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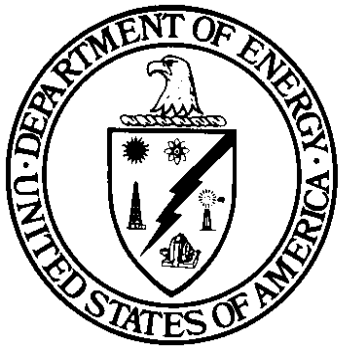
WELDON SPRING SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 2003

WELDON SPRING SITE REMEDIAL ACTION PROJECT
WELDON SPRING, MISSOURI

JUNE 2004 REV. 0



U.S. Department of Energy
Office of Legacy Management
Weldon Spring Site Remedial Action Project

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DOE/GJ/79491-944

Weldon Spring Site Remedial Action Project

EXECUTIVE SUMMARY

Weldon Spring Site Environmental Report for Calendar Year 2003

Revision 0

June 2004

Prepared by

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U.S. DEPARTMENT OF ENERGY
Office of Legacy Management
Under Contract DE-AC01-02GJ79491

EXECUTIVE SUMMARY

This *Weldon Spring Site Environmental Report for Calendar Year 2003* has been prepared as required by DOE Order 231.1 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 in southern St. Charles County, Missouri, approximately 48 km (30 mi) west of St. Louis. The site consists of two main areas, the former Weldon Spring Chemical Plant and the Weldon Spring Quarry, located on Missouri State Route 94, southwest of U.S. Route 40/61.

The objectives of the *Site Environmental Report* are to present a summary of data from the environmental monitoring program, to identify trends and characterize 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.

This report presents environmental monitoring data from routine radiological and nonradiological sampling activities. These data include estimates of dose to the public from activities at the Weldon Spring site, estimates of effluent releases, and trends in groundwater contaminant levels. Additionally, applicable compliance requirements, quality assurance programs, and special studies conducted in 2003 to support environmental protection programs are discussed.

Historical water quality and water level data for existing wells can be found on the U.S. Department of Energy Office of Legacy Management website: www.gjo.doe.gov/LM/. This data can be graphed or presented in a table format for selected analytes. Photographs, maps, and physical features can also be viewed on this web page.

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). Throughout the remediation, the ALARA principle has driven the work activities conducted under U.S. Environmental Protection Agency (EPA) enforcement of the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA).

Effluent and environmental monitoring programs provide early detection of contaminants, assessment of potential impacts to the environment, and data needed to implement the ALARA strategy. Routine monitoring also demonstrates compliance with applicable State and Federal permits and regulations.

REGULATORY COMPLIANCE

The Weldon Spring site is listed on the National Priorities List (NPL) and is governed by the CERCLA. Under CERCLA, WSSRAP is subject to meeting or exceeding applicable or relevant and appropriate requirements of Federal, State, and local laws. Primary regulations have included the *Resource Conservation and Recovery Act* (RCRA), *Clean Water Act* (CWA), and because the U.S. Department of Energy (DOE) is the lead agency for the site, the *National Environmental Policy Act* (NEPA) values are incorporated into CERCLA documents as outlined in the Secretarial Policy statement on NEPA.

The following major tasks were completed at the Weldon Spring site during 2003:

- Transition of the site from DOE Environmental Management to DOE Legacy Management, including contract transition.
- Evaluation of groundwater remedies at the Chemical Plant Area Groundwater Operable Unit.
- Stormwater outfalls at both the Chemical Plant and Quarry were removed from the NPDES permits.
- Conducted the first annual surveillance and maintenance inspection at the Weldon Spring Site.

MONITORING SUMMARY

Environmental monitoring data showed that dose estimates were below the DOE guidelines for the public of 100 mrem (1 mSv) annual total effective dose equivalent for all exposure pathways. Effluent releases were well below the DOE derived concentration guide level of 600 pCi/l. Data from groundwater and surface water monitoring indicated no measurable impact on drinking water sources from Weldon Spring site contaminants.

Dose Estimates

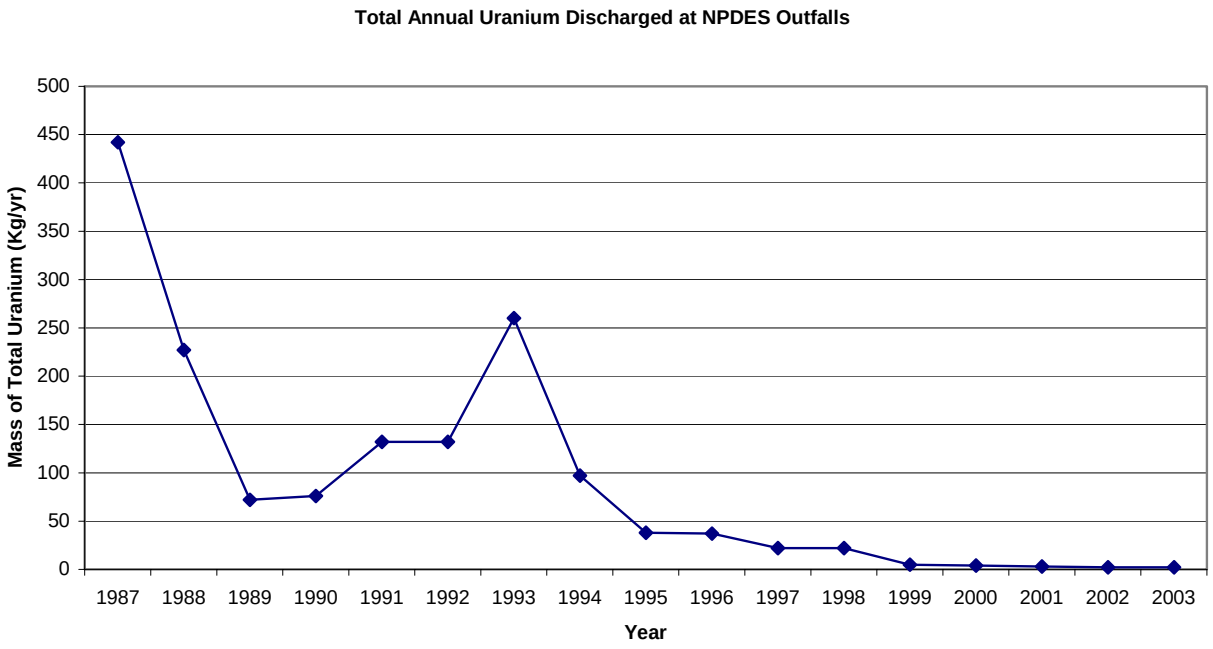
Radiation dose estimates are discussed in Section 5. Taking into account all applicable exposure pathways, the total effective dose equivalent to a hypothetical maximally exposed individual from consumption of water at Spring 5303, located in the SE Drainage, was 0.1 mrem (1.0 E-3 mSv). This estimate is well below the DOE guideline of 100 mrem (1 mSv). By comparison, the annual total effective dose equivalent in the United States due to naturally occurring sources of radioactivity is approximately 300 mrem (3 mSv).

NPDES Monitoring

In 2003, surface water runoff at the chemical plant transported residual amounts of uranium from the site through seven major discharge routes that are identified in Section 6 of this

report. The total mass of uranium migrating off-site in storm water and treated effluent was 2.29 kg/yr (5.04 lb/yr). Based on natural uranium activity ratios, this is equivalent to an activity of 0.0024 Ci/yr (8.88E7 Bq/yr). The total mass of uranium was less than the CY 2002 mass of 2.39 kg/yr (5.26 lb/yr). The total mass of uranium migrating off site in storm water and treated effluent has decreased substantially since remedial activities began, and is expected to decrease further still as the site vegetation becomes more dense.

As can be seen in the following figure, the annual release of total uranium for 2003 was a 99% reduction from the 1987 annual estimate. Annual average uranium concentrations at the NPDES outfalls were all well below the derived concentration guideline of 600 pCi/l. With respect to 2002 levels, average uranium concentrations have decreased or remained substantially the same at the stormwater outfalls. All parameters at the outfalls were in compliance with NPDES permit requirements during 2003.



Surface Water Monitoring

Surface water monitoring in 2003 indicated that contaminant concentrations were within historic ranges. Average uranium levels at the off-site surface water locations were similar to those averages reported in 2002.

Groundwater Monitoring

The groundwater monitoring programs included extensive monitoring for radiological and chemical compounds, as discussed in Section 7. Contaminant levels generally remained within historic ranges at all chemical plant and quarry groundwater locations.

At the quarry, radiological results for the St. Charles County well field remained within background levels, and no detectable concentrations of the six nitroaromatic compounds were observed.

Chemical plant area monitoring continued to show elevated concentrations of nitroaromatic compounds in the former Frog Pond area. A contaminant investigation has been performed in response to these increases. Other contaminants (nitrate, uranium, and TCE) remained within historical levels. Monitoring at Burgermeister Spring has shown a decrease in uranium and nitrate concentrations over time.

Monitoring data from wells placed around the permanent disposal cell showed no exceedances of baseline for radiological parameters. Several wells exceeded baseline levels for nonradiological contaminants, but these data are likely due to variations in the existing groundwater contamination underlying the site.

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Weldon Spring Site Remedial Action Project

Weldon Spring Site Environmental Report for Calendar Year 2003

Revision 0

June 2004

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Office of Legacy Management
Under Contract DE-AC01-02GJ79491

ABSTRACT

This *Site Environmental Report for Calendar Year 2003* 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 regulations, and to summarize trends and/or changes in contaminant concentrations identified through environmental monitoring.

The total effective dose equivalent (TEDE) to a hypothetical maximally-exposed individual during 2003 was 0.1 mrem (1.0 E-3 mSv). This estimate is well below the U.S. Department of Energy (DOE) requirement of 100 mrem (1 mSv) annual TEDE for all exposure pathways. The total mass of uranium migrating off-site in storm water and treated effluent during 2003 was 2.29 kg (5.04 lb).

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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 Management (EM). Near the end of CY2003, authority for the Site transferred from EM to the newly established Office of Legacy Management (LM). This *Weldon Spring Site Environmental Report for Calendar Year 2003* summarizes the environmental monitoring results obtained in 2003 and presents the status of Federal and State compliance activities.

DOE requirements for environmental monitoring and protection of the public, the mandate for this document, are designated in DOE Order 231.1, *Environment, Safety and Health Reporting;* DOE Order 5400.5, *Radiation Protection of the Public and Environment*; and the implementation guide for DOE Order 5400.5, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance.*

In 2003, environmental monitoring activities were conducted to support remedial action under the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA), the *National Environmental Policy Act* (NEPA), the *Clean Water Act* (CWA), and other applicable regulatory requirements. The monitoring program at the WSSRAP has been designed to protect the public and to evaluate the effects on the environment, if any, from remediation activities.

The purposes of the *Weldon Spring Site Environmental Report for Calendar Year 2003* include:

- Providing general information on the WSSRAP and the current status of remedial activities.
- Presenting summary data and interpretations for the environmental monitoring program.
- Reporting compliance with Federal, State, and local requirements and DOE standards.
- Providing dose estimates for public exposure to radiological compounds due to activities at the WSSRAP.
- Summarizing trends and/or changes in contaminant concentrations to support remedial actions, ensure public safety, maintain surveillance monitoring requirements, and demonstrate the effectiveness of the remediation.

1.1 Site Description

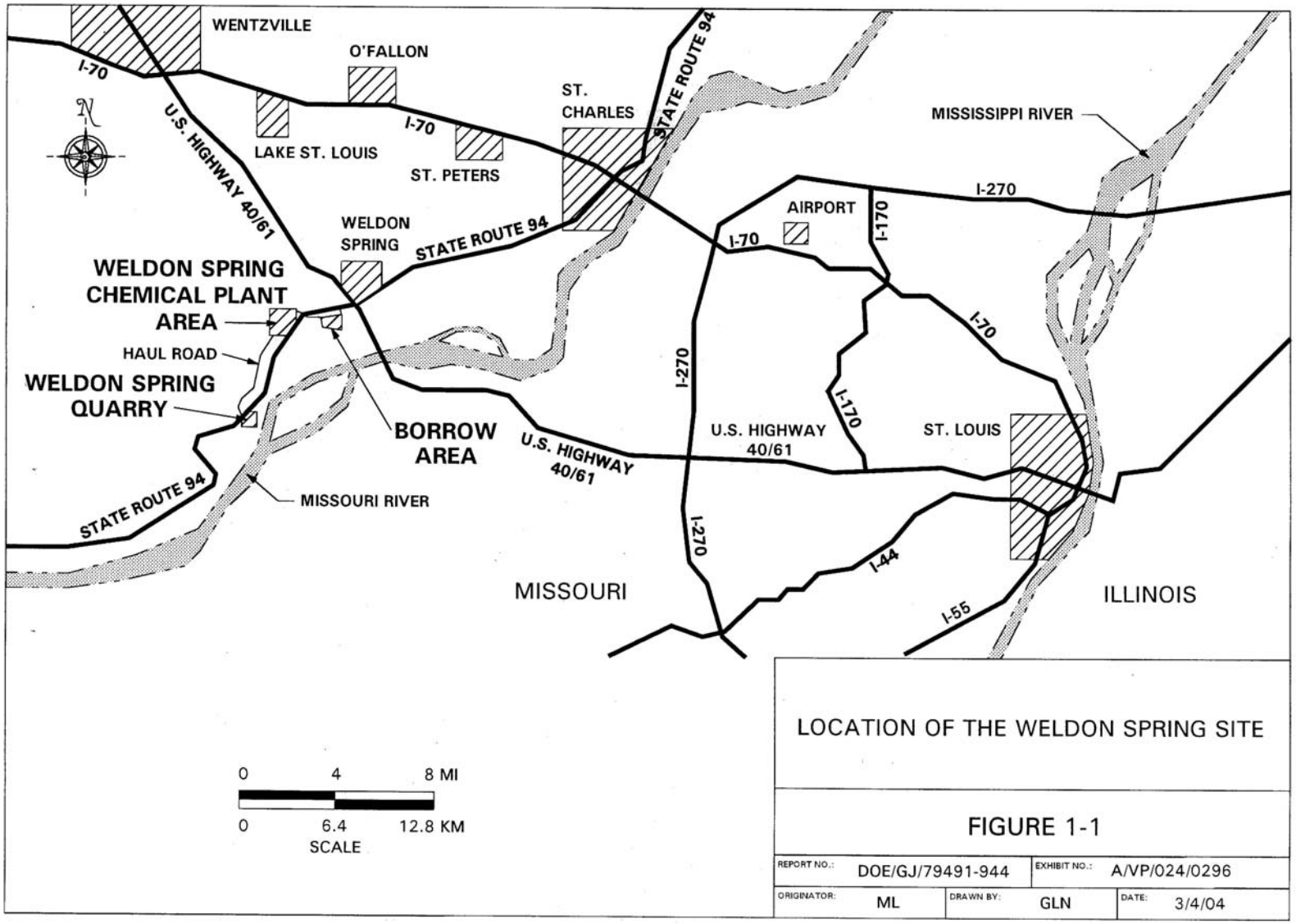
The Weldon Spring site is in southern St. Charles County, Missouri, approximately 48 km (30 mi) west of St. Louis, as shown in Figure 1-1. The site consists of two main areas, the former Weldon Spring Chemical Plant and Raffinate Pits area and the Weldon Spring Quarry, both located along Missouri State Route 94.

