2026	2028	2030	2032	2033	3003	3006	3023	4007	4016	4017	4022	Average
Aluminum	NS	NS	NS	NS	83.43	544.29	76.57	10.87	1.23	6.65	7.87	42.64	3.86	50.65	82.79
Iron	NS	NS	NS	NS	326.32	1936.84	453.16	2.73	1.46	37.17	6.82	266.46	12.96	203.33	324.73
Manganese	NS	NS	NS	NS	7.41	292.81	279.50	2.70	1.86	13.64	1.55	11.21	33.43	27.83	67.19
Chromium	NS	NS	NS	NS	ND	4.10	ND	ND	ND	ND	ND	17.31	2.29	20.25	4.95
Lead	NS	NS	NS	NS	17.45	13.13	31.80	ND	ND	ND	3.11	92.56	9.85	120.00	35.96
Nickel	NS	NS	NS	NS	1.50	3.84	1.18	ND	ND	ND	ND	14.21	ND	14.28	7.00
Calcium	NS	NS	NS	NS	X	X	1.86	X	X	X	X	X	X	3.21	1.48
Magnesium	NS	NS	NS	NS	X	X	X	X	X	X	X	X	0.88	2.18	1.24
Strontium	NS	NS	NS	NS	1.10		1.19	X	X	X	X	1.26	X	2.99	1.31
Barium	NS	NS	NS	NS	1.26	1.49	2.60	X	X	X	X	X	X	3.84	1.61
Sodium	NS	NS	NS	NS	X	X	X	X	X	X	1.89	1.51	X	X	1.08
Potassium	NS	NS	NS	NS	1.43	2.18	0.80	X	4.35		2.32	X	X	X	1.66
Phosphorus	NS	NS	NS	NS	X	7.22	4.06	X	X	2.17	1.88	7.00	2.26	8.09	4.22
Silica	NS	NS	NS	NS	1.87	0.91	0.80	X	X	1.74	X	X	X	X	1.18
Uranium	X	X	X	X	1.51	2.94	X	1.34	X	1.23	3.87	X	X	2.02	1.83
TNB	ND	ND	ND	ND	0.23	0.06	0.13	ND	ND	ND	ND	ND	ND	ND	0.14
TNT	ND	ND	ND	ND	0.42	0.17	0.19	ND	ND	X	ND	ND	ND	ND	0.41
DNT24	ND	ND	ND	ND	1.10	0.90	0.08	X	ND	X	ND	ND	ND	ND	0.84
DNT26	ND	ND	ND	ND	0.46	0.96	1.58	X	ND	X	ND	ND	ND	ND	1.05
Nitrate-N	X	X	X	X	X	1.86	X	X	X	0.66	0.45	X	X	X	1.08

NS = Not sampled
ND = Not detected in any sample X = Overlap between unfiltered and filtered values

The parameters that are most strongly affected by filtration are metals and phosphorus. Lesser effects are observed for nitroaromatics, alkalis (sodium and potassium), alkaline earth elements (magnesium, calcium, strontium, and barium), silica, and uranium. Although anion concentrations are typically the same in both unfiltered and filtered samples, nitrate displayed some relationship to filtration at a few locations. The direction of the nitrate variation appears random and is likely a result of conditions in the aquifer rather than filtration effects.

For the parameters affected, concentrations were highest in the unfiltered samples, with the nitroaromatics being a notable exception. Aluminum, iron, and manganese, which are basically insoluble at the pH and oxidation state of the shallow groundwater aquifer at the site, showed a marked increase in unfiltered samples. Aluminum and iron-manganese hydroxides are thus assumed to be present as colloidal species in many of the unfiltered samples. Modest increases in silica at some wells point toward a clay colloidal component also. Trace amounts of uranium, chromium, lead, and nickel naturally occur in both clays and iron oxyhydroxides, thus the observed increases in these elements may not reflect contamination of the aquifer. Although a potential phosphorus source exists in the raffinate pits, this element is commonly found in association with iron minerals and may be of natural origin. Uranium leached from suspended clay or iron oxide minerals is the expected source of the small increase in uranium values. This sorbed uranium may be of natural or contaminant origin.

In comparison tests, nitroaromatic concentrations were found to be generally lower in the 1992 unfiltered samples. This appears to reflect a temporary decrease in nitroaromatic concentrations during the spring of 1992 rather than filtration effects because unfiltered samples from 1991 have concentrations that are similar to the 1992 filtered samples. Dilution, perhaps due to increased infiltration rates, is a plausible explanation for the low concentrations; however, some other process, which is presently not understood, must also be involved to explain the absence of this effect on all nitroaromatic species from the same sample.

10.2.8 Geochemical Models for Groundwater Chemical Compositions at the Chemical Plant

Several of the geochemical wells were evaluated using the geochemical model MINTEQA2 Version 3.0, (EPA 1991) to gain an understanding of the relationship between site groundwater and the mineralogy of the host aquifer. MINTEQA2 calculates the species that should be present in a water analysis at equilibrium, the ionic strength, the charge imbalance of

the analytical data entered, and the Saturation Indexes (SI) of minerals that may precipitate from or dissolve into the solution. Geochemical programs such as MINTEQA2 only model equilibrium conditions, which may not be achieved in groundwater, and are limited by the availability and accuracy of the thermodynamic data required for these calculations. Thus, results of these calculations provide qualitative, not quantitative, information about the groundwater system.

The geochemical characteristics of each sample, including the chemical composition, temperature, pH, and alkalinity, were entered into the model. Other assumptions used in the model were (1) nondetects (NDs) were entered as half the detection limit; (2) minerals were not allowed to precipitate; and (3) redox reactions were not considered. Previous investigations by the USGS (Schumacher 1990) and dissolved oxygen measurements by the WSSRAP indicate that relatively oxidizing conditions are present in the groundwater; thus iron, manganese, and uranium were entered in the oxidized state.

The results of the MINTEQA2 calculations indicate that the values for ionic strengths, which reflect the concentration of charged species, are relatively low in each groundwater sample and well below the 0.1 tolerance limit for the algorithms used by MINTEQA2 to speciate a solution. The values for charge imbalance, which measures the difference between anion and cation concentrations, are generally less than 5%. Because a water sample must be electrically neutral, a perfect value would be zero. The low values recorded for most samples indicate that the entered analytical data were relatively complete and accurate. Two high SI values, 42 and 17.3, are for an unfiltered and a sediment-laden sample, respectively. These analyses probably were impacted by the presence of dissolved, sediment-derived cations.

SI values are presented in Table 10-2 for minerals that are known to be present in site soils or bedrock and are most likely to control groundwater chemistry. The formula of each mineral is also given to show which parameters are controlled by each mineral. An SI value of 0 indicates the water is at equilibrium with the designated mineral, whereas positive values indicate supersaturation (a condition where precipitation should occur and reduce the concentrations of the affected parameters in the water), and negative values indicate undersaturation (a condition where dissolution should occur and increase the concentrations of affected parameters in the water). The SI values for most minerals are near zero. Notable exceptions are kaolinite, ferrihydrite, and hydrapatite, which are all greater than 1, and gypsum, which is typically less than -1.

TABLE 10-2 Saturation Indexes for Selected Minerals in Chemical Plant Groundwater

Mineral	Formula	2002	2033	3003	3008	3023	4006	4007	4008	4020
Barite	BaSO4	0.45	-0.27	0.67	0.28	0.33	0.30	-0.42	-0.21	0.54
Calcite	CaCO3	-0.16	0.16	-0.03	0.10	0.01	-0.86	0.48	-0.47	0.11
Chalcedony	SiO2	0.07	0.01	-0.10	-0.13	-0.20	-0.16	-0.09	-0.22	-0.13
Dolomite	CaMg (CO3)2	-0.71	-0.35	-0.16	-0.17	-0.48	-1.92	0.89	-0.86	0.18
Ferrihydrite	Fe(OH)3	0.82	1.01	0.97	1.01	0.98	0.89	1.62	1.22	1.25
Hydrapatite	Ca5(PO4)3*H2	0.73	2.06	2.18	1.67	2.28	0.78	6.48	0.29	2.23
Gibbsite	Al(OH)3	0.25	0.37	0.19	0.28	0.22	0.27	0.16	0.29	0.31
Gypsum	CaSO4*(H2O)2	-1.15	-1.72	-0.94	-1.11	-0.59	-1.99	-2.16	-2.41	-1.22
Quartz	SiO2	0.59	0.52	0.47	0.40	0.33	5.02	0.44	0.3	0.38
Kaolinite	Al2Si2O6(OH)	5.43	5.55	4.98	5.09	4.85	0.36	4.94	4.94	5.15

These calculations show that iron, aluminum, and manganese, even at low levels are generally insoluble under the relatively oxidizing conditions and moderate pH values of site groundwater. This indicates that although aluminum levels may be high in the raffinate pit sludges, mobilization of aluminum into the groundwater system is unlikely.

The low SIs for gypsum indicate that this mineral does not limit calcium or sulfate concentrations and would dissolve if present in the aquifer. Equilibrium with gypsum may be responsible for the higher-than-background sulfate levels in GW-2028; however, due to the lack of geochemical data for this well, this hypothesis cannot be tested.

Calcium levels are plausibly controlled by calcite precipitation or dissolution, as calcite is near saturation in most samples. Figure 10-4 shows the relationship between calcium and alkalinity (which is proportional to carbonate concentrations) for both deep and shallow wells. Most samples plot along a gentle positive trend at the base of this diagram. The highest alkalinity levels are recorded in shallow wells and are accompanied by lower pH values, reflecting equilibrium with increased carbon dioxide pressures which naturally occur in

biologically active near-surface soils. Samples with the highest calcium values define a negative trend toward lower alkalinity values shown at the top of the graph. This negative trend indicates calcite precipitation, which decreases both calcium and carbonate concentrations in a system where calcium is present in excess of carbonate. These results indicate that calcium is not a conserved element in a strict sense; however, calcium still provides a useful tracer for groundwater impacted by chemical plant operations.

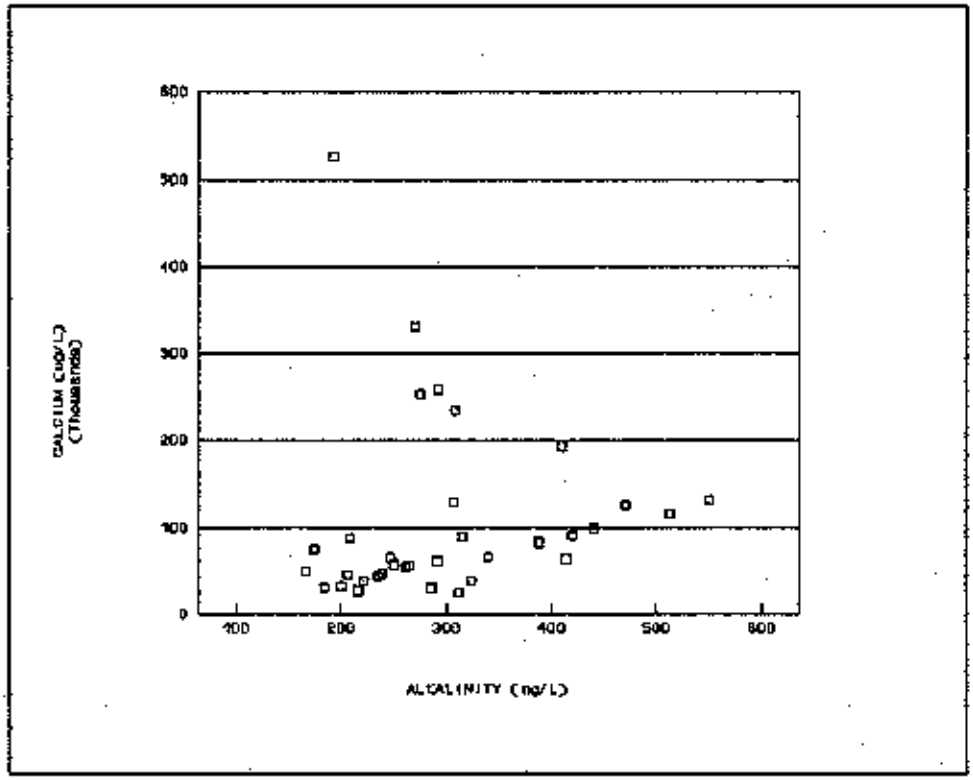


FIGURE 10-4 Alkalinity vs. Calcium Concentrations in Groundwater of Weldon Spring Site Wells

Barite, a highly insoluble mineral, is expected to limit barium and sulfate concentrations. Of the samples modeled, those with barium concentrations above 125 μg/l are supersaturated with barite.

Hydrapatite is also found to be supersaturated in several wells at the chemical plant/raffinate pits area. Nitrate, sodium, and lithium minerals were highly undersaturated, as expected, and are not listed. All uranium minerals were also undersaturated. In each of the model runs, the primary soluble uranium species were: $UO_2(CO_3)_2^{-2}$, $UO_2(CO_3)_3^{-4}$, and $UO_2H_2PO_4^{+2}$. The uranium carbonate species are both anionic complexes that are generally quite mobile but may be sorbed onto positively charged solids such as iron-manganese oxyhydroxides. Due to the supersaturated conditions calculated for hydrapatite, the presence of the phosphate complex may be an artifact of the model. The low levels and limited extent of uranium contamination (undersaturation of all uranium minerals) indicates that sorption onto site soils is an important control on uranium migration. This hypothesis is born out by laboratory studies conducted by the USGS (Schumacher 1990), which found uranium to be strongly sorbed onto certain site soils. Although sorption processes have restricted the migration of uranium, this same process will retain uranium on subsurface soils long after major sources, such as the raffinate pits, are removed. Sorbed uranium will be released to the groundwater gradually as the contaminated soils continually equilibrate with uncontaminated groundwater.

As previously noted, geochemical data are presently not available for all site wells. In 1993, geochemical samples will be collected at all site and certain quarry wells. Geochemical modelling of the additional site wells will provide further insight into the controls on potential contaminant migration, both horizontal and vertical, at the Weldon Spring Chemical Plant, raffinate pits, and vicinity property.

In summary, contaminants are primarily confined to the shallow permeable section of the aquifer. Nitroaromatic contamination from the Weldon Spring Ordnance Works overlaps some uranium-contaminated areas but is derived from different, poorly constrained sources. Although groundwater in many site wells has been impacted by previous operations at the chemical plant, the areal distribution of uranium, nitrate, and sulfate contamination is limited and relatively constant. Concentrations of some potential contaminants, such as aluminum, barium, and sulfate are controlled by mineral precipitation, whereas sorption limits uranium levels. Nitrate does not participate in precipitation or sorption reactions and is highly mobile in the aquifer. The limited distribution of nitrate may reflect nitrification or dilution and rapid transport to distant receptors.

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DOE ORDERS

5000.3A *Occurrence Reporting and Processing of Information*

5400.1 *General Environmental Protection Program*

5400.4 *Comprehensive Environmental Response, Compensation, and Liability Act Requirements*

5400.5 *Radiation Protection of the Public and the Environment*

5480.4 *Environmental Protection, Safety and Health Protection Standards*

5484.1 *Environmental Protection, Safety, and Health Protection Information Reporting Requirements*

5700.6C *Quality Assurance*

5820.2A *Radioactive Waste Management*

REGULATIONS

10 CFR 1022.14 - *Department of Energy, Compliance with Floodplain/Wetlands Environmental Review Requirements*

40 CFR 61 Appendix B - *Code of Federal Regulations, Appendix B - Test Methods*

40 CFR Part 141 - *National Primary Drinking Water Regulations*

40 CFR Part 191 - *Public Dose Limits*

40 CFR Part 171 - *Pesticide Programs, Certification of Pesticide Applicators*

40 CFR 61 Subpart H - *National Emission Standards for Hazardous Air Pollutants.*

40 CFR 261.4(b)(20) - *Identification and Listing (Exclusions)*

40 CFR 264.111 - *Closure Performance Standards*

40 CFR 261.11 - *Identification and Listing of Hazardous Wastes*

40 CFR 264.197 - *Standards for Treatment Storage and Disposal - Closure/Post Closure Care*

40 CFR 268.50 - *Land Disposal Restrictions*

40 CFR 761 - *Polychlorinated Biphenyls (PCBs) Manufacturing, Processing Distribution in Commerce, and Use Prohibitions.*

40 CFR 761.215(c)(1) - *Polychlorinated Biphenyl Management*

10 CFR 1022.12 - *Department of Energy Floodplains/Wetlands Assessment*

PROCEDURES

ES&H 1.1.5a	*The WSSRAP ALARA Procedure*
ES&H 4.4.4s	*Subsurface Monitoring Device Plugging and Abandonment Procedure*
ES&H 4.8.3s	*The WSSRAP Meteorological Monitoring Station*
ES&H 4.9.1s	*Environmental Monitoring Data Verification*
ES&H 4.4.6s	*Vegetation Surveys*

12 GLOSSARY, ACRONYMS, AND ABBREVIATIONS

12.1 Technical Terms

ABSORBED DOSE: The amount of energy absorbed in any material from incident radiation. Measured in rads, where 1 rad equals 100 ergs of energy absorbed in 1 gram of matter.

ACTIVITY: A measure of the rate at which radioactive material is undergoing radioactive decay; usually given in terms of the number of nuclear disintegrations occurring in a given quantity of material over a unit of time. The unit of activity is the curie (Ci) (see also BECQUEREL and CURIE).

ALARA: An acronym for "As Low as Reasonably Achievable." This refers to the U.S. Department of Energy goal of keeping releases of radioactive substances to the environment and exposures of humans to radiation as far below regulatory limits as "reasonably achievable."

ALLUVIAL AQUIFER: A subsurface zone, formed by the deposition of sediments by running water, capable of yielding usable quantities of groundwater to wells.

ALPHA PARTICLE: A positively charged particle emitted from the nucleus during the radioactive decay of certain radionuclides. It consists of two protons and two neutrons bound together; it is identical to the nucleus of a helium-4 atom.

BACKGROUND RADIATION: Radiation due to cosmic rays and radiation from the naturally radioactive elements in the surface of earth.

BEDROCK: A rock formation usually underlying one or more unconsolidated formations.

BECQUEREL: The SI unit for activity. 1 becquerel (Bq) = 1 disintegration/second = 2.703×10^{-11} curies.

BETA PARTICLE: A charged particle emitted from the nucleus of an atom, with a mass and charge equal in magnitude to that of the electron.

CHAIN-OF-CUSTODY FORM: A standardized form used in tracing the possession and handling of individual samples from the time of field collection through laboratory analysis.

COMMITTED EFFECTIVE DOSE EQUIVALENT: The total dose equivalent averaged throughout a tissue in the 50 years after intake of a radionuclide into the body.

CONTAMINATION: A foreign substance in or on the surfaces of soils, structures, areas, objects, or personnel.

COUNTING STATISTICS: Statistical analysis required to process the results of nuclear counting experiments and to make predictions about the expected precision of quantities derived from these measurements.

CURIE: A measure of the rate of radioactive decay. One curie (Ci) is equal to 37 billion disintegrations per second (3.7×10^{10} dps), which is equal to the decay rate of one gram of radium-226.

DAUGHTER: An element that results immediately from the disintegration of a radioactive element.

DECAY PRODUCTS: Isotopes that are formed by the radioactive decay of some other isotope. In the case of radium-226, for example, there are 10 successive decay products, ending in the stable isotope lead-206.

DERIVED CONCENTRATION GUIDE: Concentrations of radionuclides in water and air that could be continuously consumed or inhaled and not exceed an effective dose equivalent of 100 mrem/year.

DISCHARGE: In groundwater hydrology, the rate of flow (usually from a well or spring) at a given instant in terms of volume per unit of time.

DOSE: Total radiation delivered to a specific part of the body, or to the body as a whole; also called dose equivalent.

DOSE RATE: Dose or dose equivalent per unit of time (e.g., millirem per year) as it is being delivered to the body.

DOSIMETER: A device used in measuring radiation dose, such as a lithium fluoride (LiF) thermoluminescent detector (TLD).

EFFECTIVE DOSE EQUIVALENT: The proportion of the stochastic risk resulting from irradiation of a tissue to the total risk when the whole body is irradiated uniformly. A term used to express the amount of effective radiation when modifying factors have been considered, it is the product of absorbed dose (rads) multiplied by a quality factor and any other modifying factors. It is measured in rem (Roentgen Equivalent Man).

ERG: 1 ERG = 2.8×10^{-14} KWH

EXPOSURE PATHWAY: The route by which a contaminant or health hazard may enter and move through the environment or an individual.

EXPOSURE RADIATION: The amount of ionization produced in air by X-rays or gamma rays, measured in Roentgens (R).

GAMMA RADIATION: Penetrating high energy, short wave-length, electromagnetic radiation (similar to X-rays) emitted during radioactive decay. Gamma rays are very penetrating and can be attenuated only by dense materials such as lead.

GROSS ALPHA: Measurement of all alpha-emitting radionuclides in a sample.

GROSS BETA: Measurement of all beta-emitting radionuclides in a sample.

HALF-LIFE: The time it takes for half the atoms of a quantity of a particular radioactive element to decay into another form. Half-lives of different isotopes vary from millionths of a second or less to billions of years.

HECTARE: A unit of area in the metric system equal to 10,000 square meters. It is approximately 2.5 acres.

HYDROLOGIC: Pertaining to study of the properties, distribution, and circulation of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere.

ISOTOPE: Nuclides having the same atomic number but different mass numbers.

LLD: Lower limit of dection.

MDA: Minimum detectable amount.

NATURAL URANIUM: A naturally occurring radioactive element that consists of 99.2830% uranium-238, 0.7110% uranium-235 and 0.0054% uranium-234 by weight.

NUCLIDE: A general term referring to isotopes of the chemical elements, both stable and unstable.

PERCHED LENSE: A small, localized water-saturated zone of subsurface material surrounded by unsaturated material.

RAD: A unit of absorbed dose; acronym for radiation absorbed dose.

RADIATION: A very general term that covers many forms of particles and energy, from sunlight and radiowaves to the energy that is released from inside an atom. Radiation can be in the form of electromagnetic waves (gamma rays, X-rays) or particles (alpha particles, beta particles, protons, neutrons).

RADIONUCLIDE: An unstable nuclide that undergoes radioactive decay.

RAFFINATE: A waste product from a refining process, i.e., that portion of a treated liquid mixture that is not dissolved and not removed by a selective solvent.

REM (Roentgen Equivalent Man): A quantity used in radiation protection to express the effective dose equivalent for all forms of ionizing radiation. A rem is the product of the absorbed dose in rads and factors related to relative biological effectiveness.

SI: International System of Units.

SIEVERT: The SI unit used to express the effective dose equivalent for all forms of ionizing radiation. 1 Sv = 100 rem

STOCHASTIC: "Stochastic" effects are those for which the probability of an effect occurring, rather than its severity, is regarded as a function of dose, without a threshold.

WORKING LEVEL: Any combination of radon-222 decay products in 1 liter of air that will result in the ultimate emission of 0.21 erg of alpha energy is defined as 1 WL. It is based on the 0.21 erg of alpha energy that would be emitted by the decay products of 100 pCi of Ra-222 in 1 liter of air, where the decay products are in radioactive equilibrium with the parent.

WORKING LEVEL MONTH: The product of WL and duration of exposure, normalized to a 1-month exposure period.

X-RAY: Penetrating electromagnetic radiation having a wave length that is much shorter than that of visible light. It is customary to refer to rays originating in the nucleus of an atom as gamma rays and to those originating in the electron field of the atom as X-rays.

12.2 Acronyms and Abbreviations

No abbreviations for common units of measure or chemical elements and compounds are included in this list. Some less common units of measure, such *pCi* and *μCi* are included.

ACM	asbestos-containing materials
AEC	Atomic Energy Commission
AHERA	Asbestos Hazard and Emergency Response Act
ALARA	as low as reasonably achievable
ANL	Argonne National Laboratory
ARAR	applicable and/or relevant and appropriate requirements
ASME	American Society of Mechanical Engineers
BA	Baseline Assessment for the Chemical Plant Area of the Weldon Spring Site
BOD	Biochemical Oxygen Demand
Bq	becquerel
CAA	Clean Air Act
CEDE	Committed effective dose equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Ci	currie
CLP	Contract Laboratory Program
CM&O	Construction Management and Operations
COD	chemical oxygen demand
CONOPS	Conduct of Operations
CWA	Clean Water Act
CX	categorical exclusion
DCG	Derived Concentration Guideline
DL/2	detection limit
DNT	dinitrotoluene
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQO	data quality objectives
EA	Environmental Assessment
EDAP	Environmental Data Administration Plan

EDE	effective dose equivalent
EE/CA	engineering evaluation/cost analysis
EIS	Environmental Impact Statement
EMP	Environmental Monitoring Plan
EPA	Environmental Protection Agency
EPA	U.S. Environmental Protection Agency
EPPIP	Environmental Protection Program Implementation Plan
EQA	Environmental Quality Assurance
EQAPjP	Environmental Quality Assurance Project Plan
ES&H	Environmental Safety and Health
FERC	Federal Energy Regulatory Commission
FFA	Federal Facility Agreement
FHHS	Francis Howell High School
FP	Fire Protection
FS	Feasibility Study for the Remedial Action at the Chemical Plant Area of the Weldon Spring Site
HAP	hazardous air pollutants
HMWM	Hazardous Materials Waste Management
HP	Health Physics
HPO	Missouri Department of Natural Resources Historical Preservation Officer
HQ	Headquarters
HSL	Hazardous Substance List
HVAC	heating, ventilating, and air conditioning
IH	Industrial Hygiene
IS	Industrial Safety
LDR	Land Disposal Restrictions
LLD	lower limit of detection
MACT	Maximum Available Control Technology
MCL	maximum contaminant level (Safe Drinking Water Act)
MDA	minimum detectable activity
MDC	minimum detectable concentration
MDNR	Missouri Department of Natural Resources
MDOC	Missouri Department of Conservation
MHTC	Missouri Highway Transportation Commission
MSA	material storage area

msl	mean sea level
mSv	millisievert
NAAQS	national ambient air quality standards
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
PCB	polychlorinated biphenyl
pCi	picocurie
PCM	phase contrast microscopy
PMC	Project Management Contractor
PP	Proposed Plan for Remedial Action and the Chemical Plant Area of the Weldon Spring Site
ppm	parts per million
PTI	Project Training and Improvement
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
QA	Quality Assurance
QAMS	Quality Assurance Management Staff
QAPjP	Quality Assurance Project Plan
QWTP	quarry water treatment plant
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SI	Saturation Indexes
SIC	Standard Industrial Classification
SOP	Standard Operating Procedures
SWATS	Site Wide Audit Tracking System
SWTP	site water treatment plant
TBP	tributyl phosphate

TC	toxicity characteristic
TDS	total dissolved solids
TEM	transmission electron microscopy
TLD	thermoluminescent dosimeter
TNB	trinitrobenzine
TND	dinitrotoluene
TNT	trinitrotoluene
tpy	tons per year
TSA	temporary storage area
TSCA	Toxic Substance Control Act
TSS	total suspended solid
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compounds
WITS	Waste Inventory Tracking System
WLM	Working Level Monitor
WPC	Water Pollution Control
WSCP	Weldon Spring Chemical Plant
WSQ	Weldon Spring Quarry
WSRP	Weldon Spring raffinate pits
WSSRAP	Weldon Spring Site Remedial Action Project
WSUFMP	Weldon Spring Uranium Feed Materials Plant
μCi	microcurie

APPENDIX A

Annual Averages for Groundwater, Surface Water, and Springs, 1992

Appendix A is a presentation of the annual averages from all 1992 monitoring data for groundwater, surface water, and springs. All nondetected values are expressed as less than (<) the analytical detection limit. This is changed from previous reports when data were reported as "ND." Values shown in parenthesis are categorized as "uncensored" data, that is, data that are below the detection limit but reported as a measured value. Blank fields indicate that sampling was not scheduled, whereas "NS" indicates the location was not sampled as scheduled due to sampling problems such as low-flow or dry conditions. "DR" indicates that one sample was taken for the location in 1992 and the data was rejected in the data review process.

TABLE A-1 Average Inorganic Anion Concentrations for Groundwater, 1992

Location	Bromide mg/l	@	Chloride mg/l	@	Nitrate mg/l	@	Nitrite mg/l	@	Sulfate mg/l	@
MW-1002					1.16	0/6			60	0/6
MW-1004					0.34	0/6			304	0/6
MW-1005					< 0.13	4/6			157	0/6
MW-1006					0.29	1/6			336	0/6
MW-1007					0.29	3/6			151	0/6
MW-1008					0.16	4/6			256	0/6
MW-1009					< 0.15	5/6			279	0/6
MW-1010					0.10	4/7			0.31	8/15
MW-1011					< 0.10	4/4			40.2	0/12
MW-1012					0.94	0/6			83.6	0/6
MW-1013					0.17	3/6			104	0/5
MW-1014					0.15	3/5			109	0/5
MW-1015					1.87	0/6			311	0/6
MW-1016					0.93	0/6			256	0/6
MW-1017					< 0.13	3/4			0.83	1/4
MW-1018					< 0.10	4/4			70.4	0/4
MW-1019					< 0.08	4/4			1.51	0/4
MW-1020					< 0.08	3/4			28.9	0/4
MW-1021					< 0.13	4/4			0.89	2/4
MW-1022					< 0.13	3/4			0.25	2/4
MW-1023					< 0.15	3/4			6.30	0/4
MW-1024					< 0.10	3/4			1.98	1/4
MW-1026					< 0.13	5/6			15.4	0/6
MW-1027					0.26	0/6			102	0/6
MW-1028					< 0.20	5/6			75.3	0/6
MW-1029					0.22	3/6			73.6	0/6
MW-1030					1.60	3/6			91.8	0/6
MW-1031					< 0.13	5/6			33.8	0/6
MW-1032					< 0.17	5/6			251	0/6
MW-1033					< 0.08	3/4			10.5	0/4
MW-1034					0.61	1/6			90.4	0/6
MW-1035					0.15	1/6			43.4	0/6

@ Ratio of nondetects to total number of samples.

TABLE A-1 Average Inorganic Anion Concentrations for Groundwater, 1992 (Continued)

Location	Bromide mg/l	@	Chloride mg/l	@	Nitrate mg/l	@	Nitrite mg/l	@	Sulfate mg/l	@
MW-1036					< 0.12	4/6			56.9	0/6
MW-1037					< 0.13	4/6			20.5	0/6
MW-1038					< 0.12	6/6			49.3	0/6
MW-1039					< 0.13	5/6			48.8	0/6
MW-2001	< 0.81	2/3	6.03	0/4	28.4	0/4	< 1.90	3/4	8.47	0/4
MW-2002	< 0.88	3/4	10.5	0/4	302	0/4	< 5.05	4/4	116	0/4
MW-2003	< 1.13	2/2	8.50	0/4	261	0/4	36.7	3/4	117	0/4
MW-2004					0.52	0/2			1.85	0/2
MW-2005					86.3	0/2			26.0	0/2
MW-2006					3.60	0/2			33.5	0/2
MW-2007					< 0.20	1/2			15.0	0/2
MW-2008					2.07	0/2			39.0	0/2
MW-2009					1.46	0/2			108	0/2
MW-2010					1.04	0/2			31.6	0/2
MW-2011					5.20	0/2			12.9	0/2
MW-2012					0.54	0/2			72.6	0/2
MW-2013					0.85	0/2			17.8	0/2
MW-2014					0.91	0/2			33.5	0/2
MW-2015					0.34	0/2			110	0/2
MW-2017					0.20	0/2			728	0/2
MW-2018					0.32	0/2			9.45	0/2
MW-2019					< 0.10	2/2			42.1	0/2
MW-2020					0.38	0/2			135	0/2
MW-2021					0.13	1/2			13.5	0/2
MW-2022					0.15	1/2			14.1	0/2
MW-2023					0.29	0/2			15.0	0/2
MW-2024					0.16	0/2			29.4	0/2
MW-2025					0.07	1/2			17.9	0/2
MW-2026					< 0.10	2/2			14.2	0/2
MW-2027					< 0.10	2/2			9.40	0/2
MW-2028					< 0.30	2/2			123	0/2

@ Ratio of nondetects to total number of samples.

TABLE A-1 Average Inorganic Anion Concentrations for Groundwater, 1992 (Continued)

Location	Bromide mg/l	@	Chloride mg/l	@	Nitrate mg/l	@	Nitrite mg/l	@	Sulfate mg/l	@
MW-2029					0.22	0/2			24.0	0/2
MW-2030	0.70	2/4	35.6	0/4	1.24	0/4	< 0.103	3/4	41.9	0/4
MW-2032	< 2.02	2/3	19.2	0/4	92.8	0/4	< 0.078	2/4	56.2	0/4
MW-2033	0.54	1/4	7.15	0/4	0.87	0/4	< 0.078	3/4	26.2	0/4
MW-2034					0.16	0/2			634	0/2
MW-3003	< 7.50	4/4	12.4	0/4	342	0/4	< 0.078	2/4	158	0/4
MW-3006	< 0.38	4/4	1.95	0/4	0.20	1/4	< 0.078	4/4	22.7	0/4
MW-3008	< 7.50	2/2	20.2	0/4	702	0/4	< 0.100	4/4	80.8	0/4
MW-3009	< 3.54	4/4	5.47	0/4	184	0/4	20.40	1/3	58.7	0/4
MW-3019					< 0.15	2/2			6.70	0/2
MW-3023	< 3.80	1/1	16.6	0/4	393	0/4	1.05	0/4	331	0/4
MW-4001	< 3.29	3/4	4.47	0/4	24.5	1/4	< 0.68	4/4	64.1	0/4
MW-4002	< 0.38	4/4	1.75	0/4	2.66	0/4	< 0.08	3/4	16.1	0/4
MW-4003	< 0.38	4/5	6.48	0/5	0.76	0/5	< 0.08	4/5	33.0	0/5
MW-4004	0.69	3/4	4.87	0/4	0.88	0/4	< 0.09	3/4	21.3	0/4
MW-4005	0.60	2/4	7.30	0/4	3.93	0/4	< 0.12	4/4	24.0	0/4
MW-4006	< 0.38	3/4	2.10	0/4	4.68	0/4	< 0.33	4/4	28.5	0/4
MW-4007	< 0.38	4/4	0.86	0/4	0.38	0/4	< 0.08	3/4	12.9	0/4
MW-4008	< 0.38	3/4	1.52	0/4	0.07	2/4	< 0.07	4/4	14.2	0/4
MW-4009	< 0.38	4/4	1.08	0/4	0.28	0/4	< 0.10	4/4	15.4	0/4
MW-4010	0.39	3/4	1.90	0/4	0.17	0/4	< 0.10	4/4	22.9	0/4
MW-4011	< 3.87	3/4	5.88	0/4	35.8	0/4	< 0.09	4/4	56.7	0/4
MW-4012	< 0.38	3/3	4.45	0/4	0.17	0/3	< 0.08	4/4	49.3	0/4
MW-4013	7.38	3/4	6.03	0/4	50.8	0/4	< 0.06	3/4	45.0	0/4
MW-4014	< 0.38	4/4	3.80	0/4	2.91	0/4	< 0.06	3/4	26.8	0/4
MW-4015	< 0.35	3/4	2.68	1/4	1.53	0/4	< 0.08	4/4	12.8	0/4
MW-4016	< 0.35	4/4	3.83	0/4	88.9	2/4	< 7.77	4/4	17.2	0/4
MW-4017	< 0.32	3/4	1.82	0/4	0.46	0/4	< 0.08	4/4	6.45	0/4
MW-4018	< 0.38	4/4	16.9	0/4	3.20	0/4	< 0.18	4/4	7.23	0/4
MW-4019	0.49	3/4	1.70	0/4	0.33	0/4	< 0.10	4/4	8.38	0/4
MW-4020	0.49	3/4	14.5	0/4	0.83	1/4	< 0.08	4/4	129	0/4

@ Ratio of nondetects to total number of samples.

TABLE A-1 Average Inorganic Anion Concentrations for Groundwater, 1992 (Continued)

Location	Bromide mg/l	@	Chloride mg/l	@	Nitrate mg/l	@	Nitrite mg/l	@	Sulfate mg/l	@
MW-4021	< 0.38	4/4	1.50	0/4	< 0.10	3/4	< 0.10	4/4	260	0/4
MW-4022	0.47	2/4	5.17	0/4	0.32	0/4	< 0.10	4/4	35.5	0/4
MW-4023	< 0.38	3/4	18.6	0/4	3.47	0/4	< 0.08	4/4	89.5	0/4
MW-FINW					0.77	0/1			92.4	0/1
MW-PW02					< 0.01	1/1			114	0/1
MW-PW03					< 0.01	1/1			104	0/1
MW-PW04					< 0.01	1/1			107	0/1
MW-PW05					< 0.01	1/1			77.3	0/1
MW-PW06					< 0.01	1/1			87.9	0/1
MW-PW07					< 0.01	1/1			66.8	0/1
MW-PW08					< 0.01	1/1			53.1	0/1
MW-PW09					< 0.01	1/1			40.0	0/1
MW-RAWW					< 0.01	1/1			91.7	0/1
MW-RMW1	< 0.38	1/1	12.5	0/1	< 0.10	4/5	< 0.10	1/1	27.5	0/13
MW-RMW2	< 0.38	1/1	6.80	0/1	< 0.18	3/4	< 0.10	1/1	28.9	0/4
MW-RMW3	< 0.38	1/1	17.8	0/1	< 0.10	3/4	< 0.10	1/1	6.40	0/4
MW-RMW4	< 0.38	1/1	5.50	0/1	0.50	2/4	< 0.10	1/1	28.3	0/4

@ Ratio of nondetects to total number of samples.

TABLE A-2 Average Radiological Concentrations for Groundwater, 1992

Location	Gross Alpha pCi/l	@	Gross Beta pCi/l	@	Ra-226 pCi/l	@	Ra-228 pCi/l	@	Th-228 pCi/l	@	Th-230 pCi/l	@	Th-232 pCi/l	@	Uranium Total pCi/l	@
MW-1002	7.00	0/1	12.0	0/1	< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	0/1	< 0.20	1/1	1.89	1/6
MW-1004	3700	0/1	2840	0/1	0.30	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	4700	0/6
MW-1005	1480	0/1	1070	0/1	< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	1.00	0/1	< 0.20	1/1	1850	0/6
MW-1006	4300	0/1	2230	0/1	0.40	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	3260	0/6
MW-1007	2300	0/1	1320	0/1	0.60	0/1	< 0.90	1/1	< 0.20	1/1	0.30	0/1	< 0.20	1/1	454	0/6
MW-1008	6000	0/1	3400	0/1	< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	5023	0/6
MW-1009	15.0	0/1	11.0	0/1	< 0.20	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	4.46	0/6
MW-1010	<2.0	1/1	6.40	0/1	0.40	0/1	2.10	0/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	0.86	11/17
MW-1011	22.0	0/1	22.0	0/1	< 0.20	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	12.8	0/14
MW-1012	23.0	0/1	13.0	0/1	0.30	0/1	< 0.90	1/1	< 0.20	1/1	0.30	0/1	< 0.20	1/1	2.88	0/6
MW-1013	1100	0/1	610	0/1	0.70	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	872	0/6
MW-1014	600	0/1	510	0/1	< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	954	0/6
MW-1015	1400	0/1	810	0/1	0.30	0/1	< 0.90	1/1	< 0.20	1/1	1.50	0/1	< 0.20	1/1	1357	0/6
MW-1016	480	0/1	300	0/1	< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	614	0/6
MW-1017	<18.7	1/1	< 15.2	1/1	1.21	0/1	< 3.01	1/1	< 0.92	1/1	3.55	0/1	< 1.14	1/1	<0.29	2/4
MW-1018	<14.0	1/1	< 13.0	1/1	< 1.00	1/1	3.00	0/1	< 0.20	1/1	< 0.12	1/1	< 0.41	1/1	< 0.90	2/4
MW-1019	<8.9	1/1	< 12.0	1/1	< 2.00	1/1	3.00	0/1	0.23	0/1	< 0.11	1/1	0.20	0/1	2.75	3/4
MW-1020	<12.0	1/1	< 12.0	1/1	< 3.60	1/1	< 5.60	1/1	< 0.16	1/1	< 0.50	1/1	< 0.03	1/1	< 0.98	2/4
MW-1021	<19.8	1/1	< 11.7	1/1	1.65	0/1	< 3.46	1/1	< 1.52	1/1	2.43	0/1	< 1.86	1/1	0.63	2/4
MW-1022	<18.7	1/1	< 11.0	1/1	0.43	0/1	< 3.46	1/1	< 1.05	1/1	2.70	0/1	< 1.29	1/1	0.65	2/4

@ Ratio of nondetects to total number of samples.

TABLE A-2 Average Radiological Concentrations for Groundwater, 1992 (Continued)

Location	Gross Alpha pCi/l	@	Gross Beta pCi/l	@	Ra-226 pCi/l	@	Ra-228 pCi/l	@	Th-228 pCi/l	@	Th-230 pCi/l	@	Th-232 pCi/l	@	Uranium Total pCi/l	@
MW-1023	<12.5	1/1	< 10.1	1/1	0.98	0/1	< 6.01	1/1	< 1.48	1/1	3.40	0/1	< 1.81	1/1	< 0.29	2/4
MW-1024	7.10	1/4	11.1	1/4	< 1.50	1/1	< 3.70	1/1	< 0.15	0/1	0.22	0/1	< 0.20	1/1	< 0.36	4/4
MW-1026	25.0	0/1	18.0	0/1	< 0.20	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	0.37	3/6
MW-1027	680	0/1	280	0/1	< 0.20	1/1	1.10	0/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	690	0/6
MW-1028	6.80	0/1	13.0	0/1	0.30	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	168	2/6
MW-1029	13.0	0/1	12.0	0/1	< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	1.92	1/6
MW-1030	98.0	0/1	190	0/1	4.80	0/1	2.70	0/1	1.20	0/1	2.20	0/1	0.80	0/1	8.52	1/5
MW-1031	22.0	0/1	13.0	0/1	< 0.20	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	21.9	0/6
MW-1032	860	0/1	780	0/1	0.50	0/1	1.10	0/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	1407	0/6
MW-1033	5.00	0/1	7.20	0/1	0.30	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	2.03	0/4
MW-1034	3.10	0/1	5.80	0/1	< 0.20	0/1	< 0.90	1/1	< 0.20	1/1	1.60	0/1	< 0.20	1/1	1.85	0/6
MW-1035	<2.00	1/1	5.90	0/1	0.40	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	0.70	2/6
MW-1036	8.50	0/1	9.60	0/1	< 0.20	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	5.38	0/6
MW-1037	3.90	0/1	5.90	0/1	0.30	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	0/1	< 0.20	1/1	1.04	1/6
MW-1038	<2.00	1/1	8.10	0/1	< 0.20	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	2.58	0/6
MW-1039	5.00	0/1	8.70	0/1	< 0.20	1/1	< 0.90	0/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	1.41	1/6
MW-2001					< 0.79	1/1	< 2.18	1/1	< 1.18	1/1	1.74	0/1	< 1.02	1/1	0.52	2/4
MW-2002					< 0.19	1/1	< 1.98	1/1	< 1.21	1/1	1.43	0/1	< 1.48	1/1	0.42	3/4
MW-2003					< 0.79	1/1	< 2.18	1/1	< 1.81	1/1	2.22	0/1	< 1.39	1/1	1.07	1/4
MW-2004					< 0.20	0/1	< 0.90	1/1	< 0.20	1/1	0.60	0/1	< 0.20	1/1	0.60	0/2

@ Ratio of nondetects to total number of samples.

TABLE A-2 Average Radiological Concentrations for Groundwater, 1992 (Continued)

Location	Gross Alpha pCi/l	@	Gross Beta pCi/l	@	Ra-226 pCi/l	@	Ra-228 pCi/l	@	Th-228 pCi/l	@	Th-230 pCi/l	@	Th-232 pCi/l	@	Uranium Total pCi/l	@
MW-2005					< 1.08	1/1	4.00	0/1	0.64	0/1	< 0.93	1/1	0.57	0/1	< 0.57	1/2
MW-2006					< 1.59	1/1	17.1	0/1	< 2.22	1/1	3.07	0/1	< 1.93	1/1	< 0.53	2/2
MW-2007					< 1.59	1/1	< 3.72	1/1	< 2.92	1/1	4.87	0/1	< 2.53	1/1	< 0.53	1/2
MW-2008					< 4.40	1/1	< 9.20	1/1	< 0.32	1/1	< 0.35	1/1	< 0.29	1/1	< 0.95	1/2
MW-2009					< 11.0	1/1	< 22.0	1/1	< 0.37	1/1	< 0.13	1/1	< 0.13	1/1	1.75	0/2
MW-2010					< 1.59	1/1	< 5.26	1/1	< 1.55	1/1	4.90	0/1	< 1.34	1/1	< 0.53	1/2
MW-2011					< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	0.45	0/2
MW-2012					< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	0/1	< 0.20	1/1	0.55	0/2
MW-2013					< 0.52	1/1	< 4.21	1/1	< 2.54	1/1	2.89	0/1	< 1.61	1/1	< 0.38	1/2
MW-2014					< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	0.51	0/2
MW-2015					< 0.79	1/1	< 2.18	1/1	< 1.74	1/1	1.75	0/1	< 1.51	1/1	0.78	1/2
MW-2017					< 0.20	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	5.65	0/2
MW-2018	<2.00	1/1	< 7.40	1/1	< 1.30	1/1	< 6.11	1/1	< 0.10	1/1	< 0.08	1/1	< 0.14	1/1	1.34	0/2
MW-2019	<9.20	1/1	< 7.90	1/1	< 1.80	1/1	< 4.29	1/1	< 0.09	1/1	< 0.08	1/1	< 0.10	1/1	2.65	0/2
MW-2020	<7.20	1/1	< 13.0	1/1	< 5.90	1/1	< 5.21	1/1	< 0.07	1/1	< 0.06	1/1	< 0.06	1/1	3.00	0/2
MW-2021					< 0.78	1/1	< 2.79	1/1	< 0.34	1/1	1.15	0/1	< 0.24	1/1	0.70	1/2
MW-2022					< 0.78	1/1	< 2.79	1/1	< 0.79	1/1	< 1.70	1/1	< 0.56	1/1	< 0.58	2/2
MW-2023					< 0.78	1/1	< 2.79	1/1	< 0.39	1/1	1.99	0/1	0.30	0/1	1.35	1/2
MW-2024					< 0.78	1/1	< 2.79	1/1	< 0.43	1/1	< 0.93	1/1	0.67	0/1	< 0.54	2/2
MW-2025					< 0.68	1/1	< 4.47	1/1	0.30	0/1	3.39	0/1	0.83	0/1	0.78	0/2

@ Ratio of nondetects to total number of samples.