The Weldon Spring Chemical Plant is a 91 ha (226 acre) area that operated as the Weldon Spring Uranium Feed Materials Plant (WSUFMP) until 1966 (see Figure 1-2). Buildings were contaminated with asbestos, hazardous chemical substances, uranium, and thorium. (Building dismantlement was completed in 1994.) Radiological and chemical (polychlorinated biphenyls [PCBs], nitroaromatic compounds, metals and inorganic ions) contaminants were found in the soil in many areas around the site. These contaminated soils have all been remediated. The Raffinate Pits on the chemical plant site consisted of four settling basins that covered approximately 10.5 ha (26 acres). These pits were characterized as being contaminated with uranium and thorium residues and chemical contaminants including nitrate, fluoride, PCBs, and various heavy metals (Ref. 2). During 1999 and 2000, the four raffinate pits were remediated and backfilled. The disposal cell was completed in 2001.

The Weldon Spring Quarry is a former 3.6 ha (9 acre) limestone quarry south-southwest of the chemical plant area (Figure 1-3). Bulk waste stored in the quarry contained radiological and chemical contaminants including uranium, radium, thorium, metals, nitrates, PCBs, semivolatile organic compounds, nitroaromatics, and asbestos (Ref. 1). The quarry bulk waste removal operation was completed in 1995. The quarry water treatment plant was dismantled in 2001, and backfilling of the quarry was completed in 2002.

1.2 Site History

From 1941 to 1945, the U.S. Department of the Army produced trinitrotoluene (TNT) and dinitrotoluene (DNT) at the Weldon Spring Ordnance Works, which covered 6,974 ha (17,233 acres) of land that now includes the Weldon Spring site. By 1949, all but about 809 ha (2,000 acres) had been transferred to the State of Missouri (August A. Busch Memorial Conservation Area) and to the University of Missouri (agricultural land). Except for several small parcels transferred to St. Charles County, the remaining property became the Army training area.


WENTZVILLE
O'FALLON
I-70
U.S. HIGHWAY 40/61
LAKE ST. LOUIS
ST. PETERS
ST. CHARLES
STATE ROUTE 94
MISSISSIPPI RIVER
I-270
AIRPORT
I-170
WELDON SPRING
STATE ROUTE 94
WELDON SPRING CHEMICAL PLANT AREA
HAUL ROAD
WELDON SPRING QUARRY
BORROW AREA
U.S. HIGHWAY 40/61
ST. LOUIS
STATE ROUTE 94
MISSOURI RIVER
MISSOURI
ILLINOIS
I-44
I-55
0 4 8 MI
0 6.4 12.8 KM
SCALE
LOCATION OF THE WELDON SPRING SITE
FIGURE 1-1
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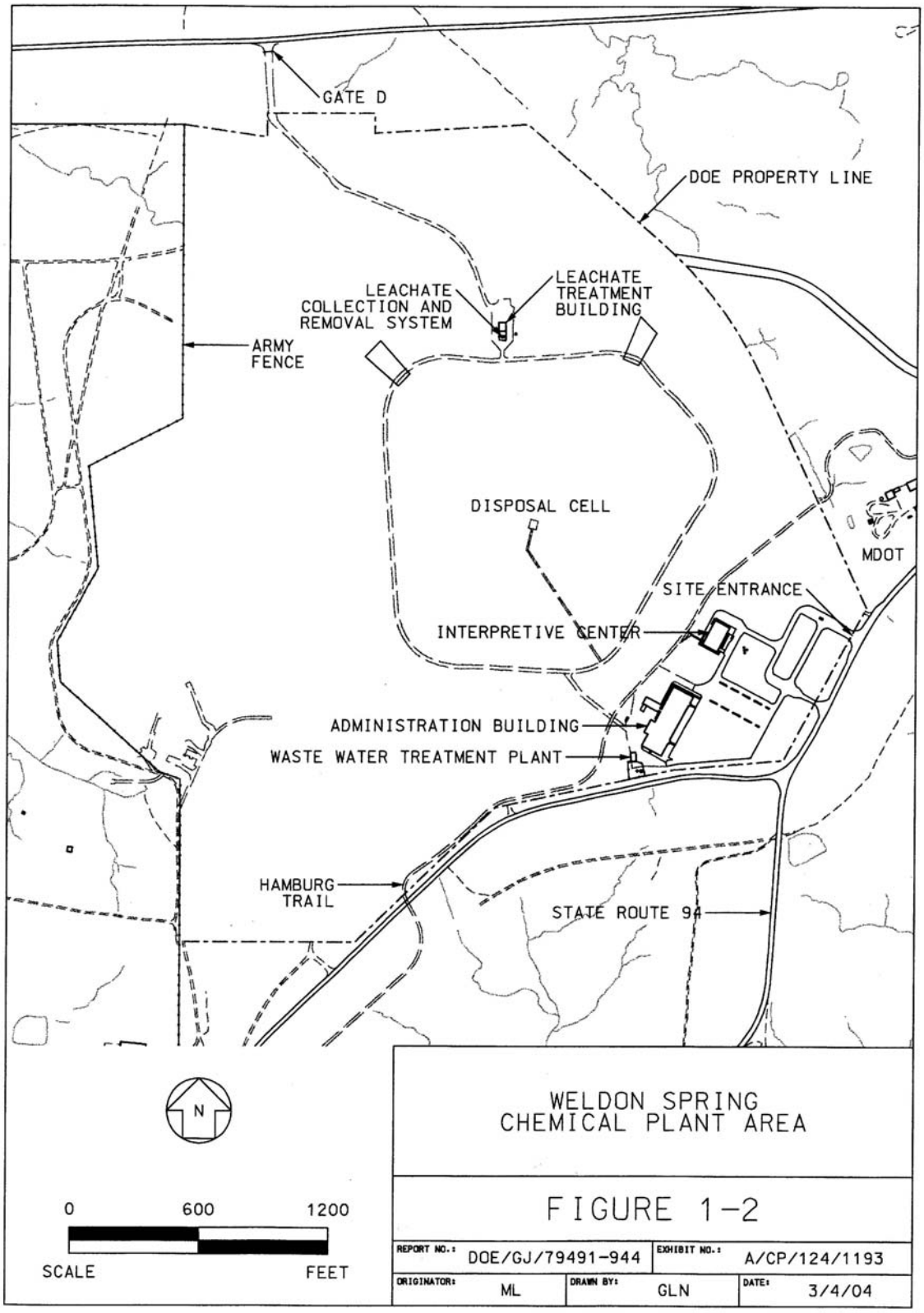
GATE D
DOE PROPERTY LINE
LEACHATE COLLECTION AND REMOVAL SYSTEM
LEACHATE TREATMENT BUILDING
ARMY FENCE
DISPOSAL CELL
MDOT
SITE ENTRANCE
INTERPRETIVE CENTER
ADMINISTRATION BUILDING
WASTE WATER TREATMENT PLANT
HAMBURG TRAIL
STATE ROUTE 94
N
0
600
1200
SCALE
FEET
WELDON SPRING
CHEMICAL PLANT AREA
FIGURE 1-2
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ORIGINATOR: ML
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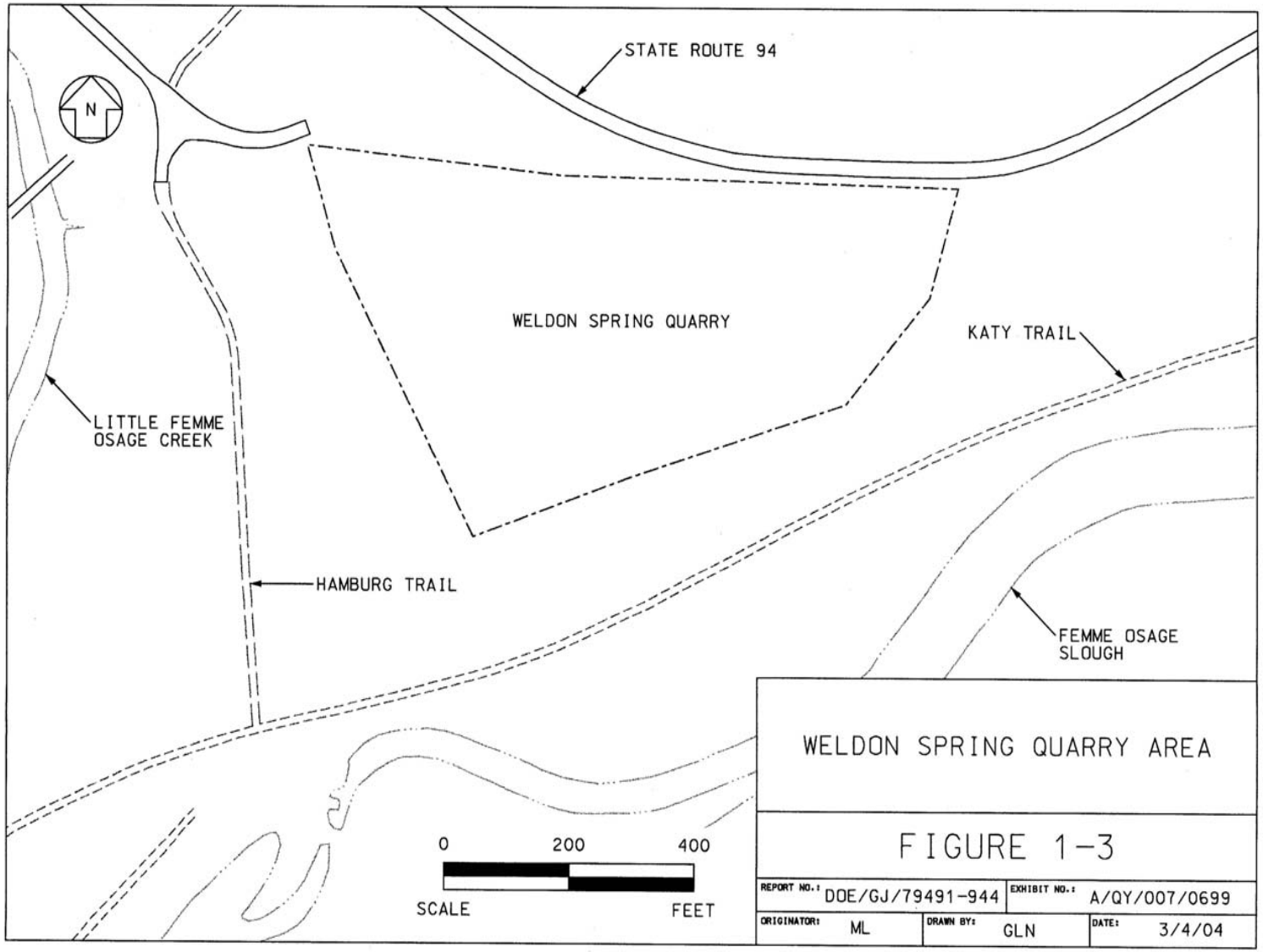

STATE ROUTE 94
N
WELDON SPRING QUARRY
KATY TRAIL
LITTLE FEMME OSAGE CREEK
HAMBURG TRAIL
FEMME OSAGE SLOUGH
0
200
400
SCALE
FEET
WELDON SPRING QUARRY AREA
FIGURE 1-3
REPORT NO.: DOE/GJ/79491-944
EXHIBIT NO.: A/QY/007/0699
ORIGINATOR: ML
DRAWN BY: GLN
DATE: 3/4/04

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 Weldon Spring Uranium Feed Materials Plant (WSUFMP), now referred to as the Weldon Spring Chemical Plant. Considerable explosives decontamination was performed by the Atlas Powder Company and the Army prior to WSUFMP construction. From 1958 until 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 the four raffinate pits.

In 1958, the AEC acquired title to the Weldon Spring Quarry from the Army. 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. Material disposed of in the quarry during this time consisted of building rubble and soils from the demolition of a uranium ore processing facility in St. Louis. These materials were contaminated with uranium and radium. Other radioactive materials in the quarry included 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. 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, which consisted of 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's National Priorities List (NPL) in July 1987. The DOE redesignated the site as a Major System Acquisition in May 1988. The chemical plant and raffinate pits were added to the NPL in March 1989.

A more detailed presentation of the production, ownership, and waste history of the Weldon Spring site is available in the *Long Term Surveillance and Maintenance Plan for the Weldon Spring Site (Ref. 38).*

1.3 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 (Ref. 3).

The uppermost bedrock units underlying the Weldon Spring Chemical Plant are the Mississippian Burlington and Keokuk Limestone. Overlying the bedrock are unlithified units consisting of fill, top soil, loess, glacial till, and limestone residuum of thicknesses ranging from a few feet to several tens of feet.

There are three bedrock aquifers underlying St. Charles County. The shallow aquifer consists of Mississippian Limestones, and the middle aquifer consists of the Ordovician Kimmswick Limestone. The deep aquifer includes formations from the top of the Ordovician St. Peter Sandstone to the base of the Cambrian Potosi Dolomite. Alluvial aquifers of Quaternary age are present near the Missouri and Mississippi Rivers.

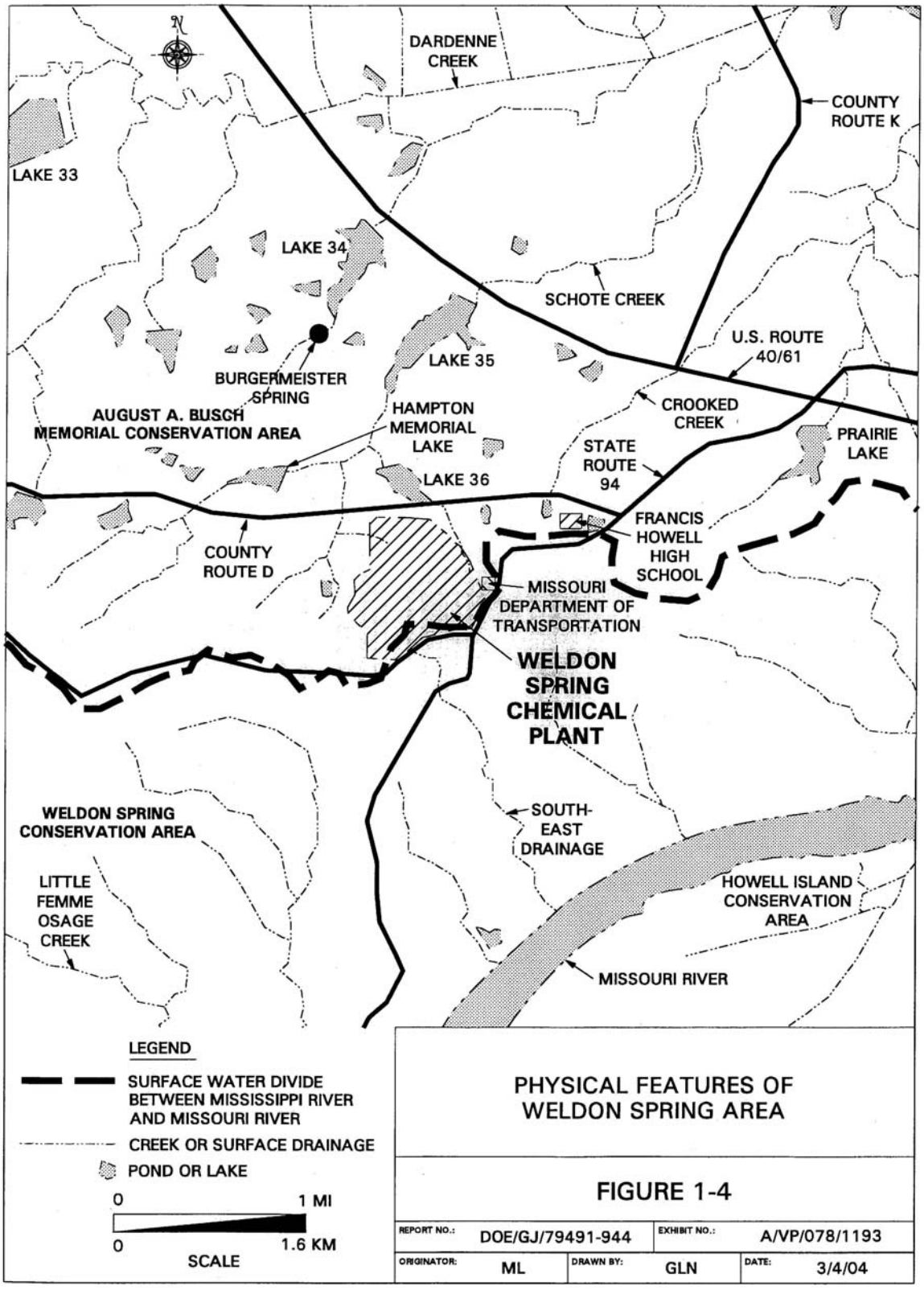
The Weldon Spring Quarry is located in low limestone hills near the northern bank of the Missouri River. The mid-Ordovician bedrock of the quarry area includes, in descending order, the Kimmswick Limestone, Decorah Formation, and Plattin Limestone. These formations are predominantly limestone and dolomite. 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) (Ref. 4). Massive quaternary deposits of Missouri River alluvium cover the bedrock to the south and east of the quarry.

1.4 Surface Water System and Use

The chemical plant and raffinate pits areas are on the Missouri –Mississippi River surface drainage divide, as shown in Figure 1-4. Elevations on the site range from approximately 185 m (608 ft) above mean sea level (msl) near the northern edge of the site to 203 m (665 ft) above msl near the southern edge. (The cell is not included in these elevation measurements.) The natural 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 (Ref. 3).

No natural drainage channels traverse the site. Drainage from the southeastern portion of the site generally flows southward to a tributary referred to as the Southeast Drainage (or 5300 Drainageway - based on the site's nomenclature) that flows to the Missouri River.

The northern and western portions of the chemical plant site drain to tributaries of the Busch Lakes and Schote Creek, which in turn enter Dardenne Creek, which ultimately drains to the Mississippi River. The manmade lakes in the August A. Busch Memorial Conservation Area are used for public fishing and boating. No swimming is allowed in the conservation area,


N
DARDENNE CREEK
COUNTY ROUTE K
LAKE 33
LAKE 34
SCHOTE CREEK
U.S. ROUTE 40/61
LAKE 35
BURGERMEISTER SPRING
AUGUST A. BUSCH MEMORIAL CONSERVATION AREA
HAMPTON MEMORIAL LAKE
CROOKED CREEK
PRAIRIE LAKE
STATE ROUTE 94
LAKE 36
FRANCIS HOWELL HIGH SCHOOL
COUNTY ROUTE D
MISSOURI DEPARTMENT OF TRANSPORTATION
WELDON SPRING CHEMICAL PLANT
WELDON SPRING CONSERVATION AREA
SOUTH-EAST DRAINAGE
LITTLE FEMME OSAGE CREEK
HOWELL ISLAND CONSERVATION AREA
MISSOURI RIVER
LEGEND
SURFACE WATER DIVIDE BETWEEN MISSISSIPPI RIVER AND MISSOURI RIVER
CREEK OR SURFACE DRAINAGE
POND OR LAKE
0 1 MI
0 1.6 KM
SCALE
PHYSICAL FEATURES OF WELDON SPRING AREA
FIGURE 1-4
REPORT NO.: DOE/GJ/79491-944
EXHIBIT NO.: A/VP/078/1193
ORIGINATOR: ML
DRAWN BY: GLN
DATE: 3/4/04

although some may occur. No water from the lakes or creeks is used for irrigation or for public drinking water supplies.

Before remediation of the chemical plant and raffinate pits area began, there were six surface water bodies on the site: the four raffinate pits, Frog Pond, and Ash Pond. The water in the raffinate pits was treated prior to release, and the pits were remediated and confirmed clean. Frog Pond and Ash Pond were flow-through ponds that were monitored prior to being remediated and confirmed clean. Throughout the project, retention basins and sedimentation basins were constructed and used to manage potentially contaminated surface water. During 2001, the four sedimentation basins that remained were remediated, and the entire site was brought to final grade and seeded with temporary vegetation. Final seeding was conducted during 2002.

The Weldon Spring Quarry is situated on a bluff of the Missouri River valley about 1.6 k (1 mi) northwest of the Missouri River at approximately River Mile 49. Because of the topography of the area, no direct surface water entered or exited the quarry before it was remediated. A 0.07 ha (0.2-acre) pond within the quarry proper acted as a sump that accumulated direct rainfall within the quarry. Past dewatering activities in the quarry suggested that the sump interacted directly with the local groundwater. All water pumped from the quarry before remediation was treated before it was released. Bulk waste removal, which included removal of some sediment from the sump area, was completed during 1995. The quarry was backfilled, graded, and seeded during 2002.

The Femme Osage Slough, located approximately 213 m (700 ft) south of the quarry, is a 2.4 km (1.5 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 experimental farms (Ref. 4). The slough is essentially land-locked and is currently used for recreational fishing. The slough is not used for drinking water or irrigation.

1.5 Ecology

The Weldon Spring site is surrounded primarily by State Conservation Areas that include the 2,828 ha (6,988 acre) Busch Conservation Area to the north, the 2,977 ha (7,356 acre) Weldon Spring Conservation Area to the east and south, and the Howell Island Conservation Area, an island in the Missouri River which covers 1,031 ha (2,548 acres) (Figure 1-4).

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. Seventeen percent of the area consists of open fields that 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 (Ref. 5). The Busch

and Weldon Spring Conservation Areas are open year-round, and the number of annual visits to both areas totals about 1,200,000.

The quarry is surrounded by the Weldon Spring Conservation Area, which consists primarily of forest with some old field habitat. Prior to bulk waste removal, the quarry floor consisted of old-field habitat containing a variety of grasses, herbs, and scattered wooded areas. When bulk waste removal began, this habitat was disturbed. The rim and upper portions of the quarry still consist primarily of slope and upland forest including cottonwood, sycamore, and oak (Ref. 4).

1.6 Climate

The climate in the Weldon Spring area is continental 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. 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 temperatures above freezing occur almost every winter and cool weather interrupts periods of heat and humidity in the summer (Ref. 6).

The National Oceanic and Atmospheric Administration has published the following information based on analysis of long-term meteorological records for the St. Louis area. Taking into account the past 30 years of data, the average annual temperature is 13.4ºC (56.1°F). The average daily maximum and minimum temperatures are 18.6°C (65.4°F) and 8.2°C (46.7°F), respectively. Maximum temperatures above 32.2°C (90°F) occur about 40 days per year. Minimum daily temperatures below 0°C (32°F) occur about 100 days of the year. Temperatures below -18°C (0°F) are infrequent, occurring less than 5 days per year. Mean annual precipitation in the area is approximately 95.0 cm (37.5 in.).

The on-site meteorological station was dismantled in May 2002, to facilitate final site restoration activities. The precipitation, temperature, wind speed, and wind direction results in Table 1-1 are from the National Weather Service. Precipitation, average temperature, wind speed, and wind direction were within historical ranges for the St. Louis area.

Table 1-1 Monthly Meteorological Monitoring Results for 2003

MONTH	TOTAL PRECIP (CM)	AVERAGE TEMP (DEGREES C)	AVERAGE WIND SPEED (M/SEC)
January	2.4	-2.2	4.2
February	5.1	-0.3	4.1
March	7.1	8.6	4.2
April	10.9	14.5	4.6
May	10.1	18.4	4.0
June	31.4	21.8	3.3
July	6.4	26.6	3.6
August	6.5	27.1	3.3
September	10.5	19.8	3.4
October	7.1	15.6	3.4
November	13.6	9.6	4.3
December	5.9	3.7	4.7

1.7 Land Use and Demography

The population of St. Charles County is about 300,000. Twenty percent of the population lives in the city of St. Charles, approximately 22 km (14 mi) northeast of the Weldon Spring site. The population in St. Charles County has increased by about 30% over the past 10 years. 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 about 5,000. 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 (Ref. 7).

Francis Howell High School (FHHS) is about 1 km (0.6 mi) northeast of the site along Missouri State Route 94 (Figure 1-4). The school employs approximately 150 faculty and staff, and about 1,600 students attend school there. In addition, approximately 50 full-time employees work at the high school annex, and about 50 bus drivers park their school buses in the adjacent parking lot.

The Missouri Department of Transportation Weldon Spring Maintenance facility, located adjacent to the north side of the chemical plant, employs about 10 workers. The Army Reserve Training Area is to the west of the WSSRAP and periodically is visited by Department of the Army (DOA) trainees and law enforcement personnel (Ref. 7). About 300 ha (741 acres) of land east 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. The conservation areas adjacent to the WSSRAP are operated by the Missouri Department of Conservation and employ about 50 people.

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 Remedial Action Project (WSSRAP). The major goals of the WSSRAP are to eliminate potential hazards to the public and the environment posed by the waste materials on the Weldon Spring site 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). Remedial actions at the site are subject to CERCLA requirements because the site is listed on the EPA National Priorities List (NPL). 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 CERCLA, the proposed strategy for remedial activities at the Weldon Spring site is organized into the following four separate operable units: Weldon Spring Quarry Bulk Waste, Weldon Spring Chemical Plant, Groundwater, and Quarry Residuals. The Weldon Spring Quarry Bulk Waste Operable Unit included all wastes deposited in the quarry and their removal. The Weldon Spring Chemical Plant Operable Unit included the original chemical plant buildings, contaminated soils, raffinate pits, quarry bulk wastes that were staged at the temporary storage area (TSA), vicinity properties, and surface waters within the chemical plant boundary. The Groundwater Operable Unit includes the groundwater at the chemical plant and vicinity areas. The Quarry Residuals Operable Unit includes the quarry proper (post-bulk waste removal), surface waters, and groundwater.

2.3 Environmental Monitoring Program Overview

At the WSSRAP, environmental monitoring is conducted 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 CERCLA. This requires a careful integration of WSSRAP activities to implement all the environmental and public health requirements of CERCLA, DOE orders, and other relevant Federal and State regulations.

The WSSRAP prepares and maintains an *Environmental Monitoring Plan* (EMP) (Ref. 8). The EMP details the schedule and analyses required for performing effluent monitoring and surveillance activities.

The WSSRAP environmental protection program involves radiological and chemical environmental monitoring and is separated into two distinct functions: effluent monitoring and environmental surveillance. Effluent monitoring assesses the quantities of contaminants in contaminant migration pathways and in pathways subject to compliance with applicable regulations. Environmental surveillance consists of analyzing environmental conditions 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 radiological and chemical exposures and to assess the potential effects to the general public and the environment.

The WSSRAP radiological environmental monitoring program involves sampling various media for radiological constituents; primarily total uranium (U-234, U-235, and U-238) and/or Ra-226, Ra-228, Th-228, Th-230, and Th-232. These parameters are the primary radiological contaminants of concern at the Weldon Spring site. Radiological monitoring is conducted on National Pollutant Discharge Elimination System (NPDES) stormwater discharges, surface water, groundwater, and springs. Radiological air monitoring was discontinued at the end of 2000 because radioactive waste handling activities were essentially complete and no critical receptor air monitoring data had ever demonstrated an effective dose equivalent to the public greater than 10% of the 10 mrem standard (Ref. 7).

Chemical environmental monitoring is primarily conducted at the chemical plant and quarry areas, but also includes monitoring at off-site locations to confirm that no releases have occurred. The nonradiological compounds included in the routine 2003 monitoring program are metals, inorganic ions (nitrate and sulfate), TCE, and nitroaromatic compounds.

2.4 Project Accomplishments in 2003

The majority of remedial action activities were completed prior to 2003 under the overall plan for remediation of the site. The remaining accomplishments from 2003 for the operable units are detailed below.

2.4.1 Weldon Spring Chemical Plant Operable Unit

The Chemical Plant Remedial Action Report was prepared in 2003 and submitted to the regulatory agencies for review during 2003. The report was finalized in January 2004.

2.4.2 Weldon Spring Quarry Bulk Waste Operable Unit

This operable unit was officially closed in April 1997.

2.4.3 Weldon Spring Quarry Residuals Operable Unit

The Quarry Residuals Remedial Action Report was prepared and submitted to the regulatory agencies during 2003. This report was finalized in January 2004.