TABLE A-2 Average Radiological Concentrations for Groundwater, 1992 (Continued)

Location	Gross Alpha pCi/l	@	Gross Beta pCi/l	@	Ra-226 pCi/l	@	Ra-228 pCi/l	@	Th-228 pCi/l	@	Th-230 pCi/l	@	Th-232 pCi/l	@	Uranium Total pCi/l	@
MW-2026					< 0.78	1/1	< 2.79	1/1	0.82	0/1	2.18	0/1	1.23	0/1	< 0.39	2/2
MW-2027					< 0.78	1/1	< 2.79	1/1	0.30	0/1	0.78	0/1	0.22	0/1	1.35	0/2
MW-2028					< 0.78	1/1	< 2.79	1/1	< 0.29	1/1	< 0.61	1/1	< 0.20	1/1	0.80	1/2
MW-2029					< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	1.75	0/2
MW-2030					1.00	0/1	1.10	0/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	11.8	0/4
MW-2032					1.10	0/1	1.80	0/1	0.70	0/1	0.90	0/1	< 0.20	0/1	7.05	1/4
MW-2033					1.20	0/1	< 0.90	1/1	< 0.20	1/1	0.30	0/1	< 0.20	1/1	1.91	1/4
MW-2034					< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	12.3	0/2
MW-3003					< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	19.8	0/4
MW-3006					< 0.33	1/1	< 5.03	1/1	< 1.06	1/1	1.18	0/1	< 1.30	1/1	0.61	1/4
MW-3008					0.70	0/1	2.00	0/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	4.34	0/4
MW-3009					0.50	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	42.7	0/4
MW-3019					< 0.52	1/1	< 4.21	1/1	< 2.41	1/1	3.50	0/1	< 1.53	1/1	1.14	1/2
MW-3023	21.0	1/1	17.0	0/1	0.30	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	8.85	0/4
MW-4001					< 0.52	1/1	< 4.21	1/1	< 1.62	1/1	2.61	0/1	< 1.40	1/1	1.62	1/4
MW-4002					0.29	0/1	< 2.87	1/1	< 1.72	1/1	2.30	0/1	< 2.11	1/1	0.73	2/4
MW-4003					< 3.30	1/1	< 6.80	1/1	< 0.26	1/1	0.25	0/1	< 0.09	1/1	1.36	3/5
MW-4004					< 1.00	1/1	5.00	0/1	< 0.18	1/1	< 0.11	1/1	< 0.08	1/1	4.07	0/3
MW-4005					< 4.00	1/1	5.00	0/1	< 0.13	1/1	< 0.50	1/1	< 0.50	1/1	2.32	1/3
MW-4006					< 0.52	1/1	< 4.21	1/1	< 2.69	1/1	6.63	0/1	< 2.33	1/1	< 0.49	4/4

@ Ratio of nondetects to total number of samples.

TABLE A-2 Average Radiological Concentrations for Groundwater, 1992 (Continued)

Location	Gross Alpha pCi/l	@	Gross Beta pCi/l	@	Ra-226 pCi/l	@	Ra-228 pCi/l	@	Th-228 pCi/l	@	Th-230 pCi/l	@	Th-232 pCi/l	@	Uranium Total pCi/l	@
MW-4007					3.40	0/1	< 0.90	1/1	< 0.20	1/1	0.50	0/1	< 0.20	1/1	2.28	0/4
MW-4008					< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	0.50	0/1	1.24	1/4
MW-4009					< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	4.06	0/4
MW-4010					< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	3.29	0/4
MW-4011					< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	5.33	0/4
MW-4012					< 0.20	1/1	1.00	0/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	2.11	0/4
MW-4013					0.40	0/1	1.10	0/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	1.26	2/4
MW-4014					< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	1.24	3/4
MW-4015					< 0.20	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	0.51	2/4
MW-4016	10.0	1/1	< 7.70	1/1	0.30	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	3.43	0/4
MW-4017		1/1	< 6.10	1/1	< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	1.34	1/4
MW-4018					< 0.20	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	0.60	2/4
MW-4019					< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	< 0.20	0/1	< 0.20	1/1	2.63	0/4
MW-4020					0.40	0/1	2.10	0/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	14.0	0/4
MW-4021					< 0.20	1/1	1.60	0/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	5.39	0/4
MW-4022					1.10	0/1	< 0.90	1/1	< 0.20	1/1	0.70	0/1	0.70	0/1	7.03	0/4
MW-4023					0.60	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	1.99	1/4
MW-FINW	<5.35	2/4	< 7.33	1/3	< 0.92	1/1	5.85	0/1	< 0.19	1/1	< 0.30	1/1	< 0.15	1/1	< 0.29	1/4
MW-PW02	<4.60	3/4	< 8.33	1/3	< 1.50	1/1	< 2.20	1/1	< 0.24	1/1	0.12	0/1	< 0.06	1/1	0.36	3/4
MW-PW03	<3.88	2/4	7.40	1/3	< 1.10	1/1	< 2.60	1/1	< 0.28	1/1	< 0.18	1/1	< 0.08	1/1	0.29	3/4

@ Ratio of nondetects to total number of samples.

TABLE A-2 Average Radiological Concentrations for Groundwater, 1992 (Continued)

Location	Gross Alpha pCi/l	@	Gross Beta pCi/l	@	Ra-226 pCi/l	@	Ra-228 pCi/l	@	Th-228 pCi/l	@	Th-230 pCi/l	@	Th-232 pCi/l	@	Uranium Total pCi/l	@
MW-PW04	<3.80	3/4	< 7.00	1/3	< 1.20	1/1	< 2.20	1/1	< 0.08	1/1	< 0.08	1/1	< 0.08	1/1	< 0.29	2/4
MW-PW05	<4.00	2/4	7.96	1/3	< 1.50	1/1	< 3.50	1/1	< 0.27	1/1	< 0.22	1/1	< 0.18	1/1	< 0.29	2/4
MW-PW06	<5.00	2/4	< 7.33	1/3	< 2.60	1/1	< 4.40	1/1	< 0.14	1/1	< 0.20	1/1	< 0.14	1/1	< 0.29	3/4
MW-PW07	<5.10	3/4	< 7.33	1/3	< 1.60	1/1	< 2.60	1/1	< 0.19	1/1	< 0.19	1/1	< 0.19	1/1	< 0.29	3/4
MW-PW08	<4.88	2/4	< 8.33	1/3	< 1.70	1/1	< 2.90	1/1	< 0.28	1/1	< 0.50	1/1	< 0.88	1/1	0.32	1/4
MW-PW09	<5.80	2/4	8.57	1/3	< 1.50	1/1	< 2.50	1/1	< 0.25	1/1	< 0.23	1/1	< 0.24	1/1	0.50	2/4
MW-RAWW	<5.23	4/4	< 8.66	1/3	< 1.31	1/1	6.59	0/1	< 0.22	1/1	< 0.12	1/1	< 0.05	1/1	< 0.29	2/4
MW-RMW1	5.04	1/5	9.56	1/5	< 1.95	1/1	5.36	0/1	< 0.25	1/1	< 0.29	1/1	< 0.25	1/1	0.65	8/15
MW-RMW2	6.58	1/4	< 8.33	1/3	< 1.50	1/1	< 2.30	1/1	< 0.14	1/1	< 0.05	1/1	< 0.05	1/1	6.15	0/4
MW-RMW3	6.28	1/4	10.8	1/4	< 1.68	1/1	5.16	0/1	< 0.17	1/1	< 0.17	1/1	< 0.19	1/1	< 0.32	1/4
MW-RMW4	<4.75	2/4	< 7.50	1/4	< 1.50	1/1	4.80	0/1	< 0.87	1/1	< 0.64	1/1	< 0.64	1/1	1.76	0/4

@ Ratio of nondetects to total number of samples.

Table A-2 Average Radiological Concentrations for Groundwater, 1992

Location	Actinium 227 pCi/l	@	Lead 210 pCi/l	@	Polonium 210 pCi/l	@	Uranium 234 pCi/l	@	Uranium 235 pCi/l	@	Uranium 238 pCi/l	@
MW-1002												
MW-1004												
MW-1005												
MW-1006												
MW-1007												
MW-1008												
MW-1009												
MW-1010							0.99	0/1	0.38	1/1	0.73	0/1
MW-1011												
MW-1012												
MW-1013							238	0/1	68.0	0/1	368	0/1
MW-1014							159	0/1	290	0/1	394	0/1
MW-1015												
MW-1016												
MW-1017							1.70	0/1	< 0.40	1/1	0.40	1/1
MW-1018	< 10.0	1/1	4.00	0/1	1.30	0/1						
MW-1019	< 10.0	1/1	4.10	0/1	< 1.00	1/1						
MW-1020	< 10.0	1/1	< 2.00	1/1	< 1.00	0/1	0.46	0/1	< 0.08	1/1	0.08	1/1
MW-1021												
MW-1022												

@ Ratio of nondetects to total number of samples.

Table A-2 Average Radiological Concentrations for Groundwater, 1992 (Continued)

Location	Actinium 227 pCi/l	@	Lead 210 pCi/l	@	Polonium 210 pCi/l	@	Uranium 234 pCi/l	@	Uranium 235 pCi/l	@	Uranium 238 pCi/l	@
MW-1023												
MW-1024	< 10.0	1/1	< 2.00	0/1	1.20	0/1						
MW-1026												
MW-1027												
MW-1028												
MW-1029												
MW-1030												
MW-1031							15.3	0/1	2.27	0/1	11.3	0/1
MW-1032												
MW-1033												
MW-1034												
MW-1035												
MW-1036												
MW-1037												
MW-1038												
MW-1039												
MW-2001	< 2.52	1/1	< 2.55	1/1	< 3.08	1/1	3.99	0/1	1.26	0/1	< 0.73	1/1
MW-2002	< 1.60	1/1	< 1.56	1/1	< 0.65	1/1	< 15.0	1/1	33.8	0/1	< 14.4	1/1
MW-2003	< 5.19	1/1	< 2.55	1/1	< 5.88	1/1	20.3	0/1	17.6	0/1	< 3.60	1/1
MW-2004	4.13	0/1	< 5.99	1/1	< 0.91	1/1						

@ Ratio of nondetects to total number of samples.

Table A-2 Average Radiological Concentrations for Groundwater, 1992 (Continued)

Location	Actinium 227 pCi/l	@	Lead 210 pCi/l	@	Polonium 210 pCi/l	@	Uranium 234 pCi/l	@	Uranium 235 pCi/l	@	Uranium 238 pCi/l	@
MW-2005	1.54	0/1	< 2.99	1/1	< 0.88	1/1						
MW-2006	< 4.19	1/1	< 5.11	1/1	< 5.46	1/1						
MW-2007	< 2.68	1/1	< 5.11	1/1	< 1.78	1/1	< 2.49	1/2	0.73	1/2	< 2.33	2/2
MW-2008	< 4.00	1/1	< 2.00	1/1	< 0.50	1/1						
MW-2009	< 4.00	1/1	< 4.40	1/1	< 2.10	1/1						
MW-2010	< 4.18	1/1	< 5.11	1/1	5.17	0/1						
MW-2011												
MW-2012	< 4.00	1/1	< 2.00	1/1	< 0.50	1/1						
MW-2013	< 5.94	1/1	< 2.41	1/1	< 1.34	1/1						
MW-2014	2.23	0/1	< 2.76	1/1	< 1.72	1/1						
MW-2015	< 2.54	1/1	< 2.55	1/1	< 1.33	1/1	11.7	1/1	< 3.31	1/1	< 11.3	1/1
MW-2017							7.05	0/1	0.64	0/1	4.97	0/1
MW-2018												
MW-2019												
MW-2020												
MW-2021												
MW-2022	1.68	0/1	< 2.57	1/1	< 1.98	1/1						
MW-2023												
MW-2024												
MW-2025												

@ Ratio of nondetects to total number of samples.

Table A-2 Average Radiological Concentrations for Groundwater, 1992 (Continued)

Location	Actinium 227 pCi/l	@	Lead 210 pCi/l	@	Polonium 210 pCi/l	@	Uranium 234 pCi/l	@	Uranium 235 pCi/l	@	Uranium 238 pCi/l	@
MW-2026												
MW-2027												
MW-2028												
MW-2029	2.63	0/1	< 2.57	1/1	< 0.90	1/1						
MW-2030	< 10.0	1/1	< 2.00	1/1	< 1.00	1/1						
MW-2032	< 10.0	1/1	< 2.00	1/1	2.30	0/1						
MW-2033	< 10.0	1/1	< 2.00	1/1	1.60	0/1						
MW-2034												
MW-3003	< 4.00	1/1	< 3.60	1/1	< 0.80	1/1						
MW-3006	< 2.80	1/1	< 2.72	1/1	< 1.61	1/1						
MW-3008	< 10.0	1/1	< 2.00	1/1	1.50	0/1						
MW-3009	< 10.0	1/1	2.40	0/1	< 1.00	1/1						
MW-3019	< 3.18	1/1	< 2.41	1/1	< 4.48	1/1	1.34	0/1	< 0.31	1/1	< 1.07	1/1
MW-3023	< 10.0	1/1	4.70	0/1	2.00	0/1						
MW-4001	< 2.64	1/1	< 2.41	1/1	< 2.69	1/1						
MW-4002	< 2.94	1/1	< 1.56	1/1	< 1.40	1/1						
MW-4003	< 10.0	1/1	< 2.00	1/1	1.10	0/1	1.40	0/1	< 0.40	1/1	< 0.40	1/1
MW-4004	< 4.80	1/1	< 2.00	1/1	< 0.50	1/1						
MW-4005	< 10.0	1/1	< 2.00	1/1	< 1.00	1/1	1.40	0/1	< 0.30	1/1	1.00	0/1
MW-4006	< 2.85	1/1	< 2.41	1/1	< 4.48	1/1						

@ Ratio of nondetects to total number of samples.

Table A-2 Average Radiological Concentrations for Groundwater, 1992 (Continued)

Location	Actinium 227 pCi/l	@	Lead 210 pCi/l	@	Polonium 210 pCi/l	@	Uranium 234 pCi/l	@	Uranium 235 pCi/l	@	Uranium 238 pCi/l	@
MW-4007												
MW-4008	< 10.0	1/1	< 2.00	1/1	< 1.00	1/1						
MW-4009	< 4.00	1/1	< 2.00	1/1	< 0.50	1/1						
MW-4010	< 4.00	1/1	< 2.90	1/1	< 0.20	0/1						
MW-4011	< 4.80	1/1	< 2.00	1/1	< 0.50	1/1	2.40	0/1	< 0.40	1/1	2.40	0/1
MW-4012	< 4.80	1/1	< 2.00	1/1	< 0.50	1/1						
MW-4013	< 2.80	1/1	< 3.60	1/1	< 0.80	1/1						
MW-4014	< 4.70	1/1	< 3.60	1/1	< 0.80	1/1						
MW-4015	< 10.0	1/1	2.10	0/1	< 1.00	0/1						
MW-4016	< 10.0	1/1	2.20	0/1	< 1.00	1/1						
MW-4017												
MW-4018	< 4.80	1/1	< 2.00	1/1	< 0.50	1/1						
MW-4019	< 4.80	1/1	< 2.00	1/1	< 0.50	1/1						
MW-4020	< 2.80	1/1	< 3.60	1/1	< 0.80	1/1	9.63	1/2	< 1.85	2/2	6.20	1/2
MW-4021	< 10.0	1/1	< 2.00	1/1	< 1.00	1/1	4.20	0/1	< 0.40	1/1	3.40	0/1
MW-4022												
MW-4023	< 4.80	1/1	< 2.00	1/1	< 0.50	1/1	2.30	0/1	0.60	0/1	< 1.30	1/1
MW-FINW												
MW-PW02												
MW-PW03												

@ Ratio of nondetects to total number of samples.

Table A-2 Average Radiological Concentrations for Groundwater, 1992 (Continued)

Location	Actinium 227 pCi/l	@	Lead 210 pCi/l	@	Polonium 210 pCi/l	@	Uranium 234 pCi/l	@	Uranium 235 pCi/l	@	Uranium 238 pCi/l	@
MW-PW04												
MW-PW05												
MW-PW06												
MW-PW07												
MW-PW08												
MW-PW09												
MW-RAWW												
MW-RMW1												
MW-RMW2												
MW-RMW3												
MW-RMW4												

@ Ratio of nondetects to total number of samples.

TABLE A-3 Average Nitroaromatic Concentrations for Groundwater, 1992

Location	1,3,5-TNB µg/l	@	1,3-DNB µg/l	@	2,4,6-TNT µg/l	@	2,4-DNT µg/l	@	2,6-DNT µg/l	@	Nitrobenzene µg/l	@
MW-1002	408	0/6	0.34	1/6	87.4	0/6	0.16	1/6	20.5	0/6	< 0.21	6/6
MW-1004	8.33	0/6	< 0.09	6/6	17.4	0/6	3.45	0/6	5.35	0/6	< 0.03	6/6
MW-1005	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	0.10	0/6	0.03	0/6	< 0.03	6/6
MW-1006	51.6	0/6	< 0.09	6/6	9.12	0/6	0.21	0/6	2.72	0/6	< 0.03	6/6
MW-1007	0.04	5/6	< 0.09	6/6	0.11	5/6	< 0.03	6/6	0.04	5/6	< 0.03	6/6
MW-1008	0.05	3/6	< 0.09	6/6	0.22	3/6	< 0.03	6/6	0.10	1/6	< 0.03	6/6
MW-1009	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	< 0.03	6/6	< 0.01	6/6	< 0.03	6/6
MW-1010	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	< 0.03	6/6	< 0.01	6/6	< 0.03	6/6
MW-1011	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-1012	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	< 0.03	6/6	< 0.01	6/6	< 0.03	6/6
MW-1013	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	0.05	1/6	0.02	2/6	< 0.03	6/6
MW-1014	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	< 0.03	3/6	< 0.01	5/6	< 0.03	6/6
MW-1015	179	0/6	0.16	2/6	24.7	0/6	0.06	0/6	0.76	0/6	< 0.03	6/6
MW-1016	22.6	0/6	< 0.09	6/6	3.99	0/6	< 0.03	6/6	0.18	0/6	< 0.03	6/6
MW-1017	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-1018	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-1019	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-1020	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-1021	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-1022	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-1023	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4

@ Ratio of nondetects to total number of samples.

TABLE A-3 Average Nitroaromatic Concentrations for Groundwater, 1992 (Continued)

Location	1,3,5-TNB µg/l	@	1,3-DNB µg/l	@	2,4,6-TNT µg/l	@	2,4-DNT µg/l	@	2,6-DNT µg/l	@	Nitrobenzene µg/l	@
MW-1024	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-1026	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	< 0.03	6/6	< 0.01	6/6	< 0.03	6/6
MW-1027	0.05	1/6	< 0.09	6/6	14.0	0/6	6.36	0/6	3.50	0/6	< 0.03	6/6
MW-1028	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	< 0.03	6/6	< 0.01	6/6	< 0.03	6/6
MW-1029	< 0.14	6/6	< 0.19	6/6	< 0.19	6/6	< 0.15	6/6	< 0.19	6/6	< 0.24	6/6
MW-1030	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	0.04	0/6	< 0.01	6/6	< 0.03	6/6
MW-1031	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	< 0.03	6/6	< 0.01	6/6	< 0.03	6/6
MW-1032	< 0.03	5/6	< 0.09	6/6	0.60	2/6	0.12	0/6	0.29	0/6	< 0.03	6/6
MW-1033	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-1034	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	< 0.03	6/6	< 0.01	6/6	< 0.03	6/6
MW-1035	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	< 0.03	6/6	< 0.01	6/6	< 0.03	6/6
MW-1036	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	< 0.03	6/6	< 0.01	6/6	< 0.03	6/6
MW-1037	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	< 0.03	6/6	< 0.01	6/6	< 0.03	6/6
MW-1038	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	< 0.03	6/6	< 0.01	6/6	< 0.03	6/6
MW-1039	< 0.03	6/6	< 0.09	6/6	< 0.03	6/6	< 0.03	6/6	< 0.01	6/6	< 0.03	6/6
MW-2001	0.04	0/4	< 0.09	4/4	< 0.03	4/4	0.09	0/4	0.06	0/4	< 0.03	4/4
MW-2002	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	0.07	0/4	0.40	0/4	< 0.03	4/4
MW-2003	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	0.17	0/4	0.84	0/4	< 0.03	4/4
MW-2004	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-2005	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	0.08	0/2	0.13	0/2	< 0.03	2/2

@ Ratio of nondetects to total number of samples.

TABLE A-3 Average Nitroaromatic Concentrations for Groundwater, 1992 (Continued)

Location	1,3,5-TNB µg/l	@	1,3-DNB µg/l	@	2,4,6-TNT µg/l	@	2,4-DNT µg/l	@	2,6-DNT µg/l	@	Nitrobenzene µg/l	@
MW-2006	9.27	0/2	< 0.35	2/2	1.10	1/2	< 0.32	1/2	2.11	0/2	< 0.56	2/2
MW-2007	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-2008	0.83	0/2	< 0.09	2/2	< 0.03	2/2	0.08	0/2	0.93	0/2	< 0.03	2/2
MW-2009	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	0.07	0/2	0.27	0/2	< 0.03	2/2
MW-2010	0.16	0/2	< 0.09	2/2	0.34	0/2	0.08	0/2	0.50	0/2	< 0.03	2/2
MW-2011	0.59	0/2	< 0.09	2/2	< 0.03	2/2	0.10	0/2	1.95	0/2	0.04	0/2
MW-2012	2.40	0/2	< 0.09	2/2	0.66	0/2	0.19	0/2	1.75	0/2	< 0.03	2/2
MW-2013	4.80	0/2	0.13	1/2	0.67	0/2	0.28	0/2	7.45	0/2	< 0.03	2/2
MW-2014	2.90	0/2	< 0.09	2/2	< 0.03	2/2	0.15	0/2	0.94	0/2	< 0.03	1/2
MW-2015	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-2017	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-2018	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-2019	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-2020	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	0.04	0/2	< 0.01	2/2	< 0.03	2/2
MW-2021	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-2022	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-2023	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-2024	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-2025	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-2026	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2

@ Ratio of nondetects to total number of samples.

TABLE A-3 Average Nitroaromatic Concentrations for Groundwater, 1992 (Continued)

Location	1,3,5-TNB µg/l	@	1,3-DNB µg/l	@	2,4,6-TNT µg/l	@	2,4-DNT µg/l	@	2,6-DNT µg/l	@	Nitrobenzene µg/l	@
MW-2027	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-2028	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-2029	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-2030	6.01	0/4	< 0.09	4/4	9.93	0/4	0.15	0/4	8.03	0/4	< 0.03	4/4
MW-2032	1.20	0/3	< 0.09	3/3	4.03	0/3	0.14	0/3	3.90	0/3	< 0.03	3/3
MW-2033	6.06	0/4	< 0.09	4/4	1.82	0/4	1.12	0/4	10.2	0/4	< 0.03	4/4
MW-2034	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-3003	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	0.06	0/4	0.13	0/4	< 0.03	4/4
MW-3006	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-3008	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	0.13	0/4	0.32	0/4	< 0.03	4/4
MW-3009	0.21	0/4	< 0.09	4/4	< 0.03	4/4	0.22	0/4	0.10	0/4	< 0.03	4/4
MW-3019	< 0.03	2/2	< 0.09	2/2	< 0.03	2/2	< 0.03	2/2	< 0.01	2/2	< 0.03	2/2
MW-3023	< 0.03	4/4	< 0.09	4/4	< 0.03	2/4	7.88	0/4	8.50	0/4	< 0.03	4/4
MW-4001	57.8	0/4	0.14	0/4	1.48	0/4	4.68	0/4	4.55	0/4	< 0.03	4/4
MW-4002	0.11	2/4	< 0.09	4/4	0.13	1/4	< 0.03	4/4	0.09	1/4	< 0.03	4/4
MW-4003	< 0.03	5/5	< 0.09	5/5	< 0.03	5/5	< 0.03	5/5	< 0.01	5/5	< 0.03	5/5
MW-4004	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-4005	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-4006	15.0	0/4	< 0.09	4/4	< 0.03	4/4	0.13	0/4	3.73	0/4	< 0.03	3/4
MW-4007	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4

@ Ratio of nondetects to total number of samples.

TABLE A-3 Average Nitroaromatic Concentrations for Groundwater, 1992 (Continued)

Location	1,3,5-TNB µg/l	@	1,3-DNB µg/l	@	2,4,6-TNT µg/l	@	2,4-DNT µg/l	@	2,6-DNT µg/l	@	Nitrobenzene µg/l	@
MW-4008	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-4009	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-4010	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-4011	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-4012	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-4013	38.5	0/4	< 0.09	4/4	0.04	0/4	0.06	0/4	0.92	0/4	< 0.03	4/4
MW-4014	0.39	0/4	< 0.09	4/4	< 0.03	1/4	< 0.03	4/4	0.06	0/4	< 0.03	4/4
MW-4015	0.69	0/4	< 0.09	4/4	< 0.03	4/4	0.10	0/4	1.00	0/4	< 0.03	4/4
MW-4016	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-4017	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-4018	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-4019	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-4020	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-4021	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-4022	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-4023	0.17	0/4	< 0.09	4/4	< 0.03	4/4	0.08	0/4	0.05	0/4	< 0.03	4/4
MW-FINW	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-PW02	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-PW03	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-PW04	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4

@ Ratio of nondetects to total number of samples.

TABLE A-3 Average Nitroaromatic Concentrations for Groundwater, 1992 (Continued)

Location	1,3,5-TNB µg/l	@	1,3-DNB µg/l	@	2,4,6-TNT µg/l	@	2,4-DNT µg/l	@	2,6-DNT µg/l	@	Nitrobenzene µg/l	@
MW-PW05	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-PW06	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-PW07	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-PW08	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-PW09	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-RAWW	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-RMW1	< 0.03	5/5	< 0.09	5/5	< 0.03	5/5	< 0.03	5/5	< 0.01	5/5	< 0.03	5/5
MW-RMW2	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-RMW3	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4
MW-RMW4	< 0.03	4/4	< 0.09	4/4	< 0.03	4/4	< 0.03	4/4	< 0.01	4/4	< 0.03	4/4

@ Ratio of nondetects to total number of samples.

TABLE A-4 Average Alkalinity, Phosphorous, and Silica Concentrations for Groundwater, 1992

Location	Alkalinity mg/l	@	Phosphorus mg/l	@	Silica mg/l	@
MW-1002	308	0/6				
MW-1004	252	0/6				
MW-1005	232	0/6				
MW-1006	410	0/6				
MW-1007	566	0/6				
MW-1008	376	0/6				
MW-1009	456	0/6				
MW-1010	353	0/16				
MW-1011	441	0/13				
MW-1012	498	0/6				
MW-1013	432	0/5				
MW-1014	464	0/5				
MW-1015	393	0/6				
MW-1016	392	0/6				
MW-1017	674	0/4				
MW-1018	509	0/4				
MW-1019	459	0/4				
MW-1020	415	0/4				
MW-1021	503	0/4				
MW-1022	495	0/4				
MW-1023	480	0/4				
MW-1024	396	0/4				
MW-1026	389	0/6				
MW-1027	446	0/6				
MW-1028	460	0/5				
MW-1029	356	0/6				
MW-1030	1498	0/6				
MW-1031	346	0/6				
MW-1032	328	0/6				
MW-1033	430	0/4				
MW-1034	440	0/6				

@ Ratio of nondetects to total number of samples.

TABLE A-4 Average Alkalinity, Phosphorous, and Silica Concentrations for Groundwater, 1992 (Continued)

Location	Alkalinity mg/l	@	Phosphorus mg/l	@	Silica mg/l	@
MW-1035	237	0/6				
MW-1036	507	0/6				
MW-1037	469	0/6				
MW-1038	450	0/6				
MW-1039	538	0/6				
MW-2001	321	0/4	0.13	0/4	7.50	0/4
MW-2002	291	0/4	0.04	0/4	14.3	0/4
MW-2003	278	0/4	0.06	0/4	10.3	0/4
MW-2004	346	0/2				
MW-2005	280	0/2				
MW-2006	297	0/2				
MW-2007	318	0/2				
MW-2008	300	0/2				
MW-2009	425	0/2				
MW-2010	358	0/2				
MW-2011	265	0/2				
MW-2012	348	0/2				
MW-2013	560	0/2				
MW-2014	465	0/2				
MW-2015	425	0/2				
MW-2017	385	0/2				
MW-2018	410	0/2				
MW-2019	365	0/2				
MW-2020	395	0/2				
MW-2021	375	0/2				
MW-2022	335	0/2				
MW-2023	228	0/2				
MW-2024	305	0/2				
MW-2025	270	0/2				
MW-2026	320	0/2				
MW-2027	233	0/2				
MW-2028	445	0/2				

@ Ratio of nondetects to total number of samples.

TABLE A-4 Average Alkalinity, Phosphorous, and Silica Concentrations for Groundwater, 1992 (Continued)

Location	Alkalinity mg/l	@	Phosphorus mg/l	@	Silica mg/l	@
MW-2029	325	0/2				
MW-2030	468	0/4	0.10	0/4	8.36	0/4
MW-2032	408	0/4	0.37	0/4	10.2	0/4
MW-2033	545	0/4	0.22	0/4	13.0	0/4
MW-2034	425	0/2				
MW-3003	301	0/4	0.09	0/4	7.87	0/4
MW-3006	406	0/4	0.06	0/4	10.4	0/4
MW-3008	224	0/4	0.06	1/4	10.5	0/4
MW-3009	177	0/4	0.02	2/4	9.68	0/5
MW-3019	280	0/2				
MW-3023	267	0/3	0.10	0/4	11.4	0/3
MW-4001	209	0/4	0.04	1/4	11.5	0/4
MW-4002	235	0/4	0.07	1/4	6.77	0/4
MW-4003	268	0/5	0.04	2/5	8.30	0/5
MW-4004	185	0/4	0.16	0/4	7.17	0/4
MW-4005	207	0/4	0.09	0/4	9.15	0/4
MW-4006	169	0/4	0.08	1/4	9.78	0/4
MW-4007	204	0/4	0.18	0/4	8.03	0/4
MW-4008	221	0/4	0.11	0/4	8.45	0/4
MW-4009	222	0/4	0.22	0/4	8.15	0/4
MW-4010	269	0/4	0.07	0/4	8.52	0/4
MW-4011	255	0/4	0.49	0/4	13.3	0/4
MW-4012	311	0/4	0.09	0/4	11.1	0/4
MW-4013	306	0/4	0.05	0/4	7.62	0/4
MW-4014	291	0/4	0.05	2/4	7.27	0/4
MW-4015	250	0/4	0.12	0/4	10.6	0/4
MW-4016	243	0/4	0.16	0/4	10.9	0/4
MW-4017	340	0/4	0.16	0/4	11.4	0/4
MW-4018	441	0/4	0.03	0/4	9.75	0/4
MW-4019	315	0/4	0.03	1/4	7.35	0/4
MW-4020	388	0/4	0.07	0/4	9.63	0/4
MW-4021	513	0/4	0.06	0/4	8.40	0/4

@ Ratio of nondetects to total number of samples.

TABLE A-4 Average Alkalinity, Phosphorous, and Silica Concentrations for Groundwater, 1992 (Continued)

Location	Alkalinity mg/l	@	Phosphorus mg/l	@	Silica mg/l	@
MW-4022	314	0/4	0.36	0/3	12.5	0/4
MW-4023	420	0/4	0.04	0/4	13.7	0/4
MW-FINW	74.	0/1				
MW-PW02	176	0/1				
MW-PW03	170	0/1				
MW-PW04	160	0/1				
MW-PW05	225	0/1				
MW-PW06	170	0/1				
MW-PW07	300	0/1				
MW-PW08	330	0/1				
MW-PW09	350	0/1				
MW-RAWW	200	0/1				
MW-RMW1	390	0/14	0.57	0/1	27.9	0/1
MW-RMW2	410	0/4	0.17	0/1	18.2	0/1
MW-RMW3	510	0/4	0.82	0/1	27.8	0/1
MW-RMW4	461	0/4	0.09	0/1	20.5	0/1

@ Ratio of nondetects to total number of samples.

TABLE A-5 Average Inorganic Anion Concentrations for Surface Water, 1992

Location	Chloride mg/l	@	Fluoride mg/l	@	Nitrate-N mg/l	@	Sulfate mg/l	@	Alkalinity mg/l	@
SW-1001					0.59	0/1	27.0	0/1	138	0/1
SW-1002					0.17	0/1	50.1	0/1	210	0/1
SW-1003					< 0.20	1/1	86.2	0/1	308	0/1
SW-1004					< 0.10	1/1	70.7	0/1	160	0/1
SW-1005					< 0.10	1/1	63.1	0/1	232	0/1
SW-1007					< 0.10	1/1	42.5	0/10	126	1/11
SW-1008	11.3	0/1	0.69	0/1	< 0.11	6/7	69.6	0/7	143	0/6
SW-1009					< 0.10	1/1	47.0	0/1	146	0/1
SW-1010					0.14	0/1	39.3	0/1	114	0/1
SW-1011					1.39	0/1	80.1	0/1	132	0/1
SW-1012					2.00	0/1	85.9	0/1	160	0/1
SW-1013					1.70	0/1	87.5	0/1	145	0/1
SW-1014					0.80	0/1	30.6	0/1	195	0/1
SW-2001					0.76	0/1	40.6	0/1	160	0/1
SW-2002					0.17	0/1	34.4	0/1	65	0/1
SW-2003					0.50	0/1	17.4	0/1	62	0/1
SW-2004					1.20	0/1	22.4	0/1	94	0/1
SW-2005					DR		28.9	0/1	< 2.00	1/1
SW-2007					< 0.10	1/1	24.8	0/1	180	1/1
SW-2010					0.27	0/1	NS		NS	
SW-2011					0.38	0/1	57.1	0/1	145	0/1
SW-2012					NS		NS		NS	
SW-2016					1.00	0/1	46.6	0/1	160	0/1
SW-3001					534	0/1	408	0/1	48	0/1
SW-3002					103	0/1	800	0/1	49	0/1
SW-3003					1760	0/1	636	0/1	46	0/1
SW-3004					0.12	0/1	67.3	0/1	386	0/1

@ Ratio of nondetects to total number of samples.

TABLE A-6 Average Radiological Concentrations for Surface Water, 1992

Location	Gross Alpha pCi/l	@	Gross Beta pCi/l	@	Ra-226 pCi/l	@	Ra-228 pCi/l	@	Th-228 pCi/l	@	Th-230 pCi/l	@	Th-232 pCi/l	@	Uranium Total pCi/l	@
SW-1001	< 2.00	1/1	8.90	0/1	< 0.20	0/1	< 0.90	1/1	< 0.20	1/1	4.80	0/1	< 0.20	1/1	0.91	2/6
SW-1002															1.5	3/6
SW-1003	77.0	0/1	72.0	0/1	< 0.20	1/1	< 0.90	1/1	< 0.20	1/1	2.20	0/1	< 0.20	1/1	50.0	0/6
SW-1004	180	0/1	140	0/1	0.40	0/1	1.40	0/1	< 0.20	1/1	2.10	0/1	< 0.20	1/1	89.8	0/6
SW-1005	30.0	0/1	28.0	0/1	< 0.20	0/1	< 0.90	1/1	< 0.20	1/1	1.50	0/1	< 0.20	1/1	24.5	0/6
SW-1007	17.0	0/1	14.0	0/1	< 0.20	1/1	1.30	0/1	< 0.20	1/1	0.30	0/1	< 0.20	1/1	12.0	0/17
SW-1008	1048	0/6	484	0/6	0.73	1/6	4.43	4/6	< 0.29	4/5	0.81	3/6	< 0.44	6/6	753	0/9
SW-1009	12.0	0/1	19.0	0/1	0.80	0/1	< 0.90	1/1	< 0.20	1/1	< 0.20	1/1	< 0.20	1/1	8.74	0/7
SW-1010															43.6	0/6
SW-1011	10.0	0/1	14.0	0/1	1.10	0/1	2.60	0/1	0.60	0/1	1.60	0/1	0.60	0/1	5.33	0/6
SW-1012															3.88	1/6
SW-1013															4.57	1/6
SW-1014															2.08	1/6
SW-2001	< 9.80	1/1	< 6.80	1/1	< 0.90	1/1	3.40	0/1	< 0.40	1/1	0.80	0/1	< 0.40	1/1	1.38	1/4
SW-2002	< 9.10	1/1	< 6.70	1/1	< 0.90	1/1	< 2.40	1/1	< 0.50	1/1	0.90	0/1	< 0.50	1/1	82.5	0/4
SW-2003	< 6.70	1/1	< 6.10	1/1	< 0.90	1/1	< 2.40	1/1	< 0.40	1/1	< 0.60	1/1	< 0.40	1/1	10.9	0/3
SW-2004	< 7.70	1/1	< 6.30	1/1	< 0.90	1/1	< 2.40	1/1	< 0.40	1/1	2.10	0/1	0.80	0/1	13.5	0/4
SW-2005	< 8.20	1/1	< 6.30	1/1	< 0.90	1/1	< 2.40	1/1	< 0.40	1/1	0.80	0/1	< 0.40	1/1	28.9	0/4
SW-2007	< 8.70	1/1	< 6.00	1/1	< 0.90	1/1	< 2.40	1/1	< 0.40	1/1	2.80	0/1	< 0.40	1/1	0.94	2/4
SW-2010	1800	0/1	660	0/1											2240	0/2

@ Ratio of nondetects to total number of samples.

TABLE A-6 Average Radiological Concentrations for Surface Water, 1992 (Continued)

Location	Gross Alpha pCi/l	@	Gross Beta pCi/l	@	Ra-226 pCi/l	@	Ra-228 pCi/l	@	Th-228 pCi/l	@	Th-230 pCi/l	@	Th-232 pCi/l	@	Uranium Total pCi/l	@
SW-2011	170	0/1	140	0/1					0.15	0/1	0.27	0/1	< 0.17	1/1	248	0/4
SW-2016	< 9.40	1/1	< 6.70	1/1	< 0.80	1/1	< 2.70	1/1	< 0.70	1/1	< 1.00	1/1	< 0.80	1/1	1.96	1/4
SW-3001					164	0/1	4.15	0/1	1.40	0/1	622	0/1	6.46	0/1	92.5	0/2
SW-3002					50.5	0/1	6.17	0/1	1.11	0/1	141	0/1	2.54	0/1	1110	0/2
SW-3003					69.3	0/1	27.3	0/1	1.61	0/1	12.4	0/1	0.56	0/1	205	0/2
SW-3004					1.47	0/1	6.81	0/1	< 0.91	1/1	1.84	0/1	< 0.74	1/1	1600	0/2
SW-5311	140	0/2	51.5	0/2	2.15	0/2	< 2.02	2/2	< 0.62	2/2	< 0.97	1/2	< 0.63	2/2	140	0/2

@ Ratio of nondetects to total number of samples.

TABLE A-6 Average Radiological Concentrations for Surface Water, 1992 (Continued)

Location	Actinium 227 pCi/l	@	Lead 210 pCi/l	@	Polonium 210 pCi/l	@	Protactin 231 pCi/l	@	RN-222 pCi/l	@	Uranium 234 pCi/l	@	Uranium 235 pCi/l	@	Uranium 238 pCi/l	@
SW-1001																
SW-1002																
SW-1003																
SW-1004																
SW-1005																
SW-1007																
SW-1008	< 3.54	1/1	41.8	1/2	< 0.34	1/1	< 0.43	1/1	266	0/1	378	0/1	38.0	0/1	500	0/1
SW-1009																
SW-1010																
SW-1011																
SW-1012																
SW-1013																
SW-1014																
SW-2001											< 0.40	1/1	< 0.40	1/1	< 0.40	1/1
SW-2002											38.0	0/1	< 0.40	1/1	41.0	0/1
SW-2003																
SW-2004											8.10	0/1	< 0.40	1/1	7.60	0/1
SW-2005											12.0	0/1	< 0.40	1/1	13.0	0/1

@ Ratio of nondetects to total number of samples.

TABLE A-6 Average Radiological Concentrations for Surface Water, 1992 (Continued)

Location	Actinium 227 pCi/l	@	Lead 210 pCi/l	@	Polonium 210 pCi/l	@	Protactin 231 pCi/l	@	RN-222 pCi/l	@	Uranium 234 pCi/l	@	Uranium 235 pCi/l	@	Uranium 238 pCi/l	@
SW-2007											< 0.40	1/1	< 0.40	1/1	< 0.40	1/1
SW-2011											120	0/1	7.60	0/1	130	0/1
SW-2016											< 0.40	1/1	< 0.40	1/1	0.90	0/1

@ Ratio of nondetects to total number of samples.

TABLE A-7 Average Nitroaromatic Concentrations for Surface Water, 1992

Location	1,3,5-TNB µg/l	@	1,3-DNB µg/l	@	2,4,6-TNT µg/l	@	2,4-DNT µg/l	@	2,6-DNT µg/l	@	Nitrobenzene µg/l	@
SW-1001	< 0.03	1/1	< 0.09	1/1	0.07	0/1	0.04	0/1	0.01	0/1	<0.03	1/1
SW-1002	< 0.03	1/1	< 0.09	1/1	< 0.03	1/1	< 0.03	1/1	< 0.01	1/1	< 0.03	1/1
SW-1003	< 0.03	1/1	< 0.09	1/1	< 0.03	1/1	< 0.03	1/1	< 0.01	1/1	< 0.03	1/1
SW-1004	< 0.03	1/1	< 0.09	1/1	< 0.03	1/1	< 0.03	1/1	< 0.01	1/1	< 0.03	1/1
SW-1005	< 0.03	1/1	< 0.09	1/1	< 0.03	1/1	< 0.03	1/1	< 0.01	1/1	< 0.03	1/1
SW-1007	< 0.03	1/1	< 0.09	1/1	< 0.03	1/1	< 0.03	1/1	< 0.01	1/1	< 0.03	1/1
SW-1008	< 0.11	4/7	< 0.16	7/7	4.76	3/7	5.53	0/9	0.43	1/7	< 0.19	7/7
SW-1008A	< 0.56	2/2	< 0.60	2/2	< 0.78	2/2	1.13	0/2	< 0.55	2/2	< 1.12	2/2
SW-1009	< 0.03	1/1	< 0.09	1/1	< 0.03	1/1	< 0.03	1/1	< 0.01	1/1	< 0.03	1/1
SW-1010	< 0.03	1/1	< 0.09	1/1	< 0.03	1/1	< 0.03	1/1	< 0.01	1/1	< 0.03	1/1
SW-1011	< 0.03	1/1	< 0.09	1/1	< 0.03	1/1	< 0.03	1/1	< 0.01	1/1	< 0.03	1/1
SW-1012	< 0.03	1/1	< 0.09	1/1	< 0.03	1/1	< 0.03	1/1	< 0.01	1/1	< 0.03	1/1
SW-1013	< 0.03	1/1	< 0.09	1/1	< 0.03	1/1	< 0.03	1/1	< 0.01	1/1	< 0.03	1/1
SW-1014	< 0.03	1/1	< 0.09	1/1	< 0.03	1/1	< 0.03	1/1	< 0.01	1/1	< 0.03	1/1

@ Ratio of nondetects to total number of samples.

TABLE A-8 Average Metals Concentrations for Surface Water, 1992

Location	Antimony µg/l	@	Arsenic µg/l	@	Barium µg/l	@	Beryllium µg/l	@	Cadmium µg/l	@	Chromium µg/l	@	Copper µg/l	@	Iron µg/l	@
SW-1001			< 2.00	1/1	90.1	0/1										
SW-1002			< 2.00	1/1	80.9	0/1										
SW-1003			2.29	0/1	89.4	0/1										
SW-1004			< 2.00	1/1	65.7	0/1										
SW-1005			3.79	0/1	120	0/1										
SW-1007			2.20	0/1	125	0/1										
SW-1008			3.70	2/4	< 108	1/2			< 5.00	1/1	< 10.0	1/1	< 25.0	1/1	< 100	1/1
SW-1008A			< 2.00	4/4	66.2	0/4			< 3.00	4/4	< 6.00	4/4				
SW-1009			< 2.00	1/1	123	0/1										
SW-1010			< 2.00	1/1	60.7	0/1										
SW-1011			4.79	0/1	302	0/1										
SW-1012			< 2.00	1/1	261	0/1										
SW-1013			4.50	0/1	219	0/1										
SW-1014			< 2.00	1/1	77.8	0/1										
SW-2001	< 36.0	1/1	< 2.00	1/1	110	0/1	< 1.00	1/1	< 4.00	1/1	< 7.00	1/1				
SW-2002	< 36.0	1/1	< 1.00	1/1	76.4	0/1	1.39	0/1	< 4.00	1/1	< 7.00	1/1				
SW-2003	< 36.0	1/1	< 1.00	1/1	60.7	0/1	1.39	0/1	< 4.00	1/1	< 7.00	1/1				
SW-2004	< 36.0	1/1	< 1.00	1/1	78.0	0/1	1.39	0/1	< 4.00	1/1	< 7.00	1/1				
SW-2005	< 36.0	1/1	< 1.40	1/1	72.4	0/1	2.39	0/1	< 4.00	1/1	< 7.00	1/1				
SW-2007	< 44.0	1/1	< 2.00	1/1	140	0/1	< 1.00	1/1	< 4.00	1/1	< 8.00	1/1				
SW-2010																
SW-2011	< 44.0	1/1	< 2.00	1/1	76.3	0/1	< 1.00	1/1	< 4.00	1/1						
SW-2015	< 36.0	1/1	< 2.00	0/1	134	0/1	< 1.00	1/1	< 4.00	1/1	< 7.00	1/1				

@ Ratio of nondetects to total number of samples.