2.4.4 Weldon Spring Groundwater Operable Unit

The Proposed Plan for Final Remedial Action for the Groundwater Operable Unit (Ref. 11) and the Supporting Evaluation for the Proposed Plan (Ref. 18) were issued on August 1, 2003, with a public meeting held on August 13, 2003.

The Draft Record of Decision and Draft Final Record of Decision (Ref. 14) were issued in September and December 2003, respectively.

The DOE issued the final ROD in January 2004 and was signed by EPA on February 20, 2004. The selected remedy is monitored natural attenuation (MNA) with institutional controls to limit groundwater use during the period of remediation. MNA involves the collection of monitoring data to verify the effectiveness of naturally occurring processes to reduce contaminant concentrations over time. The ROD establishes remedial goals and performance standards for MNA.

2.5 Incident Reporting - Environmental Occurrences in 2003

In accordance with DOE Order 231.1A, field organizations are required to prepare annual summary reports on environmental occurrence activities and to report this information in the annual site environmental report. There were no environmental occurrences during 2003.

2.6 Groundwater Protection Management Program

The WSSRAP has a formal groundwater protection and management program in place. The policies and practices are documented in the *Weldon Spring Site Remedial Action Project Groundwater Protection Management Program Plan* (Ref. 12). The 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 plan outlines the hydrogeological characterization program conducted as part of CERCLA activities. These include groundwater sampling, water level monitoring, slug tests, tracer tests, and geologic logging. The plan also describes strategies for implementing site-wide groundwater protection practices and interdepartmental integration of these practices during all aspects of project management and development.

2.7 Waste Management Program

The waste management program for the Weldon Spring site has encompassed all waste-related activities (both interim and long term) including characterization, treatment, storage, transportation, minimization, and disposal. Hazardous, radioactive, toxic, mixed, special, and uncontaminated waste produced as a direct result of project cleanup activities have been within the scope of this program. Garbage and refuse generated as a result of project administration were excluded. The majority of waste management activities at the site have been completed.

2.8 Waste Minimization/Pollution Prevention Program

The WSSRAP Waste Minimization Program is primarily geared toward material substitution and source or volume reduction methods to achieve minimization. This is accomplished by evaluating and reviewing all hazardous chemicals (as defined by 29 CFR 1926.59) before they are purchased or arrive on site, and recommending alternate materials or applying use restrictions. Because long-term, volume-specific goals for waste minimization are not appropriate for nonoperational facilities, the WSSRAP has adopted ALARA goals.

The following is a list of items recycled during 2003: paper, cardboard, aluminum cans, and toner cartridges.

3. COMPLIANCE SUMMARY

3.1 Compliance Status for 2003

The Weldon Spring site is listed on the National Priorities List (NPL), and therefore the 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 and Recovery Act* (RCRA), *Clean Water Act* (CWA), *Safe Drinking Water Act* (SDWA), *Endangered Species Act*, and Missouri State regulations as specified in the CERCLA Records of Decision. Because the U.S. Department of Energy (DOE) is the lead agency for the site, *National Environmental Policy Act* (NEPA) values must be incorporated. The requirements of DOE Orders must also be met. Section 3.1.1 is a summary of WSSRAP compliance with applicable Federal and State regulations, and Section 3.1.2 is a summary of WSSRAP compliance with major DOE Orders. With near completion of the project, the applicability of certain ARARs has been reduced or eliminated.

3.1.1 Federal and State Regulatory Compliance

Comprehensive Environmental Response, Compensation and Liability Act

The WSSRAP has integrated the procedural and documentation requirements of CERCLA, as amended by the *Superfund Amendments and Reauthorization Act* (SARA), and NEPA.

Resource Conservation and Recovery Act

Hazardous wastes at the Weldon Spring site have been managed as required by RCRA as substantive, applicable, or relevant and appropriate requirements (ARARs). This has included characterization, consolidation, inventory, storage, treatment, disposal, and transportation of hazardous wastes that remained on site after closure of the Weldon Spring Uranium Feed Materials Plant (WSUFMP) and wastes that were generated during remedial activities. All hazardous waste activities at the site have been completed.

The Weldon Spring Site is now considered a conditionally exempt small quantity generator.

Clean Water Act

Effluents discharged to waters of the United States are regulated under the *Clean Water Act* (CWA) through regulations promulgated and implemented by the State of Missouri. The

Federal government has granted regulatory authority for implementation of CWA provisions to states with regulatory programs that are at least as stringent as the Federal program.

Compliance with the CWA at the WSSRAP includes meeting parameter limits and permit conditions specified in the National Pollutant Discharge Elimination System (NPDES) permits. Under these permits, both effluent and erosion-control monitoring are performed. Section 6 provides additional details on the NPDES program.

Federal Insecticide, Fungicide, and Rodenticide Act

The WSSRAP maintains compliance with the *Federal Insecticide, Fungicide, and Rodenticide Act*. Material Safety Data Sheets are reviewed for all pesticides before they are purchased. The WSSRAP does not currently use restricted-use pesticides and, therefore, does not possess a permit/license to purchase these materials. The WSSRAP meets State requirements for pesticide application, and reviews each application for State licensing requirements.

Safe Drinking Water Act

Safe Drinking Water Act (SDWA) regulations are not applicable because maximum contaminant levels (MCLs) are applicable only to drinking water at the tap, not in groundwater. However, under the National Contingency Plan, MCLs are relevant and appropriate to groundwater that is a potential drinking water source.

Emergency Planning and Community Right-to-Know Act

The site no longer stores large quantities of chemicals and none above a threshold level, therefore the site is not required to submit a 2003 *Emergency Planning and Community Right-to-Know Act* (EPCRA) Tier II report.

The Toxic Release Inventory (TRI) report for 2003 is due on July 1, 2004. Based on the chemical usage in 2003, the WSSRAP is not required to submit a TRI report.

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 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 estimated total effective dose equivalent to the hypothetical maximally exposed individual was due to consumption of water from the Southeast Drainage. This dose was calculated to be 0.10 mrem, which is well below the 100 mrem (1 mSv) guideline for all potential exposure pathways. The annual average uranium concentrations at all NPDES outfalls were well below the derived concentration guideline (DCG) of 600 pCi/l (22.2 Bq/l).

3.1.2.2 DOE Order 231.1A, Environmental, Safety, and Health Reporting

DOE Order 231.1A ensures collection and reporting of information on environment, safety and health that is required by law or regulation. This site environmental report fulfills the requirement of the order to summarize the environmental data annually.

3.2 Summary of Permits for 2003

Table 3-1 provides a summary of the 2003 NPDES permits. Five active NPDES operating permits covered storm and treated water discharges from the site (MO-0107701); storm and treated water discharges from the quarry (MO-0108987); storm water discharges from the Borrow Area (MO-R100B69); hydrostatic test water discharges from the site (MO-G670203); and storm water discharges from the quarry borrow area (MO-R104031). Four of these permits (MO-R100B69, MO-0108987, MO-G670203, and MO-R104031) were terminated in 2003.

MDNR issued a revised permit (MO-0107701) on October 3, 2003, which eliminated the stormwater outfalls at the chemical plant site. On March 5, 2004, MDNR deleted the sanitary discharge outfall and this permit now covers only the SWTP discharge line. The SWTP discharge line will only be used if the site ever operates the Train 3 as a contingency. Waste water, including leachate from the disposal cell and purge water from certain monitoring wells, is approved for transfer to the St. Louis Metropolitan Sewer District.

Table 3-1 Summary of WSSRAP NPDES Operating Permits

PERMIT NO.	DATE ISSUED	EXPIRATION DATE	DATE RENEWAL OR EXTENSION REQUEST DUE	SCOPE AND COMMENTS
MO-0107701	07/14/00	07/13/05	01/13/05	Covers Sanitary and SWTP Line
MO-0108987	07/17/98	07/16/03	Terminated 5/14/03	Covers QWTP discharge and storm water.
MO-R100B69	05/03/02	02/02/07	Terminated 5/14/03	Storm water discharges from Borrow Area and haul road operations.
MO-G670203	12/05/97	10/23/02	Terminated 01/28/03	Covered hydrostatic test water at site.
MO-R104031	05/03/02	02/07/07	Terminated 5/14/03	Covered quarry borrow area storm water land disturbance.

QWTP Quarry water treatment plant
SWTP Site water treatment plant.

4. AIR MONITORING PROGRAMS

In the past, the Weldon Spring Site Remedial Action Project (WSSRAP) operated an extensive environmental airborne monitoring and surveillance program in accordance with U.S. Department of Energy (DOE) Orders, U.S. Environmental Protection Agency (EPA), National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations, and the WSSRAP *Environmental Monitoring Plan* (Ref. 8). Throughout the remediation of contaminated soils and materials, the potential for airborne releases and atmospheric migration of radioactive contaminants was closely monitored by measuring concentrations of radon, gamma exposure, airborne radioactive particulates, airborne asbestos, and fine particulate matter at various site perimeter and off-site locations. The potential for airborne release of radionuclides was eliminated with the final disposition of contaminated materials in the permanent disposal cell. With the completion of most site activities, no air monitoring has been conducted since 2001.

5. RADIATION DOSE ANALYSIS

This section evaluates the potential effects of surface water and groundwater discharges of radiological contaminants from the Weldon Spring Site Remedial Action Project (WSSRAP) in 2003. Effective dose equivalent has been calculated for 2003 based on the applicable exposure pathway. Doses resulting from airborne emissions are no longer calculated since the potential for airborne release of radiological contaminants has been eliminated and, therefore, 40 CFR 61, Subpart H *(National Emission Standards for Emissions of Radionuclides other than Radon From Department of Energy Facilities)* regulations are no longer relevant. Similarly, doses resulting from external gamma radiation are no longer calculated since the radon sources have been remediated and are contained within the permanent disposal cell. The cell cover effectively mitigates radon releases to levels comparable to background locations.

For this report, the exposure scenario and dose calculation for a hypothetical maximally exposed individual are presented. The estimated total effective dose equivalent (TEDE) to the hypothetical maximally exposed individual due to consumption of water from Spring 5303, which is located in the SE Drainage, is 0.1 mrem (1.0 E-3 mSv). This result is compared to U.S. Department of Energy (DOE) limits contained in DOE Order 5400.5 to demonstrate compliance with regulatory requirements.

The dose for a collective population would be similar to that calculated and presented in the *2001 Site Environmental Report* (Ref. 25) where the collective dose was reported to be 0.103 person-rem (0.103 E-3 person-Sv).

5.1 Pathway Analysis

In developing specific elements of the WSSRAP environmental monitoring program, potential exposure pathways and health effects of the radioactive and chemical materials present on site are evaluated to determine which pathways are complete. This pathway analysis is detailed in the site *Environmental Monitoring Plan* (Ref. 8). Evaluation of each exposure pathway is based on the sources, release mechanisms, types, and probable environmental fates of contaminants, and the locations and activities of potential receptors. If a link exists between one or more contaminant sources, or between one or more environmental transport processes and an exposure point where human or ecological receptors are present, a pathway exist and is used to assess radiological and nonradiological exposures.

Consumption of contaminated groundwater is not a relevant pathway as concentrations of radioactive contaminants in the production wells near the Weldon Spring Quarry are comparable to background concentrations (see Section 7.5). In addition, no drinking water wells are located in the vicinity of the contaminated groundwater in the chemical plant and raffinate pits area.

The inhalation of airborne particulates, radon gas and external gamma irradiation pathways are also not applicable to the 2003 dose estimate since the contaminated soils and water have been remediated and placed in the on-site cell.

DOE Order 5400.5 contains the radiological public dose guideline that is applicable for the WSSRAP. This guideline provides for an annual limit of 100 mrem (1 mSv) total effective dose equivalent accounting for all exposure pathways (excluding background).

5.2 Radiological Release Estimates

During 2003, intermittent surface water runoff transported isotopes of uranium from the site through seven storm water outfalls. The outfalls were monitored monthly in accordance with National Pollutant Discharge Elimination System (NPDES) requirements. Total uranium concentrations measured in runoff water were multiplied by the natural uranium activity ratios for U-234, U-235, and U-238 (49.1%, 2.3%, and 48.6%, respectively) to determine the waterborne releases of those isotopes. Table 5-1 shows the estimated activity release of radionuclides to the environment, the corresponding mass released, and the half-life for each uranium isotope present at the Weldon Spring site.

Table 5-1 Radionuclide Releases to the Environment

RADIONUCLIDE	ACTIVITY OF RADIONUCLIDES RELEASED TO WATER (Ci)	MASS OF RADIONUCLIDE RELEASED (grams)	HALF-LIFE (Yrs)
U-238	0.761 E-3	2.31E+3	4.47E+09
U-235	0.036 E-3	1.64E+1	7.04E+08
U-234	0.768 E-3	1.24E-1	2.46E+05
Total	1.565 E-3	2.33E+3	NA

Note: Multiply by 3.7E10 to convert Ci to Bq.

5.3 Exposure Scenarios

Dose calculations were performed for a hypothetical maximally exposed individual to assess dose due to radiological releases from the Weldon Spring site. A dose calculation for a population within 80 km (49.6 mi) of the site is not estimated since airborne release of radioactive contaminants is not a factor.

Dose equivalents to a single individual are estimated by hypothesizing a maximally exposed individual and placing this individual in a reasonable but conservative scenario. This method is acceptable when the magnitude of the dose to a hypothetical maximally exposed individual is small, as is the case for the WSSRAP.

All ingestion calculations were performed using the methodology described in International Commission on Radiation Protection (ICRP) Reports 26 (Ref. 26) and 30 (Ref. 27)

for a 50-year committed effective dose equivalent (CEDE). Dose conversion factors were obtained from the EPA Federal Guidance Report No. 11 (Ref. 28).

5.4 Dose Equivalent Estimates

Total effective dose equivalent (TEDE) estimate for the exposure scenario was calculated using 2003 environmental monitoring data. The dose is well below the standards set by the DOE for annual public exposure.

This section discusses the estimated total effective dose equivalent to a hypothetical individual assumed to frequent the SE Drainage (SP-5303) of the Weldon Spring Conservation Area. No private residences are adjacent to the SE Drainage, which is situated on land currently managed by the Missouri Department of Conservation (MDC). Therefore, the calculation of dose equivalent is based on a recreational user of the Conservation Area who drank from Spring 5303 twenty times per year during 2003.

Exposure scenario assumptions particular to this dose calculation include the following:

- The maximally exposed individual drank one cup (0.2 l) of water from the Spring twenty times per year (equivalent to 1.05 gal (4.0l) of water for the year).