TABLE A-8 Average Metals Concentrations for Surface Water, 1992 (Continued)

Location	Lead µg/l	@	Lithium µg/l	@	Manganese µg/l	@	Mercury µg/l	@	Selenium µg/l	@	Silver µg/l	@	Thallium µg/l	@	Zinc µg/l	@
SW-1001																
SW-1002																
SW-1003																
SW-1004																
SW-1005																
SW-1007																
SW-1008	< 3.00	1/1			74.0	0/3	< 0.20	1/1	< 5.00	1/1	< 10.0	1/1			< 20.0	1/1
SW-1008A	< 2.00	3/4					< 0.03	3/4	< 2.00	4/4	< 10.0	4/4				
SW-1009																
SW-1010																
SW-1011																
SW-1012																
SW-1013																
SW-1014																
SW-2001	< 2.00	1/1					< 0.10	1/1	< 2.00	1/1	< 8.00	1/1	< 2.00	1/1		
SW-2002	< 2.00	1/1					< 0.10	1/1	< 2.00	1/1	< 8.00	1/1	< 2.00	1/1		
SW-2003	< 2.00	1/1					< 0.10	1/1	< 2.00	1/1	< 8.00	1/1	< 2.00	1/1		
SW-2004	< 2.00	1/1					< 0.10	1/1	< 2.00	1/1	< 8.00	1/1	< 2.00	1/1		
SW-2005	< 1.00	1/1					< 0.10	1/1	< 2.00	1/1	< 8.00	1/1	< 1.00	1/1		
SW-2007	< 2.00	1/1					< 0.10	1/1	< 2.00	1/1	< 8.00	1/1	< 2.00	1/1		
SW-2010			< 100	1/1												
SW-2011	15.0	0/1					< 0.10	1/1	< 2.00	1/1	< 6.00	1/1	< 2.00	1/1		
SW-2018	< 2.00	1/1					< 0.10	1/1	< 2.00	1/1	< 8.00	1/1	< 2.00	1/1		

@ Ratio of nondetects to total number of samples.

TABLE A-9 Average Nitroaromatic Concentrations for Springs, 1992

Location	1,3,5-TNB µg/l	@	1,3-DNB µg/l	@	2,4,6-TNT µg/l	@	2,4-DNT µg/l	@	2,6-DNT µg/l	@	Nitrobenzene µg/l	@
SP-5201	< 0.56	1/1	< 0.61	1/1	< 0.78	1/1	< 0.60	1/1	0.61	0/1	< 1.13	1/1
SP-5303	0.09	0/1	< 0.09	1/1	20.0	0/1	0.240	0/1	0.43	0/1	< 0.03	1/1
SP-6301	0.05	0/1	< 0.09	1/1	0.27	0/1	0.04	0/1	0.61	0/1	< 3.02	2/2
SP-6306	< 0.03	1/1	< 0.09	1/1	< 0.03	1/1	< 0.03	1/1	< 0.01	1/1	< 0.03	1/1

@ Ratio of nondetects to total number of samples.

TABLE A-10 Average Radiological Concentrations for Springs, 1992

Location	Gross Alpha pCi/l	@	Gross Beta pCi/l	@	Ra-226 pCi/l	@	Ra-228 pCi/l	@	Th-228 pCi/l	@	Th-230 pCi/l	@	Th-232 pCi/l	@	Uranium Total pCi/l	@
SP-5201					< 0.69	1/1	< 4.66	1/1	< 0.55	1/1	5.47	0/1	< 0.77	1/1	2.00	1/4
SP-5303					< 0.69	1/1	< 2.89	1/1	0.35	0/1	4.90	0/1	< 0.53	1/1	126	0/4
SP-5304															103	0/3
SP-6301	79.0	0/1	13.0	0/1	< 1.29	2/2	2.06	1/2	< 0.24	3/3	< 0.33	2/3	< 0.14	3/3	78.6	0/8
SP-6306					< 0.69	1/1	< 4.47	1/1	< 0.33	1/1	2.61	0/1	< 0.47	1/1	3.44	1/6

@ Ratio of nondetects to total number of samples.

TABLE A-11 Average Inorganic Anion Concentrations for Springs, 1992

Location	Nitrate mg/l	@	Sulfate mg/l	@	Alkalinity mg/l	@
SP-5201	0.19	1/3	61.4	0/3	203	0/3
SP-5303	0.46	1/3	63.0	0/3	198	0/3
SP-5304	0.79	0/2	51.5	0/2	173	0/2
SP-6301	32.3	0/7	58.0	0/7	208	0/7
SP-6305	0.21	1/5	7.9	0/5	148	0/5

@ Ratio of nondetects to total number of samples.

TABLE A-12 Results of Radiological Isotopic Sampling Study at the Quarry Pond, 1992

Parameter pCi/l	SW-1008A		SW-1008B		SW-1008C	
	3 ft depth	8 ft depth	3 ft depth	8 ft depth	3 ft depth	8 ft depth
Ac-227	<0.93 <1.02*	<1.65 <1.01*	<1.69 <1.26*	<1.22 <1.18*	<1.95 0.14*	<1.15 <1.22*
Pb-210	1.18 <3.86*	1.02 0.21	1.02 0.66*	0.36 0.30*	1.18 <2.21*	0.54 <2.21*
Po-210	1.65 <2.30*	<4.60 <0.90*	0.03 <1.51*	0.47 0.41*	<1.01 <2.79*	0.31 0.97*
Pa-231	1.39 3.75*	1.21 1.50*	1.56 1.28*	1.04 0.19*	1.50 0.86*	0.18 0.29*
Ra-226	0.93 0.80*	0.96 1.28*	0.96 0.76*	0.61 1.07*	0.28 0.26*	0.32 0.39*
Ra-228	<3.48 <3.48*	<5.52 0.64*	0.64 0.26*	<3.48 <3.48*	1.70 1.70*	<3.09 <3.09*
Rn-222	152	244	267	364	180	222
Th-228	0.32 <1.65*	0.13 <1.45*	<0.79 <0.83*	<1.63 < 1.48*	<0.83 <0.59*	<0.71 0.07*
Th-230	0.64 1.23*	4.96 1.26*	1.57 1.23*	0.82 2.74*	0.93 0.66*	1.06 0.56*
Th-232	<0.98 <1.91*	<1.22 <1.68*	<0.92 <0.96*	<1.88 0.37*	<0.96 <0.68*	<0.82 <0.65*
Total Uranium	1000 970*	1200 1100*	1500 1500*	2000 1500*	1400 1400*	1600 1400*

* Filtered sample results

@ Ratio of nondetects to total number of samples.

APPENDIX B
Quarterly and Bimonthly Monitoring Results

Appendix B is a presentation of 1992 monitoring data for groundwater, surface water, NPDES locations, and springs. All nondetected values are expressed as less than (<) the analytical detection limit. This is changed from previous reports when data were reported as "ND." Values shown in parenthesis are categorized as "uncensored" data, that is, data that are below the detection limit but reported as a measured value. Blank fields indicate that sampling was not scheduled, whereas "NS" indicates the location was not sampled as scheduled due to sampling problems such as low-flow or dry conditions.

The superscript "a" is used to designate values which have been "rejected" for use by the data review or data validation procedure. These "a" values are not used in annual average concentration or data interpretation tests. The "c" superscript indicates unfiltered groundwater samples as discussed in Section 10. The "c" values are used in annual average concentrations.

TABLE B-1 Bimonthly Groundwater Monitoring Data, 1992

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
NITRATE-N							
GW-1002	0.870	1.60	2.10	0.340	0.570	1.50	mg/l
GW-1004	0.420	0.110	0.380	0.560	0.300	0.290	mg/l
GW-1005	0.120	<0.10	<0.20	<0.20	<0.10	0.150	mg/l
GW-1006	0.650	0.280	0.410	0.140	0.220	<0.10	mg/l
GW-1007	0.260	<0.10	<0.10	<0.10	0.210	1.10	mg/l
GW-1008	0.410	0.310	<0.10	<0.10	<0.20	<0.10	mg/l
GW-1009	0.230	<0.10	<0.10	<0.20	<0.20	<0.10	mg/l
GW-1010	0.120	(0.030)	<0.10	0.380	<0.10	<0.10	mg/l
GW-1011	NS	<0.10	<0.10	NS	<0.10	<0.10	mg/l
GW-1012	1.20	0.680	0.840	0.990	0.800	1.10	mg/l
GW-1013	0.470	0.140	<0.10	<0.20	0.220	<0.10	mg/l
GW-1014	0.380	<0.10	<0.10	<0.10	0.220	<0.10	mg/l
GW-1015	5.59	1.50	1.00	1.80	0.320	1.00	mg/l
GW-1016	2.20	0.930	0.570	1.30	0.150	0.450	mg/l
GW-1026	<0.20	0.140	<0.10	<0.20	<0.10	<0.10	mg/l
GW-1027	0.260	0.280	0.310	0.120	0.220	0.340	mg/l
GW-1028	0.230	<0.10	<0.10	<0.5	<0.20	<0.10	mg/l
GW-1029	0.560	<0.10	0.420	<0.10	0.150	<0.20	mg/l
GW-1030	<0.10	<0.10	8.19	<0.10	0.520	0.760	mg/l
GW-1031	0.340	<0.10	<0.10	<0.10	<0.20	<0.10	mg/l
GW-1032	0.280	<0.10	<0.20	<0.20	<0.20	<0.10	mg/l
GW-1034	0.190	<0.10	1.10	0.410	0.950	0.930	mg/l
GW-1035	<0.050	0.270	0.100	0.200	0.170	0.120	mg/l
GW-1036	<0.20	0.100	0.170	<0.10	<0.10	<0.10	mg/l
GW-1037	<0.20	0.140	0.100	<0.20	<0.10	<0.10	mg/l
GW-1038	<0.20	<0.10	<0.10	<0.10	<0.10	<0.10	mg/l
GW-1039	<0.20	<0.10	0.130	<0.20	<0.10	<0.10	mg/l
SULFATE							
GW-1002	57.6	67.4	77.2	54.2	40.7	60.8	mg/l
GW-1004	249	296	430	372	238	238	mg/l
GW-1005	145	140	143	170	180	164	mg/l
GW-1006	448	146	381	426	208	406	mg/l
GW-1007	294	307	37.6	61.6	126	80.3	mg/l
GW-1008	296	216	252	279	270	228	mg/l
GW-1009	294	288	289	275	271	257	mg/l
GW-1010	0.410	<0.250	<0.250	0.282	0.261	1.20	mg/l
GW-1011	NS	30.6	39.0	53.0	37.7	43.3	mg/l
GW-1012	72.3	179	58.4	65.9	62.4	63.8	mg/l
GW-1013	111	103	99.4	97.9	106	104	mg/l
GW-1014	111	114	114	108	102	102	mg/l
GW-1015	307	313	346	352	297	251	mg/l

TABLE B-1 Bimonthly Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
GW-1016	270	266	246	271	242	243	mg/l
GW-1026	88.3	0.670	1.00	0.920	0.690	0.710	mg/l
GW-1027	102	89.3	99.4	100	109	111	mg/l
GW-1028	72.7	70.4	74.6	71.4	81.7	81.2	mg/l
GW-1029	74.4	77.4	75.7	76.9	69.2	67.9	mg/l
GW-1030	98.4	96.9	98.7	105	81.4	70.1	mg/l
GW-1031	28.8	41.5	35.5	35.8	30.8	29.0	mg/l
GW-1032	238	258	272	254	246	241	mg/l
GW-1034	169	86.9	79.1	71.5	73.1	62.9	mg/l
GW-1035	66.6	38.8	39.1	35.3	40.5	40.1	mg/l
GW-1036	61.3	58.6	52.6	58.4	55.0	55.2	mg/l
GW-1037	13.1	10.5	9.80	15.1	16.7	58.0	mg/l
GW-1038	50.9	47.1	45.6	45.1	42.9	64.3	mg/l
GW-1039	64.7	61.5	49.0	54.6	52.0	17.3	mg/l
ARSENIC							
GW-1002	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1004	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1005	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1006	<2.00	<2.00	<2.00	<2.00	3.70	<2.00	µg/l
GW-1007	20.3	10.6	17.8	25.2	11.4	17.2	µg/l
GW-1008	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1009	8.80	3.89	<2.00	2.29	<2.00	9.09	µg/l
GW-1010	102	92.0	88.5	103	120	130	µg/l
GW-1011	NS	<2.00	<2.00	NS	<2.00	<2.00	µg/l
GW-1012	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1013	2.89	3.39	2.50	2.70	2.60	2.90	µg/l
GW-1014	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1015	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1016	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1026	21.6	22.3	22.1	20.6	19.6	19.4	µg/l
GW-1027	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1028	<2.00	6.29	<2.00	5.90	<2.00	2.20	µg/l
GW-1029	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1030	7.40	4.40	5.20	<2.00	<2.00	<2.00	µg/l
GW-1031	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1032	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1034	<12.	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1035	<12.	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1036	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1037	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l
GW-1038	<2.00	<2.00	2.39	<2.00	<2.00	<2.00	µg/l
GW-1039	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	µg/l

TABLE B-1 Bimonthly Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
BARIUM							
GW-1002	120	37.8	142	127	118	119	µg/l
GW-1004	38.5	140	44.8	43.3	33.3	30.4	µg/l
GW-1005	57.3	56.7	51.8	54.3	61.7	61.4	µg/l
GW-1006	47.9	42.5	58.6	56.7	83.4	84.0	µg/l
GW-1007	349	249	314	336	324	370	µg/l
GW-1008	47.3	48.8	49.1	50.2	55.6	45.0	µg/l
GW-1009	486	364	344	482	337	481	µg/l
GW-1010	356	230	362	407	439	503	µg/l
GW-1011	NS	288	188	NS	271	295	µg/l
GW-1012	131	122	123	124	125	138	µg/l
GW-1013	156	140	141	142	151	162	µg/l
GW-1014	219	194	149	158	161	171	µg/l
GW-1015	126	105	117	109	104	98.1	µg/l
GW-1016	140	127	139	119	133	133	µg/l
GW-1026	389	409	381	360	401	434	µg/l
GW-1027	148	107	98.1	92.6	134	98.5	µg/l
GW-1028	293	300	277	303	278	296	µg/l
GW-1029	38.8	109	119	118	107	152	µg/l
GW-1030	404	340	353	132	82.0	122	µg/l
GW-1031	96.9	95.5	102	94.1	110	103	µg/l
GW-1032	95.4	96.8	89.9	93.3	105	89.9	µg/l
GW-1034	155	167	169	154	144	156	µg/l
GW-1035	256	225	223	200	203	198	µg/l
GW-1036	308	300	281	264	279	315	µg/l
GW-1037	549	626	615	639	673	569	µg/l
GW-1038	248	242	222	199	254	250	µg/l
GW-1039	509	479	461	425	488	489	µg/l
ALKALINITY							
GW-1002	300	306	310	310	300	320	mg/l
GW-1004	250	244	260	270	260	225	mg/l
GW-1005	230	224	225	235	240	240	mg/l
GW-1006	358	390	490	360	390	470	mg/l
GW-1007	460	466	670	640	540	620	mg/l
GW-1008	370	388	315	320	415	445	mg/l
GW-1009	480	494	450	430	460	420	mg/l
GW-1010	370	341	315	331	368	385	mg/l
GW-1011	NS	498	445	342	472	465	mg/l
GW-1012	475	510	480	500	510	510	mg/l
GW-1013	390	430	520	410	400	440	mg/l
GW-1014	430	486	490	470	450	460	mg/l

TABLE B-1 Bimonthly Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
GW-1015	400	422	390	390	400	355	mg/l
GW-1016	370	412	380	390	400	400	mg/l
GW-1026	384	387	380	380	410	390	mg/l
GW-1027	460	490	430	395	460	440	mg/l
GW-1028	460	460	460	470	460	450	mg/l
GW-1029	348	358	360	345	360	364	mg/l
GW-1030	2100	2340	2100	1530	380	540	mg/l
GW-1031	340	340	365	350	340	340	mg/l
GW-1032	330	330	320	320	330	340	mg/l
GW-1034	424	462	420	435	430	470	mg/l
GW-1035	206	240	310	220	215	230	mg/l
GW-1036	510	490	490	525	525	500	mg/l
GW-1037	440	510	490	355	450	570	mg/l
GW-1038	430	450	450	440	460	470	mg/l
GW-1039	550	570	540	550	560	460	mg/l
1,3,5-TRINITROBENZENE							
GW-1002	207	480	600	280	200	680	µg/l
GW-1004	4.50	6.00	8.50	7.00	6.20	5.80	µg/l
GW-1005	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1006	26.0	62.0	70.0	140	6.00	5.50	µg/l
GW-1007	<0.03	0.180	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1008	0.047	0.150	<0.03	<0.03	<0.03	0.041	µg/l
GW-1009	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1010	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1011	NS	<0.03	<0.03	NS	<0.03	<0.03	µg/l
GW-1012	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1013	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1014	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1015	220	240	190	230	120	75.0	µg/l
GW-1016	38.0	32.0	24.0	27.0	9.00	5.80	µg/l
GW-1026	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1027	0.033	0.066	0.065	0.086	<0.03	0.058	µg/l
GW-1028	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1029	<0.5	<0.03	<0.03	<0.03	<0.03	<0.180	µg/l
GW-1030	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1031	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1032	0.043	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1034	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1035	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1036	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1037	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l

TABLE B-1 Bimonthly Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
GW-1038	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1039	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
1,3-DINITROBENZENE							
GW-1002	<0.6	0.360	0.350	0.210	0.330	0.470	µg/l
GW-1004	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1005	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1006	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1007	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1008	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1009	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1010	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1011	NS	<0.09	<0.09	NS	<0.09	<0.09	µg/l
GW-1012	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1013	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1014	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1015	0.120	<0.09	<0.09	0.093	0.220	0.450	µg/l
GW-1016	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1026	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1027	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1028	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1029	<0.6	<0.09	<0.09	<0.09	<0.09	<0.160	µg/l
GW-1030	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1031	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1032	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1034	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1035	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1036	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1037	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1038	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1039	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
2,4,6-TNT							
GW-1002	33.3	85.0	90.0	46.0	30.0	120	µg/l
GW-1004	14.0	22.0	25.0	22.0	12.0	9.50	µg/l
GW-1005	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1006	5.80	10.0	12.0	24.0	1.70	1.20	µg/l
GW-1007	<0.03	0.560	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1008	0.220	0.800	<0.03	<0.03	<0.03	0.260	µg/l
GW-1009	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1010	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1011	NS	<0.03	<0.03	NS	<0.03	<0.03	µg/l

TABLE B-1 Bimonthly Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
GW-1012	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1013	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1014	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1015	30.0	27.0	24.0	32.0	20.0	15.0	µg/l
GW-1016	5.80	5.40	4.50	5.00	1.80	1.40	µg/l
GW-1026	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1027	3.80	9.00	17.0	38.0	6.50	9.50	µg/l
GW-1028	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1029	<0.7	<0.03	<0.03	<0.03	<0.03	<0.230	µg/l
GW-1030	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1031	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1032	3.00	<0.03	<0.03	0.060	0.380	0.098	µg/l
GW-1034	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1035	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1036	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1037	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1038	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1039	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
2,4-DNT							
GW-1002	<0.5	0.130	0.120	0.078	0.100	0.260	µg/l
GW-1004	2.80	3.20	3.80	4.20	3.50	3.20	µg/l
GW-1005	0.140	0.100	0.086	0.098	0.092	0.110	µg/l
GW-1006	0.190	0.300	0.170	0.400	0.080	0.120	µg/l
GW-1007	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1008	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1009	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1010	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1011	NS	<0.03	<0.03	NS	<0.03	<0.03	µg/l
GW-1012	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1013	0.097	0.063	0.053	0.035	<0.03	0.030	µg/l
GW-1014	0.042	<0.03	<0.03	<0.03	0.036	0.044	µg/l
GW-1015	0.060	0.054	0.055	0.066	0.062	0.062	µg/l
GW-1016	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1026	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1027	9.00	0.420	0.620	7.50	19.0	1.60	µg/l
GW-1028	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1029	<0.5	<0.03	<0.03	<0.03	<0.03	<0.220	µg/l
GW-1030	0.040	0.044	0.049	0.033	0.044	0.045	µg/l
GW-1031	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1032	0.067	0.088	0.200	0.096	0.150	0.110	µg/l
GW-1034	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1035	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l

TABLE B-1 Bimonthly Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
GW-1036	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1037	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1038	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1039	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
2,6-DNT							
GW-1002	11.5	27.0	23.0	11.0	8.30	42.0	µg/l
GW-1004	4.60	6.60	7.40	5.70	4.30	3.50	µg/l
GW-1005	0.040	0.040	0.031	0.034	0.028	0.026	µg/l
GW-1006	2.20	3.20	3.60	6.00	0.630	0.680	µg/l
GW-1007	<0.01	0.210	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1008	0.096	0.240	0.078	0.100	<0.01	0.051	µg/l
GW-1009	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1011	NS	<0.01	<0.01	NS	<0.01	<0.01	µg/l
GW-1012	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1013	0.030	0.024	0.016	0.014	<0.01	<0.01	µg/l
GW-1014	0.014	<0.01	<0.01	<0.01	<0.01	(0.009)	µg/l
GW-1015	1.00	0.750	0.800	0.880	0.640	0.460	µg/l
GW-1016	0.230	0.220	0.210	0.200	0.120	0.096	µg/l
GW-1026	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1027	3.10	3.10	2.40	5.30	5.80	1.30	µg/l
GW-1028	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1029	<0.5	<0.01	<0.01	<0.01	<0.01	<0.53	µg/l
GW-1030	<0.01	<0.01	<0.01	<0.01	<0.01	(0.006)	µg/l
GW-1031	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1032	1.10	0.088	0.120	0.084	0.240	0.110	µg/l
GW-1034	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1035	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1036	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1037	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1038	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1039	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	µg/l
NITROBENZENE							
GW-1002	<1.1	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1004	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1005	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1006	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1007	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1008	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1009	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l

TABLE B-1 Bimonthly Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
GW-1010	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1011	NS	<0.03	<0.03	NS	<0.03	<0.03	µg/l
GW-1012	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1013	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1014	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1015	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1016	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1026	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1027	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1028	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1029	<1.1	<0.03	<0.03	<0.03	<0.03	<0.210	µg/l
GW-1030	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1031	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1032	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1034	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1035	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1036	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1037	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1038	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1039	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l

GROSS ALPHA

GW-1002	7.00	pCi/l
GW-1004	3700	pCi/l
GW-1005	1480	pCi/l
GW-1006	4300	pCi/l
GW-1007	2300	pCi/l
GW-1008	6000	pCi/l
GW-1009	15.0	pCi/l
GW-1010	<2.00	pCi/l
GW-1011	22.0	pCi/l
GW-1012	23.0	pCi/l
GW-1013	1100	pCi/l
GW-1014	600	pCi/l
GW-1015	1400	pCi/l
GW-1016	480	pCi/l
GW-1026	25.0	pCi/l
GW-1027	680	pCi/l
GW-1028	6.80	pCi/l
GW-1029	13.0	pCi/l
GW-1030	98.0	pCi/l
GW-1031	22.0	pCi/l
GW-1032	860	pCi/l

TABLE B-1 Bimonthly Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
GW-1034		3.10					pCi/l
GW-1035		<2.00					pCi/l
GW-1036		8.50					pCi/l
GW-1037		3.90					pCi/l
GW-1038		<2.00					pCi/l
GW-1039		5.00					pCi/l
GROSS BETA							
GW-1002		12.0					pCi/l
GW-1004		2840					pCi/l
GW-1005		1070					pCi/l
GW-1006		2230					pCi/l
GW-1007		1320					pCi/l
GW-1008		3400					pCi/l
GW-1009		11.0					pCi/l
GW-1010		6.40					pCi/l
GW-1011		22.0					pCi/l
GW-1012		13.0					pCi/l
GW-1013		610					pCi/l
GW-1014		510					pCi/l
GW-1015		810					pCi/l
GW-1016		300					pCi/l
GW-1026		18.0					pCi/l
GW-1027		280					pCi/l
GW-1028		13.0					pCi/l
GW-1029		12.0					pCi/l
GW-1030		190					pCi/l
GW-1031		13.0					pCi/l
GW-1032		780					pCi/l
GW-1034		5.80					pCi/l
GW-1035		5.90					pCi/l
GW-1036		9.60					pCi/l
GW-1037		5.90					pCi/l
GW-1038		8.10					pCi/l
GW-1039		8.70					pCi/l
RADIUM-226							
GW-1002		<0.20					pCi/l
GW-1004		0.300					pCi/l
GW-1005		<0.20					pCi/l
GW-1006		0.400					pCi/l
GW-1007		0.600					pCi/l

TABLE B-1 Bimonthly Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
GW-1008		<0.20					pCi/l
GW-1009		0.200					pCi/l
GW-1010		0.400					pCi/l
GW-1011		0.200					pCi/l
GW-1012		0.300					pCi/l
GW-1013		0.700					pCi/l
GW-1014		<0.20					pCi/l
GW-1015		0.300					pCi/l
GW-1016		<0.20					pCi/l
GW-1026		0.200					pCi/l
GW-1027		<0.20					pCi/l
GW-1028		0.300					pCi/l
GW-1029		<0.20					pCi/l
GW-1030		4.80					pCi/l
GW-1031		0.200					pCi/l
GW-1032		0.500					pCi/l
GW-1034		0.200					pCi/l
GW-1035		0.400					pCi/l
GW-1036		0.200					pCi/l
GW-1037		0.300					pCi/l
GW-1038		0.200					pCi/l
GW-1039		<0.20					pCi/l
RADIUM-228							
GW-1002		<0.90					pCi/l
GW-1004		<0.90					pCi/l
GW-1005		<0.90					pCi/l
GW-1006		(0.700)					pCi/l
GW-1007		<0.90					pCi/l
GW-1008		<0.90					pCi/l
GW-1009		<0.90					pCi/l
GW-1010		2.10					pCi/l
GW-1011		(0.700)					pCi/l
GW-1012		<0.90					pCi/l
GW-1013		<0.90					pCi/l
GW-1014		<0.90					pCi/l
GW-1015		<0.90					pCi/l
GW-1016		(0.600)					pCi/l
GW-1026		(0.800)					pCi/l
GW-1027		1.10					pCi/l
GW-1028		(0.600)					pCi/l
GW-1029		<0.90					pCi/l
GW-1030		2.70					pCi/l

TABLE B-1 Bimonthly Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
GW-1031		<0.90					pCi/l
GW-1032		1.10					pCi/l
GW-1034		(0.800)					pCi/l
GW-1035		<0.90					pCi/l
GW-1036		<0.90					pCi/l
GW-1037		<0.90					pCi/l
GW-1038		(0.500)					pCi/l
GW-1039		0.900					pCi/l
THORIUM-228							
GW-1002		<0.20					pCi/l
GW-1004		<0.20					pCi/l
GW-1005		<0.20					pCi/l
GW-1006		<0.20					pCi/l
GW-1007		<0.20					pCi/l
GW-1008		<0.20					pCi/l
GW-1009		<0.20					pCi/l
GW-1010		<0.20					pCi/l
GW-1011		<0.20					pCi/l
GW-1012		<0.20					pCi/l
GW-1013		<0.20					pCi/l
GW-1014		<0.20					pCi/l
GW-1015		<0.20					pCi/l
GW-1016		<0.20					pCi/l
GW-1026		<0.20					pCi/l
GW-1027		<0.20					pCi/l
GW-1028		<0.20					pCi/l
GW-1029		<0.20					pCi/l
GW-1030		1.20					pCi/l
GW-1031		<0.20					pCi/l
GW-1032		<0.20					pCi/l
GW-1034		<0.20					pCi/l
GW-1035		<0.20					pCi/l
GW-1036		<0.20					pCi/l
GW-1037		<0.20					pCi/l
GW-1038		<0.20					pCi/l
GW-1039		<0.20					pCi/l
THORIUM-230							
GW-1002		0.200					pCi/l
GW-1004		<0.20					pCi/l
GW-1005		1.00					pCi/l

TABLE B-1 Bimonthly Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
GW-1006		<0.20					pCi/l
GW-1007		0.300					pCi/l
GW-1008		<0.20					pCi/l
GW-1009		<0.20					pCi/l
GW-1010		<0.20					pCi/l
GW-1011		<0.20					pCi/l
GW-1012		0.300					pCi/l
GW-1013		<0.20					pCi/l
GW-1014		<0.20					pCi/l
GW-1015		1.50					pCi/l
GW-1016		<0.20					pCi/l
GW-1026		<0.20					pCi/l
GW-1027		<0.20					pCi/l
GW-1028		<0.20					pCi/l
GW-1029		<0.20					pCi/l
GW-1030		2.20					pCi/l
GW-1031		<0.20					pCi/l
GW-1032		<0.20					pCi/l
GW-1034		1.60					pCi/l
GW-1035		<0.20					pCi/l
GW-1036		<0.20					pCi/l
GW-1037		0.200					pCi/l
GW-1038		<0.20					pCi/l
GW-1039		<0.20					pCi/l
THORIUM-232							
GW-1002		<0.20					pCi/l
GW-1004		<0.20					pCi/l
GW-1005		<0.20					pCi/l
GW-1006		<0.20					pCi/l
GW-1007		<0.20					pCi/l
GW-1008		<0.20					pCi/l
GW-1009		<0.20					pCi/l
GW-1010		<0.20					pCi/l
GW-1011		<0.20					pCi/l
GW-1012		<0.20					pCi/l
GW-1013		<0.20					pCi/l
GW-1014		<0.20					pCi/l
GW-1015		<0.20					pCi/l
GW-1016		<0.20					pCi/l
GW-1026		<0.20					pCi/l
GW-1027		<0.20					pCi/l
GW-1028		<0.20					pCi/l

TABLE B-1 Bimonthly Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
GW-1029		<0.20					pCi/l
GW-1030		0.800					pCi/l
GW-1031		<0.20					pCi/l
GW-1032		<0.20					pCi/l
GW-1034		<0.20					pCi/l
GW-1035		<0.20					pCi/l
GW-1036		<0.20					pCi/l
GW-1037		<0.20					pCi/l
GW-1038		<0.20					pCi/l
GW-1039		<0.20					pCi/l
URANIUM, TOTAL							
GW-1002	2.92	1.20	2.00	<0.5	2.20	2.70	pCi/l
GW-1004	4400	5300	5900	6100	3800	2700	pCi/l
GW-1005	1700	1900	1600	2200	2100	1600	pCi/l
GW-1006	3160	3200	3500	4100	2300	3300	pCi/l
GW-1007	125	1700	400	59.0	140	300	pCi/l
GW-1008	5940	5600	4100	4800	3700	6000	pCi/l
GW-1009	2.14	4.40	4.70	10.0	4.70	0.820	pCi/l
GW-1010	<1.4	2.47	<0.20	<0.458	1.09	<0.20	pCi/l
GW-1011	NS	11.0	17.0	12.8	12.9	9.50	pCi/l
GW-1012	2.65	2.70	3.10	2.40	4.10	2.30	pCi/l
GW-1013	1050	800	880	920	750	830	pCi/l
GW-1014	802	920	1100	1100	870	930	pCi/l
GW-1015	1560	1400	1500	1500	1300	880	pCi/l
GW-1016	734	640	670	690	480	470	pCi/l
GW-1026	<0.577	0.680	0.500	<0.580	0.410	<0.20	pCi/l
GW-1027	1030	619	640	900	540	410	pCi/l
GW-1028	3.47	0.300	<0.580	<0.580	1.30	1000	pCi/l
GW-1029	2.72	2.20	2.10	<0.5	2.40	1.80	pCi/l
GW-1030	<27.	11.0	6.00	3.30	NS	8.80	pCi/l
GW-1031	20.2	17.0	28.0	26.0	23.0	17.0	pCi/l
GW-1032	1560	1300	1700	1600	1300	980	pCi/l
GW-1034	2.92	1.60	1.60	0.58	2.20	2.20	pCi/l
GW-1035	0.408	2.40	0.300	<0.500	0.750	<0.20	pCi/l
GW-1036	3.95	8.50	5.10	4.60	5.60	4.50	pCi/l
GW-1037	0.925	2.80	0.680	<0.580	0.600	0.950	pCi/l
GW-1038	1.76	2.80	2.70	2.40	2.70	3.10	pCi/l
GW-1039	<0.577	4.30	0.680	0.720	1.20	1.30	pCi/l