- The Maximum uranium concentration in water samples taken from spring locations during 2003 was found at SP-5303 (91.8 pCi/l). This concentration was assumed to be present in all of the water ingested by the maximally exposed individual. For comparison, the maximum uranium concentration at Burgermeister Spring during 2003 was 62.5 pCi/l.

- The total uranium dose conversion factor (DCFs) for ingestion (Ref. 28) is 2.69E-4 mrem/pCi (soluble). (The DCF for total soluble uranium was calculated using isotopic dose conversion factors for ingestion and the natural uranium activity ratios listed in Section 5.2.)

The total effective dose equivalent (TEDE) is calculated as shown below:

TEDE (ingestion of contaminated water for a given radionuclide) = Concentration (pCi/l) x Volume of Water Ingested (l) x Dose Conversion Factor (mrem/pCi)

TEDE (total uranium) = 91.8 pCi/l x 4l x 2.69 E-4 mrem/pCi = 0.1 mrem (1.0 E-3mSv)

This value represents less than 0.10 % of the DOE standard of 100 mrem (1 mSv) TEDE above background. In comparison, the annual average exposure to natural background radiation in the United States results in a TEDE of approximately 300 mrem (3 mSv) (Ref. 36).

6. SURFACE WATER PROTECTION

6.1 Highlights of the Surface Water Program

During 2003, vegetation became fully established at both the chemical plant and quarry sites. These items, and others, are discussed in detail in this chapter.

- The mass of uranium migrating off site in storm water, 2.29 kg/yr (5.04 lb/yr), was a 4.2% reduction from the 2002 mass of 2.39 kg/yr (5.26 lb/yr) and a 99.5 % reduction from the 1987 mass of 442 kg. This demonstrates the effectiveness of remediation.

- The annual average concentration of uranium in storm water was reduced to less than 6.4 pCi/l at all outfalls.

- Uranium levels in surface water bodies downstream of the chemical plant site continue to trend downward.

- Uranium levels in surface water bodies downstream of the quarry continue to trend downward.

- Stormwater outfalls at both the site and quarry were removed from the NPDES permits during the year; therefore, the results discussed are only for a partial year and annual averages are based on the partial year's data.

6.2 Program Overview

The environmental monitoring and protection program for surface waters at the Weldon Spring Site Remedial Action Project (WSSRAP) is described in the *Environmental Monitoring Plan* (Ref. 8) and includes discharge points permitted under the NPDES program and streams, ponds, and lakes under the surface water monitoring program.

The NPDES effluent monitoring program establishes sampling requirements for discharge points (outfalls) at the chemical plant, quarry, site and quarry borrow areas and hydrostatic test discharges. The goals of this program have been to maintain compliance with the NPDES permit requirements and to protect the health of downstream water users and the environment by characterizing water flowing from the site during remediation.

In addition, the surface water monitoring program monitors off-site water bodies for uranium levels and temporal changes in uranium levels. The data generated from this monitoring are used in conjunction with NPDES monitoring to measure the success of the project goal of cleaning up the site with no long-term increase in contaminant discharge or degradation of off-site water bodies.

6.3 Applicable Standards

Effluent discharges from the site for 2003 were authorized by five NPDES permits issued by the Missouri Department of Natural Resources (MDNR). The MDNR requires specific parameters to be monitored at outfalls listed in each permit. Each parameter is assigned either effluent limits or a "monitoring only" status, which means the concentrations are reported but not limited by the permit. Sampling frequencies and reporting requirements for the two major permits, MO-0107701 (at the chemical plant site) and MO-0108987 (at the quarry), are summarized in Table 6-1. The frequencies and requirements for the site and quarry water treatment plants are not shown because the quarry water treatment plant was removed during 2002 and there were no discharges under the site permit during 2003. The requirements for the site permit may be found in *the Long-Term Surveillance and Maintenance Plan for the Weldon Spring Site* (Ref 38). These permits were reissued on July 14, 2000, and June 17, 1998, respectively. Permit MO-0108987 for the quarry was terminated on May 14, 2003. Storm water outfalls at the chemical plant site were removed from NPDES permit MO-0107701 on October 3, 2003.

Table 6-1 Weldon Spring Chemical Plant Storm and Sanitary Water (NPDES Permit MO-0107701) and Quarry Storm Water (MO-0108987) Monitoring Requirements

PARAMETER	LOCATION	
	NP-0002, NP-0003, NP-0004, NP-0005, NP-0010, NP-0050[a] NP-1005	**NP-0006**
Sampling Frequency	once/month	Once/quarter
Flow	GPD (monitor only)	GPD (monitor only)[b]
Settleable Solids	1.0 ml/l/hr	NA
Total Suspended Solids	mg/l (monitor only)[c]	30/45 mg/l[d]
Nitrate and Nitrite as N**	mg/l (monitor only)	NA
Uranium, total	mg/l (monitor only)*	NA
Gross alpha, beta	pCi/l (monitor only)	NA
pH	6 - 9 standard units	6 - 9 standard units
Fecal coliform	NA	400/1000 colonies/ 100 ml[e]
Biochemical Oxygen Demand	NA	30/45 mg/l[d]
Total Residual Chlorine	NA	1.0 mg/l

NOTE: Refer to Figures 6-1 and 6-2 for NPDES monitoring locations.
* Permit requires reporting in both mg/l and pCi/l and notification of MDNR if uranium concentration in any sample exceeds 2 mg/l.
** Does not apply to quarry storm water Outfall NP-1005.
(a) Outfall NP-0050 represents two outfalls from the TSA area.
(b) Frequency is once/month.
(c) Limit is 50 mg/l if erosion control is not designed for a one in 10 year, 24-hour storm.
(d) Monthly average/weekly average
(e) Monthly average/daily maximum.
NA Not Applicable.

The Site Borrow Area land disturbance storm water permit, MO-R100B69, issued on September 1, 1994, and reissued on May 29, 1998, has no specified monitoring or reporting requirements. A program was developed in the *Environmental Monitoring Plan* (Ref. 8) for monitoring settleable solids and, under certain circumstances, oil and grease. The results of this monitoring were used to measure the effectiveness of erosion controls and to improve them, if required. This permit was terminated on May 14, 2003 based on the area becoming revegetated and stabilized.

Permit MO-G670203 was issued on December 5, 1997, for discharge of hydrostatic test water from the chemical plant site. Hydrostatic test water is potable water used to test tanks, pipes, etc., for leaks. It could have been used to test pumps, valves, etc. Sampling frequency and reporting requirements and results are discussed in Section 6.6.1.2.3. This permit was terminated on January 28, 2003.

The Quarry Borrow Area land disturbance storm water permit, MO-R104031, issued to the WSSRAP on July 28, 2000, had no specified monitoring or reporting requirements. This permit was terminated on May 14, 2003 based on the area becoming revegetated and stabilized.

Effluent discharges are also regulated by Department of Energy (DOE) Order 5400.5, which calls for a best available technology evaluation if the annual average uranium concentration at an outfall exceeds the derived concentration guideline (DCG) for natural uranium (600 pCi/l [22.2 Bq/l]). Measures were taken during remediation to keep uranium concentrations as low as reasonably achievable (ALARA), not just below the DCG. Stormwater runoff in 2003 did not approach the DCG level at any outfall.

The primary criteria used to develop the surface water monitoring program were the Missouri Water Quality Standards for drinking water supplies established under the Missouri Clean Water Commission Regulation 10 CSR 20-7.031 and the U.S. Environmental Protection Agency primary and secondary maximum contaminant level concentrations for drinking water. A table of applicable drinking water standards that includes contaminants routinely monitored in the surface water program can be found in Table 7-1.

Surface water other than NPDES outfalls is also monitored under the requirements of DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, which designates DCGs for ingestion of water.

6.4 Hydrology Description of the Site and Quarry

Separate surface water monitoring programs have been developed at the chemical plant and quarry due to differences in the topography and hydrologic conditions. Both programs take into account the mechanisms controlling surface water source areas.

6.4.1 Weldon Spring Chemical Plant and Raffinate Pits

The chemical plant area is located on the Missouri-Mississippi River surface drainage divide (Figure 1-4). The topography is gently undulating and generally slopes northward to the Mississippi River and, more steeply, southward to the Missouri River. Streams do not run through the property, but because the site is elevated above surrounding areas, drainageways originate on the property and convey storm water off site. Surface drainage from the western portion of the site drains to tributaries of Busch Lake 35 and then to Schote Creek, which in turn enters Dardenne Creek, ultimately draining to the Mississippi River (Figure 6-1). During 2003 vegetation became well established in the area. Runoff from part of the disposal cell cover discharges in this watershed.

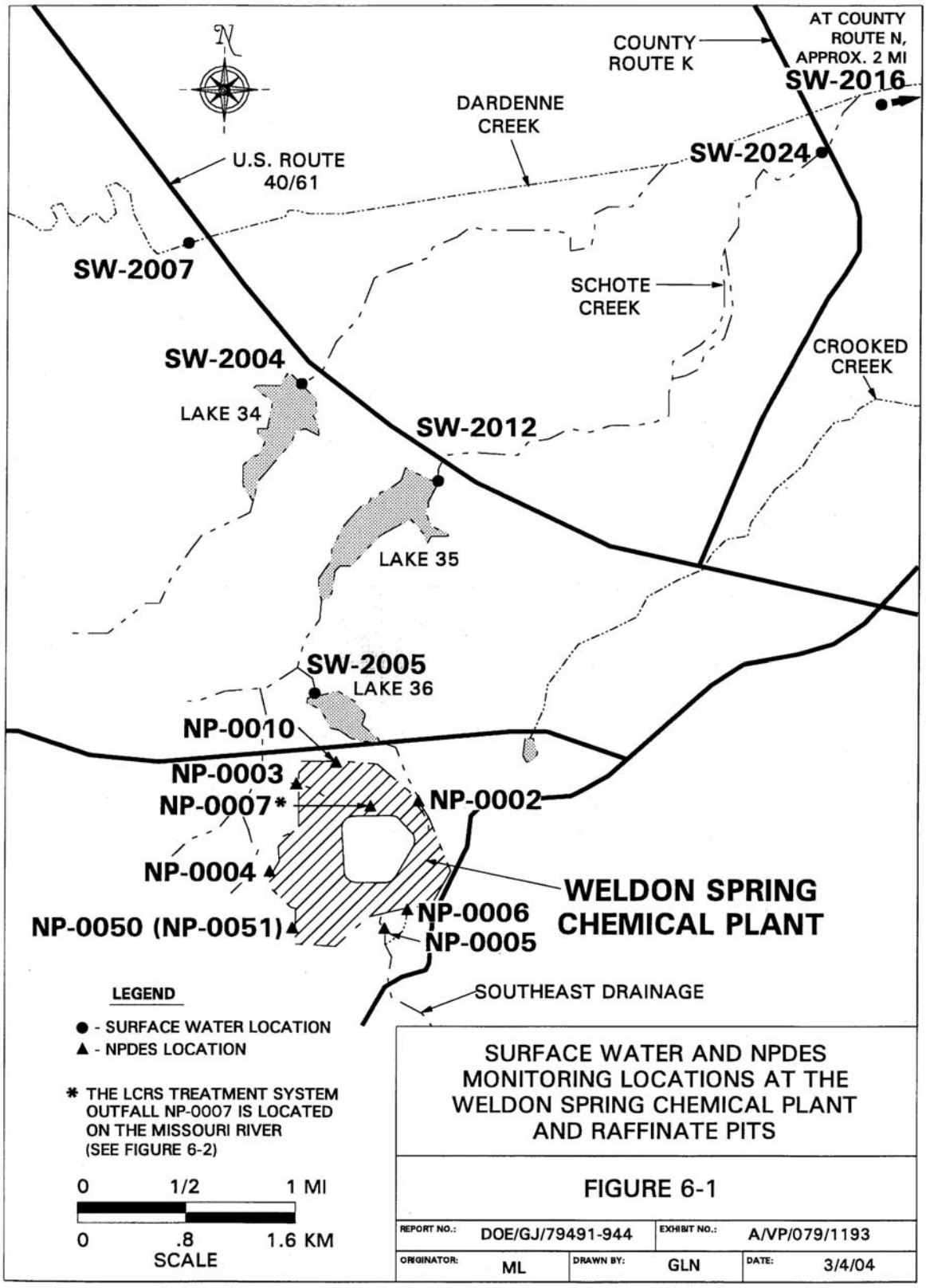
Surface water drainage from the northeast section of the chemical plant site discharges to Dardenne Creek from Schote Creek after first flowing through Busch Lakes 36 and 35 (Figure 6-1). Runoff from the southern portion of the chemical plant site (Figure 6-1) flows southeast to the Missouri River via the Southeast Drainage (Valley 5300). During 2003, the vegetation became well established in these areas.