TABLE B-1 Bimonthly Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
URANIUM-234							
GW-1010	0.990						pCi/l
GW-1013	238						pCi/l
GW-1014	159						pCi/l
GW-1031	15.3						pCi/l
URANIUM-235							
GW-1010	<0.38						pCi/l
GW-1013	68.0						pCi/l
GW-1014	290						pCi/l
GW-1031	2.27						pCi/l
URANIUM-238							
GW-1010	0.730						pCi/l
GW-1013	368						pCi/l
GW-1014	394						pCi/l
GW-1031	11.3						pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
BROMIDE					
GW-2001	1.30	<0.750	<7.5[a]	<0.38	mg/l
GW-2002	<0.38	<1.89	<7.5[a]	<0.38	mg/l
GW-2003	<0.38	<1.89	<7.50	<7.50	mg/l
GW-2030	<0.250	<0.38	0.800	1.70	mg/l
GW-2032	<0.250	<3.79	<7.50[a]	<7.50[a]	mg/l
GW-2033	<0.250	0.420	1.10	0.520	mg/l
GW-3003	<7.50	<7.50	<7.50[a]	<7.50	mg/l
GW-3006	<0.38	<0.38	<0.38	<0.38	mg/l
GW-3008	<9.50[a]	<7.50[a]	<18.8[a]	<7.50[a]	mg/l
GW-3009	<3.79	<3.80	<3.80[a]	<5.15	mg/l
GW-3023	<3.79	<188[a]	<37.5[a]	<7.50[a]	mg/l
GW-4001	<3.79	2.50	<0.38	<7.5	mg/l
GW-4002	<0.38	<0.38	<0.38	<0.38	mg/l
GW-4003	0.440	<0.38	<0.38	<0.38	mg/l
GW-4004	2.20	<0.38	<0.38	<0.38	mg/l
GW-4005	0.420	1.60	<0.38	<0.38	mg/l
GW-4006	<0.38	0.570	<0.38	<0.38	mg/l
GW-4007	<0.38	<0.38	<0.38	<0.38	mg/l
GW-4008	0.590	<0.38	<0.38	<0.38	mg/l
GW-4009	<0.38	<0.38	<0.38	<0.38	mg/l
GW-4010	<0.38	0.980	<0.38	<0.38	mg/l
GW-4011	0.440	<3.80	<7.50	<3.80	mg/l
GW-4012	<0.38	<188[a]	<0.38	<0.38	mg/l
GW-4013	<0.250	<3.80	<3.80	25.6[a]	mg/l
GW-4014	<0.38	<0.38	<0.38	<0.38	mg/l
GW-4015	0.460	<0.38	<0.250	<0.38	mg/l
GW-4016	<0.38	<0.38	<0.250	<0.38	mg/l
GW-4017	0.260	<0.38	<0.38	<0.38	mg/l
GW-4018	<0.38	<0.38	<0.38	<0.38	mg/l
GW-4019	<0.38	1.39	<0.38	<0.38	mg/l
GW-4020	<0.38	1.39	<0.38	<0.38	mg/l
GW-4021	<0.38	<0.38	<0.38	<0.38	mg/l
GW-4022	<0.150	<0.38	0.550	<0.38	mg/l
GW-4023	<0.38	0.640	<0.38	<0.38	mg/l
GW-RMW1				<0.38	mg/l
GW-RMW2				<0.38	mg/l
GW-RMW3				<0.38	mg/l
GW-RMW4				<0.38	mg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
CHLORIDE					
GW-2001	7.00	5.50	5.80	5.80	mg/l
GW-2002	13.1	7.90	8.60	12.4	mg/l
GW-2003	8.90	9.19	6.70	9.20	mg/l
GW-2030	39.5	30.7	32.6	39.6	mg/l
GW-2032	21.4	16.2	17.4	21.6	mg/l
GW-2033	10.7	5.40	6.00	6.50	mg/l
GW-3003	12.3	10.1	10.4	16.7	mg/l
GW-3006	1.80	1.30	1.60	3.10	mg/l
GW-3008	21.5	17.6	22.0	19.6	mg/l
GW-3009	5.59	4.50	4.40	7.65	mg/l
GW-3023	17.2	17.7	14.4	16.9	mg/l
GW-4001	3.89	7.09	3.20	3.70	mg/l
GW-4002	1.80	1.30	1.50	2.40	mg/l
GW-4003	8.09	6.09	6.40	5.85	mg/l
GW-4004	9.19	3.39	3.40	3.50	mg/l
GW-4005	8.19	7.70	6.60	6.70	mg/l
GW-4006	2.39	2.00	1.60	2.40	mg/l
GW-4007	1.20	0.880	0.770	1.00	mg/l
GW-4008	3.29	0.980	0.930	0.880	mg/l
GW-4009	1.30	0.840	0.960	1.20	mg/l
GW-4010	1.89	2.40	1.39	1.90	mg/l
GW-4011	6.40	5.90	5.40	5.80	mg/l
GW-4012	2.79	10.0	2.50	2.50	mg/l
GW-4013	6.20	6.50	5.80	5.60	mg/l
GW-4014	4.09	2.60	4.20	4.30	mg/l
GW-4015	5.29	<0.250	2.10	3.20	mg/l
GW-4016	2.50	1.10	4.10	7.60	mg/l
GW-4017	2.39	1.60	1.60	1.70	mg/l
GW-4018	16.8	16.7	16.0	18.1	mg/l
GW-4019	1.60	2.50	0.990	1.70	mg/l
GW-4020	14.8	15.9	15.2	12.0	mg/l
GW-4021	1.80	1.20	1.20	1.80	mg/l
GW-4022	4.09	5.29	5.90	5.40	mg/l
GW-4023	14.9	12.4	14.9	32.2	mg/l
GW-RMW1				12.5	mg/l
GW-RMW2				6.80	mg/l
GW-RMW3				17.8	mg/l
GW-RMW4				5.50	mg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
NITRATE-N					
GW-1017	0.280	<0.10	<0.10	<0.10	mg/l
GW-1018	<0.01	<0.10	<0.20	<0.10	mg/l
GW-1019	<0.01	<0.10	<0.10	<0.10	mg/l
GW-1020	<0.01	<0.10	0.170	<0.10	mg/l
GW-1021	<0.20	<0.10	<0.10	<0.10	mg/l
GW-1022	<0.20	<0.10	0.120	<0.10	mg/l
GW-1023	0.280	<0.10	<0.20	<0.10	mg/l
GW-1024	<0.01	<0.10	<0.20	0.150	mg/l
GW-1033	0.140	<0.10	<0.10	<0.10	mg/l
GW-2001	26.2	22.0	30.6	34.6	mg/l
GW-2002	312	181	264	450	mg/l
GW-2003	339	266	229	209	mg/l
GW-2004		0.780	0.260		mg/l
GW-2005	69.8		62.8		mg/l
GW-2006	6.20		1.00		mg/l
GW-2007	0.200		<0.20		mg/l
GW-2008	3.29		0.840		mg/l
GW-2009	1.60		1.30		mg/l
GW-2010	1.30		0.770		mg/l
GW-2011		5.50	4.90		mg/l
GW-2012		0.710	0.370		mg/l
GW-2013	1.10		0.600		mg/l
GW-2014		1.00	0.820		mg/l
GW-2015	0.520		0.150		mg/l
GW-2017		0.110	0.280		mg/l
GW-2018		0.240	0.400		mg/l
GW-2019		<0.10	<0.10		mg/l
GW-2020		0.520		0.230	mg/l
GW-2021		0.200		<0.10	mg/l
GW-2022		0.250	<0.10		mg/l
GW-2023		0.460	0.110		mg/l
GW-2024		0.220	0.100		mg/l
GW-2025		<0.10	0.080		mg/l
GW-2026		<0.10		<0.10	mg/l
GW-2027		<0.10	<0.10		mg/l
GW-2028		<0.10	<0.500		mg/l
GW-2029		0.120	0.310		mg/l
GW-2030	1.50	1.20	1.40	0.840	mg/l
GW-2032	119	86.0	55.0	111	mg/l
GW-2033	0.790	0.960	0.740	1.00	mg/l
GW-2034		0.180	0.130		mg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-3003	312	252	338	467	mg/l
GW-3006	<0.10	0.440	0.070	0.240	mg/l
GW-3008	844	644	623	698	mg/l
GW-3009	109	3250[a]	60.8	283	mg/l
GW-3019	<0.20		<0.10		mg/l
GW-3023	308	316	495	454	mg/l
GW-4001	32.5	<2.50[a]	32.6	31.8	mg/l
GW-4002	0.940	0.980	6.00	2.70	mg/l
GW-4003	0.760	0.600	0.910	0.760	mg/l
GW-4004	0.800	1.00	0.940	0.760	mg/l
GW-4005	2.00	2.00	2.00	9.70	mg/l
GW-4006	5.20	4.20	4.40	4.90	mg/l
GW-4007	0.190	0.980	0.250	0.100	mg/l
GW-4008	<0.050	0.170	0.030	<0.10	mg/l
GW-4009	0.630	0.190	0.170	0.130	mg/l
GW-4010	0.220	0.130	0.160	0.160	mg/l
GW-4011	30.6	37.1	28.9	46.7	mg/l
GW-4012	0.170	1180[a]	0.060	0.300	mg/l
GW-4013	5.20[a]	85.6	49.7	62.8	mg/l
GW-4014	5.20	1.10	0.020	5.30	mg/l
GW-4015	0.200	2.90	1.40	1.60	mg/l
GW-4016	316[a]	<0.060	<5.00	37.0[a]	mg/l
GW-4017	0.450	0.450	0.450	0.480	mg/l
GW-4018	6.29	2.00	2.40	2.10	mg/l
GW-4019	0.230	0.400	0.410	0.280	mg/l
GW-4020	0.110	0.340	2.80	<0.10	mg/l
GW-4021	<0.10	<0.10	0.120	<0.10	mg/l
GW-4022	0.230	0.410	0.380	0.240	mg/l
GW-4023	1.89	3.60	4.00	4.40	mg/l
GW-FINW	0.770				mg/l
GW-PW02	<0.01				mg/l
GW-PW03	<0.01				mg/l
GW-PW04	<0.01				mg/l
GW-PW05	<0.01				mg/l
GW-PW06	<0.01				mg/l
GW-PW07	<0.01				mg/l
GW-PW08	53.1				mg/l
GW-PW09	<0.01				mg/l
GW-RAWW	<0.01				mg/l
GW-RMW1	<0.01	<0.10	<0.20	0.100	mg/l
GW-RMW2	<0.01	<0.10	<0.5	0.190	mg/l
GW-RMW3	<0.01	<0.10	<0.20	0.160	mg/l
GW-RMW4	<0.01	0.790	<0.20	1.10	mg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
NITRITE-N					
GW-2001	<5.0[a]	<2.50[a]	0.010	<0.10	mg/l
GW-2002	<20[a]	<0.10	<0.01	<0.10	mg/l
GW-2003	<100[a]	<0.10	<0.01	96.8[a]	mg/l
GW-2030	0.010	<0.10	<0.20	<0.10	mg/l
GW-2032	0.010	0.120	<0.10	<0.10	mg/l
GW-2033	0.010	<0.10	<0.10	<0.10	mg/l
GW-3003	<0.10	<0.10	0.030	0.180	mg/l
GW-3006	<0.10	<0.10	<0.01	<0.10	mg/l
GW-3008	<0.10	<0.10	<0.10	<0.10	mg/l
GW-3009		0.340	60.8	<0.10	mg/l
GW-3023	1.30	0.890	1.00	1.00	mg/l
GW-4001	<2.5	<0.10	<0.01	<0.10	mg/l
GW-4002	<0.10	<0.10	0.010	<0.10	mg/l
GW-4003	0.110	<0.10	<0.01	<0.10	mg/l
GW-4004	0.050	<0.10	<0.10	<0.10	mg/l
GW-4005	<0.2	<0.10	<0.01	<0.10	mg/l
GW-4006	<1.0	<0.10	<0.10	<0.10	mg/l
GW-4007	<0.10	0.010	<0.10	<0.10	mg/l
GW-4008	<0.050	<0.10	<0.01	<0.10	mg/l
GW-4009	<0.10	<0.10	<0.10	<0.10	mg/l
GW-4010	<0.10	<0.10	<0.10	<0.10	mg/l
GW-4011	<0.050	<0.10	<0.10	<0.10	mg/l
GW-4012	<0.10	<0.10	<0.01	<0.10	mg/l
GW-4013	0.010	<0.10	<0.01	<0.10	mg/l
GW-4014	<0.01	<0.10	0.100	<0.10	mg/l
GW-4015	<0.10	<0.10	<0.01	<0.10	mg/l
GW-4016	<1.00	<0.060	<5.00[a]	<25[a]	mg/l
GW-4017	<0.10	<0.10	<0.01	<0.10	mg/l
GW-4018	<0.5	<0.10	<0.01	<0.10	mg/l
GW-4019	<0.10	<0.10	<0.10	<0.10	mg/l
GW-4020	<0.10	<0.10	<0.01	<0.10	mg/l
GW-4021	<0.10	<0.10	<0.10	<0.10	mg/l
GW-4022	<0.10	<0.10	<0.10	<0.10	mg/l
GW-4023	<0.10	<0.10	<0.01	<0.10	mg/l
GW-RMW1				<0.10	mg/l
GW-RMW2				<0.10	mg/l
GW-RMW3				<0.10	mg/l
GW-RMW4				<0.10	mg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
SULFATE					
GW-1017	2.10	0.600	<0.250	0.510	mg/l
GW-1018	35.0	50.7	100	96.0	mg/l
GW-1019	3.70	1.10	0.850	0.390	mg/l
GW-1020	18.9	43.9	41.9	11.0	mg/l
GW-1021	<0.250	<0.250	1.80	1.50	mg/l
GW-1022	<0.250	<0.250	0.330	0.430	mg/l
GW-1023	8.00	9.30	4.00	3.90	mg/l
GW-1024	1.39	<0.250	3.10	3.30	mg/l
GW-1033	12.5	10.0	10.0	9.60	mg/l
GW-2001	8.50	8.09	8.70	8.60	mg/l
GW-2002	132	89.8	118	126	mg/l
GW-2003	134	106	92.7	137	mg/l
GW-2004		1.80	1.90		mg/l
GW-2005	26.4		25.6		mg/l
GW-2006	34.8		32.2		mg/l
GW-2007	15.3		14.7		mg/l
GW-2008	40.0		38.0		mg/l
GW-2009	105		110		mg/l
GW-2010	32.5		30.7		mg/l
GW-2011		12.8	13.0		mg/l
GW-2012		78.1	67.1		mg/l
GW-2013	15.3		20.2		mg/l
GW-2014		33.6	33.3		mg/l
GW-2015	96.2		125		mg/l
GW-2017		754	701		mg/l
GW-2018		9.19	9.70		mg/l
GW-2019		42.4	41.7		mg/l
GW-2020		130		139	mg/l
GW-2021		13.0		14.0	mg/l
GW-2022		14.2	14.0		mg/l
GW-2023		15.5	14.4		mg/l
GW-2024		30.0	28.7		mg/l
GW-2025		20.0	15.8		mg/l
GW-2026		14.4		14.0	mg/l
GW-2027		7.40	11.4		mg/l
GW-2028		121	125		mg/l
GW-2029		23.4	24.5		mg/l
GW-2030	43.7	41.6	39.5	42.7	mg/l
GW-2032	56.2	53.2	55.0	60.3	mg/l
GW-2033	23.6	24.2	28.4	28.7	mg/l
GW-2034		623	645		mg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-3003	128	181	152	172	mg/l
GW-3006	23.8	22.0	22.7	22.4	mg/l
GW-3008	77.4	77.2	85.9	82.8	mg/l
GW-3009	82.1	85.3	84.9	20.7	mg/l
GW-3019	7.00		6.40		mg/l
GW-3023	353	343	305	323	mg/l
GW-4001	63.9	67.3	65.6	59.4	mg/l
GW-4002	14.1	15.4	15.3	19.6	mg/l
GW-4003	33.5	33.6	34.0	32.0	mg/l
GW-4004	26.5	19.7	19.9	19.1	mg/l
GW-4005	25.3	24.7	20.6	25.5	mg/l
GW-4006	29.9	28.0	28.4	27.5	mg/l
GW-4007	14.5	12.9	12.8	11.2	mg/l
GW-4008	14.9	14.0	14.0	13.8	mg/l
GW-4009	18.3	13.9	16.2	13.3	mg/l
GW-4010	25.2	22.0	22.3	21.9	mg/l
GW-4011	58.8	53.8	54.8	59.4	mg/l
GW-4012	55.5	47.9	46.7	47.2	mg/l
GW-4013	43.5	45.1	39.7	51.7	mg/l
GW-4014	27.8	25.5	26.8	27.0	mg/l
GW-4015	13.3	16.9	7.10	13.2	mg/l
GW-4016	14.8	14.9	17.6	21.4	mg/l
GW-4017	6.40	6.20	5.60	7.60	mg/l
GW-4018	8.00	6.70	6.50	7.70	mg/l
GW-4019	11.6	6.40	6.30	9.20	mg/l
GW-4020	133	134	129	119	mg/l
GW-4021	274	255	264	245	mg/l
GW-4022	37.5	29.0	37.8	37.5	mg/l
GW-4023	76.2	68.5	68.2	145	mg/l
GW-FINW	92.4				mg/l
GW-PW02	114				mg/l
GW-PW03	104				mg/l
GW-PW04	107				mg/l
GW-PW05	77.3				mg/l
GW-PW06	97.9				mg/l
GW-PW07	66.8				mg/l
GW-PW08	53.1				mg/l
GW-PW09	40.0				mg/l
GW-RAWW	91.7				mg/l
GW-RMW1	41.6	23.0	25.9	27.8	mg/l
GW-RMW2	21.7	58.4	12.3	23.2	mg/l
GW-RMW3	2.70	7.29	5.10	10.5	mg/l
GW-RMW4	30.4	34.8	23.4	24.7	mg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
ALUMINUM					
GW-2001	NS	<46.0	<35.0	<49.0	µg/l
GW-2002	NS	<46.0	<35.0	<49.0	µg/l
GW-2003	NS	<46.0	<35.0	<49.0	µg/l
GW-2030	2270[c]	650[c]	<35.0	<49.0	µg/l
GW-2032	13000[c]	6050[c]	<35.0	<49.0	µg/l
GW-2033	1550[c]	1130[c]	<35.0	<49.0	µg/l
GW-3003	<91.0	<46.0	337	<49.0	µg/l
GW-3006	<91.0	<46.0	38.2[c]	<49.0	µg/l
GW-3008	127[c]	<35.0	<49.0	<64.0	µg/l
GW-3009	<91.0	<35.0	<35.0	<49.0	µg/l
GW-3023	579[c]	674[c]	164	<49.0	µg/l
GW-4001	NS	<46.0	<35.0[a]	<49.0[a]	µg/l
GW-4002	<91.0	<46.0	<35.0	<64.0	µg/l
GW-4003	NS	<46.0	<35.0	(39.3)	µg/l
GW-4004	<91.0	<46.0	<35.0	<49.0	µg/l
GW-4005	<91.0	<46.0[a]	<35.0	<64.0	µg/l
GW-4006	NS	<46.0	132	<49.0	µg/l
GW-4007	258[c]	<35.0	<35.0[c]	<64.0	µg/l
GW-4008	<91.0	<46.0	<35.0	<49.0	µg/l
GW-4009	<91.0	<46.0	<35.0	<64.0	µg/l
GW-4010	<91.0	<46.0	<35.0	<49.0	µg/l
GW-4011	<91.0	<46.0[a]	<35.0	<49.0	µg/l
GW-4012	<91.0	<35.0	<35.0	<49.0	µg/l
GW-4013	<91.0	<35.0	84.8	<49.0	µg/l
GW-4014	<91.0	<35.0	<35.0	<49.0	µg/l
GW-4015	<91.0	<35.0	<35.0	<49.0	µg/l
GW-4016	<91.0	<35.0	1340[c]	<49.0	µg/l
GW-4017	30.5	235[c]	35.4[c]	<49.0	µg/l
GW-4018	<91.0	<35.0	<35.0	<64.0	µg/l
GW-4019	<91.0	<46.0	<35.0	<64.0	µg/l
GW-4020	<91.0	<35.0	41.4	<49.0	µg/l
GW-4021	<91.0	<35.0	<35.0	<49.0	µg/l
GW-4022	9150[c]	26000[c]	347	<49.0	µg/l
GW-4023	<91.0	<35.0	<35.0	<49.0	µg/l
GW-RMW1				<64.0	µg/l
GW-RMW2				<64.0	µg/l
GW-RMW3				<64.0	µg/l
GW-RMW4				<64.0	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
ARSENIC					
GW-1017	146	128	144	179	µg/l
GW-1018	123	102	127	103	µg/l
GW-1019	69.8	71.5	69.2	79.0	µg/l
GW-1020	27.4	32.5	20.5	22.2	µg/l
GW-1021	76.0	71.2	52.0	78.2	µg/l
GW-1022	147	146	138	169	µg/l
GW-1023	72.0	55.3	68.0	71.2	µg/l
GW-1024	10.6	10.5	7.90	7.00	µg/l
GW-1033	<2.00	<2.00	<2.00	<2.00	µg/l
GW-2001	<2.00	<2.00	<2.00	<2.00	µg/l
GW-2002	<2.00	<2.00	<2.00	<2.00	µg/l
GW-2003	<2.00	<2.00	<2.00	<2.00	µg/l
GW-2030	<2.00	<2.00	<2.00	<2.00	µg/l
GW-2032	2.89	<2.00	<2.00	<2.00	µg/l
GW-2033	3.39	<2.00	<2.00	<2.00	µg/l
GW-3003	<2.00	<2.00	<2.00	<2.00	µg/l
GW-3006	<2.00	2.60	2.20	2.50	µg/l
GW-3008	<2.00	<2.00	3.10	<2.00	µg/l
GW-3009	<2.00	<2.00	<2.00	<2.00	µg/l
GW-3023	NS	<2.00	<2.00	<2.00	µg/l
GW-4001	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4002	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4003	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4004	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4005	<2.00	<2.00[a]	<2.00	<2.00	µg/l
GW-4006	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4007	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4008	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4009	4.20	<2.00	<2.00	<2.00	µg/l
GW-4010	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4011	<2.00	2.00[a]	2.00	2.50	µg/l
GW-4012	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4013	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4014	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4015	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4016	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4017	<1.00	<2.00	<2.00	<2.00	µg/l
GW-4018	<2.00	<2.00	<2.00	<2.00	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-4019	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4020	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4021	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4022	<1.20	4.00	<2.00	<2.00	µg/l
GW-4023	<2.00	<2.00	<2.00	<2.00	µg/l
GW-FINW	<2.00	<2.00	<2.00	<2.00	µg/l
GW-PW02	<2.00	<2.00	<2.00	<2.00	µg/l
GW-PW03	<2.00	<2.00	<2.00	<2.00	µg/l
GW-PW04	<2.00	<2.00	<2.00	<2.00	µg/l
GW-PW05	<2.00	<2.00	<2.00	<2.00	µg/l
GW-PW06	<2.00	<2.00	<2.00	<2.00	µg/l
GW-PW07	<2.00	2.29	<2.00	<2.00	µg/l
GW-PW08	2.39	3.39	2.30	2.98	µg/l
GW-PW09	2.79	3.50	3.20	4.98	µg/l
GW-RAWW	<2.00	<2.00	<2.00	<2.00	µg/l
GW-RMW1	7.70	7.00	4.80	6.35	µg/l
GW-RMW2	14.1	13.0	14.2	15.5	µg/l
GW-RMW3	39.3	34.3	26.1	28.3	µg/l
GW-RMW4	26.5	6.79	26.1	8.40	µg/l
BARIUM					
GW-1017	985	996	1000	950	µg/l
GW-1018	581	633	719	674	µg/l
GW-1019	838	818	852	842	µg/l
GW-1020	413	412	398	411	µg/l
GW-1021	899	849	803	76	µg/l
GW-1022	584	531	524	567	µg/l
GW-1023	316	293	323	320	µg/l
GW-1024	550	134	508	513	µg/l
GW-1033	241	320	398	596	µg/l
GW-2001	227	233	202	241	µg/l
GW-2002	213	148	163	203	µg/l
GW-2003	136	175	141	195	µg/l
GW-2030	255[c]	187[c]	175	204	µg/l
GW-2032	660[c]	440[c]	369	377	µg/l
GW-2033	176[c]	172[c]	66.9	68.7	µg/l
GW-3003	168	140	142	158	µg/l
GW-3006	145	134	154[c]	157	µg/l
GW-3008	248	214	200	181	µg/l
GW-3009	979	856	804	1930	µg/l
GW-3023	NS	86.5[c]	51.3	40.9	µg/l
GW-4001	101	90.4	73.9	114	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-4002	115	118	126	132	µg/l
GW-4003	224	163	193	218	µg/l
GW-4004	55.2	83.3	118	136	µg/l
GW-4005	82.0	130[a]	93.0	112	µg/l
GW-4006	170	161	181	186	µg/l
GW-4007	75.9[c]	91.0	93.3[c]	100	µg/l
GW-4008	108	105	106	108	µg/l
GW-4009	26.2	53.5	79.3	70.6	µg/l
GW-4010	69.4	74.1	84.5	86.4	µg/l
GW-4011	109	88.5[a]	142	167	µg/l
GW-4012	40.2	53.9	54.6	19.6	µg/l
GW-4013	147	136	141	117	µg/l
GW-4014	117	102	116	103	µg/l
GW-4015	190	221	274	209	µg/l
GW-4016	240	269	286[c]	236	µg/l
GW-4017	164	179[c]	188[c]	194	µg/l
GW-4018	206	225	205	202	µg/l
GW-4019	187	206	181	230	µg/l
GW-4020	92.8	89.1	85.8	73.0	µg/l
GW-4021	37.5	38.3	42.2	34.5	µg/l
GW-4022	301[c]	344[c]	83.5	88.8	µg/l
GW-4023	91.3	82.4	89.1	84.8	µg/l
GW-FINW	89.0	103	134	90.0	µg/l
GW-PW02	347	335	321	304	µg/l
GW-PW03	278	313	249	284	µg/l
GW-PW04	281	287	283	311	µg/l
GW-PW05	332	355	398	341	µg/l
GW-PW06	284	334	328	322	µg/l
GW-PW07	468	476	470	346	µg/l
GW-PW08	426	446	464	462	µg/l
GW-PW09	496	485	528	519	µg/l
GW-RAWW	363	369	372	349	µg/l
GW-RMW1	423	481	474	493	µg/l
GW-RMW2	265	237	319	260	µg/l
GW-RMW3	629	646	727	640	µg/l
GW-RMW4	225	165	231	167	µg/l
CADMIUM					
GW-PW02	<3.00				µg/l
GW-PW03	<3.00				µg/l
GW-PW04	<3.00				µg/l
GW-PW05	<3.00				µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-PW06	<3.00				µg/l
GW-PW07	<3.00				µg/l
GW-PW08	<3.00				µg/l
GW-PW09	<3.00				µg/l
CALCIUM					
GW-2001	93200	93800	81000	98000	µg/l
GW-2002	315000	218000	242000	297000	µg/l
GW-2003	256000	279000	222000	278000	µg/l
GW-2030	153000[c]	123000[c]	126000	143000	µg/l
GW-2032	242000[c]	188000[c]	193000	194000	µg/l
GW-2033	252000[c]	238000[c]	132000	137000	µg/l
GW-3003	230000	221000	238000	250000	µg/l
GW-3006	63500	61100	63900[c]	67300	µg/l
GW-3008	549000	503000	493000	469000	µg/l
GW-3009	12400	104000	108000	203000	µg/l
GW-3023	366000[c]	329000[c]	335000	327000	µg/l
GW-4001	88400	90600	83900	93100	µg/l
GW-4002	44500	45600	48700	50500	µg/l
GW-4003	60500	50700	57400	60500	µg/l
GW-4004	31600	30200	31700	34200	µg/l
GW-4005	45700	64600[a]	43900	55200	µg/l
GW-4006	51600	46300	50900	53200	µg/l
GW-4007	29400[c]	32000	97900[c]	33900	µg/l
GW-4008	38700	37800	37500	38700	µg/l
GW-4009	14000	32400	35700	35300	µg/l
GW-4010	55400	50900	57800	58000	µg/l
GW-4011	59100	46600[a]	72600	81800	µg/l
GW-4012	25400	32100	29700	12500	µg/l
GW-4013	143000	134000	129000	111000	µg/l
GW-4014	65200	57700	63200	57500	µg/l
GW-4015	55100	55900	57400	58100	µg/l
GW-4016	42000	46000	69500[c]	44800	µg/l
GW-4017	62500	58800[c]	59600[c]	70500	µg/l
GW-4018	9660[a]	106000	95300	94500	µg/l
GW-4019	38400	36800	38300	43400	µg/l
GW-4020	93700	94000	50100	93700	µg/l
GW-4021	118000	121000	120000	105000	µg/l
GW-4022	96100[c]	96400[c]	30000	49000	µg/l
GW-4023	96600	86500	89700	90400	µg/l
GW-RMW1				121000	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-RMW2				124000	µg/l
GW-RMW3				126000	µg/l
GW-RMW4				113000	µg/l
CHROMIUM					
GW-2001	<6.00	<7.00	<8.00	<9.00	µg/l
GW-2002	<6.00	<7.00	<8.00	<9.00	µg/l
GW-2003	<6.00	<7.00	<8.00	<9.00	µg/l
GW-2030	<6.00[c]	<7.00[c]	<8.00	<9.00	µg/l
GW-2032	21.7[c]	11.1[c]	<8.00	<9.00	µg/l
GW-2033	<6.00[c]	<7.00[c]	<8.00	<9.00	µg/l
GW-3003	<6.00	<7.00	<8.00	<9.00	µg/l
GW-3006	<6.00	<7.00	<8.00[c]	<9.00	µg/l
GW-3008	<6.00	<8.00	<9.00	<7.00	µg/l
GW-3009	<6.00	<8.00	<8.00	<8.00	µg/l
GW-3023	<6.00[c]	<8.00[c]	<8.00	<9.00	µg/l
GW-4001	<6.00	<7.00	<8.00	<9.00	µg/l
GW-4002	<6.00	<7.00	<8.00	<7.00	µg/l
GW-4003	<6.00	<7.00	<8.00	<9.00	µg/l
GW-4004	<6.00	<7.00	<8.00	<9.00	µg/l
GW-4005	<6.00	<7.00[a]	<8.00	10.9	µg/l
GW-4006	<6.00	<7.00	<8.00	<9.00	µg/l
GW-4007	<6.00[c]	<8.00	<8.00[c]	<7.00	µg/l
GW-4008	<6.00	<7.00	<8.00	<9.00	µg/l
GW-4009	8.40	<7.00	<8.00	<7.00	µg/l
GW-4010	<6.00	<7.00	<8.00	<9.00	µg/l
GW-4011	<6.00	<7.00[a]	<8.00	<9.00	µg/l
GW-4012	59.0	54.4	50.8	64.0	µg/l
GW-4013	<6.00	<8.00	<8.00	<9.00	µg/l
GW-4014	<6.00	<8.00	<8.00	<9.00	µg/l
GW-4015	<6.00	<8.00	<8.00	<9.00	µg/l
GW-4016	<6.00	<8.00	60.6[c]	<9.00	µg/l
GW-4017	<5.00	13.2[c]	<8.00[c]	<9.00	µg/l
GW-4018	<6.00	<8.00	<8.00	<7.00	µg/l
GW-4019	<6.00	<7.00	<8.00	<7.00	µg/l
GW-4020	26.6	15.8	<8.00	<9.00	µg/l
GW-4021	<6.00	<8.00	<8.00	<9.00	µg/l
GW-4022	74.2[c]	87.8[c]	<8.00	<9.00	µg/l
GW-4023	<6.00	<8.00	<8.00	<9.00	µg/l
GW-RMW1				<7.00	µg/l
GW-RMW2				<7.00	µg/l
GW-RMW3				<7.00	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-RMW4				<7.00	µg/l
IRON					
GW-2001	<46.0	<30.0	<19.0	<15.0	µg/l
GW-2002	<46.0	<30.0	<19.0	234	µg/l
GW-2003	<46.0	<30.0	<19.0	28.3	µg/l
GW-2030	4780[c]	1420[c]	<19.0	52.5	µg/l
GW-2032	23300[c]	13500[c]	<19.0	26.6	µg/l
GW-2033	4780[c]	3830[c]	<19.0	16.4	µg/l
GW-3003	<46.0	<30.0	41.4	<15.0	µg/l
GW-3006	138	123	205[c]	160	µg/l
GW-3008	456	<19.0	<15.0	<10.0	µg/l
GW-3009	<46.0	19.4	20.7	<15.0	µg/l
GW-3023	1730[c]	1530[c]	80.2	<15.0	µg/l
GW-4001	<46.0	<30.0	<19.0	<15.0	µg/l
GW-4002	<46.0	42.5	95.1	53.1	µg/l
GW-4003	<46.0	<30.0	<19.0	27.9	µg/l
GW-4004	<46.0	<30.0	<19.0	<15.0	µg/l
GW-4005	<46.0	<30.0	<19.0	<10.0	µg/l
GW-4006	<46.0	<30.0	<19.0	<15.0	µg/l
GW-4007	120[c]	<19.0	<19.0[c]	<10.0	µg/l
GW-4008	<46.0	<30.0	<19.0	<15.0	µg/l
GW-4009	<46.0	<30.0	<19.0	12.4	µg/l
GW-4010	<46.0	40.5	<19.0	<15.0	µg/l
GW-4011	<46.0	<30.0	<19.0	<15.0	µg/l
GW-4012	<46.0	22.2	<19.0	<15.0	µg/l
GW-4013	<46.0	<19.0	<19.0	33.9	µg/l
GW-4014	74.4	66.3	61.7	80.8	µg/l
GW-4015	<46.0	<19.0	<19.0	15.0	µg/l
GW-4016	<46.0	<19.0	4330[c]	82.6	µg/l
GW-4017	88.6	1200[c]	45.8[c]	<15.0	µg/l
GW-4018	<46.0	<19.0	<19.0	11.0	µg/l
GW-4019	<46.0	<30.0	<19.0	10.1	µg/l
GW-4020	<46.0	<19.0	<19.0	<15.0	µg/l
GW-4021	<46.0	21.7	22.1	34.8	µg/l
GW-4022	18600[c]	42400[c]	150	21.0	µg/l
GW-4023	<46.0	<19.0	<19.0	<15.0	µg/l
GW-RMW1				7970	µg/l
GW-RMW2				2800	µg/l
GW-RMW3				11800	µg/l
GW-RMW4				344	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
LEAD					
GW-2001	NS	<2.00	<2.00	3.40	µg/l
GW-2002	NS	<2.00	<2.00	4.10	µg/l
GW-2003	NS	<2.00	<2.00	2.90	µg/l
GW-2030	26.3[c]	8.59[c]	<2.00	<2.00	µg/l
GW-2032	33.7[c]	18.8[c]	2.00	2.10	µg/l
GW-2033	37.6[c]	26.0[c]	<2.00	<2.00	µg/l
GW-3003	2.70	<2.00	<2.00	<2.00	µg/l
GW-3006	<2.00	<2.00	<2.00[c]	<2.00	µg/l
GW-3008	4.59	3.20	<2.00	<2.00	µg/l
GW-3009	<2.00	<2.00	7.40	<2.00	µg/l
GW-3023	18.6[c]	12.0[c]	<2.00	<2.00	µg/l
GW-4001	NS	<2.00	3.10	<2.00	µg/l
GW-4002	<2.00	<2.00	<2.00	5.50	µg/l
GW-4003	NS	2.50	<2.00	(1.65)	µg/l
GW-4004	7.00	<2.00	2.60	2.90	µg/l
GW-4005	21.4	<2.00[a]	13.3	21.6	µg/l
GW-4006	NS	<2.00	<2.00	<2.00	µg/l
GW-4007	22.0[c]	3.70	<2.00[c]	<2.00	µg/l
GW-4008	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4009	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4010	<2.00	12.8	13.6	12.1	µg/l
GW-4011	<2.00	<2.00[a]	<2.00	<2.00	µg/l
GW-4012	2.39	<2.00	<2.00	<2.00	µg/l
GW-4013	<2.0	<2.00	<2.00	<2.00	µg/l
GW-4014	2.00	<2.00	<2.00	<2.00	µg/l
GW-4015	4.00	<2.00	<2.00	<2.00	µg/l
GW-4016	3.29	<2.00	199[c]	<20.0	µg/l
GW-4017	<1.00	18.3[c]	<2.00[c]	<2.00	µg/l
GW-4018	2.70	6.79	<2.00	<2.00	µg/l
GW-4019	13.7	<2.00	2.20	<2.00	µg/l
GW-4020	2.39	2.50	<2.00	<2.00	µg/l
GW-4021	4.50	<2.00	<2.00	<2.00	µg/l
GW-4022	200[c]	40.0[c]	<2.00	<2.00	µg/l
GW-4023	9.09	<2.00	<2.00	<2.00	µg/l
GW-PW02	4.90				µg/l
GW-PW03	2.70				µg/l
GW-PW04	<2.00				µg/l
GW-PW05	<2.00				µg/l
GW-PW06	<2.00				µg/l
GW-PW07	<2.00				µg/l
GW-PW08	<2.00				µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-PW09	<2.00				µg/l
GW-RMW1				<2.00	µg/l
GW-RMW2				3.20	µg/l
GW-RMW3				<2.00	µg/l
GW-RMW4				<2.00	µg/l
LITHIUM					
GW-2001	<100	<23.0	<24.0	<27.0	µg/l
GW-2002	521	303	381	529	µg/l
GW-2003	455	480	388	535	µg/l
GW-2030	<100[c]	<23.0[c]	<24.0	<27.0	µg/l
GW-2032	<100[c]	35.4[c]	<24.0	<27.0	µg/l
GW-2033	<100[c]	<23.0[c]	<24.0	<27.0	µg/l
GW-3003	511	465	511	494	µg/l
GW-3006	<100	<23.0	<24.0[c]	<27.0	µg/l
GW-3008	277	246	282	252	µg/l
GW-3009	<100	<24.0	<24.0	(25.6)	µg/l
GW-3023	905[c]	794[c]	849	804	µg/l
GW-4001	<100	<23.0	<24.0	<27.0	µg/l
GW-4002	<100	<23.0	<24.0	<29.0	µg/l
GW-4003	<100	<23.0	<24.0	<27.0	µg/l
GW-4004	<100	<23.0	<24.0	<27.0	µg/l
GW-4005	<100	30.5[a]	<24.0	<29.0	µg/l
GW-4006	<100	<23.0	<24.0	<27.0	µg/l
GW-4007	<100[c]	<24.0	<24.0[c]	<29.0	µg/l
GW-4008	<100	<23.0	<24.0	<27.0	µg/l
GW-4009	<100	38.2	28.7	<29.0	µg/l
GW-4010	<100	<23.0	<24.0	<27.0	µg/l
GW-4011	<100	<23.0[a]	35.2	<27.0	µg/l
GW-4012	<100	42.4	41.2	57.1	µg/l
GW-4013	<100	51.4	66.1	50.3	µg/l
GW-4014	<100	<24.0	<24.0	<27.0	µg/l
GW-4015	<100	35.4	<24.0	<27.0	µg/l
GW-4016	<100	<24.0	<24.0[c]	<27.0	µg/l
GW-4017	<100[c]	<24.0[c]	<24.0	<27.0	µg/l
GW-4018	<100	<24.0	<24.0	<29.0	µg/l
GW-4019	<100	<23.0	<24.0	<29.0	µg/l
GW-4020	<100	<24.0	24.6	<27.0	µg/l
GW-4021	<100	<24.0	<24.0	46.3	µg/l
GW-4022	<100	32.9	31.1	<27.0	µg/l
GW-4023	<100	<24.0	<24.0	29.3	µg/l
GW-RMW1				32.7	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-RMW2				38.2	µg/l
GW-RMW3				37.9	µg/l
GW-RMW4				<29.0	µg/l
MAGNESIUM					
GW-2001	43500	45400	39400	47200	µg/l
GW-2002	103000	63100	69800	99000	µg/l
GW-2003	87400	107000	83800	101000	µg/l
GW-2030	24000[c]	20100[c]	20700	23600	µg/l
GW-2032	69000[c]	54200[c]	54600	55200	µg/l
GW-2033	20000[c]	18900[c]	18700	20400	µg/l
GW-3003	138000	130000	145000	149000	µg/l
GW-3006	51800	49400	51500[c]	53300	µg/l
GW-3008	153000	145000	137000	130000	µg/l
GW-3009	64300	62500	63400	96900	µg/l
GW-3023	84800[c]	75100[c]	76700	74500	µg/l
GW-4001	33600	33700	31400	35500	µg/l
GW-4002	32000	31800	33200	34000	µg/l
GW-4003	37500	30700	35500	37950	µg/l
GW-4004	28900	28000	29600	31900	µg/l
GW-4005	27600	40200[a]	26300	32900	µg/l
GW-4006	22500	20600	22600	23300	µg/l
GW-4007	21100[c]	22200	60300[c]	23400	µg/l
GW-4008	33000	31800	31800	32400	µg/l
GW-4009	8070[a]	21100	26800	25600	µg/l
GW-4010	39800	37000	41900	42400	µg/l
GW-4011	40000	27100[a]	39800	43300	µg/l
GW-4012	34600	33800	32600	29700	µg/l
GW-4013	52000	48600	49000	42700	µg/l
GW-4014	44000	40900	43200	38600	µg/l
GW-4015	28100	28500	30500	29600	µg/l
GW-4016	28200	31100	36200[c]	29900	µg/l
GW-4017	41100	38100[c]	38700[c]	46200	µg/l
GW-4018	53800	58800	53100	52600	µg/l
GW-4019	45700	42600	44800	50300	µg/l
GW-4020	62200	58400	47100	59300	µg/l
GW-4021	117000	117000	113000	98700	µg/l
GW-4022	46500[c]	46400[c]	21300	44700	µg/l
GW-4023	39700	35800	37400	37100	µg/l
GW-RMW1				28500	µg/l
GW-RMW2				25700	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-RMW3				35600	µg/l
GW-RMW4				24400	µg/l
MANGANESE					
GW-2001	<2.00	<2.00	7.90	<4.00	µg/l
GW-2002	<2.00	<2.00	<2.00	<4.00	µg/l
GW-2003	<2.00	<2.00	<2.00	<4.00	µg/l
GW-2030	163[c]	47.4[c]	14.2	11.1	µg/l
GW-2032	1060[c]	814[c]	3.20	<4.00	µg/l
GW-2033	255[c]	304[c]	<2.00	<4.00	µg/l
GW-3003	8.90	3.29	15.3	4.80	µg/l
GW-3006	72.3	34.4	114[c]	77.2	µg/l
GW-3008	72.4	<2.00	7.30	<2.00	µg/l
GW-3009	7.59	8.90	5.20	<4.00	µg/l
GW-3023	90.8[c]	32.0[c]	4.80	4.20	µg/l
GW-4001	<2.00	2.29	5.90	<4.00	µg/l
GW-4002	3.00	3.39	7.00	<2.00	µg/l
GW-4003	<2.00	2.00	<2.00	<4.00	µg/l
GW-4004	<2.00	<2.00	<2.00	<4.00	µg/l
GW-4005	2.00	<2.00	<2.00	<2.00	µg/l
GW-4006	<2.00	<2.00	<2.00	<4.00	µg/l
GW-4007	47.4[c]	52.3	115[c]	56.5	µg/l
GW-4008	34.7	16.9	33.6	30.9	µg/l
GW-4009	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4010	<2.00	<2.00	6.90	<4.00	µg/l
GW-4011	<2.00	2.00	3.30	<4.00	µg/l
GW-4012	<2.00	<2.00	<2.00	<4.00	µg/l
GW-4013	<2.00	<2.00	<2.00	<4.00	µg/l
GW-4014	45.9	39.8	48.6	38.3	µg/l
GW-4015	<2.00	<2.00	<2.00	<4.00	µg/l
GW-4016	54.8	75.8	732[c]	83.3	µg/l
GW-4017	<2.00	93.6[c]	6.70[c]	<4.00	µg/l
GW-4018	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4019	<2.00	<2.00	<2.00	<2.00	µg/l
GW-4020	136	110	<2.00	75.7	µg/l
GW-4021	47.8	10.6	17.9	22.0	µg/l
GW-4022	1020[c]	1540[c]	46.0	4.10	µg/l
GW-4023	<2.00	<2.00	<2.00	<4.00	µg/l
GW-RMW1				1300	µg/l
GW-RMW2				786	µg/l
GW-RMW3				318	µg/l
GW-RMW4				56.7	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
MERCURY					
GW-PW02	<0.03				µg/l
GW-PW03	<0.03				µg/l
GW-PW04	<0.03				µg/l
GW-PW05	<0.03				µg/l
GW-PW06	<0.03				µg/l
GW-PW07	<0.03				µg/l
GW-PW08	<0.03				µg/l
GW-PW09	<0.03				µg/l
NICKEL					
GW-2001	<11.0	<18.0	<18.0	<20.0	µg/l
GW-2002	<11.0	<18.0	<18.0	<20.0	µg/l
GW-2003	<11.0	<18.0	<18.0	<20.0	µg/l
GW-2030	18.0[c]	<18.0[c]	<18.0	<20.0	µg/l
GW-2032	41.5[c]	27.6[c]	<18.0	<20.0	µg/l
GW-2033	12.2[c]	<18.0[c]	<18.0	<20.0	µg/l
GW-3003	<11.0	<18.0	<18.0	<20.0	µg/l
GW-3006	<11.0	<18.0	<18.0[c]	<20.0	µg/l
GW-3008	<11.0	<18.0	<20.0	<19.0	µg/l
GW-3009	46.1	44.8	41.5	<19.5	µg/l
GW-3023	<11.0[c]	<18.0[c]	<18.0	<20.0	µg/l
GW-4001	<11.0	<18.0	<18.0	<20.0	µg/l
GW-4002	<11.0	<18.0	<18.0	<19.0	µg/l
GW-4003	<11.0	<18.0	<18.0	<20.0	µg/l
GW-4004	<11.0	<18.0	<18.0	<20.0	µg/l
GW-4005	<11.0	<18.0	<18.0	<19.0	µg/l
GW-4006	<11.0	<18.0	<18.0	<20.0	µg/l
GW-4007	<11.0[c]	<18.0	<18.0[c]	<19.0	µg/l
GW-4008	<11.0	<18.0	<18.0	<20.0	µg/l
GW-4009	<11.0	<18.0	<18.0	<19.0	µg/l
GW-4010	<11.0	<18.0	<18.0	<20.0	µg/l
GW-4011	<11.0	<18.0	<18.0	<20.0	µg/l
GW-4012	<11.0	<18.0	<18.0	<20.0	µg/l
GW-4013	<11.0	<18.0	<18.0	<20.0	µg/l
GW-4014	<11.0	<18.0	<18.0	<20.0	µg/l
GW-4015	<11.0	<18.0	<18.0	<20.0	µg/l
GW-4016	<11.0	<18.0	103[c]	<20.0	µg/l
GW-4017	<8.00	<18.0[c]	<18.0[c]	<20.0	µg/l
GW-4018	<11.0	<18.0	<18.0	<19.0	µg/l
GW-4019	<11.0	<18.0	<18.0	<19.0	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-4020	12.3	<18.0	<18.0	<20.0	µg/l
GW-4021	<11.0	<18.0	<18.0	<20.0	µg/l
GW-4022	106[c]	151[c]	<18.0	<20.0	µg/l
GW-4023	<11.0	<18.0	<18.0	<20.0	µg/l
GW-RMW1				<19.0	µg/l
GW-RMW2				<19.0	µg/l
GW-RMW3				<19.0	µg/l
GW-RMW4				<19.0	µg/l
<u>POTASSIUM</u>					
GW-2001	1800	1080	1460	1990	µg/l
GW-2002	10200	6000	6620	9760	µg/l
GW-2003	6900	6710	5630	10900	µg/l
GW-2030	4770	4040	3070	3780	µg/l
GW-2032	4130[c]	3640[c]	1780	3550	µg/l
GW-2033	4400[c]	2510[c]	4310	5410	µg/l
GW-3003	9920[c]	9060[c]	10200	10300	µg/l
GW-3006	925	<896	2960[c]	<1340	µg/l
GW-3008	2420	2680	2180	1350	µg/l
GW-3009	1150	1870	1060	2200	µg/l
GW-3023	3310[c]	3510[c]	1830	3400	µg/l
GW-4001	1530	<896	<970	<1340	µg/l
GW-4002	867	<896	<970	<877	µg/l
GW-4003	1520	941	<970	<737	µg/l
GW-4004	964	<896	<970	<1340	µg/l
GW-4005	2200	6430[a]	2010	3430	µg/l
GW-4006	<862	<896	<970	<1340	µg/l
GW-4007	2940[c]	1500	4020[c]	1580	µg/l
GW-4008	<862	<896	<970	1360	µg/l
GW-4009	53400	27300	15600	13700	µg/l
GW-4010	1530	1510	<970	<1340	µg/l
GW-4011	7620	1290[a]	5200	7320	µg/l
GW-4012	57800	41300	48100	66700	µg/l
GW-4013	6610	6630	6630	4890	µg/l
GW-4014	<862	1620	<970	<1340	µg/l
GW-4015	1660	1470	1940	1480	µg/l
GW-4016	920	1500	1410[c]	<1340	µg/l
GW-4017	1840	3210[c]	2250[c]	2640	µg/l
GW-4018	2440	3280	3770	3210	µg/l
GW-4019	<862	947	<970	<877	µg/l
GW-4020	8540	5780	2260	3590	µg/l
GW-4021	<862	1130	<970	<1340	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-4022	1820	3120	3160	1890	µg/l
GW-4023	<862	<970	1360	<1340	µg/l
GW-RMW1				4730	µg/l
GW-RMW2				2470	µg/l
GW-RMW3				4750	µg/l
GW-RMW4				2180	µg/l
SILVER					
GW-2001	NS	<8.00	<6.00	<10.0	µg/l
GW-2002	NS	<8.00	<6.00	<10.0	µg/l
GW-2003	NS	<8.00	<6.00	<10.0	µg/l
GW-2030	<10.0	<8.00	<6.00	<10.0	µg/l
GW-2032	<10.0	<8.00	<6.00	<10.0	µg/l
GW-2033	<10.0	<8.00	<6.00	<10.0	µg/l
GW-3003	<10.0	<8.00	<6.00	<10.0	µg/l
GW-3006	<10.0	<8.00	<6.00	<10.0	µg/l
GW-3008	<10.0	<6.00	<10.0	<7.00	µg/l
GW-3009	<10.0	<6.00	<6.00	<8.90	µg/l
GW-3023	<10.0	<6.00	<6.00	<10.0	µg/l
GW-4001	NS	<8.00	<6.00	<10.0	µg/l
GW-4002	<10.0	<8.00	<6.00	<7.00	µg/l
GW-4003	NS	<8.00	<6.00	<10.0	µg/l
GW-4004	<10.0	<8.00	<6.00	<10.0	µg/l
GW-4005	<10.0	<8.00	<6.00	<7.00	µg/l
GW-4006	NS	<8.00	<6.00	<10.0	µg/l
GW-4007	<10.0	<6.00	<6.00	<7.00	µg/l
GW-4008	<10.0	<8.00	<6.00	<10.0	µg/l
GW-4009	<10.0	<8.00	<6.00	<7.00	µg/l
GW-4010	<10.0	<8.00	<6.00	<10.0	µg/l
GW-4011	<10.0	<8.00	<6.00	<10.0	µg/l
GW-4012	<10.0	<6.00	<6.00	<10.0	µg/l
GW-4013	<10.0	<6.00	<6.00	<10.0	µg/l
GW-4014	<10.0	<6.00	<6.00	<10.0	µg/l
GW-4015	<10.0	<6.00	<6.00	<10.0	µg/l
GW-4016	<10.0	<6.00	<6.00	<10.0	µg/l
GW-4017	<4.00	<6.00	<6.00	<10.0	µg/l
GW-4018	<10.0	<6.00	<6.00	<7.00	µg/l
GW-4019	<10.0	<8.00	<6.00	<7.00	µg/l
GW-4020	<10.0	<6.00	<6.00	<10.0	µg/l
GW-4021	<10.0	<6.00	<6.00	<10.0	µg/l
GW-4022	<4.00	9.10	<6.00	<10.0	µg/l
GW-4023	<10.0	<6.00	<6.00	<10.0	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-RMW1				<7.00	µg/l
GW-RMW2				<7.00	µg/l
GW-RMW3				<7.00	µg/l
GW-RMW4				<7.00	µg/l
SODIUM					
GW-2001	9140	9370	8090	9690	µg/l
GW-2002	127000	81800	97800	126000	µg/l
GW-2003	114000	121000	95900	131000	µg/l
GW-2030	54600[c]	46000[c]	46400	54800	µg/l
GW-2032	67800[c]	62700[c]	72700	75600	µg/l
GW-2033	87600[c]	83300[c]	84200	89000	µg/l
GW-3003	160000	145000	160000	164000	µg/l
GW-3006	18600	17500	19500[c]	18700	µg/l
GW-3008	218000	210000	211000	201000	µg/l
GW-3009	26200	24800	26200	62800	µg/l
GW-3023	229000[c]	214000[c]	223000	217000	µg/l
GW-4001	20600	23300	23500	23200	µg/l
GW-4002	4900	4890	6150	6240	µg/l
GW-4003	8880	7950	9110	8965	µg/l
GW-4004	10100	6670	8340	9230	µg/l
GW-4005	6770	62200[a]	8080	11400	µg/l
GW-4006	7440	6990	8000	8030	µg/l
GW-4007	28600[c]	15200	22800[c]	19100	µg/l
GW-4008	3510	3330	3350	4140	µg/l
GW-4009	37100	18400	18100	14800	µg/l
GW-4010	12400	11400	12800	13300	µg/l
GW-4011	69900	7490[a]	56300	69300	µg/l
GW-4012	50200	44600	44700	46100	µg/l
GW-4013	35700	33000	31300	25400	µg/l
GW-4014	6460	6050	6370	5650	µg/l
GW-4015	7470	7680	7770	7900	µg/l
GW-4016	7870	8680	12500[c]	11600	µg/l
GW-4017	8580	10300[c]	8780[c]	10100	µg/l
GW-4018	8670	8870	8060	9480	µg/l
GW-4019	9880	8770	9390	11400	µg/l
GW-4020	24500	23600	12800	19200	µg/l
GW-4021	15000	15300	15200	14000	µg/l
GW-4022	12000	11800	26400	12700	µg/l
GW-4023	60300	55300	59200	57900	µg/l
GW-RMW1				13700	µg/l
GW-RMW2				7460	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-RMW3				18900	µg/l
GW-RMW4				10800	µg/l
STRONTIUM					
GW-2001	103	108	92.3	109	µg/l
GW-2002	408	287	317	402	µg/l
GW-2003	460	533	430	532	µg/l
GW-2030	183[c]	172[c]	162	182	µg/l
GW-2032	362[c]	352[c]	371	388	µg/l
GW-2033	174[c]	178[c]	148	159	µg/l
GW-3003	580	575	609	636	µg/l
GW-3006	233	219	222[c]	220	µg/l
GW-3008	1540	1400	1360	1290	µg/l
GW-3009	234	214	224	449	µg/l
GW-3023	NS	615[c]	624	612	µg/l
GW-4001	77.3	90.1	80.9	90.5	µg/l
GW-4002	92.4	82.9	84.5	92.5	µg/l
GW-4003	118	94.2	108	116	µg/l
GW-4004	112	79.0	82.5	86.2	µg/l
GW-4005	156	308[a]	144	186	µg/l
GW-4006	59.0	60.9	67.6	71.3	µg/l
GW-4007	89.5[c]	91.5	218[ac]	97.0	µg/l
GW-4008	112	104	89.9	99.2	µg/l
GW-4009	102	146	140	130	µg/l
GW-4010	174	137	143	130	µg/l
GW-4011	283	139[a]	382	366	µg/l
GW-4012	86.8	107	100	40.4	µg/l
GW-4013	153	145	144	121	µg/l
GW-4014	162	150	163	144	µg/l
GW-4015	63.4	64.6	65.9	65.7	µg/l
GW-4016	89.7	96.5	117[c]	94.3	µg/l
GW-4017	129	119[c]	117[c]	143	µg/l
GW-4018	113	119	108	115	µg/l
GW-4019	173	180	174	203	µg/l
GW-4020	227	217	229	198	µg/l
GW-4021	223	219	224	193	µg/l
GW-4022	259[c]	284[c]	90.7	232	µg/l
GW-4023	176	153	163	160	µg/l
GW-RMW1				807	µg/l
GW-RMW2				555	µg/l
GW-RMW3				907	µg/l
GW-RMW4				454	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
ALKALINITY					
GW-1017	670	674	670	680	mg/l
GW-1018	480	490	585	480	mg/l
GW-1019	450	440	460	485	mg/l
GW-1020	420	410	390	440	mg/l
GW-1021	517	540	475	480	mg/l
GW-1022	470	520	480	510	mg/l
GW-1023	450	470	500	500	mg/l
GW-1024	400	390	390	405	mg/l
GW-1033	400	420	460	440	mg/l
GW-2001	330	280	335	340	mg/l
GW-2002	265	310	300	290	mg/l
GW-2003	270	265	290	285	mg/l
GW-2004		332	360		mg/l
GW-2005	270		290		mg/l
GW-2006	294		300		mg/l
GW-2007	320		315		mg/l
GW-2008	300		300		mg/l
GW-2009	424		425		mg/l
GW-2010	360		355		mg/l
GW-2011		260	270		mg/l
GW-2012		366	330		mg/l
GW-2013	540		580		mg/l
GW-2014		470	460		mg/l
GW-2015	420		430		mg/l
GW-2017		380	390		mg/l
GW-2018		400	420		mg/l
GW-2019		360	370		mg/l
GW-2020		390		400	mg/l
GW-2021		375		375	mg/l
GW-2022		330	340		mg/l
GW-2023		225	230		mg/l
GW-2024		300	310		mg/l
GW-2025		270	270		mg/l
GW-2026		360		280	mg/l
GW-2027		225	240		mg/l
GW-2028		450	440		mg/l
GW-2029		320	330		mg/l
GW-2030	470	470	470	460	mg/l
GW-2032	400	410	410	410	mg/l
GW-2033	550	540	550	540	mg/l
GW-2034		420	430		mg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-3003	290	334	280	300	mg/l
GW-3006	370	392	380	480	mg/l
GW-3008	186	200	260	250	mg/l
GW-3009	168	190	165	38.0[a]	mg/l
GW-3019	280		280		mg/l
GW-3023	NS	260	280	260	mg/l
GW-4001	204	220	200	210	mg/l
GW-4002	254	226	235	225	mg/l
GW-4003	264	270	260	273	mg/l
GW-4004	186	180	185	190	mg/l
GW-4005	209	210	200	210	mg/l
GW-4006	162	170	165	180	mg/l
GW-4007	200	200	215	200	mg/l
GW-4008	220	225	220	220	mg/l
GW-4009	188	230	230	240	mg/l
GW-4010	190	295	300	290	mg/l
GW-4011	280	270	190	280	mg/l
GW-4012	315	300	300	330	mg/l
GW-4013	310	300	305	310	mg/l
GW-4014	290	285	290	300	mg/l
GW-4015	240	250	250	260	mg/l
GW-4016	240	230	250	250	mg/l
GW-4017	328	340	340	350	mg/l
GW-4018	440	430	450	445	mg/l
GW-4019	290	280	400	290	mg/l
GW-4020	380	390	390	390	mg/l
GW-4021	510	510	520	510	mg/l
GW-4022	400	380	285	190	mg/l
GW-4023	470	400	400	410	mg/l
GW-FINW	74.0				mg/l
GW-PW02	176				mg/l
GW-PW03	170				mg/l
GW-PW04	160				mg/l
GW-PW05	225				mg/l
GW-PW06	170				mg/l
GW-PW07	300				mg/l
GW-PW08	330				mg/l
GW-PW09	350				mg/l
GW-RAWW	200				mg/l
GW-RMW1	360	400	388	400	mg/l
GW-RMW2	400	374	440	425	mg/l
GW-RMW3	505	515	520	500	mg/l
GW-RMW4	520	415	520	390	mg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
PHOSPHOROUS					
GW-2001	0.340	0.070	0.030	0.080	mg/l
GW-2002	0.020	0.050	0.030	0.060	mg/l
GW-2003	0.050	0.030	0.080	0.060	mg/l
GW-2030	0.130[c]	0.100[c]	0.090	0.090	mg/l
GW-2032	0.84[c]	0.460[c]	0.090	0.090	mg/l
GW-2033	0.370[c]	0.360[c]	0.090	0.060	mg/l
GW-3003	0.040	0.100	0.070	0.120	mg/l
GW-3006	0.020	0.140	0.050[c]	0.040	mg/l
GW-3008	0.140	<0.020	0.050	0.070	mg/l
GW-3009	<0.020	0.040	0.050	<0.020	mg/l
GW-3023	0.130[c]	0.130[c]	0.060	0.060	mg/l
GW-4001	0.050	0.080	<0.020	0.030	mg/l
GW-4002	0.050	0.170	<0.020	0.030	mg/l
GW-4003	<0.020	0.100	<0.020	0.035	mg/l
GW-4004	0.170	0.110	0.100	0.240	mg/l
GW-4005	0.080	0.080	0.060	0.120	mg/l
GW-4006	0.020	0.230	<0.020	0.040	mg/l
GW-4007	0.170[c]	0.110[a]	0.200[c]	0.160	mg/l
GW-4008	0.080	0.050	0.040	0.280	mg/l
GW-4009	0.480	0.160	0.140	0.090	mg/l
GW-4010	0.080	0.070	0.060	0.080	mg/l
GW-4011	0.650	0.300	0.300	0.720	mg/l
GW-4012	0.050	0.080	0.050	0.160	mg/l
GW-4013	0.030	0.060	0.050	0.040	mg/l
GW-4014	<0.020	<0.020	0.070	0.090	mg/l
GW-4015	0.120	0.060	0.190	0.090	mg/l
GW-4016	0.070	0.050	0.420[c]	0.100	mg/l
GW-4017	0.090	0.140[c]	0.290[c]	0.100	mg/l
GW-4018	0.030	0.030	0.020	0.030	mg/l
GW-4019	0.030	<0.020	0.030	0.040	mg/l
GW-4020	0.040	0.070	0.070	0.080	mg/l
GW-4021	0.050	0.040	0.050	0.110	mg/l
GW-4022	6.79[c]	0.890[c]	0.110	0.090	mg/l
GW-4023	0.020	0.020	0.040	0.070	mg/l
GW-RMW1				0.570	mg/l
GW-RMW2				0.170	mg/l
GW-RMW3				0.820	mg/l
GW-RMW4				0.090	mg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
SILICA, DISSOLVED					
GW-2001	7.79	7.70	4.80	9.70	mg/l
GW-2002	14.3	16.0	14.2	12.8	mg/l
GW-2003	11.8	11.0	10.0	8.30	mg/l
GW-2030	8.40[c]	10.7[c]	5.10	9.20	mg/l
GW-2032	7.00[c]	11.1[c]	9.90	12.9	mg/l
GW-2033	9.30[c]	14.0[c]	14.6	14.0	mg/l
GW-3003	4.79	10.3	11.4	5.00	mg/l
GW-3006	8.40	11.9	11.1[c]	10.1	mg/l
GW-3008	13.1	10.1	11.5	7.10	mg/l
GW-3009	12.3	10.0	12.3	8.90	mg/l
GW-3023	14.1[c]	11.8[c]	6.50[a]	8.40	mg/l
GW-4001	14.9	11.6	11.1	8.30	mg/l
GW-4002	7.58	9.00	5.00	5.50	mg/l
GW-4003	3.79	10.1	10.9	8.35	mg/l
GW-4004	8.68	4.40	9.20	6.40	mg/l
GW-4005	10.8	7.30	7.40	11.1	mg/l
GW-4006	12.2	9.50	10.7	6.70	mg/l
GW-4007	4.40[c]	9.80	11.0[c]	10.9	mg/l
GW-4008	10.0	8.30	7.90	7.59	mg/l
GW-4009	5.70	9.50	10.4	7.00	mg/l
GW-4010	6.79	10.6	10.9	5.80	mg/l
GW-4011	14.8	12.8	13.7	12.2	mg/l
GW-4012	10.8	10.7	11.5	11.2	mg/l
GW-4013	5.29	10.8	10.2	4.20	mg/l
GW-4014	4.29	10.0	10.8	4.00	mg/l
GW-4015	13.8	10.0	10.3	8.30	mg/l
GW-4016	10.4	10.4	11.2[c]	11.5	mg/l
GW-4017	13.1	10.9[c]	11.8[c]	9.90	mg/l
GW-4018	12.8	9.50	7.80	8.90	mg/l
GW-4019	2.89	9.09	8.60	8.80	mg/l
GW-4020	9.40	10.3	10.5	8.30	mg/l
GW-4021	10.3	9.00	9.50	4.80	mg/l
GW-4022	10.4[c]	13.3[c]	13.7	12.6	mg/l
GW-4023	14.7	15.7	13.2	11.3	mg/l
GW-RMW1				27.9	mg/l
GW-RMW2				18.2	mg/l
GW-RMW3				27.8	mg/l
GW-RMW4				20.5	mg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
1,3,5-TRINITROBENZE					
GW-1017	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1018	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1019	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1020	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1021	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1022	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1023	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1024	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1033	<0.03	<0.03	<0.03	<0.03	µg/l
GW-2001	0.031	0.040	0.035	0.034	µg/l
GW-2002	<0.03	<0.03	<0.03	<0.03	µg/l
GW-2003	<0.03	<0.03	<0.03	<0.03	µg/l
GW-2004		<0.03	<0.03		µg/l
GW-2005	<0.03		<0.03		µg/l
GW-2006	10.0		8.53		µg/l
GW-2007	<0.03		<0.03		µg/l
GW-2008	0.410		0.850		µg/l
GW-2009	<0.03		<0.03		µg/l
GW-2010	0.140		0.170		µg/l
GW-2011		0.760	0.420		µg/l
GW-2012		2.00	2.80		µg/l
GW-2013	3.80		5.80		µg/l
GW-2014		3.60	2.20		µg/l
GW-2015	<0.03		<0.03		µg/l
GW-2017		<0.03	<0.03		µg/l
GW-2018		<0.03	<0.03		µg/l
GW-2019		<0.03[c]	<0.03		µg/l
GW-2020		<0.03		<0.03	µg/l
GW-2021		<0.03		<0.03	µg/l
GW-2022		<0.03	<0.03		µg/l
GW-2023		<0.03[c]	<0.03[c]		µg/l
GW-2024		<0.03[c]	<0.03[c]		µg/l
GW-2025		<0.03[c]	<0.03[c]		µg/l
GW-2026		<0.03		<0.03	µg/l
GW-2027		<0.03	<0.03		µg/l
GW-2028		<0.03	<0.03		µg/l
GW-2029		<0.03	<0.03		µg/l
GW-2030	0.320[c]	4.20[c]	9.50	10.0	µg/l
GW-2032	0.092[c]	0.300[c]	3.20	NS	µg/l
GW-2033	0.036[c]	2.80[c]	12.0	9.40	µg/l
GW-2034		<0.03[c]	<0.03[c]		µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-3003	<0.03	<0.03	<0.03	<0.03	µg/l
GW-3006	<0.03	<0.03	<0.03[c]	<0.03	µg/l
GW-3008	<0.03	<0.03	<0.03	<0.03	µg/l
GW-3009	0.170	0.170	0.140	0.360	µg/l
GW-3019	<0.03		<0.03		µg/l
GW-3023	<0.03[c]	<0.03[c]	<0.03	<0.03	µg/l
GW-4001	46.0	65.0	72.0	48.0	µg/l
GW-4002	<0.03	<0.03	0.320	0.086	µg/l
GW-4003	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4004	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4005	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4006	16.0	17.0	10.0	17.0	µg/l
GW-4007	<0.03[c]	<0.03	<0.03[c]	<0.03	µg/l
GW-4008	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4009	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4010	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4011	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4012	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4013	48.0	46.0	32.0	28.0	µg/l
GW-4014	0.440	0.230	0.400	0.500	µg/l
GW-4015	0.700	0.860	0.340	0.850	µg/l
GW-4016	<0.03	<0.03	<0.03[c]	<0.03	µg/l
GW-4017	<0.03	<0.03[c]	<0.03[c]	<0.03	µg/l
GW-4018	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4019	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4020	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4021	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4022	<0.03[c]	<0.03[c]	<0.03	<0.03	µg/l
GW-4023	0.210	0.170	0.140	0.160	µg/l
GW-FINW	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW02	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW04	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW05	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW06	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW07	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW08	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW09	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RAWW	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RMW1	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RMW2	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RMW3	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RMW4	<0.03	<0.03	<0.03	<0.03	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
1,3-DINITROBENZENE					
GW-1017	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1018	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1019	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1020	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1021	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1022	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1023	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1024	<0.09	<0.09	<0.09	<0.09	µg/l
GW-1033	<0.09	<0.09	<0.09	<0.09	µg/l
GW-2001	<0.09	<0.09	<0.09	<0.09	µg/l
GW-2002	<0.09	<0.09	<0.09	<0.09	µg/l
GW-2003	<0.09	<0.09	<0.09	<0.09	µg/l
GW-2004		<0.09	<0.09		µg/l
GW-2005	<0.09		<0.09		µg/l
GW-2006	<0.09		<0.610		µg/l
GW-2007	<0.09		<0.09		µg/l
GW-2008	<0.09		<0.09		µg/l
GW-2009	<0.09		<0.09		µg/l
GW-2010	<0.09		<0.09		µg/l
GW-2011		<0.09	<0.09		µg/l
GW-2012		<0.09	<0.09		µg/l
GW-2013	<0.09		0.220		µg/l
GW-2014		<0.09	<0.09		µg/l
GW-2015	<0.09		<0.09		µg/l
GW-2017		<0.09	<0.09		µg/l
GW-2018		<0.09	<0.09		µg/l
GW-2019		<0.09[c]	<0.09		µg/l
GW-2020		<0.09		<0.09	µg/l
GW-2021		<0.09		<0.09	µg/l
GW-2022		<0.09[c]	<0.09[c]		µg/l
GW-2023		<0.09[c]	<0.09[c]		µg/l
GW-2024		<0.09[c]	<0.09[c]		µg/l
GW-2025		<0.09[c]	<0.09[c]		µg/l
GW-2026		<0.09		<0.09	µg/l
GW-2027		<0.09	<0.09		µg/l
GW-2028		<0.09	<0.09		µg/l
GW-2029		<0.09	<0.09		µg/l
GW-2030	<0.09[c]	<0.09[c]	<0.09	<0.09	µg/l
GW-2032	<0.09[c]	<0.09[c]	<0.09	NS	µg/l
GW-2033	<0.09[c]	<0.09[c]	<0.09	<0.09	µg/l
GW-2034		<0.09[c]	<0.09[c]		µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-3003	<0.09	<0.09	<0.09	<0.09	µg/l
GW-3006	<0.09	<0.09	<0.09[c]	<0.09	µg/l
GW-3008	<0.09	<0.09	<0.09	<0.09	µg/l
GW-3009	<0.09	<0.09	<0.09	<0.09	µg/l
GW-3019	<0.09		<0.09		µg/l
GW-3023	<0.09[c]	<0.09[c]	<0.09	<0.09	µg/l
GW-4001	0.220	0.098	0.110	0.130	µg/l
GW-4002	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4003	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4004	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4005	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4006	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4007	<0.09[c]	<0.09	<0.09[c]	<0.09	µg/l
GW-4008	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4009	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4010	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4011	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4012	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4013	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4014	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4015	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4016	<0.09	<0.09	<0.09[c]	<0.09	µg/l
GW-4017	<0.09	<0.09[c]	<0.09[c]	<0.09	µg/l
GW-4018	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4019	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4020	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4021	<0.09	<0.09	<0.09	<0.09	µg/l
GW-4022	<0.09[c]	<0.09[c]	<0.09	<0.09	µg/l
GW-4023	<0.09	<0.09	<0.09	<0.09	µg/l
GW-FINW	<0.09	<0.09	<0.09	<0.09	µg/l
GW-PW02	<0.09	<0.09	<0.09	<0.09	µg/l
GW-PW03	<0.09	<0.09	<0.09	<0.09	µg/l
GW-PW04	<0.09	<0.09	<0.09	<0.09	µg/l
GW-PW05	<0.09	<0.09	<0.09	<0.09	µg/l
GW-PW06	<0.09	<0.09	<0.09	<0.09	µg/l
GW-PW07	<0.09	<0.09	<0.09	<0.09	µg/l
GW-PW08	<0.09	<0.09	<0.09	<0.09	µg/l
GW-PW09	<0.09	<0.09	<0.09	<0.09	µg/l
GW-RAWW	<0.09	<0.09	<0.09	<0.09	µg/l
GW-RMW1	<0.09	<0.09	<0.09	<0.09	µg/l
GW-RMW2	<0.09	<0.09	<0.09	<0.09	µg/l
GW-RMW3	<0.09	<0.09	<0.09	<0.09	µg/l
GW-RMW4	<0.09	<0.09	<0.09	<0.09	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
2,4,6-TNT					
GW-1017	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1018	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1019	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1020	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1021	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1022	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1023	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1024	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1033	<0.03	<0.03	<0.03	<0.03	µg/l
GW-2001	<0.03	<0.03	<0.03	<0.03	µg/l
GW-2002	<0.03	<0.03	<0.03	<0.03	µg/l
GW-2003	<0.03	<0.03	<0.03	<0.03	µg/l
GW-2004		<0.03	<0.03		µg/l
GW-2005	<0.03		<0.03		µg/l
GW-2006	<0.03		2.18		µg/l
GW-2007	<0.03		<0.03		µg/l
GW-2008	<0.03		<0.03		µg/l
GW-2009	<0.03		<0.03		µg/l
GW-2010	0.280		0.400		µg/l
GW-2011		<0.03	<0.03		µg/l
GW-2012		0.640	0.680		µg/l
GW-2013	0.580		0.760		µg/l
GW-2014		<0.03	<0.03		µg/l
GW-2015	<0.03		<0.03		µg/l
GW-2017		<0.03	<0.03		µg/l
GW-2018		<0.03	<0.03		µg/l
GW-2019		<0.03[c]	<0.03		µg/l
GW-2020		<0.03		<0.03	µg/l
GW-2021		<0.03		<0.03	µg/l
GW-2022		<0.03[c]	<0.03[c]		µg/l
GW-2023		<0.03[c]	<0.03[c]		µg/l
GW-2024		<0.03[c]	<0.03[c]		µg/l
GW-2025		<0.03[c]	<0.03[c]		µg/l
GW-2026		<0.03		<0.03	µg/l
GW-2027		<0.03	<0.03		µg/l
GW-2028		<0.03	<0.03		µg/l
GW-2029		<0.03	<0.03		µg/l
GW-2030	3.60[c]	8.10[c]	14.0	14.0	µg/l
GW-2032	0.900[c]	2.20[c]	9.00	NS	µg/l
GW-2033	0.082[c]	1.10[c]	3.20	2.90	µg/l
GW-2034		<0.03[c]	<0.03[c]		µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-3003	<0.03	<0.03	<0.03	<0.03	µg/l
GW-3006	<0.03	<0.03	<0.03[c]	<0.03	µg/l
GW-3008	<0.03	<0.03	<0.03	<0.03	µg/l
GW-3009	<0.03	<0.03	<0.03	<0.03	µg/l
GW-3019	<0.03		<0.03		µg/l
GW-3023	<0.03[c]	0.033[c]	<0.03	0.040	µg/l
GW-4001	1.30	1.60	1.70	1.30	µg/l
GW-4002	<0.03	0.044	0.220	0.250	µg/l
GW-4003	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4004	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4005	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4006	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4007	<0.03[c]	<0.03	<0.03[c]	<0.03	µg/l
GW-4008	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4009	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4010	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4011	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4012	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4013	0.057	0.048	0.040	0.032	µg/l
GW-4014	0.037	<0.03	0.031	0.036	µg/l
GW-4015	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4016	<0.03	<0.03	<0.03[c]	<0.03	µg/l
GW-4017	<0.03	<0.03[c]	<0.03[c]	<0.03	µg/l
GW-4018	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4019	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4020	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4021	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4022	<0.03[c]	<0.03[c]	<0.03	<0.03	µg/l
GW-4023	<0.03	<0.03	<0.03	<0.03	µg/l
GW-FINW	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW02	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW04	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW05	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW06	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW07	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW08	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW09	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RAWW	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RMW1	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RMW2	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RMW3	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RMW4	<0.03	<0.03	<0.03	<0.03	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
2,4-DNT					
GW-1017	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1018	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1019	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1020	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1021	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1022	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1023	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1024	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1033	<0.03	<0.03	<0.03	<0.03	µg/l
GW-2001	0.083	0.080	0.087	0.098	µg/l
GW-2002	0.071	0.052	0.063	0.110	µg/l
GW-2003	0.170	0.180	0.150	0.190	µg/l
GW-2004		<0.03	<0.03		µg/l
GW-2005	0.076		0.082		µg/l
GW-2006	0.140		<0.600		µg/l
GW-2007	<0.03		<0.03		µg/l
GW-2008	0.071		0.080		µg/l
GW-2009	0.070		0.067		µg/l
GW-2010	0.080		0.079		µg/l
GW-2011		0.092	0.100		µg/l
GW-2012		0.081	0.300		µg/l
GW-2013	0.260		0.300		µg/l
GW-2014		0.130	0.170		µg/l
GW-2015	<0.03		<0.03		µg/l
GW-2017		<0.03	<0.03		µg/l
GW-2018		<0.03	<0.03		µg/l
GW-2019		<0.03[c]	<0.03		µg/l
GW-2020		0.038		0.031	µg/l
GW-2021		<0.03		<0.03	µg/l
GW-2022		<0.03[c]	<0.03[c]		µg/l
GW-2023		<0.03[c]	<0.03[c]		µg/l
GW-2024		<0.03[c]	<0.03[c]		µg/l
GW-2025		<0.03[c]	<0.03[c]		µg/l
GW-2026		<0.03		<0.03	µg/l
GW-2027		<0.03	<0.03		µg/l
GW-2028		<0.03	<0.03		µg/l
GW-2029		<0.03	<0.03		µg/l
GW-2030	0.190[c]	0.130[c]	0.140	0.150	µg/l
GW-2032	0.150[c]	0.120[c]	0.150	NS	µg/l
GW-2033	0.180[c]	0.160[c]	0.340	3.80	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-2034		<0.03[c]	<0.03[c]		µg/l
GW-3003	0.082	0.031	0.061	0.058	µg/l
GW-3006	<0.03	<0.03	<0.03[c]	<0.03	µg/l
GW-3008	0.150	0.097	0.140	0.120	µg/l
GW-3009	0.180	0.190	0.200	0.300	µg/l
GW-3019	<0.03		<0.03		µg/l
GW-3023	8.00[c]	8.00[c]	8.50	7.00	µg/l
GW-4001	6.00	3.00	3.20	6.50	µg/l
GW-4002	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4003	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4004	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4005	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4006	0.160	0.100	0.091	0.150	µg/l
GW-4007	<0.03[c]	<0.03	<0.03[c]	<0.03	µg/l
GW-4008	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4009	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4010	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4011	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4012	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4013	0.079	0.065	0.056	0.051	µg/l
GW-4014	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4015	0.140	0.110	0.048	0.084	µg/l
GW-4016	<0.03	<0.03	<0.03[c]	<0.03	µg/l
GW-4017	<0.03	<0.03[c]	<0.03[c]	<0.03	µg/l
GW-4018	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4019	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4020	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4021	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4022	<0.03[c]	<0.03[c]	<0.03	<0.03	µg/l
GW-4023	0.100	0.067	0.076	0.087	µg/l
GW-FINW	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW02	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW04	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW05	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW06	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW07	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW08	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW09	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RAWW	<0.03	<0.03	<0.03	<0.03	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-RMW1	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RMW2	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RMW3	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RMW4	<0.03	<0.03	<0.03	<0.03	µg/l
2,6-DNT					
GW-1017	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1018	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1019	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1020	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1021	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1022	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1023	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1024	<0.01	<0.01	<0.01	<0.01	µg/l
GW-1033	<0.01	<0.01	<0.01	<0.01	µg/l
GW-2001	0.074	0.044	0.060	0.051	µg/l
GW-2002	0.380	0.300	0.390	0.510	µg/l
GW-2003	0.680	0.660	0.800	1.20	µg/l
GW-2004		<0.01	<0.01		µg/l
GW-2005	0.120		0.140		µg/l
GW-2006	1.20		3.02		µg/l
GW-2007	<0.01		<0.01		µg/l
GW-2008	0.860		1.00		µg/l
GW-2009	0.270		0.260		µg/l
GW-2010	0.470		0.530		µg/l
GW-2011		2.30	1.60		µg/l
GW-2012		1.10	2.40		µg/l
GW-2013	5.80		9.10		µg/l
GW-2014		0.980	0.900		µg/l
GW-2015	<0.01		<0.01		µg/l
GW-2017		<0.01	<0.01		µg/l
GW-2018		<0.01	<0.01		µg/l
GW-2019		<0.01[c]	<0.01		µg/l
GW-2020		<0.01		<0.01	µg/l
GW-2021		<0.01		<0.01	µg/l
GW-2022		<0.01[c]	<0.01[c]		µg/l
GW-2023		<0.01[c]	<0.01[c]		µg/l
GW-2024		<0.01[c]	<0.01[c]		µg/l
GW-2025		<0.01[c]	<0.01[c]		µg/l
GW-2026		<0.01		<0.01	µg/l
GW-2027		<0.01	<0.01		µg/l
GW-2028		<0.01	<0.01		µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-2029		<0.01	<0.01		µg/l
GW-2030	4.60[c]	5.50[c]	10.0	12.0	µg/l
GW-2032	3.70[c]	4.00[c]	4.00	NS	µg/l
GW-2033	15.0[c]	10.0[c]	8.00	7.80	µg/l
GW-2034		<0.01[c]	<0.01[c]		µg/l
GW-3003	0.200	0.079	0.130	0.098	µg/l
GW-3006	<0.01	<0.01	<0.01[c]	<0.01	µg/l
GW-3008	0.440	0.240	0.310	0.290	µg/l
GW-3009	0.093	0.091	0.057	0.170	µg/l
GW-3019	<0.01		<0.01		µg/l
GW-3023	11.0[c]	7.50[c]	8.40	7.10	µg/l
GW-4001	3.50	5.00	5.80	3.90	µg/l
GW-4002	<0.01	0.034	0.190	0.120	µg/l
GW-4003	<0.01	<0.01	<0.01	<0.01	µg/l
GW-4004	<0.01	<0.01	<0.01	<0.01	µg/l
GW-4005	<0.01	<0.01	<0.01	<0.01	µg/l
GW-4006	3.60	3.60	4.40	3.30	µg/l
GW-4007	<0.01[c]	<0.01	<0.01[c]	<0.01	µg/l
GW-4008	<0.01	<0.01	<0.01	<0.01	µg/l
GW-4009	<0.01	<0.01	<0.01	<0.01	µg/l
GW-4010	<0.01	<0.01	<0.01	<0.01	µg/l
GW-4011	<0.01	<0.01	<0.01	<0.01	µg/l
GW-4012	<0.01	<0.01	<0.01	<0.01	µg/l
GW-4013	1.30	0.900	0.840	0.630	µg/l
GW-4014	0.082	0.031	0.052	0.076	µg/l
GW-4015	1.30	1.20	0.590	0.900	µg/l
GW-4016	<0.01	<0.01	<0.01[c]	<0.01	µg/l
GW-4017	<0.01	<0.01[c]	<0.01[c]	<0.01	µg/l
GW-4018	<0.01	<0.01	<0.01	<0.01	µg/l
GW-4019	<0.01	<0.01	<0.01	<0.01	µg/l
GW-4020	<0.01	<0.01	<0.01	<0.01	µg/l
GW-4021	<0.01	<0.01	<0.01	<0.01	µg/l
GW-4022	<0.01[c]	<0.01[c]	<0.01	<0.01	µg/l
GW-4023	0.062	0.052	0.039	0.042	µg/l
GW-FINW	<0.01	<0.01	<0.01	<0.01	µg/l
GW-PW02	<0.01	<0.01	<0.01	<0.01	µg/l
GW-PW03	<0.01	<0.01	<0.01	<0.01	µg/l
GW-PW04	<0.01	<0.01	<0.01	<0.01	µg/l
GW-PW05	<0.01	<0.01	<0.01	<0.01	µg/l
GW-PW06	<0.01	<0.01	<0.01	<0.01	µg/l
GW-PW07	<0.01	<0.01	<0.01	<0.01	µg/l
GW-PW08	<0.01	<0.01	<0.01	<0.01	µg/l
GW-PW09	<0.01	<0.01	<0.01	<0.01	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-RAWW	<0.01	<0.01	<0.01	<0.01	µg/l
GW-RMW1	<0.01	<0.01	<0.01	<0.01	µg/l
GW-RMW2	<0.01	<0.01	<0.01	<0.01	µg/l
GW-RMW3	<0.01	<0.01	<0.01	<0.01	µg/l
GW-RMW4	<0.01	<0.01	<0.01	<0.01	µg/l
NITROBENZENE					
GW-1017	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1018	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1019	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1020	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1021	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1022	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1023	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1024	<0.03	<0.03	<0.03	<0.03	µg/l
GW-1033	<0.03	<0.03	<0.03	<0.03	µg/l
GW-2001	<0.03	<0.03	<0.03	<0.03	µg/l
GW-2002	<0.03	<0.03	<0.03	<0.03	µg/l
GW-2003	<0.03	<0.03	<0.03	<0.03	µg/l
GW-2004		<0.03	<0.03		µg/l
GW-2005	<0.03		<0.03		µg/l
GW-2006	<0.03		<1.13		µg/l
GW-2007	<0.03		<0.03		µg/l
GW-2008	<0.03		<0.03		µg/l
GW-2009	<0.03		<0.03		µg/l
GW-2010	<0.03		<0.03		µg/l
GW-2011		0.040	0.042		µg/l
GW-2012		<0.03	<0.03		µg/l
GW-2013	<0.03		<0.03		µg/l
GW-2014		<0.03	0.033		µg/l
GW-2015	<0.03		<0.03		µg/l
GW-2017		<0.03	<0.03		µg/l
GW-2018		<0.03	<0.03		µg/l
GW-2019		<0.03[c]	<0.03		µg/l
GW-2020		<0.03		<0.03	µg/l
GW-2021		<0.03		<0.03	µg/l
GW-2022		<0.03[c]	<0.03[c]		µg/l
GW-2023		<0.03[c]	<0.03[c]		µg/l
GW-2024		<0.03[c]	<0.03[c]		µg/l
GW-2025		<0.03[c]	<0.03[c]		µg/l
GW-2026		<0.03		<0.03	µg/l
GW-2027		<0.03	<0.03		µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-2028		<0.03	<0.03		µg/l
GW-2029		<0.03	<0.03		µg/l
GW-2030	<0.03[c]	<0.03[c]	<0.03	<0.03	µg/l
GW-2032	<0.03[c]	<0.03[c]	<0.03	NS	µg/l
GW-2033	<0.03[c]	<0.03[c]	<0.03	<0.03	µg/l
GW-2034		<0.03[c]	<0.03[c]		µg/l
GW-3003	<0.03	<0.03	<0.03	<0.03	µg/l
GW-3006	<0.03	<0.03	<0.03[c]	<0.03	µg/l
GW-3008	<0.03	<0.03	<0.03	<0.03	µg/l
GW-3009	<0.03	<0.03	<0.03	<0.03	µg/l
GW-3019	<0.03		<0.03		µg/l
GW-3023	<0.03[c]	<0.03[c]	<0.03	<0.03	µg/l
GW-4001	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4002	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4003	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4004	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4005	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4006	<0.03	<0.03	0.037	<0.03	µg/l
GW-4007	<0.03[c]	<0.03	<0.03[c]	<0.03	µg/l
GW-4008	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4009	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4010	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4011	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4012	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4013	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4014	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4015	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4016	<0.03	<0.03	<0.03[c]	<0.03	µg/l
GW-4017	<0.03	<0.03[c]	<0.03[c]	<0.03	µg/l
GW-4018	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4019	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4020	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4021	<0.03	<0.03	<0.03	<0.03	µg/l
GW-4022	<0.03[c]	<0.03[c]	<0.03	<0.03	µg/l
GW-4023	<0.03	<0.03	<0.03	<0.03	µg/l
GW-FINW	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW02	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW03	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW04	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW05	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW06	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW07	<0.03	<0.03	<0.03	<0.03	µg/l
GW-PW08	<0.03	<0.03	<0.03	<0.03	µg/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-PW09	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RAWW	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RMW1	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RMW2	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RMW3	<0.03	<0.03	<0.03	<0.03	µg/l
GW-RMW4	<0.03	<0.03	<0.03	<0.03	µg/l
ACTINIUM-227					
GW-1018				<10.0	pCi/l
GW-1019				<10.0	pCi/l
GW-1020				<10.0	pCi/l
GW-1024				<10.0	pCi/l
GW-2001	<2.52				pCi/l
GW-2002	<1.60				pCi/l
GW-2003	<5.18				pCi/l
GW-2004			4.13		pCi/l
GW-2005			1.54		pCi/l
GW-2006	(2.72)				pCi/l
GW-2007	<2.68				pCi/l
GW-2008			<4.00		pCi/l
GW-2009			<4.00		pCi/l
GW-2010	<4.16				pCi/l
GW-2012			<4.00		pCi/l
GW-2013	<5.94				pCi/l
GW-2014			2.23		pCi/l
GW-2015	<2.54				pCi/l
GW-2022			1.68		pCi/l
GW-2029			2.63		pCi/l
GW-2030				<10.0	pCi/l
GW-2032				<10.0	pCi/l
GW-2033				<10.0	pCi/l
GW-3003			<4.00		pCi/l
GW-3006	<2.80				pCi/l
GW-3008				<10.0	pCi/l
GW-3009				<10.0	pCi/l
GW-3019	<3.18				pCi/l
GW-3023				<10.0	pCi/l
GW-4001	<2.64				pCi/l
GW-4002	<2.94				pCi/l
GW-4003				<10.0	pCi/l
GW-4004			<4.80		pCi/l
GW-4005				<10.0	pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-4006	<2.65				pCi/l
GW-4008				<10.0	pCi/l
GW-4009			<4.00		pCi/l
GW-4010			<4.00		pCi/l
GW-4011			<4.80		pCi/l
GW-4012			<4.80		pCi/l
GW-4013			<2.80		pCi/l
GW-4014			<4.70		pCi/l
GW-4015				(9.00)	pCi/l
GW-4016				<10.0	pCi/l
GW-4018			<4.80		pCi/l
GW-4019			<4.80		pCi/l
GW-4020			<2.80		pCi/l
GW-4021				<10.0	pCi/l
GW-4023			<4.80		pCi/l
GROSS ALPHA					
GW-1017	<18.7				pCi/l
GW-1018	<14.0				pCi/l
GW-1019	(8.09)				pCi/l
GW-1020	<12.0				pCi/l
GW-1021	<19.8				pCi/l
GW-1022	<18.7				pCi/l
GW-1023	<12.5				pCi/l
GW-1024	<14.	18.0	3.00	<2.00	pCi/l
GW-1033	5.00				pCi/l
GW-2018		<2.00			pCi/l
GW-2019		<9.20[c]			pCi/l
GW-2020		<7.20			pCi/l
GW-3023		<21.0[c]			pCi/l
GW-4016		<7.70			pCi/l
GW-4017		<6.10[c]			pCi/l
GW-FINW	<14.	(1.10)	<3.40	<2.00	pCi/l
GW-PW02	<11.	(1.80)	<3.40	<2.00	pCi/l
GW-PW03	<8.0	<2.00	<3.50	<2.00	pCi/l
GW-PW04	<8.2	(1.20)	<3.00	<2.00	pCi/l
GW-PW05	<8.00	<2.00	<4.00	2.50	pCi/l
GW-PW06	<12.	(1.60)	<4.01	(1.60)	pCi/l
GW-PW07	<13.	3.70	<3.40	<2.00	pCi/l
GW-PW08	<12.	(1.40)	<3.50	2.20	pCi/l
GW-PW09	<13.	4.80	<6.20	(1.40)	pCi/l
GW-RAWW	<13.	<2.00	<3.90	<2.00	pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-RMW1	<14.	3.30	7.70	3.60	pCi/l
GW-RMW2	<11.	4.90	7.20	8.70	pCi/l
GW-RMW3	<16.	2.30	7.40	7.40	pCi/l
GW-RMW4	<13.	<2.00	3.90	(1.50)	pCi/l
GROSS BETA					
GW-1017	<15.2				pCi/l
GW-1018	<13.0				pCi/l
GW-1019	<12.0				pCi/l
GW-1020	<12.0				pCi/l
GW-1021	(6.17)				pCi/l
GW-1022	(7.57)				pCi/l
GW-1023	(9.77)				pCi/l
GW-1024	<17.	20.0	9.00	7.00	pCi/l
GW-1033	7.20				pCi/l
GW-2018		<7.40			pCi/l
GW-2019		<7.90[c]			pCi/l
GW-2020		<13.0			pCi/l
GW-3023		17.0[c]			pCi/l
GW-4016		<9.30			pCi/l
GW-4017		<8.80[c]			pCi/l
GW-FINW	<16.	6.00		5.00	pCi/l
GW-PW02	<19.	8.60		6.20	pCi/l
GW-PW03	<14.	8.60		6.60	pCi/l
GW-PW04	<15.	5.50		7.40	pCi/l
GW-PW05	<17.	7.50		7.90	pCi/l
GW-PW06	<16.	6.40		5.10	pCi/l
GW-PW07	<16.	6.00		4.80	pCi/l
GW-PW08	<19.	3.80		6.00	pCi/l
GW-PW09	<17.	7.90		9.30	pCi/l
GW-RAWW	<20.	4.90		5.10	pCi/l
GW-RMW1	<21.	6.80	13.0	8.75	pCi/l
GW-RMW2	<19.	5.60		6.00	pCi/l
GW-RMW3	<21.	11.0	12.0	9.70	pCi/l
GW-RMW4	<20.	5.00	6.10	4.80	pCi/l
LEAD-210					
GW-1018				4.00	pCi/l
GW-1019				4.10	pCi/l
GW-1020				(1.60)	pCi/l
GW-1024				2.00	pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-2001	<2.55				pCi/l
GW-2002	<1.56				pCi/l
GW-2003	<2.55				pCi/l
GW-2004			<5.99		pCi/l
GW-2005			<2.99		pCi/l
GW-2006	<5.11				pCi/l
GW-2007	<5.11				pCi/l
GW-2008			<2.00		pCi/l
GW-2009			<4.40		pCi/l
GW-2010	<5.11				pCi/l
GW-2012			<2.00		pCi/l
GW-2013	<2.41				pCi/l
GW-2014			(1.99)		pCi/l
GW-2015	<2.55				pCi/l
GW-2022			<2.57		pCi/l
GW-2029			<2.57		pCi/l
GW-2030				(1.40)	pCi/l
GW-2032				<2.00	pCi/l
GW-2033				<2.00	pCi/l
GW-3003			<3.60		pCi/l
GW-3006	<2.72				pCi/l
GW-3008				(1.60)	pCi/l
GW-3009				2.40	pCi/l
GW-3019	<2.41				pCi/l
GW-3023				4.70	pCi/l
GW-4001	<2.41				pCi/l
GW-4002	<1.56				pCi/l
GW-4003				<2.00	pCi/l
GW-4004			<2.00		pCi/l
GW-4005				(1.70)	pCi/l
GW-4006	<2.41				pCi/l
GW-4008				<2.00	pCi/l
GW-4009			<2.00		pCi/l
GW-4010			<2.90		pCi/l
GW-4011			<2.00		pCi/l
GW-4012			<2.00		pCi/l
GW-4013			<3.60		pCi/l
GW-4014			<3.60		pCi/l
GW-4015				2.10	pCi/l
GW-4016				2.20	pCi/l
GW-4018			<2.00		pCi/l
GW-4019			<2.00		pCi/l
GW-4020			<3.60		pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-4021				<2.00	pCi/l
GW-4023			<2.00		pCi/l
POLONIUM-210					
GW-1018				1.30	pCi/l
GW-1019				(0.900)	pCi/l
GW-1020				1.00	pCi/l
GW-1024				1.20	pCi/l
GW-2001	<3.08				pCi/l
GW-2002	<0.650				pCi/l
GW-2003	<5.88				pCi/l
GW-2004			<0.913		pCi/l
GW-2005			<0.880		pCi/l
GW-2006	<5.46				pCi/l
GW-2007	<1.78				pCi/l
GW-2008			(0.30)		pCi/l
GW-2009			<2.10		pCi/l
GW-2010	5.17				pCi/l
GW-2012			<0.500		pCi/l
GW-2013	<1.34				pCi/l
GW-2014			<1.72		pCi/l
GW-2015	<1.33				pCi/l
GW-2022			<1.98		pCi/l
GW-2029			<0.901		pCi/l
GW-2030				(0.60)	pCi/l
GW-2032				2.30	pCi/l
GW-2033				1.60	pCi/l
GW-3003			<0.800		pCi/l
GW-3006	<1.61				pCi/l
GW-3008				1.50	pCi/l
GW-3009				<1.00	pCi/l
GW-3019	<4.48				pCi/l
GW-3023				2.00	pCi/l
GW-4001	<2.69				pCi/l
GW-4002	<1.40				pCi/l
GW-4003				1.10	pCi/l
GW-4004			<0.500		pCi/l
GW-4005				<1.00	pCi/l
GW-4006	<4.48				pCi/l
GW-4008				(0.60)	pCi/l
GW-4009			(0.30)		pCi/l
GW-4010			0.200		pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-4011			<0.500		pCi/l
GW-4012			<0.500		pCi/l
GW-4013			<0.800		pCi/l
GW-4014			<0.800		pCi/l
GW-4015				1.00	pCi/l
GW-4016				<1.00	pCi/l
GW-4018			<0.500		pCi/l
GW-4019			<0.500		pCi/l
GW-4020			<0.800		pCi/l
GW-4021				(0.90)	pCi/l
GW-4023			<0.500		pCi/l
RADIUM-226					
GW-1017	1.21				pCi/l
GW-1018	<1.00				pCi/l
GW-1019	<2.00				pCi/l
GW-1020	<3.60				pCi/l
GW-1021	1.65				pCi/l
GW-1022	0.431				pCi/l
GW-1023	0.983				pCi/l
GW-1024	<1.50				pCi/l
GW-1033	0.300				pCi/l
GW-2001	<0.797				pCi/l
GW-2002	(0.164)				pCi/l
GW-2003	<0.797				pCi/l
GW-2004		0.200			pCi/l
GW-2005			(0.70)		pCi/l
GW-2006	<1.59				pCi/l
GW-2007	<1.59				pCi/l
GW-2008	<4.40				pCi/l
GW-2009	<11.0				pCi/l
GW-2010	<1.59				pCi/l
GW-2011		<0.20			pCi/l
GW-2012		<0.20			pCi/l
GW-2013	(0.266)				pCi/l
GW-2014		<0.20			pCi/l
GW-2015	<0.797				pCi/l
GW-2017		0.200			pCi/l
GW-2018		<1.30			pCi/l
GW-2019		<1.80			pCi/l
GW-2020		<5.90			pCi/l
GW-2021		<0.777			pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-2022		<0.777[c]			pCi/l
GW-2023		<0.777[c]			pCi/l
GW-2024		(0.706)			pCi/l
GW-2025		<0.687[c]			pCi/l
GW-2026		(0.555)			pCi/l
GW-2027		(0.777)			pCi/l
GW-2028		(0.504)			pCi/l
GW-2029		<0.20			pCi/l
GW-2030	1.00[c]				pCi/l
GW-2032	1.10[c]				pCi/l
GW-2033	1.20[c]				pCi/l
GW-2034		<0.20[c]			pCi/l
GW-3003	<0.20				pCi/l
GW-3006	<0.334				pCi/l
GW-3008	0.700				pCi/l
GW-3009	0.500				pCi/l
GW-3019	<0.520				pCi/l
GW-3023	0.300[c]				pCi/l
GW-4001	<0.520				pCi/l
GW-4002	0.287				pCi/l
GW-4003	<3.30				pCi/l
GW-4004	<1.00				pCi/l
GW-4005	<4.00				pCi/l
GW-4006	<0.520				pCi/l
GW-4007	3.40[c]				pCi/l
GW-4008	<0.20				pCi/l
GW-4009	<0.20				pCi/l
GW-4010	<0.20				pCi/l
GW-4011	<0.20				pCi/l
GW-4012	<0.20				pCi/l
GW-4013	0.400				pCi/l
GW-4014	<0.20				pCi/l
GW-4015	0.200				pCi/l
GW-4016	0.300				pCi/l
GW-4017	<0.20				pCi/l
GW-4018	0.200				pCi/l
GW-4019	<0.20				pCi/l
GW-4020	0.400				pCi/l
GW-4021	<0.20				pCi/l
GW-4022	1.10[c]				pCi/l
GW-4023	0.600				pCi/l
GW-FINW	<0.920				pCi/l
GW-PW02	<1.50				pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-PW03	<1.10				pCi/l
GW-PW04	<1.20				pCi/l
GW-PW05	<1.50				pCi/l
GW-PW06	<2.60				pCi/l
GW-PW07	<1.60				pCi/l
GW-PW08	<1.70				pCi/l
GW-PW09	<1.50				pCi/l
GW-RAWW	<1.31				pCi/l
GW-RMW1	<1.95				pCi/l
GW-RMW2	<1.50				pCi/l
GW-RMW3	<1.68				pCi/l
GW-RMW4	<1.45				pCi/l
RADIUM-228					
GW-1017	<3.01				pCi/l
GW-1018	3.00				pCi/l
GW-1019	3.00				pCi/l
GW-1020	<5.60				pCi/l
GW-1021	<3.46				pCi/l
GW-1022	(3.08)				pCi/l
GW-1023	(4.36)				pCi/l
GW-1024	<3.70				pCi/l
GW-1033	<0.90				pCi/l
GW-2001	(1.46)				pCi/l
GW-2002	(1.26)				pCi/l
GW-2003	<2.18				pCi/l
GW-2004		<0.90			pCi/l
GW-2005			4.00		pCi/l
GW-2006	17.1				pCi/l
GW-2007	<3.72				pCi/l
GW-2008	<9.20				pCi/l
GW-2009	<22.0				pCi/l
GW-2010	<5.28				pCi/l
GW-2011		<0.90			pCi/l
GW-2012		<0.90			pCi/l
GW-2013	<4.21				pCi/l
GW-2014		<0.90			pCi/l
GW-2015	<2.18				pCi/l
GW-2017		<0.90			pCi/l
GW-2018		<6.11			pCi/l
GW-2019		<4.29[c]			pCi/l
GW-2020		<5.21			pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-2021		<2.79			pCi/l
GW-2022		<2.79[c]			pCi/l
GW-2023		<2.79[c]			pCi/l
GW-2024		<2.79[c]			pCi/l
GW-2025		<4.47[c]			pCi/l
GW-2026		<2.79			pCi/l
GW-2027		<2.79			pCi/l
GW-2028		<2.79			pCi/l
GW-2029		<0.90			pCi/l
GW-2030	1.10[c]				pCi/l
GW-2032	1.80[c]				pCi/l
GW-2033	(0.500)[c]				pCi/l
GW-2034		<0.90[c]			pCi/l
GW-3003	<0.90				pCi/l
GW-3006	<5.03				pCi/l
GW-3008	2.00				pCi/l
GW-3009	<0.90				pCi/l
GW-3019	<4.21				pCi/l
GW-3023	<0.90				pCi/l
GW-4001	<4.21				pCi/l
GW-4002	(0.500)				pCi/l
GW-4003	<6.80				pCi/l
GW-4004	5.00				pCi/l
GW-4005	5.00				pCi/l
GW-4006	<4.21				pCi/l
GW-4007	<0.90[c]				pCi/l
GW-4008	<0.90				pCi/l
GW-4009	(0.600)				pCi/l
GW-4010	(0.700)				pCi/l
GW-4011	<0.90				pCi/l
GW-4012	1.00				pCi/l
GW-4013	1.10				pCi/l
GW-4014	(0.700)				pCi/l
GW-4015	(0.700)				pCi/l
GW-4016	<0.90				pCi/l
GW-4017	<0.90				pCi/l
GW-4018	<0.90				pCi/l
GW-4019	(0.600)				pCi/l
GW-4020	2.10				pCi/l
GW-4021	1.60				pCi/l
GW-4022	<0.90[c]				pCi/l
GW-4023	(0.600)				pCi/l
GW-FINW	5.95				pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-PW02	<2.20				pCi/l
GW-PW03	<2.60				pCi/l
GW-PW04	<2.20				pCi/l
GW-PW05	<3.50				pCi/l
GW-PW06	<4.40				pCi/l
GW-PW07	<2.60				pCi/l
GW-PW08	<2.90				pCi/l
GW-PW09	<2.50				pCi/l
GW-RAWW	6.59				pCi/l
GW-RMW1	5.36				pCi/l
GW-RMW2	<2.30				pCi/l
GW-RMW3	5.16				pCi/l
GW-RMW4	4.80				pCi/l
THORIUM-228					
GW-1017	<0.929				pCi/l
GW-1018	<0.20				pCi/l
GW-1019	0.232				pCi/l
GW-1020	<0.160				pCi/l
GW-1021	<1.52				pCi/l
GW-1022	<1.05				pCi/l
GW-1023	<1.48				pCi/l
GW-1024	0.150				pCi/l
GW-1033	<0.20				pCi/l
GW-2001	<1.18				pCi/l
GW-2002	<1.21				pCi/l
GW-2003	<1.61				pCi/l
GW-2004		<0.20			pCi/l
GW-2005			0.638		pCi/l
GW-2006	<2.22				pCi/l
GW-2007	<2.92				pCi/l
GW-2008	<0.320				pCi/l
GW-2009	<0.370				pCi/l
GW-2010	<1.55				pCi/l
GW-2011		<0.20			pCi/l
GW-2012		<0.20			pCi/l
GW-2013	<2.54				pCi/l
GW-2014		<0.20			pCi/l
GW-2015	<1.74				pCi/l
GW-2017		<0.20			pCi/l
GW-2018		<0.10			pCi/l
GW-2019		<0.09[c]			pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-2020		<0.070			pCi/l
GW-2021		<0.343			pCi/l
GW-2022		<0.799[c]			pCi/l
GW-2023		<0.398[c]			pCi/l
GW-2024		<0.439[c]			pCi/l
GW-2025		0.304[c]			pCi/l
GW-2026		0.819			pCi/l
GW-2027		0.297			pCi/l
GW-2028		<0.291			pCi/l
GW-2029		<0.20			pCi/l
GW-2030	<0.20[c]				pCi/l
GW-2032	0.700[c]				pCi/l
GW-2033	<0.20[c]				pCi/l
GW-2034		<0.20[c]			pCi/l
GW-3003	<0.20				pCi/l
GW-3006	<1.06				pCi/l
GW-3008	<0.20				pCi/l
GW-3009	<0.20				pCi/l
GW-3019	<2.41				pCi/l
GW-3023	<0.20				pCi/l
GW-4001	<1.62				pCi/l
GW-4002	<1.72				pCi/l
GW-4003	<0.260				pCi/l
GW-4004	<0.180				pCi/l
GW-4005	<0.130				pCi/l
GW-4006	<2.69				pCi/l
GW-4007	<0.20[c]				pCi/l
GW-4008	<0.20				pCi/l
GW-4009	<0.20				pCi/l
GW-4010	<0.20				pCi/l
GW-4011	<0.20				pCi/l
GW-4012	<0.20				pCi/l
GW-4013	<0.20				pCi/l
GW-4014	<0.20				pCi/l
GW-4015	<0.20				pCi/l
GW-4016	<0.20				pCi/l
GW-4017	<0.20				pCi/l
GW-4018	<0.20				pCi/l
GW-4019	<0.20				pCi/l
GW-4020	<0.20				pCi/l
GW-4021	<0.20				pCi/l
GW-4022	<0.20[c]				pCi/l
GW-4023	<0.20				pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-FINW	<0.190				pCi/l
GW-PW02	<0.240				pCi/l
GW-PW03	<0.280				pCi/l
GW-PW04	<0.080				pCi/l
GW-PW05	<0.270				pCi/l
GW-PW06	<0.140				pCi/l
GW-PW07	<0.190				pCi/l
GW-PW08	<0.280				pCi/l
GW-PW09	<0.250				pCi/l
GW-RAWW	<0.220				pCi/l
GW-RMW1	<0.250				pCi/l
GW-RMW2	<0.140				pCi/l
GW-RMW3	<0.170				pCi/l
GW-RMW4	<0.870				pCi/l
THORIUM-230					
GW-1017	3.55				pCi/l
GW-1018	<0.120				pCi/l
GW-1019	<0.110				pCi/l
GW-1020	<0.500				pCi/l
GW-1021	2.43				pCi/l
GW-1022	2.70				pCi/l
GW-1023	3.40				pCi/l
GW-1024	0.220				pCi/l
GW-1033	<0.20				pCi/l
GW-2001	1.74				pCi/l
GW-2002	1.43				pCi/l
GW-2003	2.22				pCi/l
GW-2004		0.600			pCi/l
GW-2005			<0.935		pCi/l
GW-2006	3.07				pCi/l
GW-2007	4.87				pCi/l
GW-2008	<0.350				pCi/l
GW-2009	<0.130				pCi/l
GW-2010	4.90				pCi/l
GW-2011		<0.20			pCi/l
GW-2012		0.200			pCi/l
GW-2013	2.89				pCi/l
GW-2014		<0.20			pCi/l
GW-2015	1.75				pCi/l
GW-2017		<0.20			pCi/l
GW-2018		<0.080			pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-2019		<0.080[c]			pCi/l
GW-2020		<0.060			pCi/l
GW-2021		1.15			pCi/l
GW-2022		(0.97)[c]			pCi/l
GW-2023		1.99[c]			pCi/l
GW-2024		(0.599)[c]			pCi/l
GW-2025		3.39[c]			pCi/l
GW-2026		2.18			pCi/l
GW-2027		0.779			pCi/l
GW-2028		(0.529)			pCi/l
GW-2029		<0.20			pCi/l
GW-2030	<0.20				pCi/l
GW-2032	0.900				pCi/l
GW-2033	0.300				pCi/l
GW-2034		<0.20			pCi/l
GW-3003	<0.20				pCi/l
GW-3006	1.18				pCi/l
GW-3008	<0.20				pCi/l
GW-3009	<0.20				pCi/l
GW-3019	3.50				pCi/l
GW-3023	<0.20[c]				pCi/l
GW-4001	2.61				pCi/l
GW-4002	2.30				pCi/l
GW-4003	0.250				pCi/l
GW-4004	<0.110				pCi/l
GW-4005	<0.500				pCi/l
GW-4006	6.63				pCi/l
GW-4007	0.500				pCi/l
GW-4008	<0.20				pCi/l
GW-4009	<0.20				pCi/l
GW-4010	<0.20				pCi/l
GW-4011	<0.20				pCi/l
GW-4012	<0.20				pCi/l
GW-4013	<0.20				pCi/l
GW-4014	<0.20				pCi/l
GW-4015	<0.20				pCi/l
GW-4016	<0.20				pCi/l
GW-4017	<0.20				pCi/l
GW-4018	<0.20				pCi/l
GW-4019	0.200				pCi/l
GW-4020	<0.20				pCi/l
GW-4021	<0.20				pCi/l
GW-4022	0.700[c]				pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-4023	<0.20				pCi/l
GW-FINW	<0.300				pCi/l
GW-PW02	0.120				pCi/l
GW-PW03	<0.180				pCi/l
GW-PW04	<0.080				pCi/l
GW-PW05	<0.220				pCi/l
GW-PW06	<0.20				pCi/l
GW-PW07	<0.190				pCi/l
GW-PW08	<0.500				pCi/l
GW-PW09	<0.230				pCi/l
GW-RAWW	<0.120				pCi/l
GW-RMW1	<0.290				pCi/l
GW-RMW2	<0.050				pCi/l
GW-RMW3	<0.170				pCi/l
GW-RMW4	<0.640				pCi/l
THORIUM-232					
GW-101	<1.14				pCi/l
GW-1018	<0.410				pCi/l
GW-1019	0.198				pCi/l
GW-1020	<0.039				pCi/l
GW-1021	<1.86				pCi/l
GW-1022	<1.29				pCi/l
GW-1023	<1.81				pCi/l
GW-1024	<0.20				pCi/l
GW-1033	<0.20				pCi/l
GW-2001	<1.02				pCi/l
GW-2002	<1.48				pCi/l
GW-2003	<1.39				pCi/l
GW-2004		<0.20			pCi/l
GW-2005			0.567		pCi/l
GW-2006	<1.93				pCi/l
GW-2007	<2.53				pCi/l
GW-2008	<0.290				pCi/l
GW-2009	<0.130				pCi/l
GW-2010	<1.34				pCi/l
GW-2011		<0.20			pCi/l
GW-2012		<0.20			pCi/l
GW-2013	<1.61				pCi/l
GW-2014		<0.20			pCi/l
GW-2015	<1.51				pCi/l
GW-2017		<0.20			pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-2018		<0.140			pCi/l
GW-2019		<0.10[c]			pCi/l
GW-2020		<0.060			pCi/l
GW-2021		(0.237)			pCi/l
GW-2022		(0.364)[c]			pCi/l
GW-2023		0.302[c]			pCi/l
GW-2024		0.666[c]			pCi/l
GW-2025		0.826[c]			pCi/l
GW-2026		1.23			pCi/l
GW-2027		0.223			pCi/l
GW-2028		<0.205			pCi/l
GW-2029		<0.20			pCi/l
GW-2030	<0.20[c]				pCi/l
GW-2032	0.200[c]				pCi/l
GW-2033	<0.20[c]				pCi/l
GW-2034		<0.20[c]			pCi/l
GW-3003	<0.20				pCi/l
GW-3006	<1.30				pCi/l
GW-3008	<0.20				pCi/l
GW-3009	<0.20				pCi/l
GW-3019	<1.53				pCi/l
GW-3023	<0.20[c]				pCi/l
GW-4001	<1.40				pCi/l
GW-4002	<2.11				pCi/l
GW-4003	<0.09				pCi/l
GW-4004	<0.086				pCi/l
GW-4005	<0.500				pCi/l
GW-4006	<2.33				pCi/l
GW-4007	<0.20				pCi/l
GW-4008	0.500				pCi/l
GW-4009	<0.20				pCi/l
GW-4010	<0.20				pCi/l
GW-4011	<0.20				pCi/l
GW-4012	<0.20				pCi/l
GW-4013	<0.20				pCi/l
GW-4014	<0.20				pCi/l
GW-4015	<0.20				pCi/l
GW-4016	<0.20				pCi/l
GW-4017	<0.20				pCi/l
GW-4018	<0.20				pCi/l
GW-4019	<0.20				pCi/l
GW-4020	<0.20				pCi/l
GW-4021	<0.20				pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-4022	0.700[c]				pCi/l
GW-4023	<0.20				pCi/l
GW-FINW	<0.150				pCi/l
GW-PW02	<0.060				pCi/l
GW-PW03	<0.080				pCi/l
GW-PW04	<0.080				pCi/l
GW-PW05	<0.180				pCi/l
GW-PW06	<0.140				pCi/l
GW-PW07	<0.190				pCi/l
GW-PW08	<0.660				pCi/l
GW-PW09	<0.240				pCi/l
GW-RAWW	<0.050				pCi/l
GW-RMW1	<0.250				pCi/l
GW-RMW2	<0.050				pCi/l
GW-RMW3	<0.190				pCi/l
GW-RMW4	<0.640				pCi/l
URANIUM, TOTAL					
GW-1017	<0.577	<0.20	0.200	<0.20	pCi/l
GW-1018	<3.0	0.200	0.610	<0.20	pCi/l
GW-1019	<3.0	<0.20	9.30	<0.20	pCi/l
GW-1020	<3.0	0.200	0.58	<0.20	pCi/l
GW-1021	<0.577	1.40	<0.550	0.540	pCi/l
GW-1022	<0.577	1.20	1.00	<0.20	pCi/l
GW-1023	<0.577	0.300	0.200	<0.20	pCi/l
GW-1024	<0.8	<0.20	<0.20	<0.20	pCi/l
GW-1033	2.50	2.10	2.30	1.20	pCi/l
GW-2001	<0.577	0.820	<0.580	0.680	pCi/l
GW-2002	1.18	<0.20	<0.580	<0.20	pCi/l
GW-2003	1.58	1.20	<0.580	1.20	pCi/l
GW-2004		0.300	0.890		pCi/l
GW-2005	<0.577		0.660		pCi/l
GW-2006	<0.577		<0.500		pCi/l
GW-2007	0.605		<0.500		pCi/l
GW-2008	<1.40		0.680		pCi/l
GW-2009	2.10		1.40		pCi/l
GW-2010	<0.577		0.680		pCi/l
GW-2011		0.400	0.500		pCi/l
GW-2012		0.300	0.800		pCi/l
GW-2013	<0.577		0.400		pCi/l
GW-2014		0.200	0.810		pCi/l
GW-2015	1.30		<0.500		pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-2017		5.30	8.00		pCi/l
GW-2018		1.80	0.880		pCi/l
GW-2019		2.80	2.50[c]		pCi/l
GW-2020		2.90		3.10	pCi/l
GW-2021		<0.580		1.10	pCi/l
GW-2022		<0.580[c]	<0.580[c]		pCi/l
GW-2023		<0.580[c]	2.40[c]		pCi/l
GW-2024		<0.580[c]	<0.500[c]		pCi/l
GW-2025		0.610	0.950		pCi/l
GW-2026		<0.580		<0.20	pCi/l
GW-2027		2.50	0.200		pCi/l
GW-2028		<0.580	1.30		pCi/l
GW-2029		2.20	1.30		pCi/l
GW-2030	13.5[c]	16.0[c]	9.80	8.00	pCi/l
GW-2032	10.1[c]	9.90[c]	<6.8	4.80	pCi/l
GW-2033	4.28[c]	1.00[c]	<1.1	1.80	pCi/l
GW-2034		9.60[c]	15.0[c]		pCi/l
GW-3003	15.0	2.30	18.0	23.0	pCi/l
GW-3006	<0.577	1.40	<0.500[c]	0.200	pCi/l
GW-3008	7.96	3.40	2.70	3.30	pCi/l
GW-3009	43.0	59.0	62.0	6.70	pCi/l
GW-3019	<0.577		2.00		pCi/l
GW-3023	10.3[c]	9.20[c]	8.30	7.60	pCi/l
GW-4001	3.84	1.40	<0.580	0.950	pCi/l
GW-4002	<0.577	1.40	<0.580	0.950	pCi/l
GW-4003	<1.40	4.20	<0.580	0.800	pCi/l
GW-4004	NS	7.10	2.00	3.10	pCi/l
GW-4005	NS	5.80	<0.580	0.880	pCi/l
GW-4006	<0.577	<0.680	<0.500	<0.20	pCi/l
GW-4007	3.33[c]	1.50	2.50[c]	1.80	pCi/l
GW-4008	1.97	1.10	<0.580	1.60	pCi/l
GW-4009	3.13	3.30	5.40	4.40	pCi/l
GW-4010	3.67	3.40	3.70	2.40	pCi/l
GW-4011	4.62	4.50	6.40	5.80	pCi/l
GW-4012	4.40	2.90	0.820	0.300	pCi/l
GW-4013	3.60	1.10	<0.500	<0.20	pCi/l
GW-4014	4.28	<0.680	<0.500	<0.20	pCi/l
GW-4015	0.820	<0.580	<0.500	0.680	pCi/l
GW-4016	3.70	3.10	3.70[c]	3.20	pCi/l
GW-4017	2.30	1.40[c]	<0.500[c]	1.40	pCi/l
GW-4018	1.40	<0.680	<0.500	0.400	pCi/l
GW-4019	2.11	5.10	1.70	1.60	pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-4020	17.0	14.0	12.0	13.0	pCi/l
GW-4021	6.94	4.10	6.90	3.60	pCi/l
GW-4022	6.40[c]	13.0[c]	4.80	3.90	pCi/l
GW-4023	4.62	1.10	<0.500	2.00	pCi/l
GW-FINW	<0.68	0.400	0.190	0.200	pCi/l
GW-PW02	<0.68	0.950	<0.078	<0.20	pCi/l
GW-PW03	<0.68	0.680	<0.078	<0.20	pCi/l
GW-PW04	<0.68	0.200	0.130	<0.20	pCi/l
GW-PW05	<0.68	0.400	0.220	<0.20	pCi/l
GW-PW06	<0.68	<0.20	0.200	<0.20	pCi/l
GW-PW07	<0.68	<0.20	<0.078	0.200	pCi/l
GW-PW08	<0.68	0.500	0.240	0.200	pCi/l
GW-PW09	<0.68	1.20	0.350	<0.20	pCi/l
GW-RAWW	<0.68	0.400	0.170	<0.20	pCi/l
GW-RMW1	<0.68	0.68	0.59	0.825	pCi/l
GW-RMW2	5.50	5.60	8.40	5.10	pCi/l
GW-RMW3	<0.6	0.400	0.200	0.300	pCi/l
GW-RMW4	1.95	2.40	1.40	1.30	pCi/l
URANIUM-234					
GW-1017			1.70		pCi/l
GW-1020	0.460				pCi/l
GW-2001	3.99				pCi/l
GW-2002	<15.0[a]				pCi/l
GW-2003	20.3				pCi/l
GW-2007	2.02		<4.30		pCi/l
GW-2015	<11.7				pCi/l
GW-2017			7.05		pCi/l
GW-3019	1.34				pCi/l
GW-4003			1.40		pCi/l
GW-4005	1.40				pCi/l
GW-4011	2.40				pCi/l
GW-4020	13.0		(7.20)		pCi/l
GW-4021			4.20		pCi/l
GW-4023			2.30		pCi/l
URANIUM-235					
GW-1017			<0.400		pCi/l
GW-1020	<0.080				pCi/l
GW-2001	1.26				pCi/l
GW-2002	33.8				pCi/l