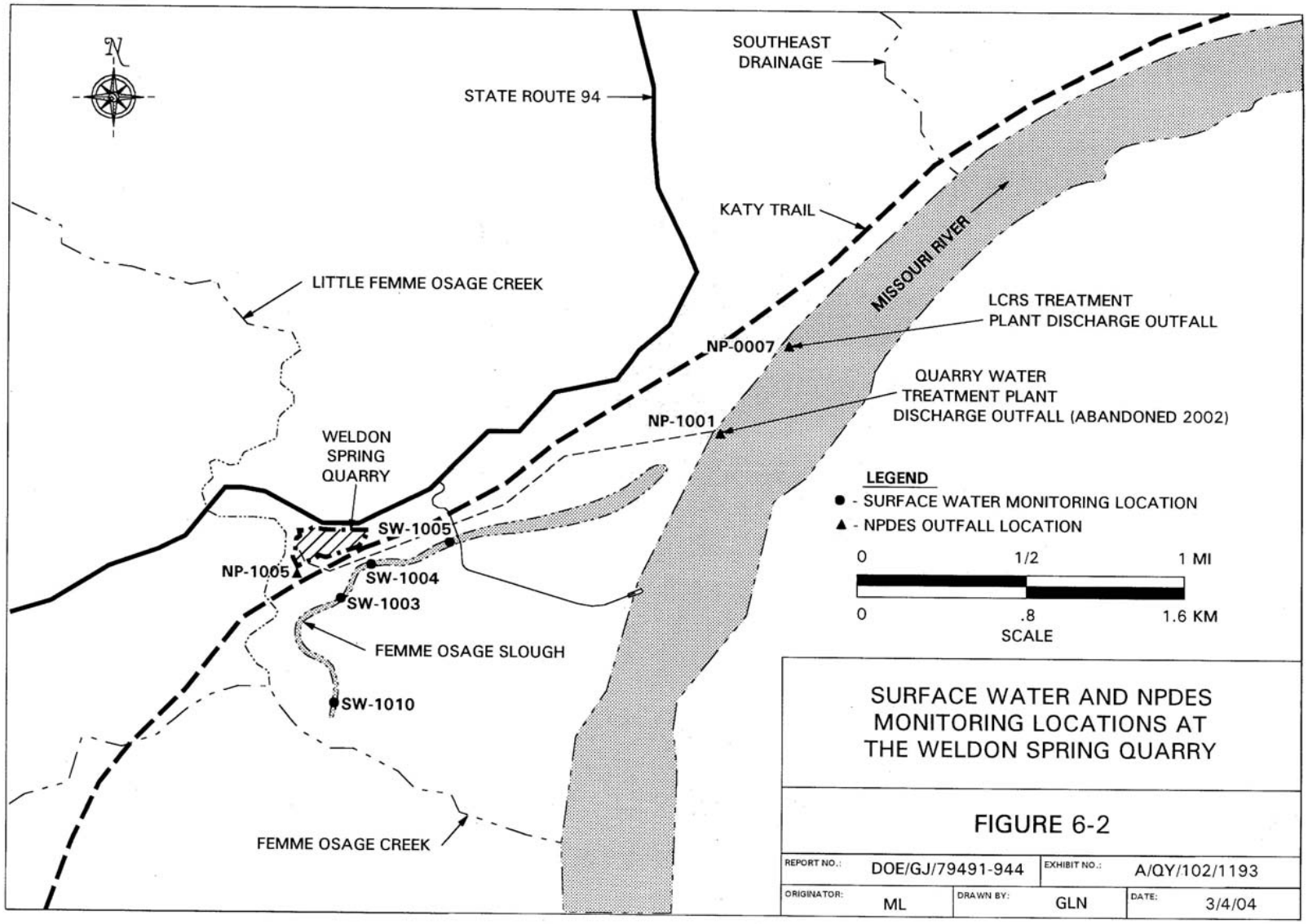
6.4.2 Weldon Spring Quarry

The Femme Osage Slough is directly south of the quarry and is known to receive contaminated groundwater from the quarry through subsurface recharge (Figure 6-2). The quarry was backfilled and graded during 2002 to prevent water from ponding in the quarry area. There is no natural surface flow from the slough; it is essentially land locked. The Femme Osage Slough is monitored to detect changes in the system.

6.5 Monitoring Requirements

Sections 6.5.1 and 6.5.2 discuss monitoring requirements at NPDES outfalls and surface water locations at the chemical plant site and the quarry.


N
AT COUNTY ROUTE N, APPROX. 2 MI
COUNTY ROUTE K
SW-2016
DARDENNE CREEK
SW-2024
U.S. ROUTE 40/61
SW-2007
SCHOTE CREEK
CROOKED CREEK
SW-2004
LAKE 34
SW-2012
LAKE 35
SW-2005
LAKE 36
NP-0010
NP-0003
NP-0007*
NP-0002
NP-0004
WELDON SPRING CHEMICAL PLANT
NP-0006
NP-0050 (NP-0051)
NP-0005
SOUTHEAST DRAINAGE
LEGEND
● - SURFACE WATER LOCATION
▲ - NPDES LOCATION
* THE LCRS TREATMENT SYSTEM OUTFALL NP-0007 IS LOCATED ON THE MISSOURI RIVER (SEE FIGURE 6-2)
0 1/2 1 MI
0 .8 1.6 KM
SCALE
SURFACE WATER AND NPDES MONITORING LOCATIONS AT THE WELDON SPRING CHEMICAL PLANT AND RAFFINATE PITS
FIGURE 6-1
REPORT NO.: DOE/GJ/79491-944
EXHIBIT NO.: A/VP/079/1193
ORIGINATOR: ML
DRAWN BY: GLN
DATE: 3/4/04


N
SOUTHEAST DRAINAGE
STATE ROUTE 94
KATY TRAIL
MISSOURI RIVER
LITTLE FEMME OSAGE CREEK
LCRS TREATMENT PLANT DISCHARGE OUTFALL
NP-0007
QUARRY WATER TREATMENT PLANT DISCHARGE OUTFALL (ABANDONED 2002)
NP-1001
WELDON SPRING QUARRY
SW-1005
NP-1005
SW-1004
SW-1003
FEMME OSAGE SLOUGH
SW-1010
FEMME OSAGE CREEK
LEGEND
● - SURFACE WATER MONITORING LOCATION
▲ - NPDES OUTFALL LOCATION
0 1/2 1 MI
0 .8 1.6 KM
SCALE
SURFACE WATER AND NPDES MONITORING LOCATIONS AT THE WELDON SPRING QUARRY
FIGURE 6-2
REPORT NO.: DOE/GJ/79491-944
EXHIBIT NO.: A/QY/102/1193
ORIGINATOR: ML
DRAWN BY: GLN
DATE: 3/4/04

6.5.1 National Pollutant Discharge Elimination System Monitoring

The NPDES permits issued to the WSSRAP site identify the parameters to be monitored. The requirements for the two major permits are shown in Table 6-1. Requirements for the quarry and site water treatment plant outfalls are not noted here but are located in the EMP (Ref. 8). The quarry water treatment plant was removed during 2002 and there were no treated water discharges from the chemical plant site during 2003.

Leachate was transported to the Metropolitan St. Louis Sewer District Bissell Point Treatment Plant for treatment instead of being treated and discharged through Outfall #007. During each leachate transport event, samples are collected and analyzed for parameters required by MSD. Also, in conjunction with cell well monitoring, additional parameters are monitored semiannually to reflect disposal cell well parameters (see Section 7.6). Average analytical results are presented in Table 6-2 and individual sample results are presented in the *2003 Annual Inspection Report for the Weldon Spring Site St. Charles, Missouri* (Ref. 20). Except for manganese, all the parameters were in compliance with NPDES limits. In addition, radiological parameters were all analyzed at less than the DOE Derived Concentration Guide (DCG) values.

The MSD approval to discharge to their facility sets a maximum discharge of 15,000 gallons per month and 0.15 mCi of radioactivity per year. The total activity released during 2003 was 0.00934 mCi, well below the ceiling of 0.15 mCi. The total volume discharged was 89,702 gallons over 10 discharges for an average of 8,970 gallons per month. MSD is responsible for meeting NPDES limits at their outfall.

Table 6-2 Average Results for Leachate

PARAMETER	RESULT	UNITS	# OF SAMPLES	# OF NON DETECTS
PCB's	0.5	µg/l	3	3
Volatile Organic Compounds	N.D.	µg/l	10	10
Aluminum (7.5)*	0.0101	mg/l	1	1
Antimony	0.0014	mg/l	1	1
Arsenic (0.20)*	0.0033	mg/l	10	1
Barium	0.9538	mg/l	10	0
Cadmium	0.0010	mg/l	1	1
Calcium	149.0	mg/l	1	0
Chromium (0.40)*	0.0005	mg/l	10	10
Cobalt	0.0081	mg/l	3	0
Copper	0.0064	mg/l	10	3
Iron	13.585	mg/l	10	0
Lead (0.20)*	0.0012	mg/l	10	4
Lithium	0.0032	mg/l	1	1
Magnesium	57.4	mg/l	1	0
Manganese (0.50)*	2.053	mg/l	3	0
Mercury (0.005)*	0.00003	mg/l	10	10
Molybdenum	0.0036	mg/l	1	1

Table 6-2 Average Results for Leachate (Continued)

PARAMETER	RESULT	UNITS	# OF SAMPLES	# OF NON DETECTS
Nickel	0.0069	mg/l	10	1
Potassium	6.960	mg/l	1	0
Selenium (0.05)*	0.0007	mg/l	10	1
Silver	0.0004	mg/l	10	3
Sodium	70.7	mg/l	1	0
Strontium	0.640	mg/l	1	0
Thallium	0.0014	mg/l	2	0
Vanadium	0.0007	mg/l	2	2
Zinc	0.0018	mg/l	10	6
PH	6.54 – 7.47	S.U.	10	N.A.
Sulfate (1000)*	43.733	mg/l	3	0
Chloride	24.067	mg/l	3	0
Nitrate (as N) (100)*	0.200	mg/l	3	1
Fluoride (12)*	0.1791	mg/l	3	1
Total Dissolved Solids	784.667	mg/l	3	0
Total Suspended Solids (30)*	28.8	mg/l	10	0
COD (60)*	27.9	mg/l	10	10
Total Organic Carbon	10.067	mg/l	3	0
Total Organic Halogens	0.0003	mg/l	1	0
Gross Alpha (monitor)*	13.671	pCi/l	10	0
Gross Beta (monitor)*	13.605	pCi/l	10	0
Americium-241	0.272	pCi/l	1	1
Plutonium-238	0.330	pCi/l	1	0
Plutonium-239/234	0.110	pCi/l	1	1
Neptunium-237	0.124	pCi/l	1	1
Radium-226 (monitor)*	0.5359	pCi/l	10	0
Radium-228 (monitor)*	0.5947	pCi/l	10	7
Technetium-99	2.23	pCi/l	1	0
Thorium-228 (monitor)*	0.0858	pCi/l	10	1
Thorium-230 (monitor)*	0.1747	pCi/l	10	2
Thorium-232 (monitor)*	0.0253	pCi/l	10	10
Uranium (monitor)*	27.93	pCi/l	10	0

* NPDES limits for leachate if it is discharge directly from the site to outfall #007. These limits do not apply for leachate transported to the MSD Bissell Point sewage treatment plant.

The requirements for the three minor permits are discussed in the following text. Physical, chemical, and radiological parameters were monitored at all storm water outfalls. The *Environmental Monitoring Plan* (Ref. 8) reflects the requirements of the NPDES permits.

6.5.2 Surface Water Monitoring

The following two subsections discuss surface water monitoring requirements at the chemical plant site and the quarry.

6.5.2.1 Weldon Spring Chemical Plant and Raffinate Pits

In accordance with the surface water monitoring program, Schote Creek, Dardenne Creek, and Busch Lakes 34, 35, and 36 were sampled semi-annually, at five locations (Figure 6-1) for total uranium. This monitoring was conducted to measure the effects of remediation and surface water discharges from the site on the quality of downstream surface water.

6.5.2.2 Weldon Spring Quarry

Four locations within the Femme Osage Slough were monitored to determine the impact of groundwater migration from the quarry. These locations, which are shown on Figure 6-2, were monitored semi-annually for total uranium.

6.6 Monitoring Results

Analytical results of the monitoring of surface water and NPDES outfalls are presented in the following subsections. Annual averages for storm water discharges are based on discharges only until the outfalls were removed from the permit.

6.6.1 National Pollutant Discharge Elimination System Program Monitoring Results

Radiochemical, chemical, and physical analytical results for NPDES outfalls are presented in Subsections 6.6.1.1 and 6.6.1.2.

6.6.1.1 Radiochemical Analysis

For 2003, the annual average uranium concentrations at the storm water discharge points ranged from 1.8 pCi/l (0.07 Bq/l) at NP-0004 to 6.4 pCi/l (0.24 Bq/l) at NP-0050, which are 0.3% and 1.1%, respectively, of the DCG for natural uranium. Average annual gross alpha concentrations ranged from 4.2 pCi/l (0.16 Bq/l) at NP-0002 to 9.5 pCi/l (0.35 Bq/l) at NP-0050. The year 2003 annual average radionuclide concentrations for all the permitted storm water outfalls are shown in Table 6-3.

Uranium concentration averages were calculated for storm water Outfalls NP-0002, NP-0003, NP-0004, NP-0005, NP-0010 and, NP-0050 (NP-0051) through September 2003, when the outfalls were removed from the permits. The permit for NP-1005 was terminated on May 11, 2003. Flow was measured at these outfalls using visual estimates. Beginning January 1, 2000, total flows were calculated using watershed areas, precipitation measurements, and runoff coefficients. A straight average was used rather than a flow weighted average, as in the past, because V-notch weirs and flow meters were not used to measure flows and uranium concentrations had declined to very low levels.

Table 6-3 2003 Annual Average NPDES Results for the Weldon Spring Chemical Plant and Quarry Storm Water Outfalls

PARAMETER	LOCATIONS						
	CHEMICAL PLANT						QUARRY
	NP-0002	NP-0003	NP-0004	NP-0005	NP-0010	NP-0050, 51	NP-1005
Number of sample events	9	9	7	8	5	6	4
pH range	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Nitrate as N (mg/l)	0.67	0.8	6.0	2.0	5.7	1.1	NS
Total suspended solids (mg/l)	129	376	270	76	153	159	414
Settleable solids (ml/l/hr)	9/0[b]	9/0[b]	7/0[b]	8/0[b]	5/0[b]	6/0[b]	4/0[b]
Total uranium (pCi/l)	2.9	3.1	1.8	3.8	4.0	6.4	2.2
Gross alpha (pCi/l)	4.2	8.7	6.2	5.4	5.6	9.5	8.3
Gross beta (pCi/l)	8.9	20.3	13.9	16.2	11.2	20.0	16.8

(a) All pH readings were in the permitted range of 6.0 to 9.0 standard units.
(b) Number of samples/number of results above daily maximum limit of 1.0 ml/l/hr.
NS Not Sampled.
Note: 1 pCi/l = 0.037 Bq/l.

Estimated quantities of total natural uranium released off site through surface water runoff are shown in Table 6-4. The total volume of storm water at all the outfalls was calculated using watershed area, total precipitation, and runoff curve numbers. Runoff curve numbers are cited in the U.S. Department of Transportation *Design of Roadside Drainage Channels* (Ref. 31). Best professional judgment was used in determining runoff curve numbers. The estimated mass of uranium released off site in storm water and treated effluent during 2003 was 2.29 kg (5.04 lb) and was calculated by multiplying the total runoff volume by the average uranium concentration. This is a decrease from the estimated amount released during 2002, which was 2.39 kg (5.26 lb). Table 6-5 shows the annual average uranium concentrations at NPDES outfalls from 1987 to 2003. Average uranium concentrations at storm water outfalls for 2003, in comparison to levels for 2002, have decreased or remained the same at all outfalls except NP-0004, NP-1005 and NP-0050. Although the average uranium levels slightly increased at three outfalls, they were still less than 10 pCi/l and well below the DCG of 600 pCi/l. The increases are attributed to natural variation.

Descriptions of each outfall are provided in the following paragraphs. All levels were well below the DCG.