TABLE B-2 Quarterly, Semi and Annual Groundwater Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
GW-2003	17.6				pCi/l
GW-2007	0.863		<1.20		pCi/l
GW-2015	<3.31				pCi/l
GW-2017			0.635		pCi/l
GW-3019	(0.30)				pCi/l
GW-4003				<0.400	pCi/l
GW-4005	<0.300				pCi/l
GW-4011	<0.400				pCi/l
GW-4020	<0.400		<3.30		pCi/l
GW-4021			<0.400		pCi/l
GW-4023			0.600		pCi/l
URANIUM-238					
GW-1017			<0.400		pCi/l
GW-1020	<0.080				pCi/l
GW-2001	<0.739				pCi/l
GW-2002	<14.4[a]				pCi/l
GW-2003	<3.60[a]				pCi/l
GW-2007	<0.674		<4.00		pCi/l
GW-2015	<11.3				pCi/l
GW-2017			4.97		pCi/l
GW-3019	<1.07				pCi/l
GW-4003				(0.300)	pCi/l
GW-4005	1.00				pCi/l
GW-4011	2.40				pCi/l
GW-4020	6.60		(10.0)		pCi/l
GW-4021			3.40		pCi/l
GW-4023			(1.00)		pCi/l

TABLE B-3 Quarry Surface Water Monitoring Data, 1992

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
CHLORIDE							
SW-1008	11.3						mg/l
FLUORIDE							
SW-1008	0.690						mg/l
NITRATE-N							
SW-1001		0.590					mg/l
SW-1002		0.170					mg/l
SW-1003		<0.20					mg/l
SW-1004		<0.10					mg/l
SW-1005		<0.10					mg/l
SW-1007		<0.10					mg/l
SW-1008	0.110	0.110	<0.20	<0.10	<0.10	<0.10	mg/l
SW-1009		<0.10					mg/l
SW-1010		0.140					mg/l
SW-1011		1.39					mg/l
SW-1012		2.00					mg/l
SW-1013		1.70					mg/l
SW-1014		0.800					mg/l
SULFATE							
SW-1001		27.0					mg/l
SW-1002		50.1					mg/l
SW-1003		86.2					mg/l
SW-1004		70.7					mg/l
SW-1005		63.1					mg/l
SW-1007		44.5		45.7	41.3		mg/l
SW-1008	78.2	76.9	71.5	57.8	67.9	57.0	mg/l
SW-1009		47.0					mg/l
SW-1010		39.3					mg/l
SW-1011		80.1					mg/l
SW-1012		85.9					mg/l
SW-1013		87.5					mg/l
SW-1014		30.6					mg/l
ARSENIC							
SW-1001	<2.00						µg/l
SW-1002	<2.00						µg/l
SW-1003	2.29						µg/l

TABLE B-3 Quarry Surface Water Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
SW-1004	<2.00						µg/l
SW-1005	3.79						µg/l
SW-1007	2.20						µg/l
SW-1008	<3.3				4.40		µg/l
SW-1009	<2.00						µg/l
SW-1010	<2.00						µg/l
SW-1011	4.79						µg/l
SW-1012	<2.00						µg/l
SW-1013	4.50						µg/l
SW-1014	<2.00						µg/l
BARIUM							
SW-1001	90.1						µg/l
SW-1002	80.9						µg/l
SW-1003	89.4						µg/l
SW-1004	65.7						µg/l
SW-1005	120						µg/l
SW-1007	125						µg/l
SW-1008	72.5						µg/l
SW-1009	123						µg/l
SW-1010	60.7						µg/l
SW-1011	302						µg/l
SW-1012	261						µg/l
SW-1013	219						µg/l
SW-1014	77.8						µg/l
CADMIUM							
SW-1008	<3.40						µg/l
CHROMIUM							
SW-1008	<6.80						µg/l
COPPER							
SW-1008	<25.0						µg/l
IRON							
SW-1008	(87.0)						µg/l

TABLE B-3 Quarry Surface Water Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
LEAD							
SW-1008	(1.38)						µg/l
MANGANESE							
SW-1008	51.0					85.5	µg/l
MERCURY							
SW-1008	(0.037)						µg/l
SELENIUM							
SW-1008	<2.60						µg/l
SILVER							
SW-1008	<10.0						µg/l
ZINC							
SW-1008	<20.0						µg/l
2,4,5-T							
SW-1008	<0.190						µg/l
2,4-D							
SW-1008	<0.600						µg/l
ALKALINITY							
SW-1001		138					mg/l
SW-1002		210					mg/l
SW-1003		308					mg/l
SW-1004		160					mg/l
SW-1005		232					mg/l
SW-1007		130		77.0	147		mg/l
SW-1008	150	145	125	150	160	130	mg/l
SW-1009		146					mg/l
SW-1010		114					mg/l

TABLE B-3 Quarry Surface Water Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
SW-1011		132					mg/l
SW-1012		160					mg/l
SW-1013		145					mg/l
SW-1014		195					mg/l
BIOCHEMICAL OXYGEN DEMAND							
SW-1008	2.50						mg/l
CHEMICAL OXYGEN DEMAND							
SW-1008	5.00						mg/l
CYANIDE							
SW-1008	<11.7						µg/l
TOTAL DISSOLVED SOLIDS							
SW-1008	422						mg/l
TOTAL SUSPENDED SOLIDS							
SW-1008	(2.83)						mg/l
1,3,5-TRINITROBENZENE							
SW-1001		<0.03					µg/l
SW-1002		<0.03					µg/l
SW-1003		<0.03					µg/l
SW-1004		<0.03					µg/l
SW-1005		<0.03					µg/l
SW-1007		<0.03					µg/l
SW-1008	<0.4	<0.03	<0.03	0.049	0.079	0.031	µg/l
SW-1009		<0.03					µg/l
SW-1010		<0.03					µg/l
SW-1011		<0.03					µg/l
SW-1012		<0.03					µg/l
SW-1013		<0.03					µg/l
SW-1014		<0.03					µg/l

TABLE B-3 Quarry Surface Water Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
1,3-DINITROBENZENE							
SW-1001		<0.09					µg/l
SW-1002		<0.09					µg/l
SW-1003		<0.09					µg/l
SW-1004		<0.09					µg/l
SW-1005		<0.09					µg/l
SW-1007		<0.09					µg/l
SW-1008	<0.473	<0.09	<0.09	<0.09	<0.09	<0.09	µg/l
SW-1009		<0.09					µg/l
SW-1010		<0.09					µg/l
SW-1011		<0.09					µg/l
SW-1012		<0.09					µg/l
SW-1013		<0.09					µg/l
SW-1014		<0.09					µg/l
2,4,6-TNT							
SW-1001		0.067					µg/l
SW-1002		<0.03					µg/l
SW-1003		<0.03					µg/l
SW-1004		<0.03					µg/l
SW-1005		<0.03					µg/l
SW-1007		<0.03					µg/l
SW-1008	0.94	<0.03	<0.03	4.20	10.0	16.0	µg/l
SW-1009		<0.03					µg/l
SW-1010		<0.03					µg/l
SW-1011		<0.03					µg/l
SW-1012		<0.03					µg/l
SW-1013		<0.03					µg/l
SW-1014		<0.03					µg/l
2,4-DNT							
SW-1001		0.037					µg/l
SW-1002		<0.03					µg/l
SW-1003		<0.03					µg/l
SW-1004		<0.03					µg/l
SW-1005		<0.03					µg/l
SW-1007		<0.03					µg/l
SW-1008	2.65	0.300	0.600	18.0	7.00	5.17	µg/l
SW-1009		<0.03					µg/l
SW-1010		<0.03					µg/l

TABLE B-3 Quarry Surface Water Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
SW-1011		<0.03					µg/l
SW-1012		<0.03					µg/l
SW-1013		<0.03					µg/l
SW-1014		<0.03					µg/l
2,6-DNT							
SW-1001		0.014					µg/l
SW-1002		<0.01					µg/l
SW-1003		<0.01					µg/l
SW-1004		<0.01					µg/l
SW-1005		<0.01					µg/l
SW-1007		<0.01					µg/l
SW-1008	(0.309)	0.016	0.046	1.10	0.660	0.500	µg/l
SW-1009		<0.01					µg/l
SW-1010		<0.01					µg/l
SW-1011		<0.01					µg/l
SW-1012		<0.01					µg/l
SW-1013		<0.01					µg/l
SW-1014		<0.01					µg/l
NITROBENZENE							
SW-1001		<0.03					µg/l
SW-1002		<0.03					µg/l
SW-1003		<0.03					µg/l
SW-1004		<0.03					µg/l
SW-1005		<0.03					µg/l
SW-1007		<0.03					µg/l
SW-1008	<0.8	<0.03	<0.03	<0.03	<0.03	<0.03	µg/l
SW-1009		<0.03					µg/l
SW-1010		<0.03					µg/l
SW-1011		<0.03					µg/l
SW-1012		<0.03					µg/l
SW-1013		<0.03					µg/l
SW-1014		<0.03					µg/l
ACTINIUM-227							
SW-1008	<1.44						pCi/l

TABLE B-3 Quarry Surface Water Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
GROSS ALPHA							
SW-1001		<2.00					pCi/l
SW-1003		77.0					pCi/l
SW-1004		180					pCi/l
SW-1005		30.0					pCi/l
SW-1007		17.0					pCi/l
SW-1008	1370	1650	930	360	610		pCi/l
SW-1009		12.0					pCi/l
SW-1011		10.0					pCi/l
GROSS BETA							
SW-1001		8.90					pCi/l
SW-1003		72.0					pCi/l
SW-1004		140					pCi/l
SW-1005		28.0					pCi/l
SW-1007		14.0					pCi/l
SW-1008	508	690	790	200	210		pCi/l
SW-1009		19.0					pCi/l
SW-1011		14.0					pCi/l
LEAD-210							
SW-1008	7.20						pCi/l
POLONIUM-210							
SW-1008	(0.81)						pCi/l
PROTACTINIUM-231							
SW-1008	1.16						pCi/l
RADIUM-226							
SW-1001		0.200					pCi/l
SW-1003		<0.20					pCi/l
SW-1004		0.400					pCi/l
SW-1005		0.200					pCi/l
SW-1007		<0.20					pCi/l
SW-1008	0.707	0.800	<2.8		0.700	<0.300	pCi/l

TABLE B-3 Quarry Surface Water Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
SW-1009		0.600					pCi/l
SW-1011		1.10					pCi/l
RADIUM-228							
SW-1001		<0.90					pCi/l
SW-1003		(0.70)					pCi/l
SW-1004		1.40					pCi/l
SW-1005		<0.90					pCi/l
SW-1007		1.30					pCi/l
SW-1008	(2.41)	<0.90	<18	(0.600)	(0.900)		pCi/l
SW-1009		<0.90					pCi/l
SW-1011		2.60					pCi/l
RADON-222							
SW-1008	242						pCi/l
THORIUM-228							
SW-1001		<0.20					pCi/l
SW-1003		<0.20					pCi/l
SW-1004		<0.20					pCi/l
SW-1005		<0.20					pCi/l
SW-1007		<0.20					pCi/l
SW-1008	(0.504)	<0.20	<0.470			<0.400	pCi/l
SW-1009		<0.20					pCi/l
SW-1011		0.600					pCi/l
THORIUM-230							
SW-1001		4.80					pCi/l
SW-1003		2.20					pCi/l
SW-1004		2.10					pCi/l
SW-1005		1.50					pCi/l
SW-1007		0.300					pCi/l
SW-1008	1.54	0.200	<0.340		0.900	<0.400	pCi/l
SW-1009		<0.20					pCi/l
SW-1011		1.60					pCi/l

TABLE B-3 Quarry Surface Water Monitoring Data, 1992 (Continued)

WSSRAP ID	B1	B2	B3	B4	B5	B6	UNITS
THORIUM-232							
SW-1001		<0.20					pCi/l
SW-1003		<0.20					pCi/l
SW-1004		<0.20					pCi/l
SW-1005		<0.20					pCi/l
SW-1007		<0.20					pCi/l
SW-1008	(0.560)	<0.20	<0.340		<0.400	<0.400	pCi/l
SW-1009		<0.20					pCi/l
SW-1011		0.600					pCi/l
URANIUM, TOTAL							
SW-1001	0.748	0.820	<0.6	<0.500	1.60	1.70	pCi/l
SW-1002	1.36	5.03	<0.680	<0.580	<1.1	1.40	pCi/l
SW-1003	47.0	110	46.0	44.0	8.20	45.0	pCi/l
SW-1004	53.0	300	73.0	51.0	18.0	44.0	pCi/l
SW-1005	10.0	42.0	26.0	41.0	10.0	18.0	pCi/l
SW-1007	13.0	16.0	7.60	4.88	16.6	13.5	pCi/l
SW-1008	1431	1200	13.0	570	58.0	493	pCi/l
SW-1009	14.0	18.0	6.35	7.20	5.70	3.60	pCi/l
SW-1010	39.0	54.5	43.0	71.0	22.0	32.0	pCi/l
SW-1011	9.79	8.50	3.30	2.40	4.20	3.80	pCi/l
SW-1012	9.11	5.85	1.80	<0.580	4.00	2.20	pCi/l
SW-1013	10.0	5.51	5.00	<0.580	4.50	2.10	pCi/l
SW-1014	<3.0	4.08	3.80	0.500	1.80	0.820	pCi/l
URANIUM-234							
SW-1008		378					pCi/l
URANIUM-235							
SW-1008		38.0					pCi/l
URANIUM-238							
SW-1008		500					pCi/l

TABLE B-4 Chemical Plant Area Surface Water Monitoring Data, 1992

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
NITRATE-N					
SW-2001		0.760			mg/l
SW-2002		0.170			mg/l
SW-2003		0.500			mg/l
SW-2004		1.20			mg/l
SW-2005		1300[a]			mg/l
SW-2007		<0.10			mg/l
SW-2010		0.270			mg/l
SW-2011		0.380			mg/l
SW-2016		1.00			mg/l
SW-3001		534			mg/l
SW-3002		103			mg/l
SW-3003		1760			mg/l
SW-3004		0.120			mg/l
SULFATE					
SW-2001		40.6			mg/l
SW-2002		34.4			mg/l
SW-2003		17.4			mg/l
SW-2004		22.4			mg/l
SW-2005		28.9			mg/l
SW-2007		24.8			mg/l
SW-2011		57.1			mg/l
SW-2016		48.6			mg/l
SW-3001		408			mg/l
SW-3002		800			mg/l
SW-3003		636			mg/l
SW-3004		67.3			mg/l
ANTIMONY					
SW-2001		<36.0			µg/l
SW-2002		<36.0			µg/l
SW-2003		<36.0			µg/l
SW-2004		<36.0			µg/l
SW-2005		<36.0			µg/l
SW-2007		<44.0			µg/l
SW-2011		<44.0			µg/l
SW-2016		<36.0			µg/l

TABLE B-4 Chemical Plant Area Surface Water Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
ARSENIC					
SW-2001		<2.00			µg/l
SW-2002		<1.00			µg/l
SW-2003		<1.00			µg/l
SW-2004		<1.00			µg/l
SW-2005		<1.40			µg/l
SW-2007		<2.00			µg/l
SW-2011		2.00			µg/l
SW-2016		<2.00			µg/l
BARIUM					
SW-2001		110			µg/l
SW-2002		76.4			µg/l
SW-2003		60.7			µg/l
SW-2004		78.0			µg/l
SW-2005		72.4			µg/l
SW-2007		140			µg/l
SW-2011		76.3			µg/l
SW-2016		134			µg/l
BERYLLIUM					
SW-2001		<1.00			µg/l
SW-2002		1.39[a]			µg/l
SW-2003		1.39[a]			µg/l
SW-2004		1.39[a]			µg/l
SW-2005		2.39[a]			µg/l
SW-2007		<1.00			µg/l
SW-2011		<1.00			µg/l
SW-2016		<1.00			µg/l
CADMIUM					
SW-2001		<4.00			µg/l
SW-2002		<4.00			µg/l
SW-2003		<4.00			µg/l
SW-2004		<4.00			µg/l
SW-2005		<4.00			µg/l
SW-2007		<4.00			µg/l
SW-2011		<4.00			µg/l
SW-2016		<4.00			µg/l

TABLE B-4 Chemical Plant Area Surface Water Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
CHROMIUM					
SW-2001		<7.00			µg/l
SW-2002		<7.00			µg/l
SW-2003		<7.00			µg/l
SW-2004		<7.00			µg/l
SW-2005		<7.00			µg/l
SW-2007		<7.00			µg/l
SW-2011		<8.00			µg/l
SW-2016		<7.00			µg/l
LEAD					
SW-2001		<2.00			µg/l
SW-2002		<2.00			µg/l
SW-2003		<2.00			µg/l
SW-2004		<2.00			µg/l
SW-2005		<1.00			µg/l
SW-2007		<2.00			µg/l
SW-2011		15.0			µg/l
SW-2016		<2.00			µg/l
LITHIUM					
SW-2010		<100			µg/l
MERCURY					
SW-2001		<0.100			µg/l
SW-2002		<0.100			µg/l
SW-2003		<0.100			µg/l
SW-2004		<0.100			µg/l
SW-2005		<0.100			µg/l
SW-2007		<0.100			µg/l
SW-2011		<0.100			µg/l
SW-2016		<0.100			µg/l
SELENIUM					
SW-2001		<2.00			µg/l
SW-2002		<2.00			µg/l
SW-2003		<2.00			µg/l
SW-2004		<2.00			µg/l

TABLE B-4 Chemical Plant Area Surface Water Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
SW-2005		<2.00			µg/l
SW-2007		<2.00			µg/l
SW-2011		<2.00			µg/l
SW-2016		<2.00			µg/l
SILVER					
SW-2001		<8.00			µg/l
SW-2002		<8.00			µg/l
SW-2003		<8.00			µg/l
SW-2004		<8.00			µg/l
SW-2005		<8.00			µg/l
SW-2007		<6.00			µg/l
SW-2011		<6.00			µg/l
SW-2016		<8.00			µg/l
THALLIUM					
SW-2001		<2.00			µg/l
SW-2002		<2.00			µg/l
SW-2003		<2.00			µg/l
SW-2004		<2.00			µg/l
SW-2005		<1.00			µg/l
SW-2007		<2.00			µg/l
SW-2011		<2.00			µg/l
SW-2016		<2.00			µg/l
ALKALINITY					
SW-2001		160			mg/l
SW-2002		65.0			mg/l
SW-2003		62.0			mg/l
SW-2004		94.0			mg/l
SW-2005		<2.00[a]			mg/l
SW-2007		180			mg/l
SW-2011		145			mg/l
SW-2016		160			mg/l
SW-3001		48.0			mg/l
SW-3002		49.0			mg/l
SW-3003		46.0			mg/l
SW-3004		386			mg/l

TABLE B-4 Chemical Plant Area Surface Water Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
TOTAL SUSPENDED S					
SW-2010		21.0			mg/l
GROSS ALPHA					
SW-2001			<9.80		pCi/l
SW-2002			(6.50)		pCi/l
SW-2003			<6.70		pCi/l
SW-2004			<7.70		pCi/l
SW-2005			<8.20		pCi/l
SW-2007			<8.70		pCi/l
SW-2010		1800			pCi/l
SW-2011			170		pCi/l
SW-2016			<9.40		pCi/l
SW-5311		170	109		pCi/l
GROSS BETA					
SW-2001			<6.80		pCi/l
SW-2002			<6.70		pCi/l
SW-2003			<6.10		pCi/l
SW-2004			<6.30		pCi/l
SW-2005			<6.30		pCi/l
SW-2007			<6.00		pCi/l
SW-2010		660			pCi/l
SW-2011			140		pCi/l
SW-2016			<6.70		pCi/l
SW-5311		38.5	64.4		pCi/l
RADIUM-226					
SW-2001			<0.90		pCi/l
SW-2002			<0.90		pCi/l
SW-2003			<0.90		pCi/l
SW-2004			<0.90		pCi/l
SW-2005			<0.90		pCi/l
SW-2007			<0.90		pCi/l
SW-2016			<0.90		pCi/l
SW-3001		164			pCi/l
SW-3002		50.5			pCi/l
SW-3003		69.3			pCi/l

TABLE B-4 Chemical Plant Area Surface Water Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
SW-3004		1.47			pCi/l
SW-5311		2.29	2.00		pCi/l
RADIUM-228					
SW-2001			3.40		pCi/l
SW-2002			<2.40		pCi/l
SW-2003			<2.40		pCi/l
SW-2004			<2.40		pCi/l
SW-2005			<2.40		pCi/l
SW-2007			(1.40)		pCi/l
SW-2016			<2.70		pCi/l
SW-3001		4.15			pCi/l
SW-3002		6.17			pCi/l
SW-3003		27.3			pCi/l
SW-3004		6.81			pCi/l
SW-5311		(0.683)	<2.70		pCi/l
THORIUM-228					
SW-2001			<0.400		pCi/l
SW-2002			<0.500		pCi/l
SW-2003			<0.400		pCi/l
SW-2004			<0.400		pCi/l
SW-2005			<0.400		pCi/l
SW-2007			<0.400		pCi/l
SW-2011			0.150		pCi/l
SW-2016			<0.700		pCi/l
SW-3001		1.40			pCi/l
SW-3002		1.11			pCi/l
SW-3003		1.61			pCi/l
SW-3004		<0.912			pCi/l
SW-5311		<0.757	<0.500		pCi/l
THORIUM-230					
SW-2001			0.800		pCi/l
SW-2002			0.900		pCi/l
SW-2003			<0.600		pCi/l
SW-2004			2.10		pCi/l
SW-2005			0.800		pCi/l
SW-2007			2.80		pCi/l
SW-2011			0.270		pCi/l

TABLE B-4 Chemical Plant Area Surface Water Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
SW-2016			1.00		pCi/l
SW-3001		622			pCi/l
SW-3002		141			pCi/l
SW-3003		12.4			pCi/l
SW-3004		1.84			pCi/l
SW-5311		(1.03)	0.900		pCi/l
THORIUM-232					
SW-2001			<0.400		pCi/l
SW-2002			<0.500		pCi/l
SW-2003			<0.400		pCi/l
SW-2004			0.800		pCi/l
SW-2005			<0.400		pCi/l
SW-2007			<0.400		pCi/l
SW-2011			<0.170		pCi/l
SW-2016			<0.800		pCi/l
SW-3001		6.46			pCi/l
SW-3002		2.54			pCi/l
SW-3003		0.555			pCi/l
SW-3004		<0.744			pCi/l
SW-5311		<0.757	<0.500		pCi/l
URANIUM, TOTAL					
SW-2001	2.90	1.70	<0.500	0.680	pCi/l
SW-2002	171	56.0	23.0	80.0	pCi/l
SW-2003	13.7	13.0	6.10		pCi/l
SW-2004	17.8	11.0	11.0	14.0	pCi/l
SW-2005	35.6	35.0	21.0	24.0	pCi/l
SW-2007	1.40	2.00	<0.500	<0.20	pCi/l
SW-2010	2880	1600			pCi/l
SW-2011	200	280	240	270	pCi/l
SW-2016	3.00	1.80	<0.500	2.78	pCi/l
SW-3001		130		55.0	pCi/l
SW-3002		1300		920	pCi/l
SW-3003		240		170	pCi/l
SW-3004		2200		1000	pCi/l
SW-5311		170	110		pCi/l

TABLE B-4 Chemical Plant Area Surface Water Monitoring Data, 1992 (Continued)

WSSRAP ID	Q1	Q2	Q3	Q4	UNITS
URANIUM-234					
SW-2001				(0.30)	pCi/l
SW-2002				38.0	pCi/l
SW-2004				8.10	pCi/l
SW-2005				12.0	pCi/l
SW-2007				<0.400	pCi/l
SW-2011				120	pCi/l
SW-2016				0.400	pCi/l
URANIUM-235					
SW-2001				(0.30)	pCi/l
SW-2002				0.400	pCi/l
SW-2004				<0.400	pCi/l
SW-2005				<0.400	pCi/l
SW-2007				<0.400	pCi/l
SW-2011				7.60	pCi/l
SW-2016				<0.400	pCi/l
URANIUM-238					
SW-2001				<0.400	pCi/l
SW-2002				41.0	pCi/l
SW-2004				7.60	pCi/l
SW-2005				13.0	pCi/l
SW-2007				<0.400	pCi/l
SW-2011				130	pCi/l
SW-2016				0.900	pCi/l

TABLE B-6 Annual Spring Monitoring Results, 1992

LOCATION	Q1	Q2	Q3	Q4	UNITS
NITRATE					
SP-5201		< 0.200	0.180	0.300	MG/L
SP-5303		0.220	0.650	0.500	MG/L
SP-5304			0.760	0.81	MG/L
SP-6301		32.5	28.9	34.4	MG/L
SP-6306		0.180	0.300	0.140	MG/L
SULFATE					
SP-5201		69.8	57.8	56.5	MG/L
SP-5303		62.8	62.1	64.0	MG/L
SP-5304			50.7	52.3	MG/L
SP-6301		51.3	59.4	61.6	MG/L
SP-6306		8.90	6.05	9.25	MG/L
ALKALINITY					
SP-5201		210	200	200	MG/L
SP-5303		275	215	105	MG/L
SP-5304			205	140	MG/L
SP-6301		205	248	183	MG/L
SP-6303		140	160	140	MG/L
1,3,5-TRINITROBENZENE					
SP-5201		< 0.56			UG/L
SP-5303		0.09			UG/L
SP-6301		0.045			UG/L
SP-6306		< 0.03			UG/L
1,3-DINITROBENZENE					
SP-5201		< 0.61			UG/L
SP-5303		< 0.09			UG/L
SP-6301		< 0.09			UG/L
SP-6306		< 0.09			UG/L
2,4,6-TNT					
SP-5201		< 0.78			UG/L
SP-5303		20.0			UG/L
SP-6301		0.27			UG/L
SP-6306		< 0.03			UG/L

TABLE B-6 Annual Spring Monitoring Results, 1992 (Continued)

LOCATION	Q1	Q2	Q3	Q4	UNITS
2,4-DNT					
SP-5201		< 0.60			UG/L
SP-5303		0.24			UG/L
SP-6301		0.042			UG/L
SP-6303		< 0.03			UG/L
2,6-DNT					
SP-5201		0.61			UG/L
SP-5303		0.43			UG/L
SP-6301		0.61			UG/L
SP-6303		< 0.01			UG/L
NITROBENZENE					
SP-5201		< 1.13			UG/L
SP-5303		< 0.03			UG/L
SP-6301		< 0.03			UG/L
SP-6303		< 0.03			UG/L
GROSS ALPHA					
SP-6301			79.0		PCI/L
GROSS BETA					
SP-6301			13.0		PCI/L
RADIUM-226					
SP-5201		< 0.68			PCI/L
SP-5303		(0.63)			PCI/L
SP-6301		< 1.29			PCI/L
SP-6306		(0.41)			PCI/L
RADIUM-228					
SP-5201		< 4.66			PCI/L
SP-5303		< 2.89			PCI/L
SP-6301		2.06			PCI/L
SP-6306		< 4.47			PCI/L

TABLE B-6 Annual Spring Monitoring Results, 1992 (Continued)

LOCATION	Q1	Q2	Q3	Q4	UNITS
THORIUM-228					
SP-5201		< 0.55			PCI/L
SP-5303		0.394			PCI/L
SP-6301		< 0.31			PCI/L
SP-6306		(0.25)			PCI/L
THORIUM-230					
SP-5201		5.47			PCI/L
SP-5303		4.90			PCI/L
SP-6301		(0.25)			PCI/L
SP-6306		2.61			PCI/L
THORIUM-232					
SP-5201		< 0.77			PCI/L
SP-5303		(0.45)			PCI/L
SP-6301		< 0.16			PCI/L
SP-6306		< 0.47			PCI/L
URANIUM, TOTAL					
SP-5201	6.30	< 0.58	0.75	0.82	PCI/L
SP-5303	80.0	190	160	73.0	PCI/L
SP-5304	80.0		140	88.0	PCI/L
SP-6301	44.0	88.5	80.7	82.3	PCI/L
SP-6306	14.0	1.40	0.61	2.00	PCI/L

TABLE B-7 NPDES Monitoring Data, 1992

WSSRAP ID	JAN	FEB	MAR	APRIL	MAY	JUNE	UNITS
NITRATE-N							
NP-0001	0.48	0.45		0.50			mg/l
NP-0002	0.58	0.89	0.97	1.10	0.41	0.47	mg/l
NP-0003	8.30	2.95	2.05	3.39	0.21		mg/l
NP-0004			0.57				mg/l
NP-0005	129	38.4	31.1	18.60	0.31		mg/l
LITHIUM							
NP-0001	<100	<100		<100			µg/l
NP-0002	<100	<100	<100	<100	<100	<23.0	µg/l
NP-0003	<100	<100	<100	<100	<100		µg/l
NP-0004			<100				µg/l
NP-0005	<100	(96.0)	(27.2)	<100	<100		µg/l
TOTAL SUSPENDED SOLIDS							
NP-0001	13.0	11.0		15.0			mg/l
NP-0002	6.00	<5.00	8.00	38.0	48.0	16.0	mg/l
NP-0003	63.0	11.3	<5[a]	40.0	10.0		mg/l
NP-0004			97.0				mg/l
NP-0005	6.00	9.00[a]	136	129	35.0		mg/l
GROSS ALPHA							
NP-0001	732	150		410			pCi/l
NP-0002	310	270	260	140	220	190	pCi/l
NP-0003	163	1205	810	540	280		pCi/l
NP-0004			10.0				pCi/l
NP-0005	338	271	285	350	460		pCi/l
GROSS BETA							
NP-0001				150			pCi/l
NP-0002			110	29.0	61.0		pCi/l
NP-0003			405	190	49.0		pCi/l
NP-0004			11.0				pCi/l
NP-0005			210	160	55.0		pCi/l
URANIUM, TOTAL							
NP-0001	1090	184		450			pCi/l
NP-0002	437	286	287	100	150	170	pCi/l
NP-0003	237	1420	556	540	270		pCi/l

TABLE B-7 NPDES Monitoring Data, 1992 (Continued)

WSSRAP ID	JAN	FEB	MAR	APRIL	MAY	JUNE	UNITS
NP-0004			6.12				pCi/l
NP-0005	470	216	335	360	510		pCi/l
CHLORIDE							
NP-0002						83.5	mg/l
NP-0003				12.6			mg/l
NP-0004						1.65	mg/l
NP-0005					6.95		mg/l
FLUORIDE							
NP-0002						0.225	mg/l
NP-0003				<0.50			mg/l
NP-0004						0.275	mg/l
NP-0005					0.575		mg/l
NITRATE-N							
NP-0001	0.543	0.246		0.63			mg/l
NP-0002	0.26	0.044	0.12	0.66	0.40	53.1	mg/l
NP-0003	0.26	0.45		0.38	0.96	1.30	mg/l
NP-0004						539	mg/l
NP-0005	0.810	0.960		0.58	0.546	0.410	mg/l
NITRITE-N							
NP-0002						<20.0	mg/l
NP-0004						<20.0	mg/l
SULFATE							
NP-0002						103	mg/l
NP-0003				140			mg/l
NP-0004						226	mg/l
NP-0005					40.6		mg/l
ARSENIC							
NP-0002						(1.98)	µg/l
NP-0003				<2.00			µg/l
NP-0004						<38.0	µg/l
NP-0005					5.85		µg/l

TABLE B-7 NPDES Monitoring Data, 1992 (Continued)

WSSRAP ID	JAN	FEB	MAR	APRIL	MAY	JUNE	UNITS
BARIUM							
NP-0002						67.0	µg/l
NP-0003				92.6			µg/l
NP-0004						34.0	µg/l
NP-0005					266		µg/l
CADMIUM							
NP-0002						5.00	µg/l
NP-0003				<7.00			µg/l
NP-0004						5.50	µg/l
NP-0005					<7.00		µg/l
CHROMIUM							
NP-0002						<6.00	µg/l
NP-0003				<9.00			µg/l
NP-0004						<6.00	µg/l
NP-0005					19.7		µg/l
COPPER							
NP-0002						<17.00	µg/l
NP-0003				<8.00			µg/l
NP-0004						19.8	µg/l
NP-0005					30.6		µg/l
IRON							
NP-0002						572	µg/l
NP-0003				722			µg/l
NP-0004						513	µg/l
NP-0005					26200		µg/l
LEAD							
NP-0002						<1.50	µg/l
NP-0003				<2.00			µg/l
NP-0004						<2.00	µg/l
NP-0005					33.3		µg/l

TABLE B-7 NPDES Monitoring Data, 1992 (Continued)

WSSRAP ID	JAN	FEB	MAR	APRIL	MAY	JUNE	UNITS
LITHIUM							
NP-0001	<9.00	<9.00		<27.0			µg/l
NP-0002	<23.0	<9.00	<9.00	<24.0	<27.0	<9.00	µg/l
NP-0003	<6.00	<10.0		<27.0	<27.0	<27.0	µg/l
NP-0004						<9.00	µg/l
NP-0005	<23.0	13.1		<27.0	27.4	<27.0	µg/l
MANGANESE							
NP-0002						78.0	µg/l
NP-0003				34.9			µg/l
NP-0004						27.0	µg/l
NP-0005					793		µg/l
MERCURY							
NP-0002						0.125	µg/l
NP-0003				<0.10			µg/l
NP-0004						0.13	µg/l
NP-0005					<0.10		µg/l
SELENIUM							
NP-0002						<1.00	µg/l
NP-0003				<2.00			µg/l
NP-0004						5.5	µg/l
NP-0005					<2.00		µg/l
SILVER							
NP-0002						<1.00	µg/l
NP-0003				<10.0			µg/l
NP-0004						<1.00	µg/l
NP-0005					<10.0		µg/l
ZINC							
NP-0002						<15.0	µg/l
NP-0003				38.1			µg/l
NP-0004						46.5	µg/l
NP-0005					190		µg/l

TABLE B-7 NPDES Monitoring Data, 1992 (Continued)

WSSRAP ID	JAN	FEB	MAR	APRIL	MAY	JUNE	UNITS
BIOCHEMICAL OXYGEN DEMAND							
NP-0002						<1.00	mg/l
NP-0003				4.00	3.70		mg/l
NP-0004						2.70	mg/l
NP-0005					3.15		mg/l
CHEMICAL OXYGEN DEMAND							
NP-0002						20.0	mg/l
NP-0003				29.1			mg/l
NP-0004						15.0	mg/l
NP-0005					169		mg/l
CYANIDE							
NP-0002						<5.00	µg/l
NP-0003				<20.0			µg/l
NP-0004						<5.00	µg/l
NP-0005					<20.0		µg/l
NITROGEN, TOTAL KJELDAHL							
NP-0002						0.262	mg/l
NP-0003				0.875			mg/l
NP-0004						0.26	mg/l
NP-0005					2.00		mg/l
OIL & GREASE							
NP-0002						<5.00	mg/l
NP-0003				<5.00			mg/l
NP-0004						<5.00	mg/l
NP-0005					<5.00		mg/l
NP-1001					<5.00	<5.00	mg/l
PHOSPHOROUS							
NP-0002						0.04	mg/l
NP-0003				0.30			mg/l
NP-0004						0.05	mg/l
NP-0005					1.04		mg/l

TABLE B-7 NPDES Monitoring Data, 1992 (Continued)

WSSRAP ID	JAN	FEB	MAR	APRIL	MAY	JUNE	UNITS
TOTAL SUSPENDED SOLIDS							
NP-0001	59.0	21.000		64.0			mg/l
NP-0002	148	10.0	<2.00	7.00	26.0	7.50	mg/l
NP-0003	3.00	32.0		18.5	25.0	9.00	mg/l
NP-0004						28.5	mg/l
NP-0005	112	432		65.0	374	38.0	mg/l
NP-1001					6.750	<5.000	mg/l
1,3,5-TRINITROBENZENE							
NP-0002						<0.03	µg/l
NP-0003				<0.03			µg/l
NP-0004						<0.03	µg/l
NP-0005					<0.03		µg/l
1,3-DINITROBENZENE							
NP-0002						<0.09	µg/l
NP-0003				<0.09			µg/l
NP-0004						<0.09	µg/l
NP-0005					<0.09		µg/l
2,4,6-TNT							
NP-0002						<0.03	µg/l
NP-0003				<0.03			µg/l
NP-0004						<0.03	µg/l
NP-0005					<0.03		µg/l
2,4-DNT							
NP-0002						<0.03	µg/l
NP-0003				<0.03			µg/l
NP-0004						<0.03	µg/l
NP-0005					<0.03		µg/l
2,6-DNT							
NP-0002						<0.01	µg/l
NP-0003				<0.01			µg/l
NP-0004						<0.01	µg/l
NP-0005					<0.01		µg/l

TABLE B-7 NPDES Monitoring Data, 1992 (Continued)

WSSRAP ID	JAN	FEB	MAR	APRIL	MAY	JUNE	UNITS
NITROBENZENE							
NP-0002						<0.03	µg/l
NP-0003				<0.03			µg/l
NP-0004						<0.03	µg/l
NP-0005					<0.03		µg/l
GROSS ALPHA							
NP-0001	404	432		306			pCi/l
NP-0002	183	96.7	110	240	220	300	pCi/l
NP-0003	58.0	251	39.0	120.0	30.0	510	pCi/l
NP-0004						17.0	pCi/l
NP-0005	5.67[a]	177	70.2	320	260	230	pCi/l
GROSS BETA							
NP-0001				140			pCi/l
NP-0002				69.0	70.0	73.0	pCi/l
NP-0003				39.0	30.0	180	pCi/l
NP-0004						4.90	pCi/l
NP-0005				130	120	50.0	pCi/l
RADIUM-226							
NP-0002						0.70	pCi/l
NP-0003				1.60			pCi/l
NP-0004						0.95	pCi/l
NP-0005					7.65		pCi/l
RADIUM-228							
NP-0002						<1.00	pCi/l
NP-0003				(0.55)			pCi/l
NP-0004						<1.00	pCi/l
NP-0005					3.60		pCi/l
THORIUM-228							
NP-0002						<0.40	pCi/l
NP-0003				<0.40			pCi/l
NP-0004						<0.40	pCi/l
NP-0005					1.10		pCi/l

TABLE B-7 NPDES Monitoring Data, 1992 (Continued)

WSSRAP ID	JAN	FEB	MAR	APRIL	MAY	JUNE	UNITS
THORIUM-230							
NP-0002						(0.35)	pCi/l
NP-0003				(0.35)			pCi/l
NP-0004						1.65	pCi/l
NP-0005					2.45		pCi/l
THORIUM-232							
NP-0002						<0.40	pCi/l
NP-0003				<0.40			pCi/l
NP-0004						(0.25)	pCi/l
NP-0005					1.00		pCi/l
URANIUM, TOTAL							
NP-0001	450	450					
NP-0002	200	110	240	470	210	280	pCi/l
NP-0003	64.0	290	65.0	140	54.0	610	pCi/l
NP-0004						15.0[a]	pCi/l
NP-0005	1.4[a]	170	140	390	240	230	pCi/l

APPENDIX C
Assumptions and Scenarios for Dose Calculations

A. Dose from the chemical plant/raffinate pits to a maximally exposed individual.

1. Inhalation and external gamma pathway:

a. Airborne particulate: no contribution to the estimated EDE for the hypothetical individual was calculated for airborne particulates. Based on statistical analysis of the data collected, there is no reason to suspect at the 95% confidence level that the measured results from any of the monitoring locations were greater than background.

b. External gamma radiation: no contribution to the estimated EDE for the hypothetical individual was calculated for external gamma radiation. Based on statistical analysis of the data collected, there is no reason to suspect at the 95% confidence level that the measured results from any of the monitoring locations were greater than background.

c. Radon gas: statistical analysis of the radon track etch detector data indicated that two stations at the chemical plant/raffinate pits, RD-2001 and RD-3002, were greater than background. Although the actual annual average measured concentrations at these locations were only approximately 0.1 pCi/l greater than the annual background station average, an EDE was calculated for a hypothetical individual who frequents the northern perimeter boundary. The individual was assumed to frequent the northern boundary rather than the boundary immediately adjacent to the sampling locations, which are part of the Weldon Spring Army Reserve Training Area and not accessible to the general public.

Although large scale remediation has not begun at the chemical plant/raffinate pits, contaminated soils have been removed and relocated to spoil piles in order to construct facilities such as the temporary storage area and site water treatment plant. In this scenario, it was assumed that the slightly above background concentrations at RD-2001 and RD-3002 resulted from these contaminated soil spoil areas. A computer model called CAP-88 PC was used to estimate the airborne concentrations at the Northern perimeter. The model was executed using emmission rates from two area sources that resulted in concentrations at the monitoring locations RD-2001 and RD-3002 that were similar to the actual annual average measured concentrations. The computer model estimated that the concentration along the northern border was 0.14 pCi/l.

Assume an annual exposure time of 50 hrs/yr based on a scenario where an individual walks along the northern boundary once per day, 12 minutes per visit, 250 visits per year.

Radon concentrations are often expressed in units of working levels (WL) where 1 WL = 100 pCi/l for Rn-222 (Radon). Radon exposure is often expressed in terms of working level months (WLM) which correspond to an exposure of 1 WL during the reference working period of 1 month (i.e., 2000 working hours per 12 months or 170 hrs). Assume a working level ratio for Rn-222 of 50% and a dose conversion factor of 1 rem/WLM (ICRP 1981).

CEDE (inhalation) = net radon concentration X exposure time X working level ratio X dose conversion factor X working level month conversion factor.

= 0.14 pCi/l X 50 hrs X 0.50 X 1 WL/100 pCi/l X 1.00 rem/WLM X 1 working month/170 hrs X 1000 mrem/rem

= 0.2 mrem

2. Ingestion pathway:

Lakes that receive effluent from the chemical plant/raffinate pits are used in order to determine the estimated effective dose equivalent to a maximally exposed individual via ingestion of fish, water, and sediment obtained from these lakes.

On average, fishing at the Busch Wildlife Area requires 2.5 hr per visit (MDOC 1991). Assume that the maximally exposed individual visited the lakes for the purpose of fishing 25 times during the year. The ratio of fish caught to hours spent fishing was reported as 0.41, while the ratio of fish kept to fish caught was reported as 0.48 (MDOC 1991). Thus on an annual basis, the maximally exposed individual would keep 12.3 fish from the lakes. Assume that the edible portion of a fish has an average mass of 200 g. Thus, the annual consumption rate of 6.5 g/day (EPA 1988) provides a good estimate of the consumption rate for fish caught from the three affected lakes for the hypothetical individual.

Boating at the Busch Wildlife Area requires more hours per visit than any other activity; therefore, boating was assumed to be the activity in which the maximally exposed individual participated for the water and sediment ingestion scenarios. Assume the average time spent by the maximally exposed individual per boating trip is 5.7 hr, (MDOC 1991) and the hypothetical individual visits the area for the purpose of boating 10 times in a year. Assume that 25% of the time is devoted to swimming during each visit. Thus, 14.3 hr are spent swimming in the lakes.

a. Fish: Assume a 6.5 g/day fresh water fish consumption rate (EPA 1988) from Lake 36 at the Busch Wildlife Area and a 0.017 pCi/g total uranium content in fish, which is the highest average net uranium concentration in fish of all lakes receiving runoff from the Weldon Spring site.

b. Water: Assume a 0.05 l/hr swimming ingestion rate (EPA 1988) for the 14.3 hr for a total annual consumption of 0.72 liters. The water is assumed to have a total uranium concentration as detected in Lake 36 of 171 pCi uranium/l, which is the highest uranium water concentrations of all lakes receiving runoff from the site.

c. Sediment: Assume a 200 mg/day ingestion rate for the 14.3 hr for a total of 120 mg of sediment. The sediment is assumed to have a total uranium concentration as detected in Lake 34 of 46.8 pCi uranium/g sediment, which is the highest uranium concentration of all lakes receiving runoff from the site.

CEDE (ingestion) = annual fish consumption x uranium concentration x uranium DCF[1] + annual water consumption x uranium concentration x uranium DCF[1] + annual sediment ingestion x uranium concentration x uranium DCF[1].

= 6.5 g/day X 365 day/yr X 0.017 pCi/g X 2.83E-4 mrem/pCi + 0.72 liter/yr X 171 pCi/liter X 2.83E-4 mrem/pCi + 0.12 g/yr X 110 pCi/g X 2.83E-4 mrem/pCi

= 0.04 mrem

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1 The uranium dose conversion factor (DCF) was the greater of the two DCFs reported for each uranium isotope (U-234 and U-238) in Table 2.2 of Eckerman et al. (1988).

The total estimated committed effective dose equivalent to the maximally exposed individual at the chemical plant/raffinate pits area is 0.24 mrem (0.0002 mSv).

B. Dose from the Weldon Spring Quarry to a maximally exposed individual.

1. Inhalation pathway:

   a. Airborne radioactive particulate: Not applicable since there is no reason to suspect at the 95% confidence level that airborne radioactive particulate data are greater than the background concentrations.

   b. Radon gas: Assume the concentration at State Route 94 is equal to the measured net concentration at RD-1002 of 1.3 pCi/l. Assume an annual exposure time of 50 hrs (Section 4.2.2).

   Radon concentrations are often expressed in units of working levels (WL) where 1 WL = 100 pCi/liter for Rn-222. Radon exposure is often expressed in terms of working level months (WLM) which corresponds to an exposure of 1 WL during the reference working period of 1 month (i.e., 2000 working hours per 12 months or 170 hours). Assume a working level ratio for Rn-222 of 50% and a dose conversion factor of 1 rem/WLM (ICRP 1981).

   CEDE (inhalation) = net radon concentration x exposure time x working level ratio x dose conversion factor x working month conversion factor.

   = 1.3 pCi/l x 50 hrs x 0.50 x 1 WL/100 pCi/l x 1.00 rem/WLM x 1 working month/170 hrs x 1000 mrem/rem

   = 1.912 mrem

2. External gamma radiation pathway: not applicable since there is no reason to suspect at the 95% confidence level that external gamma radiation data are greater than background.

3. Ingestion pathway: because the quarry is controlled by a 2.4 m (8 ft) high barbed wire fence, fishing, swimming, and drinking water at the quarry do not constitute realistic scenarios.

The total estimated committed effective dose equivalent to the maximally exposed individual at the quarry is 1.9 mrem (0.019 mSv).

C. Dose from the vicinity properties to a maximally exposed individual.

1. Inhalation pathway: Statistical analysis of airborne particulate and radon concentrations at the quarry perimeter indicated that there was no reason to suspect at the 95% confidence level that there should be no contribution of the individual via these pathways at a location beyond the quarry perimeter.

2. External gamma pathway: not applicable since there is no reason to suspect at the 95% confidence level that external gamma radiation data are greater than background.

3. Ingestion pathway:

Fish: Assume a 6.5 g/day fresh water fish consumption rate (EPA 1988) from the slough. Assume the average net uranium concentration in fish collected from the slough of 0.0043 pCi uranium/g. Net uranium concentrations in fish were obtained by subtracting the background uranium concentration of 0.0005 pCi/g total uranium/gram. The net uranium concentration was used to calculate the effective dose equivalent via the ingestion pathway.

CEDE (ingestion) = Fish consumption x uranium concentration x DCF[1]

= 6.5 g/day x 365 d/yr x 0.0043 pCi/g x 2.83E-04 mrem/pCi

= 0.003 mrem

The total estimated committed effective dose equivalent for the maximally exposed individual at the Little Femme Osage Slough is 0.003 mrem (0.00003 mSv).

(1) Uranium dose conversion factor (DCF) was obtained from the EPA Federal Report No. 11 (Eckerman et al. 1988).

D. Collective Population Dose Estimate

<u>Exposure Points</u> - Exposure points are locations where members of the public are potentially being exposed to above-background concentrations of (1) airborne radioactive particulates, (2) radon gas concentrations, (3) external gamma radiation, or (4) radionuclides in food or water. All three pathways are addressed for the collective population dose estimate. Exposure to above-background radionuclide concentrations in food or water is addressed only for users of the Busch Wildlife Area, a recreational area adjacent to the chemical plant/raffinate pits area. Three of the lakes on this property receive runoff from the site and are used by the general public for fishing and boating purposes. None of these bodies of water are used as drinking water sources.

Exposure points, by definition, must be located where there is potential for public exposure as a result of activities performed at the site or from materials stored at the site. If there is no reason to suspect that environmental monitoring results are different from the appropriate background monitoring results, then the area surrounding the environmental monitoring station cannot be considered an exposure point; therefore, the population near the station, as well as the population beyond the station, is not included in the collective population dose estimate.

The only area where there was reason to suspect that environmental monitoring results could be different than the appropriate background monitoring results was at the quarry perimeter. This was true only for radon concentrations. The only potential receptors near the quarry perimeter are people using the Katy Trail, a recreational hiking and biking trail located on state-owned land south of the quarry. However, track etch detectors placed at the trail indicate that there was no reason to suspect at the 95% confidence level that concentrations exceeded background. As a result, no collective dose was calculated for the population which frequents the Katy Trail.

The Katy Trail was chosen as the only public exposure point near the quarry because at all environmental monitoring locations near the quarry (i.e., AP-4011, and RD-4006), there was no reason to suspect at the 95% confidence level that the monitoring results were different from the background monitoring results.

The only area where there was reason to suspect that a significant amount of the general population could consume fish, water, and sediments from waters that receive runoff from the site was at the Busch Wildlife Area. The only potential receptors in that area are the

people who actually use the Busch Wildlife property for recreational purposes. Three of the lakes at the area (i.e., Lakes 34, 35, and 36) receive runoff from the Weldon Spring site and are utilized for fishing and boating activities. The Missouri Department of Conservation recently conducted a year long survey to determine the number of visitors to the area, the types of activities in which users participate, and the amount of time allocated for these activities.

Fishing at the Busch Wildlife Area averaged 2.5 hr per visit for the approximately 15,000 visits to the area for that purpose. On average, 7,232 fish from the lakes are kept each year. Assuming that one person keeps one fish, the population of concern would be 7,232 persons (MDOC 1991). For the water and sediment ingestion scenarios, boating is the activity assumed to provide the potential for incidental water and sediment ingestion. An estimated 3,838 visits were made for the purpose of boating with an average of 5.7 hr per visit. Assuming that each visit constitutes one individual, the total population would be 3,838 persons. Each of these ingestion scenarios is further addressed in calculations one, two, and three.

Although data from two radon track etch stations at the perimeter of the chemical plant/raffinate pits were found to be statistically greater than background, it is not realistic to calculate a population dose based on the concentrations that were measured. The annual averages for the stations were only approximately 0.1 pCi/l greater than the annual average of the background stations. In addition, at all off-site monitoring stations in the vicinity of the chemical plant/raffinate pits there was no reason to suspect at the 95% confidence level that any of the stations were greater than background. As a result, no dose was calculated for the population that frequents the Busch Wildlife Area.

1. Population dose estimate due to ingestion of fish obtained at the Busch Wildlife Area.

    a. Assuming that each person of the 7,232 population consumes one fish and that the edible portion of a fish has a mass of 200 g, the average consumption rate specific to the affected population is 0.55 g/person/day.

    b. Using the total uranium fish content of 0.017 pCi/g obtained from samples collected in Lake 36 and the population specific consumption rate derived from Missouri Department of Conservation data, the estimated population dose is:

Population Dose Estimate (fish ingestion) = consumption rate x total uranium concentration in fish x exposure time x dose conversation factor[1] x persons

$$= 0.55\ \frac{g}{day}\ x\ 0.017\ \frac{pCi}{g}\ x\ 365\ day\ x\ 2.83E{-}4\ \frac{mrem}{pCi}$$
$$x\ 7{,}232\ persons\ x\ \frac{1\ rem}{1{,}000\ mrem}$$
$$= 0.007\ person{-}rem$$

2. Population dose estimate due to incidental ingestion of water at the Busch Wildlife lakes.

   a. Assume that each person of the 3,838 population makes one boating visit on an annual basis and 25% of the visit is spent swimming (1.425 hr/visit).

   b. Using the total uranium surface water content of 51 pCi/l obtained from Lake 36 and an ingestion rate of 0.05 l/hr (EPA 1988) the estimated population dose is

Population Dose Estimate (water ingestion) = ingestion rate x total uranium concentration in surface water x exposure time x dose conversation factor[1] x persons

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1 Uranium dose conversion factor (DCF) was the greater of the two DCFs reported for each uranium isotope (U-234 and U-238) in Table 2.2 of Eckerman et al. (1988)

$$= 0.05\ \frac{l}{hr}\ x\ 171\ \frac{pCi}{l}\ x\ 1.425\ hr\ x\ 2.83E{-}4\ \frac{mrem}{pCi}$$
$$x\ 3{,}838\ persons\ x\ \frac{1\ rem}{1{,}000\ mrem}$$
$$= 0.013\ person\ rem$$

3. Population dose estimate due to ingestion of sediments at the Busch lakes.

   a. Assume that each person of the 3,838 population makes one boating visit on an annual basis and 25% of the visit is spent swimming (1.425 hr/visit).

   b. Using the total uranium sediment content of 46.8 pCi/g obtained from Lake 34 and an ingestion rate of 200 mg/day, the estimated population dose is:

Population Dose Estimate (sediment ingestion) = ingestion rate x total uranium concentration in sediment x exposure time x dose conversion factor[1] x persons

$$= 200\ \frac{mg}{day}\ x\ \frac{1\ g}{1{,}000\ mg}\ x\ 110\ \frac{pCi}{g}\ x\ 1.425\ hr\ x\ \frac{1\ day}{24\ hr}\ x\ 2.83E{-}4\ \frac{mrem}{pCi}$$
$$x\ 3{,}838\ persons\ x\ \frac{1\ rem}{1{,}000\ mrem}$$
$$= 0.0014\ person{-}rem$$

The total estimated population dose for all potential exposure pathways for calendar year 1992 is 0.021 person-rem.

E. Radon Release Estimate

In order to estimate airborne radon progeny concentrations at the Katy Trail, the above-background radon results measured at the WSQ perimeter were incorporated into a box

model. A box model predicts the radon release rate in pCi/y by multiplying the measured net airborne or radon concentration by the assumed box model parameters for length, height, and average annual wind speed. The box model assumes that airborne contaminants are dispoersed homogeneously within the modeled volume of air. The selected value for model length is 122 m (134 yd); for height it is 3 m (3.3 yd); and the value for average annual wind speed is 2 m/s (4.4 mi/hr). The model length value corresponds to the length of the major contaminated area within the quarry. A simplified box model is justified for calculating the airborne radon release rate sin ce the effective dose equivalent and population doses are low as indicated by the calculation results.

The net annual average radon concentration at the WSQ is 0.4 pCi/l and is calculated by averaging the results from stations RD-1001 through RD-1006 less the average background result of 0.25 pCi/l.

Box Model: length = 122 m (134 yd), height = 3 m (3.3 yd), average wind spead (μ) = 2 m/x (4.4 mi/hr).

Release rate = length x height x μ x net annual average radon concentration = 9.2 Ci/y.

APPENDIX D
NPDES Monitoring Information and Annual Averages

TABLE D-1 Priority Pollutant List Quarry Water Treatment Plant

Acenaphthene	4-chlorophenyl phenyl ether
Acrolein	4-bromophenyl phenyl ether
Acrylonitrile	Bis (2-chloroisopropyl) ether
Benzene	Bis (2-chloroithexy) methane
Benzidine	Methylene chloride (dichloromethane)
Carbon Tetrachloride (tetrachloromethane)	Methyl chloride (chloromethane)
Chlorobenzene	Methyl bromide (bromomethane)
1,2,4-trichlorobenzene	Bromoform (tribromomethane)
Hexachlorobenzene	Dichlorobromomethane
1,2-dichloroethane	Chlorodibromomethane
1,1,1-trichloroethane	Hexachlorobutadiene
Hexachloroethane	Hexachlorocyclopentadiene
1,1-dichloroethane	Isophorone
1,1,2-trichloroethane	Naphthalene
1,1,2,2-tetrachloroethane	Nitrobenzene
Chloroethane	2-nitrophenol
Bis (2-chloroethyl) ether	4-nitrophenol
2-chloroethyl vinyl ether	2,4-dinitrophenol
N-nitrosodi-n-propylamine	4,6-dinitro-o-cresol
Pentachlorophenol	N-nitrosodimethylamine
Phenol	N-nitrosodiphenylamine
Bis (2-ethylhexyl) phthalate	Phenanthrene
Butyl benzyl phthalate	1,2,5,6-dibenzanthracene (dibenzo(a,h)anthracene)
Di-n-butyl phthalate	Indeno (1,2,3-cd) pyrene (2,3-o-phenylene pyrene)
Di-n-octyl phthalate	Pyrene
Diethyl phthalate	Tetrachloroethylene
Dimethyl phthalate	Toluene
1,2-benzanthracene (benzo(a)anthracene)	Trichloroethylene
Benzo(a)pyrene (3,4-benzopyrene)	Vinyl Chloride (chloroethylene)

TABLE D-1 Priority Pollutant List Quarry Water Treatment Plant (Continued)

3,4-benzofluoranthene (benzo(b)fluoranthene)	Aldrin
11,12-benzofluoranthene (benzo(k)fluoranthene)	Dieldrin
Chrysene	Chlordane (technical mixture and metabolites)
Anthracene	4,4-DDT
1,12-benzoperylene (benzo(ghi)perylene)	4,4-DDE (p,p-DDX)
Fluorene	4,4-DDD (p,p-TDE)
2-chloronaphthalene	Alpha-endosulfan
2,4,6-trichlorophenol	Beta-endosulfan
Parachlorometa cresol	Endosulfan sulfate
Chloroform (trichloromethane)	Endrin
2-chlorophenol	Endrin aldehyde
1,2-dichlorobenzene	Heptachlor
1,3-dichlorobenzene	Heptachlor epoxide (BHC hexachlorocyclohexane)
1,4-dichlorobenzene	Alpha-BHC
3,3-dichlorobenzidine	Beta-BHC
1,1-dichloroethylene	Gamma-BHC
1,2-trans-dichloroethylene	Delta-BHC (PCB polychlorinated biphenyls)
2,4-dichlorophenol	PCB-1242 (Arochlor 1242)
1,2-dichloropropane (1,3-dichloropropane)	PCB-1254 (Arochlor 1254)
2,4-dimethylphenol	PCB-1221 (Arochlor 1221)
2,4-dinitrotoluene	PCB 1232 (Arochlor 1232)
2,6-dinitrotoluene	PCB-1248 (Arochlor 1248)
1,2-diphenylhydrazine	PCB-1260 (Arochlor 1260)
Ethylbenzene	PCB-1016 (Arochlor 1016)
Fluoranthene	Toxaphene
Xylene[a]	2,4,6-trinitrotoluene[a]

(a) QY NP-1001 only

TABLE D-2 Average Inorganic Anion Concentrations for NPDES Locations, 1992

Location	Chloride mg/l	@	Fluoride mg/l	@	Nitrate-N mg/l	@	Nitrite-N mg/l	@	Sulfate mg/l	@
NP-0001					0.48	0/6				
NP-0002	83.5	0/2	0.23	0/2	8.62	0/13	< 20.0	2/2	103	0/2
NP-0003	12.6	0/2	< 0.60	2/2	1.75	0/15			140	0/2
NP-0004	1.65	0/2	0.28	0/2	360	0/3	< 20.0	2/2	226	0/2
NP-0005	8.95	0/2	0.58	0/2	18.3	0/15			40.6	0/2

@ Ratio of non-detects to total number of samples

TABLE D-3 Average Radiological Concentrations for NPDES Locations, 1992.

Location	Gross Alpha pCi/l	@	Gross Beta pCi/l	@	Ra-226 pCi/l	@	Ra-228 pCi/l	@	Th-228 pCi/l	@	Th-230 pCi/l	@	Th-232 pCi/l	@	Uranium Total pCi/L	@
NP-0001	406	0/6	145	0/2											516	0/6
NP-0002	212	0/12	69.3	0/7	0.70	0/2	< 1.00	2/2	< 0.40	2/2	< 0.40	0/2	< 0.40	2/2	228	0/12
NP-0003	463	0/13	167	0/8	1.60	0/2	< 1.00	1/2	< 0.40	2/2	< 0.40	1/2	< 0.40	2/2	478	0/13
NP-0004	10	0/1	11	0/1	0.95	0/2	< 1.00	2/2	< 0.40	2/2	1.65	0/2	< 0.40	1/2	6	0/1
NP-0005	275	0/13	121	0/8	7.65	0/2	3.60	0/2	1.10	1/2	2.45	0/2	1.00	0/2	296	0/13

@ Ratio of non-detects to total number of samples.

TABLE D-4 Average Metals Concentrations for NPDES Locations, 1992.

Location	Arsenic µg/l	@	Barium µg/l	@	Cadmium µg/l	@	Chromium µg/l	@	Copper µg/l	@	Iron µg/l	@
NP-0001												
NP-0002	<1.98	1/2	67.0	0/2	5.00	1/2	<6.00	2/2	<17.00	2/2	572	0/2
NP-0003	<2.00	2/2	92.6	0/2	<7.00	2/2	<9.00	2/2	<8.00	2/2	722	0/2
NP-0004	<39.0	2/2	34.0	0/2	5.50	0/2	<6.00	2/2	19.8	1/2	513	0/2
NP-0005	5.85	0/2	266	0/2	<7.00	2/2	19.7	0/2	30.6	0/2	26200	0/2

Location	Lead µg/l	@	Lithium µg/l	@	Manganese µg/l	@	Mercury µg/l	@	Selenium µg/l	@
NP-0001			<58	6/6						
NP-0002	<1.50	2/2	<49	13/13	78.0	0/2	0.13	0/2	<1.00	2/2
NP-0003	<2.00	2/2	<63	13/13	34.9	0/2	<0.10	2/2	<2.00	2/2
NP-0004	<2.00	2/2	<39	3/3	27.0	0/2	0.13	0.2	5.45	0/2
NP-0005	33.3	0/2	<55	9/14	793	0/2	<0.10	2/2	<2.00	2/2

@ Ratio of non-detects to total number of samples.

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TABLE D-5 Average NPDES Concentrations for Miscellaneous Parameters, 1992.

Location	Biochemical Oxygen Demand mg/l	@	Chemical Oxygen Demand mg/l	@	Cyanide µg/l	@	Nitrogen, Total Kjeldahl	@	Oil & Grease	@	Phosphorous mg/l	@	Total Suspended Solids mg/l	@
NP-0001													30.5	0/6
NP-0002	< 1.00	2/2	20	0/2	< 5.00	1/1	0.262	0/2	< 5.00	1/1	0.04	0/2	25.0	2/13
NP-0003	3.90	0/3	29.1	0/2	< 20.0	1/1	0.875	0/2	< 5.00	1/1	0.30	0/2	265	1/14
NP-0004	2.70	0/2	15	0/2	< 5.00	1/1	0.280	0/2	< 5.00	1/1	0.05	0/2	51.3	0/3
NP-0005	3.15	0/2	169	0/2	< 20.0	1/1	2.000	0/2	< 5.00	1/1	1.04	0/2	865	1/14
NP-1001									< 5.00	4/4			5.90	3/5

@ Ratio of non-detects to total number of samples.

TABLE D-6 Average Nitroaormatic Concentrations for NPDES Locations 1992

Location	1,3,5-Trinit	@	1,3-Dinitrob	@	2,4,6-TNT	@	2,4-DNT	@	2,6-DNT	@	Nitrobenzene	@
NP-0002	<0.030	2/2	<0.090	2/2	<0.030	2/2	<0.030	2/2	<0.010	2/2	<0.030	2/2
NP-0003	<0.030	2/2	<0.090	2/2	<0.030	2/2	<0.030	2/2	<0.010	2/2	<0.030	2/2
NP-0004	<0.030	2/2	<0.090	2/2	<0.030	2/2	<0.030	2/2	<0.010	2/2	<0.030	2/2
NP-0005	<0.030	2/2	<0.090	2/2	<0.030	2/2	<0.030	2/2	<0.010	2/2	<0.030	2/2

@ Ratio of non-detects to total number of samples.

APPENDIX E
Groundwater Monitoring Information and Field Data Results

TABLE E-1 Lithologic Zones at the Weldon Spring Chemical Plant Area.

Monitoring Well	Lithologic Unit
MW-2001	Weathered Zone
MW-2002	Weathered Zone
MW-2003	Weathered Zone
MW-2004	Weathered Zone
MW-2005	Weathered Zone
MW-2006	Weathered Zone
MW-2007	Top of Competent Zone
MW-2008	Weathered Zone
MW-2009	Weathered Zone
MW-2010	Weathered Zone
MW-2011	Weathered Zone
MW-2012	Weathered Zone
MW-2013	Weathered Zone
MW-2014	Weathered Zone
MW-2015	Weathered Zone
MW-2017	Weathered Zone
MW-2018	Weathered Zone
MW-2019	Competent Zone
MW-2020	Weathered Zone
MW-2021	Competent Zone
MW-2022	Competent Zone
MW-2023	Competent Zone
MW-2024	Competent Zone
MW-2025	Competent Zone

TABLE E-1 Lithologic Zones at the Weldon Spring Chemical Plant Area.

Monitoring Well	Lithologic Unit
MW-2026	Competent Zone
MW-2027	Competent Zone
MW-2028	Competent Zone
MW-2029	Competent Zone
MW-2030	Weathered Zone
MW-2031	Weathered Zone
MW-2032	Weathered Zone
MW-2033	Weathered Zone
MW-2034	Weathered Zone
MW-3003	Competent Zone
MW-3006	Weathered Zone
MW-3008	Weathered Zone
MW-3009	Competent Zone
MW-3013	Weathered Zone
MW-3023	Weathered Zone
MW-4001	Weathered Zone
MW-4002	Weathered Zone
MW-4003	Competent Zone
MW-4004	Competent Zone
MW-4005	Weathered Zone
MW-4006	Competent Zone
MW-4007	Competent Zone
MW-4008	Competent Zone
MW-4009	Competent Zone

TABLE E-1 Lithologic Zones at the Weldon Spring Chemical Plant Area.

Monitoring Well	Lithologic Unit
MW-4010	Weathered Zone
MW-4011	Weathered Zone
MW-4012	Competent Zone
MW-4013	Top of Competent Zone
MW-4014	Weathered Zone
MW-4015	Weathered Zone
MW-4016	Weathered Zone
MW-4017	Weathered Zone
MW-4018	Weathered Zone
MW-4019	Weathered Zone
MW-4020	Weathered Zone
MW-4021	Weathered Zone
MW-4022	Weathered Zone
MW-4023	Weathered Zone

Table E-2 Field Measurements for Groundwater Wells, 1992.

Location	Unit	Sample Date	Water Level (feet)	Temperature °C	pH	Conductivity (umho/cm)	Dissolved Oxygen (mg/l)
MW-2001	W	01/14/92	24.94	10.80	6.79	849	3.80
MW-2001	W	05/18/92	24.66	14.20	7.29	532	6.20
MW-2001	W	07/20/92	25.02	14.70	6.71	611	5.40
MW-2001	W	10/14/92	25.30	14.10	7.15	744	6.90
MW-2002	W	01/28/92	32.43	11.30	7.00	2253	
MW-2002	W	05/18/92	31.76	14.80	6.70	1102	6.80
MW-2002	W	07/20/92	32.29	15.90	6.81	1704	3.10
MW-2002	W	10/19/92	32.89	12.80	7.01	2360	6.30
MW-2003	W	01/14/92	40.95	11.50	6.42	2233	6.20
MW-2003	W	05/18/92	40.52	14.70	7.01	1717	5.80
MW-2003	W	07/20/92	40.77	15.40	6.68	1621	3.40
MW-2003	W	10/14/92	40.86	15.20	6.81	2270	5.20
MW-2004	W	04/23/92	61.15	13.90	6.91	481	
MW-2004	W	07/15/92	61.08	16.00	7.12	579	
MW-2005	W	01/23/92	49.59	10.40	7.52	920	
MW-2005	W	07/15/92	49.68	15.40	6.72	931	
MW-2006	W	01/16/92	35.53	12.00	6.17	1313	
MW-2006	W	08/13/92	36.20	15.40	7.04	1286	
MW-2007	C/W	01/13/92	59.63	12.70	6.76	568	
MW-2007	C/W	07/30/92	60.73	17.80	7.52	557	
MW-2008	W	02/13/92	36.32	8.70	6.68	713	
MW-2008	W	07/23/92	36.20	15.90	7.10	950	
MW-2009	W	02/13/92	42.34	10.80	6.63	736	

Table E-2 Field Measurements for Groundwater Wells, 1992.

Location	Unit	Sample Date	Water Level (feet)	Temperature °C	pH	Conductivity (umho/cm)	Dissolved Oxygen (mg/l)
MW-2009	W	08/06/92	41.49	14.70	6.81	700	
MW-2010	W	01/16/92	44.32	8.60	6.86	817	
MW-2010	W	07/23/92	44.42	18.30	6.80	830	
MW-2011	W	04/22/92	54.59	13.00	7.09	467	
MW-2012	W	04/22/92	29.49	11.50	6.64	723	
MW-2012	W	07/23/92	31.60	19.20	6.75	942	
MW-2013	W	01/23/92	40.78	12.80	7.14	832	
MW-2013	W	09/30/92	41.93	13.40	6.68	877	
MW-2014	W	04/29/92	44.91	16.40	6.26	743	
MW-2014	W	07/16/92	45.00	19.20	6.73	793	
MW-2015	W	01/13/92	55.77	12.50	6.77	897	
MW-2015	W	07/30/92	56.11	18.60	7.15	918	
MW-2017	W	04/29/92	54.25	15.80	6.89	1361	
MW-2017	W	07/16/92	54.28	16.60	6.67	1386	
MW-2018	W	06/10/92	48.30	15.50	6.89	519	
MW-2018	W	09/29/92	48.77	14.10	7.13	717	
MW-2019	C	09/29/92	71.75	13.80	8.36	644	
MW-2019-UF	C	06/11/92	71.00	15.30	7.91	610	
MW-2020	W	06/10/92	45.86	17.60	7.00	679	
MW-2020	W	10/12/92	46.37	16.10	7.26	1012	
MW-2021	C	10/12/92	37.09	13.90	7.53	683	
MW-2021-X	C	06/23/92	36.65	17.20	6.99	337	
MW-2022-UF	C	06/23/92	51.52	17.00	6.72	298	
MW-2022-UF	C	07/15/92	51.59	19.30	7.03	554	

Table E-2 Field Measurements for Groundwater Wells, 1992.

Location	Unit	Sample Date	Water Level (feet)	Temperature °C	pH	Conductivity (umho/cm)	Dissolved Oxygen (mg/l)
MW-2023-UF	C	06/23/92	54.80	16.00	7.04	279	
MW-2023-UF	C	08/11/92	55.15	16.00	8.34	435	
MW-2024-UF	C	06/23/92	67.50	16.50	7.24	314	
MW-2024-UF	C	08/11/92	67.31	15.20	7.91	584	
MW-2025-UF	C	06/29/92	40.25	14.30	7.48	559	
MW-2025-X	C	08/11/92	40.53	14.40	7.33	507	
MW-2026	C	10/26/92	46.11	14.10	7.06	401	
MW-2026-UF	C	06/22/92	46.00	14.80	8.58	284	
MW-2027-UF	C	06/22/92	54.61	14.40	8.31	248	
MW-2027-UF	C	09/30/92	54.96	15.40	8.31	447	
MW-2028	C	06/22/92	64.25	15.30	8.06	479	
MW-2028-UF	C	09/30/92	64.52	16.50	7.55	898	
MW-2029	C	04/29/92	62.59	13.30	6.21	501	
MW-2029	C	07/15/92	62.67	15.50	6.56	595	
MW-2030	W	09/02/92	53.77	15.30	6.73	865	3.70
MW-2030	W	10/19/92	52.99	10.20	6.70	854	4.60
MW-2030-UF	W	03/16/92	53.79	13.50	6.07	912	6.20
MW-2030-UF	W	05/20/92	53.67	17.50	6.88	559	6.40
MW-2032	W	09/03/92	54.30	18.50	6.93	1325	5.90
MW-2032	W	11/09/92	54.30	13.00	7.00	1385	5.70
MW-2032-UF	W	03/16/92	54.27	13.60	6.20	1214	7.10
MW-2032-UF	W	05/20/92	54.26	16.10	6.85	777	8.70
MW-2033	W	09/08/92	41.98	16.90	6.89	954	4.80
MW-2033	W	11/09/92	42.00	12.50	6.92	877	5.40

Table E-2 Field Measurements for Groundwater Wells, 1992.