Table 6-4 2003 Estimated Annual Release of Natural Uranium from NPDES Outfalls

OUTFALL	DRAINAGE AREA HECTARES (ACRES)	ESTIMATED % OF PRECIPITATION AS RUNOFF[(a)]	AVERAGE URANIUM CONCENTRATION (pCi/l)	TOTAL RAINFALL VOLUME Ml/yr (Mgal/yr)	TOTAL RUNOFF VOLUME Ml/yr (Mgal/yr)	TOTAL U RELEASE (Ci/yr)	TOTAL U RELEASE (kg/yr)
NP-0002	30.6 (75.7)	60	2.9	359.93 (95.09)	215.96 (57.05)	0.626 E-3	0.909
NP-0003	27.8 (68.6)	50	3.1	326.18 (86.17)	163.09 (43.08)	0.506 E-3	0.744
NP-0004	11.3 (28)	30	1.8	133.13 (35.17)	39.94 (10.55)	0.072 E-3	0.106
NP-0005	9.1 (22.4)	30	3.8	106.51 (28.14)	31.95 (8.44)	0.121 E-3	0.179
NP-0010	5.7 (14)	30	4.0	66.57 (17.59)	19.97 (5.28)	0.080 E-3	0.117
NP-0050, 51[(b)]	5 (12.4)	30	6.4	58.96 (15.58)	17.69 (4.67)	0.113 E-3	0.166
NP-1005	6.0 (15)	30	2.2	71.32 (18.84)	21.40 (5.65)	0.047 E-3	0.069
TOTAL	NA	NA	NA	1,122.60 (296.57)	509.99 (134.73)	1.565 E-3	2.29

(a) Runoff curve number estimated from U.S. Department of Transportation *Design of Roadside Drainage Channels* (Ref. 31).
(b) One outfall is monitored to represent both.
NA Not Applicable.
Note: To convert from Ci/yr to Bq/yr, multiply Ci/yr by 3.7×10^{10}

Table 6-5 Seventeen-Year Annual Average Uranium Concentrations (pCi/l) at NPDES Outfalls Since 1987

	NP-0001	NP-0002	NP-0003	NP-0004	NP-0005	NP-0010	NP-0007	NP-1001	NP-1005	NP-0050, NP-0051
1987	680	210	2240	9.5	780	---	---	---	---	---
1988	539	141	1178	6.2	497	---	---	---	---	---
1989	368	145	280	6.5	347	---	---	---	---	---
1990	413	139	89	7.6	364	---	---	---	---	---
1991	475	158	456	6.4	581	---	---	---	---	---
1992	516	228	478	6	296	---	---	<0.0003	---	---
1993	1003*	230*	607*	9	133*	---	---	1.9	---	---
1994	1226*	182*	332*	12	347*	82	0.74	1.6	---	---
1995	(a)	124*	67*	(b)	128*	107	0.46	1.8	---	---
1996	(a)	54*	88*	(b)	107*	50	1.37	1.1	---	---
1997	(a)	14*	143*	(b)	19*	2.7	1.50	0.5	---	---
1998	(a)	22*	83*	23	10*	10.7*	3.11	0.4	1.0(c)	---
1999	(a)	8.0*	38.3*	3.5*	20.3*	7.3	17.1	1.1	1.9	2.7(d)
2000	(a)	5.6*	15.6*	6.0*	6.9*	6.1*	2.7	0.8	1.0*	8.4
2001	(a)	5.7*	4.7*	1.8*	7.2*	3.2*	2.2	6.4	3.5	7.6
2002	(a)	3.8*	3.1*	0.9*	4.0*	6.6*	---	12.5	1.3	3.5
2003	(a)	2.9	3.1	1.8	3.8	4.0	---	---	2.2	6.4

* Flow weighted average.
--- Not applicable.
(a) Outfall removed, flow diverted to NP-0005.
(b) Outfall removed from permit in 1995, added in 1998.
(c) Outfall added in 1998.
(d) Outfall added in 1999.

Outfall NP-0001 was the outlet of an abandoned process sewer line. This outfall was physically removed in May 1994 and was officially eliminated from the permit on August 4, 1995.

Outfall NP-0002 is along the northeast perimeter of the site. The average uranium concentration for Outfall NP-0002 in 2003 was 2.9 pCi/l (0.11 Bq/l), lower than the 2002 average of 3.8 pCi/l (0.14 Bq/l). Annual average NPDES results for Outfall NP-0002 are in Table 6-3.

Outfall NP-0003 is along the western perimeter. The average uranium concentration for Outfall NP-0003 was 3.1 pCi/l (0.11 Bq/l), which is the same as the 2002 average. Annual average values are shown in Table 6-3.

Outfall NP-0004 is along the western perimeter. Outfall NP-0004 was eliminated from NPDES permit MO-0107701 on March 4, 1994, but was repermitted on May 22, 1998. The annual average for uranium at NP-0004 was 1.8 pCi/l (0.07 Bq/l), which was slightly higher than the 2002 annual average of 0.9 pCi/l (0.03 Bq/l). Annual average values are shown in Table 6-3.

Outfall NP-0005 is along the southern perimeter at the head of the southeast drainage. The annual average uranium concentration at Outfall NP-0005 for 2003 was 3.8 pCi/l (0.14 Bq/l), which was less than the 2002 average of 4.0 pCi/l (0.15 Bq/l). Annual average NPDES results are in Table 6-3.

Outfall NP-0010 is along the northern perimeter. The annual average uranium concentration for 2003 was 4.0 pCi/l (0.15 Bq/l), less than the 2002 average of 6.6 pCi/l (0.24 Bq/l). The annual average NPDES results are in Table 6-3.

Outfall NP-1005 is the storm water outfall at the quarry. This outfall discharges water from the quarry area. The annual average uranium concentration for 2003 was 2.2 pCi/l (0.08 Bq/l), a slight increase from the 2001 average of 1.3 pCi/l (0.05 Bq/l). The annual average NPDES results are reported in Table 6-3.

Outfall NP-0051 is along the western side of the site. Before the area was remediated, this outfall was actually two separate outfalls (NP-0050 and NP-0051). After the remediation, sheet flow was established, and only one outfall was being sampled at the property line. The annual average uranium concentration for 2003 was 6.4 pCi/l (0.24 Bq/l), which is higher than the 2002 average of 3.5 pCi/l (0.13 Bq/l). The annual average NPDES results are in Table 6-3.

6.6.1.2 Physical and Chemical Results

Analytical results for physical and chemical parameters at NPDES outfalls and other sample locations are discussed in Subsections 6.6.1.2.1 through 6.6.1.2.4.

6.6.1.2.1 Chemical Plant and Quarry Storm Water

The annual averages for the physical and chemical parameters for storm water Outfalls NP-0002, NP-0003, NP-0004, NP-0005, NP-0010, NP-0050, NP-0051, and NP-1005 are in Table 6-3. For 2003, all results were below NPDES limits.

6.6.1.2.2 Administration Building Sewage Treatment Plant

Monitoring results for the sewage treatment plant, Outfall NP-0006, are in Table 6-6. All parameters were in compliance for the year.

Table 6-6 NP-0006, Sewage Treatment Plant Outfall, Sample Test Results for Permitted Parameters

	PARAMETER [a] (PERMIT LIMITS)				
MONTH (QUARTER)	TSS (30/45 mg/l)*	BOD (30/45 mg/l)*	FC [b] (400/1000 col/100 ml)**	pH (6.0 – 9.0 SU)	TOTAL RESIDUAL CHLORINE (1.0/1.0 mg/l)**
January (1)	<5	6	<2	7.32	0.17
April (2)	17	16	<2	6.7	0.73
July (3)	<5	<5	<2	7.18	0.75
October (4)	<5	7	<2	7.44	0.62

(a) One sample analysis required for each calendar quarter.
(b) FC – Fecal Coliform.
* Monthly average/Weekly average.
** Monthly average/daily maximum.

6.6.1.2.3 Hydrostatic Test Water Results

There were no hydrostatic test water discharges during calendar year 2003. Permit MO-G670203 was terminated on January 28, 2003.

6.6.1.2.4 Borrow Area Land Disturbance Results

NDPES Permit MO-R100B69 was reissued on May 29, 1998, for stormwater at the Site borrow area and has no specified monitoring or reporting requirements. The entire area was seeded and mulched and vegetation became established during 2002, therefore no samples were collected during 2003. The permit was terminated on May 14, 2003.

The quarry borrow area permit, MO-R104031, was terminated on May 14, 2003. Vegetation was well established prior to 2003; therefore, no samples were collected for 2003.

6.6.2 Surface Water Monitoring Results

Analytical results for surface water monitoring locations at the chemical plant site and quarry are in Subsections 6.6.2.1 and 6.6.2.2, respectively.

6.6.2.1 Weldon Spring Chemical Plant

Uranium levels at the off-site surface water locations for 2003 were similar to 2002 averages, being slightly lower at three locations, slightly higher at one location and the same at one location. This reflects the lower levels seen at the NPDES outfalls. The slightly higher value located at the outlet of Lake 34 and is attributed to natural variations. Semi-annual uranium concentrations for surface water are presented in Table 6-7 along with the recent 3 year high for each location for comparison. Historic annual averages for these locations are plotted in Figure 6-3. Uranium levels at the Busch Lake outlets have shown an overall decline since remediation started. The Schote Creek and Dardenne Creek locations are downstream of the lakes and have always shown relatively low levels because the chemical plant portion of the watershed is much smaller than the total watershed area.

Table 6-7 2003 Results for Total Uranium (pCi/l) Concentrations at Weldon Spring Chemical Plant Area Surface Water Locations

LOCATION	1st Semi-annual	2nd Semi-annual	Average	RECENT 3 YEAR HIGH*
SW-2004	6.9	5.3	6.1	11.5
SW-2005	3.9	2.5	3.2	8.0
SW-2012	3.7	1.7	2.7	7.5
SW-2016	0.4	1.4	0.9	3.1
SW-2024	0.5	1.0	0.8	2.8
SW-2007	N/A	N/A	1.2	---

Note 1: 1 pCi/l = 0.037 Bq/l.
Note 2: SW-2007 represents the historical averages for the background location.
N/A Not Applicable
* 2000-2002

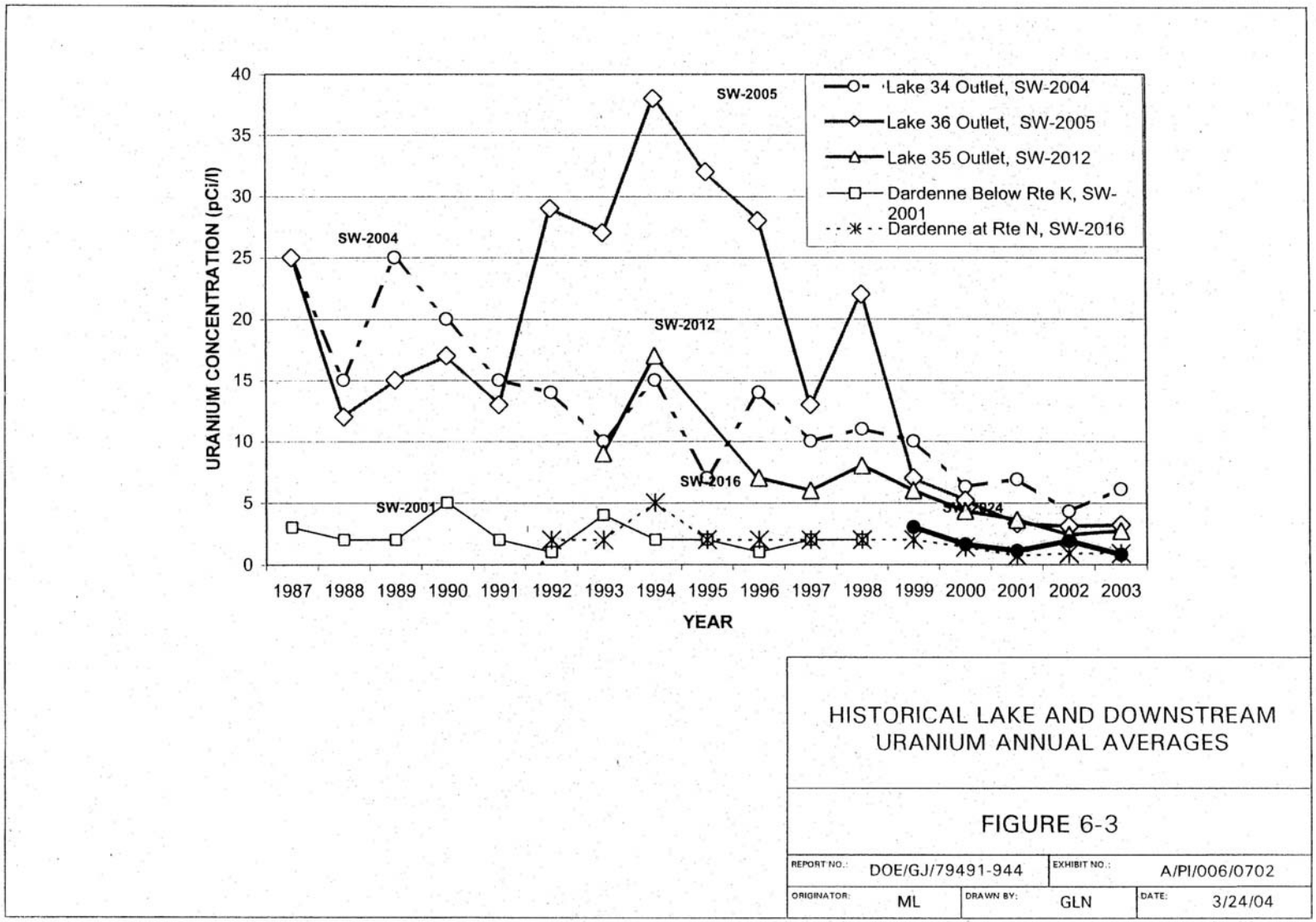
6.6.2.2 Weldon Spring Quarry

The 2003 semi-annual uranium concentrations for the quarry surface water locations are summarized in Table 6-8. Uranium levels in the Femme Osage Slough declined from the 2002 maximums at all four locations. No new historic total uranium high concentrations were reported for quarry surface water during 2003. Historic annual averages are presented in Figure 6-4.