Location	Unit	Sample Date	Water Level (feet)	Temperature °C	pH	Conductivity (umho/cm)	Dissolved Oxygen (mg/l)
MW-2033-UF	W	03/16/92	41.09	13.80	6.42	922	5.00
MW-2033-UF	W	05/19/92	40.82	16.02	6.66	616	8.40
MW-2034-UF	W	05/11/92	54.61	15.60	6.75	1448	
MW-2034-UF	W	07/16/92	54.63	18.50	6.93	1388	
MW-3003	W	03/11/92	47.34	11.50	6.68	2242	3.80
MW-3003	W	05/26/92	46.82	13.50	6.87	2580	8.10
MW-3003	W	10/21/92	47.56	15.40	7.17	2700	3.40
MW-3003-UF	W	08/03/92	47.24	16.50	7.50	2280	7.50
MW-3006	C	05/26/92	53.69	13.60	7.01	671	6.50
MW-3006	C	10/21/92	54.61	14.50	7.41	662	3.00
MW-3006-UF	C	08/03/92	54.57	14.60	6.87	683	4.40
MW-3006-X	C	01/29/92	54.39	8.60	7.08	639	2.80
MW-3008	W	03/17/92	34.00	15.80	8.20	2409	7.20
~~MW-3008~~	~~W~~	~~06/09/92~~	~~33.68~~	~~15.00~~	~~6.93~~	~~3950~~	~~5.80~~
MW-3008	W	10/19/92	34.18	14.50	6.96	340	6.00
MW-3008	W	12/09/92	33.88	11.60	7.26	3760	5.70
MW-3009	W	03/25/92	38.20	13.40	6.37	990	4.70
MW-3009	W	06/08/92	38.33	15.40	7.25	1880	6.70
MW-3009	W	09/09/92	38.81	16.30	7.20	1063	
MW-3009-X	W	12/08/92	38.65	9.40	7.14	1801	4.90
MW-3019	C	01/23/92	55.24	12.90	7.59	449	
MW-3019	C	09/28/92	55.73	14.30	7.14	502	
MW-3023	W	09/03/92	45.66	16.10	7.07	2610	3.30
MW-3023	W	10/21/92	45.27	14.00	6.89	2720	4.10

Table E-2 Field Measurements for Groundwater Wells, 1992.

Location	Unit	Sample Date	Water Level (feet)	Temperature °C	pH	Conductivity (umho/cm)	Dissolved Oxygen (mg/l)
MW-3023-UF	W	03/11/92	45.77	12.20	6.65	2247	7.30
MW-3023-UF	W	03/12/92	45.30	11.90	5.98	2221	
MW-3023-UF	W	03/13/92	0.00	13.50	5.70	2213	
MW-3023-UF	W	06/09/92	45.21	15.50	6.91	2730	5.10
MW-3023-UF	W	06/10/92	45.13	0.00	0.00	0	
MW-4001	W	01/09/92	19.80	14.20	6.90	604	6.50
MW-4001	W	05/21/92	19.29	17.20	7.12	405	2.80
MW-4001	W	07/22/92	20.02	15.70	7.33	477	4.00
MW-4001	W	12/02/92	20.26	8.50	7.04	703	4.00
MW-4002	W	01/29/92	67.21	12.30	7.21	438	3.40
MW-4002	W	05/21/92	60.92	14.60	7.28	244	8.40
MW-4002	W	07/21/92	66.33	14.60	7.20	385	4.70
MW-4002	W	12/14/92	61.62	8.70	7.23	475	3.90
MW-4003	W	02/11/92	59.45	12.80	6.97	485	4.40
MW-4003	W	06/03/92	57.64	14.40	6.79	244	9.30
MW-4003	W	07/22/92	58.81	16.70	7.30	360	6.90
MW-4003	W	10/06/92	60.40	16.40	7.33	375	7.00
MW-4003	W	11/30/92	60.50	12.90	7.43	569	6.30
MW-4004	C	02/04/92	41.41	12.70	7.72	347	2.50
MW-4004	C	02/11/92	41.64	10.70	5.81	358	3.60
MW-4004	C	06/03/92	40.79	14.40	6.84	172	9.10
MW-4004	C	07/28/92	41.23	18.00	7.50	386	6.80
MW-4004	C	12/02/92	41.19	13.00	7.71	384	4.50
MW-4005	C	02/04/92	48.30	12.00	7.41	391	3.60

Table E-2 Field Measurements for Groundwater Wells, 1992.

Location	Unit	Sample Date	Water Level (feet)	Temperature °C	pH	Conductivity (umho/cm)	Dissolved Oxygen (mg/l)
MW-4005	C	06/03/92	47.48	14.30	6.93	200	9.30
MW-4005	C	07/21/92	48.15	15.00	7.36	328	4.70
MW-4005	C	12/09/92	48.39	11.20	7.64	411	7.00
MW-4006	W	01/09/92	20.00	13.00	7.22	310	5.90
MW-4006	W	06/04/92	18.91	15.10	6.75	235	7.60
MW-4006	W	07/27/92	19.72	15.50	6.92	429	5.60
MW-4006	W	12/02/92	20.31	12.60	7.43	395	4.50
MW-4007	C	06/18/92	30.37	13.80	7.77	258	
MW-4007	C	12/15/92	28.26	12.80	7.85	398	6.70
MW-4007-UF	C	03/10/92	27.55	12.00	7.85	358	3.50
MW-4007-UF	C	06/17/92	27.87	15.30	8.02	243	
MW-4007-UF	C	08/05/92	28.33	14.30	7.75	302	7.80
MW-4008	C	02/18/92	40.15	12.80	7.65	653	2.70
MW-4008	C	06/01/92	40.09	15.30	7.12	239	7.10
MW-4008	C	07/21/92	40.36	17.00	7.48	322	3.50
MW-4008	C	11/24/92	40.62	10.90	7.93	372	4.30
MW-4009	C	03/09/92	30.92	14.20	7.80	459	2.70
MW-4009	C	06/01/92	31.18	14.10	7.43	275	7.40
MW-4009	C	07/27/92	31.53	15.00	6.64	554	4.90
MW-4009	C	12/14/92	31.65	10.80	8.24	471	5.70
MW-4010	W	03/09/92	40.83	13.70	6.91	567	4.70
MW-4010	W	06/01/92	41.35	13.90	7.09	319	5.50
MW-4010	W	07/27/92	41.87	19.00	7.50	602	5.00
MW-4010	W	12/08/92	41.73	11.70	7.35	531	3.90

Table E-2 Field Measurements for Groundwater Wells, 1992.

Location	Unit	Sample Date	Water Level (feet)	Temperature °C	pH	Conductivity (umho/cm)	Dissolved Oxygen (mg/l)
MW-4011	C	02/18/92	37.83	12.00	7.59	842	2.10
MW-4011	C	06/04/92	37.78	15.10	6.96	487	8.40
MW-4011	C	07/28/92	38.37	20.10	7.42	935	5.60
MW-4011	C	12/08/92	38.25	10.00	7.39	881	5.00
MW-4012	C/W	03/24/92	46.20	13.00	6.82	697	5.60
MW-4012	C/W	06/08/92	46.38	15.00	8.81	556	1.80
MW-4012	C/W	07/29/92	46.58	15.20	7.83	644	5.60
MW-4012	C/W	10/27/92	46.80	11.60	9.08	485	4.10
MW-4013	W	03/16/92	48.00	13.00	6.83	1007	5.60
MW-4013	W	06/09/92	45.48	16.50	7.17	826	5.50
MW-4013	W	08/04/92	46.55	13.80	7.33	847	6.00
MW-4013	W	10/27/92	42.18	12.90	6.78	742	5.10
MW-4014	W	03/16/92	47.77	12.70	6.05	591	4.20
MW-4014	W	06/09/92	47.72	15.60	7.34	398	3.00
MW-4014	W	08/04/92	47.92	13.70	7.41	485	3.50
MW-4014	W	10/27/92	47.96	13.40	7.51	444	3.20
MW-4015	W	03/23/92	37.62	12.90	6.28	524	6.80
MW-4015	W	06/29/92	38.28	13.70	7.67	501	4.00
MW-4015	W	08/17/92	38.45	14.90	7.36	488	5.00
MW-4015	W	10/13/92	38.62	12.40	7.78	484	7.20
MW-4016	W	03/23/92	54.87	12.80	6.77	454	4.40
MW-4016	W	06/10/92	54.71	15.40	8.89	422	5.40
MW-4016	W	10/14/92	54.81	14.30	7.64	471	5.40
MW-4016-UF	W	08/11/92	54.73	0.00	0.00	0	

Table E-2 Field Measurements for Groundwater Wells, 1992.

Location	Unit	Sample Date	Water Level (feet)	Temperature °C	pH	Conductivity (umho/cm)	Dissolved Oxygen (mg/l)
MW-4016-UF	W	08/17/92	54.88	14.30	7.31	496	2.80
MW-4017	W	03/30/92	58.75	11.70	6.56	613	7.80
MW-4017	W	10/13/92	58.70	13.70	7.03	590	7.20
MW-4017-UF	W	06/10/92	58.53	15.20	7.01	607	10.50
MW-4017-UF	W	08/17/92	59.38	14.60	7.75	644	5.70
MW-4018	W	03/24/92	51.90	14.00	6.59	808	5.70
MW-4018	W	07/29/92	52.00	15.40	6.88	816	5.40
MW-4018	W	12/22/92	52.22	11.30	7.13	617	7.30
MW-4019	W	03/11/92	35.67	12.30	6.90	469	5.60
MW-4019	W	06/02/92	35.42	15.00	6.90	247	9.20
MW-4019	W	07/28/92	35.43	19.40	7.56	525	4.90
MW-4019	W	12/14/92	35.43	9.40	7.52	521	5.00
MW-4020	W	03/24/92	53.82	13.90	6.81	931	6.70
MW-4020	W	06/09/92	53.50	15.80	7.17	695	6.00
MW-4020	W	08/04/92	53.62	19.40	7.07	706	4.90
MW-4020	W	10/28/92	54.00	14.40	6.90	605	5.70
MW-4021	W	03/17/92	44.03	13.00	6.87	1031	
MW-4021	W	06/08/92	43.92	16.20	6.65	866	1.50
MW-4021	W	09/15/92	44.21	14.00	6.70	1177	
MW-4021	W	10/28/92	34.10	12.70	6.88	790	3.70
MW-4022	C	08/05/92	72.23	15.20	7.16	450	5.40
MW-4022	C	11/09/92	72.17	13.60	7.39	509	5.90
MW-4022-UF	C	03/30/92	72.95	13.30	6.76	589	6.50
MW-4022-UF	C	06/02/92	72.13	15.40	6.79	287	9.60

Table E-2 Field Measurements for Groundwater Wells, 1992.

Location	Unit	Sample Date	Water Level (feet)	Temperature °C	pH	Conductivity (umho/cm)	Dissolved Oxygen (mg/l)
MW-4023	W	03/17/92	33.81	13.40	7.00	819	4.20
MW-4023	W	06/09/92	33.33	17.40	6.15	685	
MW-4023	W	07/29/92	33.51	17.00	7.01	886	5.10
MW-4023	W	10/26/92	33.37	12.40	7.21	601	4.30

Unit: W = weathered zone, C = competent zone, C/W = top of competent zone.

APPENDIX F
Biological Monitoring Data

TABLE F-1 Radionuclide Concentrations in Vegetation (pCi/g)

Location	Vegetation type	Uranium	Ra-226	Ra-228	Th-228	Th-230	Th-232
Ash Pond	Sedge rosettes	0.730	0.006	0.006	<0.001	<0.001	<0.001
Background	Sedge rosettes	0.014	0.006	0.015	<0.001	<0.001	<0.001

[a] Does not include background concentrations

TABLE F-2 Waterfowl Species at the WSCP/WSRP, 1992

Locations	Background Location
American wigeons	American coot
Blue-winged teals	Blue-winged teals
Bufflaheads	Canada geese
Canada geese*	Canvasbacks
Canvasbacks	Green-winged teals
Gadwalls	Hooded mergansers
Mallards*	Lesser scaup
Northern pintails	Mallards
Northern shovelar	Ruddy ducks
Ringed-necked ducks	Wood ducks
Wood ducks*	

* Resident species

TABLE F-3 Waterfowl Survey Results for Resident Species, 1992

Femme Osage Slough												
Description	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Wood Duck	0	0	0	25	79	54	16	0	0	2	0	0
Mallard	0	0	0	0	2	0	0	0	0	0	0	0
Canada Geese	0	0	2	6	2	0	0	0	0	0	0	0
Total Count	0	0	2	31	81	54	16	0	0	2	0	0
Total Survey Days	1	2	2	4	4	5	6	4	5	4	2	2
Average/Individual Per Day	0	0	1	8	20	11	3	0	0	<1	0	0

Prairie Lake												
Description	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Wood Duck	0	5	0	4	0	0	0	0	0	0	0	0
Mallard	0	4	4	6	5	6	13	9	6	0	0	0
Canada Geese	26	48	5	20	60	40	77	0	6	0	0	0
Total Count	26	57	9	30	65	46	90	9	12	0	0	0
Total Survey Days	2	2	2	3	5	4	6	4	5	4	2	1
Average/Individual Per Day	13	29	5	10	13	12	15	2	2	0	0	0

TABLE F-3 Waterfowl Survey Results for Resident Species, 1992 (Continued)

Missouri River												
Description	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Wood Duck	0	0	0	3	4	1	0	0	0	0	0	0
Mallard	0	0	0	0	0	0	0	0	0	0	0	0
Canada Geese	0	2	2	8	13	0	24	0	0	0	0	0
Total Count	0	2	2	11	17	1	24	0	0	0	0	0
Total Survey Days	3	1	1	4	4	4	5	4	5	4	2	1
Average/Individual Per Day	0	2	2	3	4	<1	5	0	0	0	0	0

Raffinate Pits 1 and 2												
Description	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Wood Duck	0	2	0	1	1	1	1	2	3	0	0	0
Mallard	0	0	0	2	2	2	0	0	0	0	0	0
Canada Geese	0	4	0	10	6	0	0	0	0	0	0	0
Total Count	0	6	0	13	9	3	1	2	3	0	0	0
Total Survey Days	2	2	0	4	4	5	4	4	4	5	2	2
Average/Individual Per Day	0	3	0	3	2	<1	<1	<1	<1	0	0	0

TABLE F-3 Waterfowl Survey Results for Resident Species, 1992 (Continued)

Raffinate Pits 3 and 4												
Description	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Wood Duck	0	1	0	13	20	44	29	18	23	11	0	0
Mallard	15	5	0	4	11	29	28	28	12	33	9	5
Canada Geese	2	14	0	33	11	49	26	1	30	26	40	0
Total Count	17	20	0	50	42	122	83	47	65	70	49	5
Total Survey Days	2	2	0	4	4	6	4	4	4	5	2	2
Average/Individual Per Day	9	10	0	13	11	20	20.8	12	16	14	25	3

Ash Pond												
Description	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Wood Duck	0	0	1	6	5	6	1	0	0	0	0	0
Mallard	4	2	2	2	0	0	0	0	0	0	41	0
Canada Geese	0	0	0	4	0	0	0	0	0	0	0	0
Total Count	4	2	3	12	9	6	1	0	0	0	41	0
Total Survey Days	2	2	2	4	4	5	3	*	*	*	3	2
Average/Individual Per Day	2	1	2	3	2	1	<1	0	0	0	14	0

* Ash Pond was dry August, September, and October.

TABLE F-3 Waterfowl Survey Results for Resident Species, 1992 (Continued)

Frog Pond												
Description	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Wood Duck	0	0	0	0	0	0	0	0	0	0	0	0
Mallard	0	1	0	1	2	0	0	0	0	0	0	0
Canada Geese	0	0	3	2	0	0	0	0	0	0	0	0
Total Count	0	1	3	3	2	0	0	0	0	0	0	0
Total Survey Days	2	2	1	4	4	4	4	4	4	5	2	2
Average/Individual Per Day	0	<1	3	<1	<1	0	0	0	0	0	0	0

TABLE F-4 Herpetofauna Survey Results

Locations	Species					Total Number of Survey Days
	Common Snapper	Red-Eared Slider	Western Painted	False Map	Eastern Spiny Softshell	
Weldon Spring Chemical Plant						
Raffinate Pit 4	2	6	0	0	0	5
Frog Pond	2	0	0	0	0	4
Weldon Spring Quarry						
Femme Osage Slough	16	92	11	16	4	10
Vicinity Properties						
Lake 36	0	0	0	0	0	5
Memorial Lake	7	39	26	0	0	18
Borrow Pond	2	1	0	0	0	4

TABLE F-5 Bird Species Observed at the WSS and Surrounding Areas, 1992

Species	Location														
	Ash Pond	North Dump	Frog Pond	Raffinate Pits 1/2	Raffinate Pits 3/4	Quarry Rim Area	SE Drainage Upper	SE Drainage Lower	Yellow Trail Drainage	Katy Trail	Femme Osage Slough	St. Charles County Well Field	WSWA Fields 1&5	WSWA Prairie Lake	Burgermeister Spring
American crow	9	4	13	11	4	28	4	21	19	12	35	152	41	5	19
American goldfinch	8		51		8		2		2	3	109	71	50	27	
American kestrel		1	2	2	3						1	3	2	1	
American redstart									1						
American robin	16	7	17	17	1	9	16	21		3	4	4	27	63	41
American tree sparrow											6	4	10	6	
Bank swallow											10				
Barn swallow				1	8						3	11	3	13	2
Belted kingfisher			1		2								1	1	1
Black-capped chickadee	23	21	5				49	21	39	38	21	4	3	4	18
Blue-gray gnatcatcher								1					1		
Blue grosbeak			1	1								1	3		
Black and white warbler															1
Blue-winged warbler	1	1					4								1
Blue jay	80	36	33	11	25	52	58	72	36	131	42	28	69	34	84
Brown creeper*		1						1							1
Brown-headed cowbird	21	3	15	1	21	1	1				44	83	28	20	4
Brown thrasher	3	1									1		7	7	5

TABLE F-5 Bird Species Observed at the WSS and Surrounding Areas, 1992 (Continued)

Species	Location														
	Ash Pond	North Dump	Frog Pond	Raffinate Pits 1/2	Raffinate Pits 3/4	Quarry Rim Area	SE Drainage Upper	SE Drainage Lower	Yellow Trail Drainage	Katy Trail	Femme Osage Slough	St. Charles County Well Field	WSWA Fields 1&5	WSWA Prairie Lake	Burgermeister Spring
Carolina chickadee	1						3								
Carolina wren	8		2			8	7	15			7	1			5
Cattle egret														8	
Cedar waxwing	30	1					2						9		
Chimney swift	3	2	4	16	4	8			2	2	1		23	5	
Common grackle	7	1	8	17	17	10	81		1		208	33	64	102	7
Common yellowthroat	7										7	4	4	1	2
Cooper's hawk*					1								1		
Dark-eyed junco	33	11	8	7	2	2	15	16		128	16	1	9	15	9
Dickcissel												1	2		
Dowitcher					3										
Downy woodpecker	1	2	1			2	4	5	5	6	5	2	7	1	4
Eastern bluebird	2		7	1	6		1			7	3	14	5	3	1
Eastern meadowlark			5	10	3							15	56	66	2
Eastern kingbird	1		1	3	7								127	28	
Eastern wood-pewee	2	5	3		3	3	3	6	8	3			3		3
Eastern phoebe		1			1	1		1				3	7		1

TABLE F-5 Bird Species Observed at the WSS and Surrounding Areas, 1992 (Continued)

Species	Location														
	Ash Pond	North Dump	Frog Pond	Raffinate Pits 1/2	Raffinate Pits 3/4	Quarry Rim Area	SE Drainage Upper	SE Drainage Lower	Yellow Trail Drainage	Katy Trail	Femme Osage Slough	St. Charles County Well Field	WSWA Fields 1&5	WSWA Prairie Lake	Burgermeister Spring
European starling	17		35	14	13						4	9	24	15	30
Field sparrow	19	10	6	17	12	1	1						43	10	2
Forester's tern														2	
Fox sparrow													2		
Gray catbird	2	1					2		1	5	3		2	1	8
Great-blue heron								1			9	4	1	4	3
Great-crested flycatcher	2									1					1
Great horned owl								1							
Green-backed heron			7								1			2	1
Hairy woodpecker	2						3		2	2	2			1	
Horned lark											2	16		2	
House finch			2											4	
House sparrow														60	
House wren							1								
Indigo bunting	5	3	12			5	5	3	2	6	20	21	3		2
Kentucky warbler							3								
Loggerhead Shrike*												2	5		

TABLE F-5 Bird Species Observed at the WSS and Surrounding Areas, 1992 (Continued)

Species	Location														
	Ash Pond	North Dump	Frog Pond	Raffinate Pits 1/2	Raffinate Pits 3/4	Quarry Rim Area	SE Drainage Upper	SE Drainage Lower	Yellow Trail Drainage	Katy Trail	Femme Osage Slough	St. Charles County Well Field	WSWA Fields 1&5	WSWA Prairie Lake	Burgermeister Spring
Killdeer	3	1	3	16	28	1				1	2	13	3	37	1
Louisiana waterthrush								3							
Mississippi kite*													1		
Mourning dove	7		8	5	25	5	3	1		2	6	26	30	60	8
Northern bobwhite	9	12	2		5	1				3	4	2	18	5	13
Northern cardinal	41	24	20	8	16	49	45	24	26	96	71	24	25	23	51
Northern flicker	10	2	3	1	10	9	34	12	20	23	17	15	11	1	13
Northern harrier*												1			
Northern mockingbird	4				3	1	2					1	9	5	1
Northern oriole	3		1		4					2	1		3		2
Northern parula warbler	2	5	1		1	1					1				1
Northern rough-winged swallow				3	7									1	
Orchard oriole	1									1	2		4		
Osprey*															1
Ovenbird		1	2		1	1	4	4	5		2				
Palm warbler					1										
Pileated woodpecker	2	2					1	6	6	3	1				

TABLE F-5 Bird Species Observed at the WSS and Surrounding Areas, 1992 (Continued)

Species	Location														
	Ash Pond	North Dump	Frog Pond	Raffinate Pits 1/2	Raffinate Pits 3/4	Quarry Rim Area	SE Drainage Upper	SE Drainage Lower	Yellow Trail Drainage	Katy Trail	Femme Osage Slough	St. Charles County Well Field	WSWA Fields 1&5	WSWA Prairie Lake	Burgermeister Spring
Purple finch															
Purple martin						1				2				7	
Red-bellied woodpecker	1		3		2	1	6	2	4	1	4		2	4	6
Red-headed woodpecker	1									1	5	4			2
Red-tailed hawk	4		1		1			1		1		4	8		2
Red-winged blackbird	65	1		30	44	10	1				16	33	86	95	15
Rock dove	2	1	7	22	13				20			6		4	
Rose-breasted grosbeak													1		3
Rough-legged hawk													1	3	
Ruby-throated hummingbird									1					2	
Rufous-sided towhee	7	6	3		5		5		2			2	1		8
Scarlet tanager	1					1	2	1	2	1	1		1		
Song sparrow	8			7	4	1					13	21	8	39	4
Spotted sandpiper			1		2									1	
Summer tanager						1	3		3					2	
Swainson's hawk*					1						2				
Swamp sparrow			1								1				

TABLE F-5 Bird Species Observed at the WSS and Surrounding Areas, 1992 (Continued)

Species	Location														
	Ash Pond	North Dump	Frog Pond	Raffinate Pits 1/2	Raffinate Pits 3/4	Quarry Rim Area	SE Drainage Upper	SE Drainage Lower	Yellow Trail Drainage	Katy Trail	Femme Osage Slough	St. Charles County Well Field	WSWA Fields 1&5	WSWA Prairie Lake	Burgermeister Spring
Tree swallow				5	16									123	
Tufted titmouse	21	17	2	2	1	12	34	23	20	12	18	6	1	5	41
Turkey vulture										1	7	2	1	1	
Vesper sparrow												1			
White-breasted nuthatch	1	2	1			2	3	8	7	3	2				2
White-crowned sparrow													10		
White-eyed vireo	1							1							1
White-throated sparrow	13	3	9	11	3						1				1
Wild turkey	1									1					
Winter wren															1
Wood thrush		2					3	1							2
Worm-eating warbler							9	1	2						
Yellow-billed cuckoo	2				1		2	4		2	2				
Yellow-breasted chat	2										1				
Yellow-rumped warbler	2		2				3			1	8		1		1
Yellow-throated vireo	6	1							2				1		
Yellow warbler	2													2	

TABLE F-5 Bird Species Observed at the WSS and Surrounding Areas, 1992 (Continued)

Species	Location														
	Ash Pond	North Dump	Frog Pond	Raffinate Pits 1/2	Raffinate Pits 3/4	Quarry Rim Area	SE Drainage Upper	SE Drainage Lower	Yellow Trail Drainage	Katy Trail	Femme Osage Slough	St. Charles County Well Field	WSWA Fields 1&5	WSWA Prairie Lake	Burgermeister Spring
Total number of birds	523	192	310	237	337	244	425	277	256	519	753	643	761	982	438
Total number of species	53	34	41	26	42	29	38	29	26	33	49	39	54	50	50
Total days	24	19	23	21	23	22	24	18	18	19	24	23	23	24	23

* Species on the Federal and/or State rare or endangered list see Table 8-5

TABLE F-6 Owls Observed at the WSS and Surroundint Areas, 1992

Species	Location				
	Ash Pond	L.F.O. Creek	SE Drainage	Quarry Haul Road	Frog Pond Drainage
Great-Horned Owl	5	0	0	0	0
Eastern Screech Owl	0	0	2	2	0
Barred Owl	5	5	5	0	4
Unknown Visual	0	1	0	0	0
Total Number Observed	10	6	7	2	4
Total Observation Periods	4	4	5	4	2

TABLE F-7 Radiological Results (pCi/g) of the Small Mammal Survey

Site No.	Small Mammals						Soils					
	Uranium	Ra-226	Ra-228	Th-228	Th-230	Th-232	Uranium	Ra-226	Ra-228	Th-228	Th-230	Th-232
01	<0.068	1.66	<2.22R	<0.03	0.05	<0.03	1.81	3.40	6.40	1.40	1.30	1.10
02	0.17	<0.73	<1.69R	<0.07	<0.02	<0.02	4.88	3.10	<2.43	0.76	0.84	0.81
03	<0.41	<1.5	<2.33R	<0.04	0.10	0.02	2.05	3.50	<3.42	0.79	0.88	0.80
04	<0.068	<2.28	<2.25R	<0.05	0.07	<0.04	2.04	3.50	<2.42	0.69	0.84	0.70
05	0.13	<0.51	<3.50R	<0.03	<0.03	<0.03	1.91	2.60	<3.03	0.82	0.86	0.76
07	<0.10	<0.55	<2.02R	<0.16	0.04	<0.08	1.22	2.20	4.40	0.80	0.80	0.70
08	<0.68	<0.68	<11.8R	<0.04	0.03	<0.01	1.83	3.00	<3.10	0.94	0.96	0.93
09	No Samples Obtained						4.48	2.70	3.20	0.94	0.97	1.10
10	0.070	<0.46	<3.95R	<0.07	0.06	<0.02	15.72	7.50	<2.91	1.20	5.80	1.10
11	No Samples Obtained						1.85	2.80	<3.24	0.94	0.78	0.99
12	No Samples Obtained						36.08	6.10	<2.67	0.98	2.70	1.00
13	0.11	<0.57	<2.09R	<0.05	<0.01	<0.01	13.45	3.60	<3.21	0.75	1.50	0.82
14	No Samples Obtained						10.18	3.30	4.65	1.05	0.97	1.05
15	<0.07	<0.58	<1.73R	<2.80	<1.60	<2.40	7.23	3.40	<4.21	0.98	1.60	1.10
16	<0.68	<0.53	<3.71R	<0.03	<0.02	<0.02	2.90	3.20	<2.10	1.50	1.40	1.40
17	<0.07	<0.65	<7.39R	<0.26	<0.07	<0.07	1.81	3.50	<2.54	0.78	0.86	0.91

< less than the detection limit and reported as ND.
R data rejected by WSS validation (Section 9.1.3).

TABLE F-8 Metal Results (ug/g) for Soils of the Small Mammal Survey

Site No.	Parameters								
	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver	Zinc
01	5.6	153	<0.25	14.0	18.8	0.04	0.52	<0.99	52.5
02	8.2	196	<0.26	17.5	28.4	0.10	<5.3	<1.1	76.3
03	8.1	205	0.29	23.7	23.5	0.05	<4.9	<1.0	83.2
04	15.1	149	5.6	13.4	115	0.05	0.80	<0.95	1140
05	6.4	219	0.49	20.6	21.6	0.06	<5.2	<1.0	87.0
07	5.1	257	0.54	11.0	12.1	0.05	<5.0	<1.0	35.0
08	4.4	159	<0.24	17.3	15.6	0.06	0.65	<0.98	61.8
09	5.2	113	<0.25	10.3	21.8	0.06	<0.50	<0.99	35.9
10	7.3	148	<0.26	17.4	29.2	0.17	<5.2	<1.0	62.8
11	4.9	121	0.38	14.0	22.5	0.07	1.1	<1.0	54.8
12	6.7	62.1	0.81	15.6	20.0	0.05	<0.51	<1.0	130
13	8.0	124	0.47	22.4	26.4	0.06	0.80	<0.95	72.5
14	15.5	120.5	<0.26	14.05	19.9	0.06	<0.51	<1.0	30.0
15	6.8	134	<0.24	18.3	40.8	0.08	0.72	<0.96	44.4
16	8.7	128	<0.25	18.0	35.8	0.03	<0.48	<0.98	38.3
17	4.9	142	<0.24	14.1	20.9	0.05	<0.49	<0.96	47.6
18	7.15	166.5	0.35	25.4	13,435	0.10	<0.53	1.0	156

ND - Not Detected

TABLE F-9 Average Radiological Concentrations (pCi/g) in Deer Samples Collected During 1992

Location	Sample Type	Total Uranium	Ra-226	Ra-228	Th-228	Th-230	Th-232
WSCP	Bone	0.025	1.84	1.11	0.213	<0.024	<0.051
	Stomach	0.043	<0.14	<0.35	<0.028	<0.006	<0.020
	Internal organs	0.023	<0.30	<1.04	<0.013	<0.009	<0.013
Background	Bone	0.006	0.69	<1.15	0.07	0.042	<0.031
	Muscle	0.005	<0.07	<0.28	<0.007	0.005	<0.002

TABLE F-10 List of Vegetation Occuring on the WSCP Area

Box elder
Sugar maple
Pawpaw
Paper mulberry
Pignut hickory
Shagbark hickory
Sugarberry
Hackberry
Eastern redbud
Flowering dogwood
Roughleaf dogwood
Cockspur
hawthorne
Persimmon
Green ash
White ash
Honey locust
Black walnut
Red cedar
Sweetgum
Red mulberry
Short-leaf pine
American sycamore
Easten cottonwood
American plum
Black cherry
Hoptree
Post oak
Shingle oak
Winged sumac
Smooth sumac
Black locust
Willow sp.
Sassafras
American elm
Slippery elm

Black-eyed susan
Broad-leaved arrowhead
Skullcap
Setaceum
Prairie foxtail
Nodding foxtail
Greenbrier
Horse weed
Goldenrod
Smooth hedge nettle
Coralberry
Common dandelion
Virginia knotweed
Plantain
Swamp smartweed
Heal-all
Scurf pea
Poison ivyYarrow
Southern ragweed
Ragweed
Hog peanut
Tall bluestem
Common milkweed
Spreading aster
Spanish needles
Tickseed sunflower
Tall bellflower
Trumpet creeper
Partridge pea
Canada thistle
Hedge bindweed
Dodder
Sedge
Queen Anne's lace
Showy tick trefoil
Daisy fleabane

White snakeroot
Late flowering thoroughwort
Sweet-scented bedstraw
Hairy bedstraw
White avens
Common sunflower
Spotted touch-me-not
Canada rush
Creeping water primrose
Bush cloverAmur honeysuckle
Japanese honeysuckle
Cut-leaved water horhound
Alfalfa
Yellow sweet clover
White sweet clover
Yellow wood sorrel
Panicgrass
Switchgrass
Virginia Creeper
Ground cherry
Common pokeweedBlackberry
Common mulleia
Ironweed
Wild grape
Purpletop grass
Red clover
Common cattail
Slender nettle
Stinging nettle
Ground cherry
Common pokeweed
Fragrant sumac
Gooseberry
Rose sp.

TABLE F-11 Average Radiological Results for Agricultural Samples (Grain Portions Only) for 1992 Sampling

Parameter (pCi/g)	Locations grouped by distance from site								
	0-2 km	2-4 km	4-6 km	6-8 km	8-10 km	10-12 km	12-14 km	14-16 km	Background
Uranium - Corn	0.002	0.002	0.005	0.001	NS	0.002	NS	NS	0.008
- Soybean	NS	0.017	0.004	0.004	NS	NS	NS	NS	0.014
- Milo	0.004	0.002	0.005	NS	NS	NS	NS	NS	0.037
Th-228 - Corn	<0.4	<0.4	<0.4	<0.4	NS	<0.4	NS	NS	<0.4
- Soybeans	NS	<0.4	0.167	<0.4	NS	NS	NS	NS	<0.4
- Milo	0.160	<0.4	<0.4	NS	NS	NS	NS	NS	<0.4
Th-230 - Corn	0.105	0.074	0.156	0.028	NS	0.014	NS	NS	0.046
- Soybeans	NS	0.072	0.109	0.061	NS	NS	NS	NS	0.134
- Milo	0.022	0.001	0.010	NS	NS	NS	NS	NS	0.002
Th-232 - Corn	<0.4	<0.4	<0.4	<0.4	NS	<0.4	NS	NS	<0.4
- Soybeans	NS	<0.4	<0.4	<0.4	NS	NS	NS	NS	<0.4
- Milo	<0.4	<0.4	0.171	NS	NS	NS	NS	NS	<0.4
Ra-226 - Corn	0.024	0.023	0.031	0.013	NS	0.059	NS	NS	0.038
- Soybeans	NS	0.045	0.042	0.050	NS	NS	NS	NS	0.015
- Milo	0.012	0.025	0.007	NS	NS	NS	NS	NS	0.008
Ra-228 - Corn	0.106	0.186	0.139	0.048	NS	0.263	NS	NS	0.261
- Soybeans	NS	0.120	0.171	0.252	NS	NS	NS	NS	0.188
- Milo	0.113	0.013	0.108	NS	NS	NS	NS	NS	0.033

NS - No samples were obtained within this range
( ) - Number of samples used to calculate average concentration

TABLE F-12 Average Radiological Results for Agricultural Soil Samples from 1992 Sampling

Parameter (pCi/g)	Locations grouped by distance from site								
	0-2 km	2-4 km	4-6 km	6-8 km	8-10 km	10-12 km	12-14 km	14-16 km	Background
Uranium - Corn Field	2.18	1.55	1.93	2.0	NS	1.3	NS	NS	1.8
- Soybean Field	NS	1.38	1.6	1.43	NS	NS	NS	NS	1.6
- Milo Field	1.73	1.7	1.95	NS	NS	NS	NS	NS	1.1
Th-228 - Corn Field	1.78	1.5	1.5	1.6	NS	0.6	NS	NS	1.8
- Soybean Field	NS	1.45	1.48	1.2	NS	NS	NS	NS	1.4
- Milo Field	1.6	1.2	0.95	NS	NS	NS	NS	NS	1.0
Th-230 - Corn Field	1.90	1.5	1.55	2.6	NS	1.0	NS	NS	1.6
- Soybean Field	NS	1.33	1.7	1.83	NS	NS	NS	NS	1.2
- Milo Field	1.58	3.5	1.7	NS	NS	NS	NS	NS	1.1
Th-232 - Corn Field	0.94	1.05	1.18	1.2	NS	1.0	NS	NS	1.2
- Soybean Field	NS	1.43	1.38	0.93	NS	NS	NS	NS	0.8
- Milo Field	1.15	1.4	1.45	NS	NS	NS	NS	NS	1.2
Ra-226 - Corn Field	1.74	1.45	1.83	1.4	NS	1.4	NS	NS	1.9
- Soybean Field	NS	1.33	1.64	1.4	NS	NS	NS	NS	1.3
- Milo Field	1.2	1.6	0.9	NS	NS	NS	NS	NS	1.5
Ra-228 - Corn Field	1.9	1.35	1.94	1.9	NS	1.2	NS	NS	1.3
- Soybean Field	NS	1.53	1.28	0.97	NS	NS	NS	NS	2.5
- Milo Field	1.33	0.9	0.8	NS	NS	NS	NS	NS	0.6

NS - Soil samples not taken if agricultural samples not collected
( ) - Number of samples used to calculate average concentration

APPENDIX G
Special Studies

Table G-1 Southeast Drainage Flow Study Results Total Uranium Values Measured From Top to Bottom of Valley (pCi/l)

Sampling Location	Step 1	Step 2	Step 3	Stormwater Runoff	
				Maximum	Average
NP-0001 and NP-0005	—	—	—	2240	450
SW-5302	—	—	14	—	—
SW-5301	--	--	24	--	–
SW-5305	52.4	88.4	28	--	--
SW-5301	--	--	56	592	321
SW-5312	--	–	44	–	–
SP-5302	--	--	67	544	314
SW-5313	--	--	72	--	–
SW-5307	109	517**	71	--	–
SW-5303	--	–	116	265	198
SW-5309	102	150 - 218 (4)	100	--	–
SW-5316	--	--	145	--	–
SP-5304	238	156	113	142	99
SW-5311	128	150	104	--	155

** Represents sample of wetting front (see Section __).
– Represents locations not sampled.

TABLE G-2 Concentration of Metals Resuspended in Water During Flow Study Steps 2 and 3 (μg/l)

		Step 2			Step 3				
Analyte	(μg/l) (NPDES Permit Level)	SW-5305	SW-5311	Lower Limit of Detection	SW-5305	SW-5307	SW-5309	SW-5311	Lower Limit of Detection
Aluminum		105	ND	118	—	—	—	—	
Antimony		ND	ND	16.4	ND	ND	ND	ND	20
Arsenic	(100)	ND	ND	2.30	ND	ND	ND	ND	2
Barium	(1500)	67.3	103	44.1	78.3	85	84	105	16
Beryllium		ND	ND	1.80	ND	ND	ND	ND	1
Cadmium	(20)	ND	ND	5.00	ND	ND	ND	ND	3
Calcium		34000	69500	108	—	—	—	—	
Chromium	(100)	ND	ND	9.30	ND	ND	ND	ND	6
Cobalt		ND	ND	12.9	—	—	—	—	
Copper	(1000)	ND	ND	10.1	—	—	—	—	
Iron	(600)	237	135	28.9	—	—	—	—	
Lead	(100)	0.80	1.40	0.40	5.2	3.1	ND	2.2	2
Lithium		16.5	ND	8.40	—				
Magnesium		10700	110000	75.3	—				
Manganese	(100)	15.4	6.00	3.50	—				
Mercury	(4)	ND	ND	0.17	ND	ND	ND	ND	0.04
Molybdenum		ND	ND	17.8	—	—	—	—	
Nickel		ND	ND	27.1	—	—	—	—	
Potassium		3350	2830	310	—	—	—	—	

TABLE G-2 Concentration of Metals Resuspended in Water During Flow Study Steps 2 and 3 (µg/l) (Continued)

		Step 2			Step 3				
Analyte	(µg/l) (NPDES Permit Level)	SW-5305	SW-5311	Lower Limit of Detection	SW-5305	SW-5307	SW-5309	SW-5311	Lower Limit of Detection
Selenium	(20)	ND	ND	2.60	ND	ND	ND	ND	2
Silver	(100)	ND	ND	0.60	ND	ND	ND	ND	10
Sodium		31000	12200	190	–	–	–	–	
Thallium		ND	ND	2.00	ND	ND	ND	ND	2
Vanadium		ND	ND	7.90	–	–	–	–	
Zinc	(5000)	ND	ND	8.00	–	–	–	–	

ND Not detected above the lower limit of detection given as LLD.
– Not analyzed for that parameter.

Table G-3 Other Radionuclides Analyzed in Steps 1, 2, and 3 of the Flow Study (pCi/l)

	Step 1		Step 2		Step 3		
	SW-5311		SW-5305	SW-5311	SW-5305	SW-5307	SW-5311
	F8	F24					
Ra-226	ND	1.5±0.4	0.7	1.1±0.3	0.48	0.52	1.32±0.48
Ra-228	0.3	0.7	0.6	ND	–	–	–
Th-228	ND	ND	–	–	–	–	–
Th-230	0.2	0.2	ND	ND	4.37±1.65	2.17±1.55	4.57±1.34
Th-232	ND	ND	ND	ND	ND	ND	ND

ND Not detected above the lower limit of detection.
– Not analyzed for that parameter.

TABLE G-4 Concentrations of Nitroaromatic Compounds in Waters from Steps 2 and 3 (μg/l)

	Step 2	Step 3			
	SW-5311	SP-5303	SP-5304	SW-5311	LLD
1,3,5-TNB	ND	0.068	0.04	ND	0.03
1,3-DNB	ND	ND	ND	ND	0.09
2,4,6-TNT	ND	0.16	4.2	0.033	0.03
2,4-DNT	ND	0.078	0.095	0.037	0.03
2,6-DNT	0.057	0.078	0.22	0.096	0.01
Nitrobenzene	ND	ND	ND	ND	0.03

ND Not detected above the lower limit of detection given as LLD.

APPENDIX H
Unpublished Documents

United States Department of the Interior

GEOLOGICAL SURVEY
Water Resources Division
1400 Independence Road
Mail Stop 200
Rolla, Missouri 65401

March 25, 1993

Jean,

This is in response to your data request of March 22, 1993 concerning background water-quality concentrations for selected constituents. The US Geological Survey collected water-quality data from wells, springs, and streams in the vicinity of the Weldon Spring chemical plant site from 1984 to 1989. These data can be found in Kleeschulte and others, 1986 and Kleeschulte and Cross, 1990. These data were analysed and water-quality data from sites that were considered to be uneffected by the chemical plant were tabulated and summary statistics were calculated for selected water-quality constituents. Proposed background water-quality concentrations for the shallow bedrock aquifer and area springs are listed in a report by Kleeschulte and Imes that is currently in review. In this report, we proposed that the 95th percentile concentrations from uneffected sites be used as background concentrations for the shallow bedrock aquifer and area springs near the chemical plant. These are the proposed concentrations for dissolved constituents:

Parameter	Bedrock wells	Springs
Calcium	82 mg/L	99 mg/L
Sodium	30 mg/L	36 mg/L
Sulfate	32 mg/L	76 mg/L
Nitrate	1.6 mg/L	1.3 mg/L
Lithium	13 ug/L	9 ug/L
Uranium	3 ug/L	2.7 ug/L

(mg/L, milligrams per liter; ug/L, micrograms per liter)

Sincerely,

Mike Kleeschulte
US Geological Survey

** TOTAL PAGE.001 **

JUL-30-92 THU 7:58 WELDON SPRING SITE FAX NO. 3144470803 P.01

4336

MK-FERGUSON COMPANY
A MORRISON KNUDSEN COMPANY

REPORT OF TELECON

To: R. Ferguson
From: G. Velest
Date: 21 MAY 1992
Time: 4:00 pm

___ Incoming
X Outgoing

Conversation with: Danny Crigler (Acting Dist. Supv.) (Name) Phone: 441-4554
of: MDC - Busch Wildlife (Company)
and: G. Velest (Name) Phone: 441-8086
of: PMC (Company)

SUMMARY OF CONVERSATION:

As requested by John Peterson of ANL, I contacted Danny Crigler to obtain the latest annual usage statistics for the Busch and Weldon Spring Wildlife Areas. According to Crigler the MDC estimates current annual usage at approximately 1.2 million visitors; 1.0 million visitors annually at Busch Wildlife and 0.2 million visitors annually at Weldon Spring Wildlife. Crigler also added that projections indicate combined future usage may exceed 2.0 million visitors annually by 1994.

ACTION OR FOLLOW-UP/RECOMMENDATIONS:

Transmit above information to J. Peterson

[signature]
(Signature)

RA-21-02

MISSOURI DEPARTMENT OF CONSERVATION

MAILING ADDRESS:
P.O. Box 180
Jefferson City, Missouri 65102-0180

STREET LOCATION:
2901 West Truman Boulevard
Jefferson City, Missouri

Telephone: 314 751-4115
JERRY J. PRESLEY, Director

August 24, 1988

Dr. Ihor Hlohowskyj
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Dear Dr. Hlohowskyj:

In response to your recent request for species information in the Weldon Spring-St. Charles County area, I have provided copies of available data. The information is not in a format that allows us to provide separate lists for Weldon Spring Chemical Plant and Quarry Site, Weldon Spring Wildlife Area, Busch Wildlife Area, Howell Island Wildlife Area, St. Charles County and St. Louis County.

Hopefully, these lists will provide you with enough information to complete your environmental assessment.

Sincerely,

Dan F. Dickneite

DAN F. DICKNEITE
ENVIRONMENTAL ADMINISTRATOR

Enclosure

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JEFF CHURAN
Chillicothe

JAY HENGES
Earth City

JOHN POWELL
Rolla

RICHARD REED
East Prairie

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