Table 6-8 2003 Results for Total Uranium (pCi/l) at Weldon Spring Quarry Surface Water Locations

LOCATION	1st Semi-annual	2nd Semi-annual	Average	RECENT 3 YEAR HIGH *
SW-1003	11.9	13.2	12.6	25.5
SW-1004	12.5	12.6	12.6	24.6
SW-1005	8.8	6.8	7.8	21.0
SW-1010	9.4	16.5	13.0	27.5

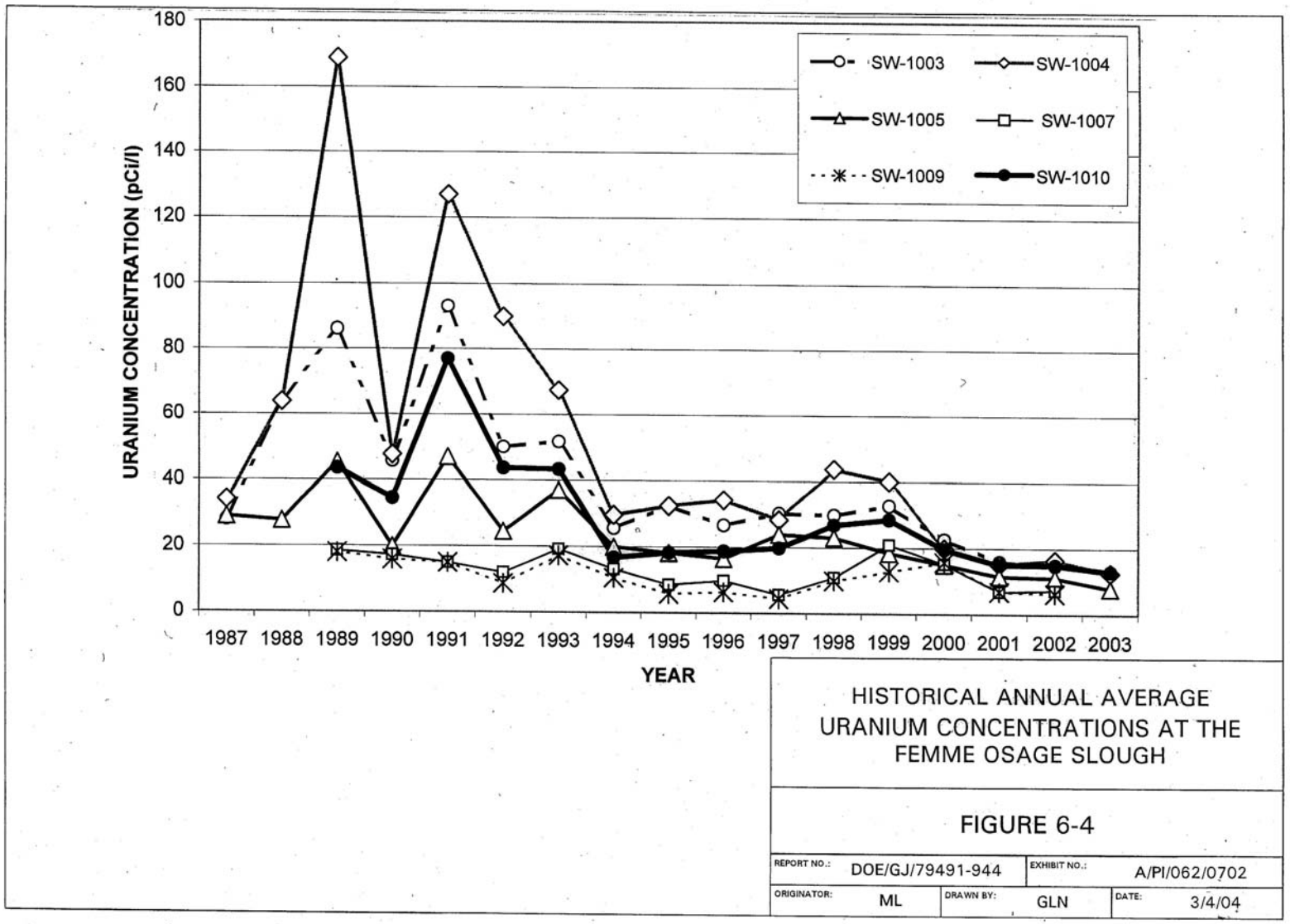
Note 1: 1 pCi/l = 0.037 Bq/l
* 2000-2002



HISTORICAL LAKE AND DOWNSTREAM URANIUM ANNUAL AVERAGES

FIGURE 6-3

REPORT NO.:	DOE/GJ/79491-944	EXHIBIT NO.:	A/PI/006/0702
ORIGINATOR:	ML	DRAWN BY:	GLN
DATE:	3/24/04		


URANIUM CONCENTRATION (pCi/l)
180
160
140
120
100
80
60
40
20
0
SW-1003
SW-1004
SW-1005
SW-1007
SW-1009
SW-1010
1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003
YEAR
HISTORICAL ANNUAL AVERAGE URANIUM CONCENTRATIONS AT THE FEMME OSAGE SLOUGH
FIGURE 6-4
REPORT NO.: DOE/GJ/79491-944
EXHIBIT NO.: A/PI/062/0702
ORIGINATOR: ML
DRAWN BY: GLN
DATE: 3/4/04

7. GROUNDWATER MONITORING

7.1 Highlights of the Groundwater Monitoring Program

The following are highlights of the 2003 groundwater monitoring program. These items, and others, are discussed in detail in this chapter.

- Uranium, nitrate, and TCE concentrations generally remained within historic ranges at all chemical plant groundwater monitoring locations.

- High concentrations of nitroaromatic compounds reported in groundwater monitoring locations in the vicinity of Frog Pond which were initially detected in 1999, continued to be monitored during 2003.

- Volatile organic compounds (VOC) trichloroethene (TCE) and 1,2-dichloroethene (DCE), which were detected in groundwater in 1996 at the chemical plant, continued to be monitored during 2003.

- Groundwater detection monitoring for the disposal cell that was initiated in June 1998, continued in 2003.

- Monitoring results for Burgermeister Spring were within historical ranges. No new highs or lows were recorded, although average annual concentrations of contaminants are decreasing.

- Contaminant levels generally remained within historic ranges at all quarry groundwater monitoring locations.

- Uranium concentrations were within background ranges, and no detectable concentrations of nitroaromatic compounds were observed in groundwater south of the Femme Osage Slough.

7.2 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 chemical plant and raffinate pits site, the quarry site, adjacent properties, and selected springs in the vicinity of the chemical plant site. The groundwater protection program is formally defined in the *Weldon Spring Site Remedial Action Project Groundwater Protection Management Program Plan* (Ref. 12). The groundwater monitoring portion of the program is detailed in the *Environmental Monitoring Plan* (EMP) (Ref. 8).

Due to lithologic differences, including geologic features that influence groundwater flow mechanics, and the geographical separation of the chemical plant and quarry areas, separate

groundwater monitoring programs have been established for the two sites. Generalized geologic and hydrologic descriptions of the two sites are found in Section 1.3. A generalized stratigraphic column for reference is provided in Figure 7-1, and hydrogeologic descriptions of lithologies monitored for the program are in Sections 7.4 and 7.5.

7.3 Referenced Standards

Two references used to develop the criteria for the groundwater monitoring program are: (1) the U.S. Environmental Protection Agency (EPA) *Quality Criteria for Water 1986* (Ref. 32), which is intended to protect public groundwater resources, and (2) the Missouri Drinking Water Standards (Ref. 33). Table 7-1 identifies EPA water quality standards and Missouri Drinking Water Standards for contaminants that are routinely monitored in the groundwater program.

Table 7-1 Referenced Federal and State Water Standards

PARAMETER		LEVEL	REFERENCE STANDARD
Radiochemical	Uranium, total	30 μg/l (20 pCi/l)	Primary MCL: EPA - 40 CFR 141.66[(a)]
Organics	2,4-DNT	0.11 μg/l	Criteria for use: MGWQS - 10 CSR 20-7
	1,3 DNB	1.0 μg/l	Criteria for use: MGWQS-10CSR20-7
	NB	17 μg/l	Criteria for use: MGWQS-10CSR20-7
	2,6-DNT	1.3 μg/l	Criteria for use: Risk based concentration equivalent to 10^{-5} for a resident scenario
	2,4,6-TNT	2.8 μg/l	Criteria for use: Risk based concentration equivalent to 10^{-5} for a resident scenario
	TCE	5 μg/l	Primary MCL: EPA - 40 CFR 141.61
Anions	NO_3(asN)	10 mg/l	Primary MCL: MDWS - 10 CSR 60-4 Primary MCL: EPA - 40 CFR 141.62

(a) EPA promulgated a drinking water MCL of 30 μg/l (20 pCi/l) December 7, 2000. The new regulation, 40 CFR 141.66, took effect December 8, 2003.

EPA U. S. Environmental Protection Agency
MCL Maximum Contaminant Level
MDWS Missouri Drinking Water Standard
MGWQS Missouri Ground Water Quality Standard

SYSTEM	SERIES	STRATIGRAPHIC UNIT	TYPICAL THICKNESS (FT.)(1)	LITHOLOGY	PHYSICAL CHARACTERISTICS	HYDROSTRATIGRAHIC UNIT
QUATERNARY	HOLOCENE	ALLUVIUM	0 – 120		GRAVELLY, SILTY LOAM.	ALLUVIAL AQUIFER
	PLEISTOCENE	LOESS AND GLACIAL DRIFT (2)	10– 60	VARIABLE	SILTY CLAY, GRAVELLY CLAY, SILTY LOAM, OR LOAM OVER RESIDUUM FROM WEATHERED BEDROCK.	(UNSATURATED)(2)
MISSISSIPPIAN	MERAMECIAN	SALEM FORMATION (3)	0 – 15		LIMESTONE, LIMEY DOLOMITE, FINELY TO COARSELY CRYSTALINE, MASSIVELY BEDDED, AND THIN BEDDED SHALE.	
		WARSAW FORMATION (3)	60 – 80		SHALE AND THIN TO MEDIUM BEDDED FINELY CRYSTALINE LIMESTONE WITH INTERBEDDED CHERT.	
	OSAGEAN	BURLINGTON AND KEOKUK LIMESTONES	100 – 200		CHERTY LIMESTONE, VERY FINE TO VERY COARSELY CRYSTALINE, FOSSILIFEROUS, THICKLY BEDDED TO MASSIVE.	SHALLOW AQUIFER SYSTEM
		FERN GLEN LIMESTONE	45 – 70		CHERTY LIMESTONE, DOLOMITIC IN PART, VERY FINE TO VERY COARSELY CRYSTALINE, MEDIUM TO THICKLY BEDDED.	
	KINDERHOOKIAN	CHOUTEAU LIMESTONE	20 – 50		DOLOMITIC, ARGILLACEOUS LIMESTONE; FINELY CRYSTALINE; THIN TO MEDIUM BEDDED.	UPPER LEAKY CONFINING UNIT
DEVONIAN	UPPER	SULPHUR SPRINGS GROUP BUSHBERG SANDSTONE (4)	40 – 55		QUARTZ ARERNITE, FINE TO MEDIUM GRAINED, FRIABLE.	
		LOWER PART OF SULPHUR SPRINGS GROUP UNDIFFERENTIATED			CALCAREOUS SILTSTONE, SANDSTONE, COLITIC LIMESTONE, AND HARD CARBONACEOUS SHALE.	
ORDOVICIAN	CINCINNATIAN	MAQUOKETA SHALE (5)	10 – 30		CALCAREOUS TO DOLOMITIC SILTY SHALE AND MUDSTONE. THINLY LAMINATED TO MASSIVE.	
	CHAMPLAINIAN	KIMMSWICK LIMESTONE	70 – 100		LIMESTONE, COARSELY CRYSTALLINE, MEDIUM TO THICKLY BEDDED, FOSSILIFEROUS AND CHERTY NEAR BASE.	MIDDLE AQUIFER SYSTEM
		DECORAH GROUP	30 – 60		SHALE WITH THIN INTERBEDS OF VERY FINELY CRYSTALINE LIMESTONE.	LOWER CONFINING UNIT
		PLATTIN LIMESTONE	100 – 130		DOLOMITIC LIMESTONE, VERY FINELY CRYSTALLINE, FOSSILIFEROUS, THINLY BEDDED.	
		JOACHIM DOLOMITE	80 – 105		INTERBEDDED VERY FINELY CRYSTALLINE, THINLY BEDDED DOLOMITE; LIMESTONE; AND SHALE. SANDY AT BASE.	
		ST. PETER SANDSTONE	120 – 150		QUARTZ ARENITE, FINE TO MEDIUM GRAINED, MASSIVE.	DEEP AQUIFER SYSTEM
	CANADIAN	POWELL DOLOMITE	50 – 60		SANDY DOLOMITE, MEDIUM TO FINELY CRYSTALINE, MINOR CHERT AND SHALE.	
		COTTER DOLOMITE	200 – 250		ARGILLACEOUS, CHERTY DOLOMITE; FINE TO MEDIUM CRYSTALINE. INTERBEDDED WITH SHALE.	
		JEFFERSON CITY DOLOMITE	160 – 180		DOLOMITE, FINE TO MEDIUM CRYSTALINE.	
		ROUBIDOUX FORMATION	150 – 170		DOLOMITIC SANDSTONE.	
		GASCONADE DOLOMITE	250		CHERTY DOLOMITE AND ARENACEOUS DOLOMITE (GUNTER MEMBER).	
CAMBRIAN	UPPER	EMINENCE DOLOMITE	200		DOLOMITE, MEDIUM TO COARSELY CRYSTALLINE, MEDIUM BEDDED TO MASSIVE.	
		POTOSI DOLOMITE	100		DOLOMITE, FINE TO MEDIUM CRYSTALLINE, THICKLY BEDDED TO MASSIVE. DRUSY QUARTZ COMMON.	

(1) THICKNESS DATA SOURCES VARY. QUATERNARY UNIT THICKNESS BASED ON ON-SITE DRILLING AND TRENCHING. BURLINGTON AND KEOKUK THROUGH JOACHIM DOLOMITE BASED ON USGS WELLS MW-GS02 AND GS05. ST. PETER SANDSTONE AND BELOW FROM KLEESCHULTE AND EMMETT (REF 3). WARSAW AND SALEM FORMATIONS FROM MISSOURI DNR-DGLS GEOLOGIC MAP OFM-89-252-GI.

(2) GLACIAL DRIFT UNIT SATURATED IN NORTHERN PORTION OF ORDNANCE WORKS WHERE THIS UNIT BEHAVES LOCALLY AS A LEAKY CONFINING UNIT. (GEOLOGIC LOG)

(3) THE WARSAW AND SALEM FORMATIONS ARE CONSIDERED TO BE ABSENT FROM THE WELDON SPRING AREA DUE TO EROSION.

(4) THE SULPHUR SPRINGS GROUP ALSO INCLUDES THE BACHELOR SANDSTONE AND THE GLEN PARK LIMESTONE-MISSOURI DIVISION OF GEOLOGY AND LAND SURVEY.

(5) THE MAQUOKETA SHALE IS NOT PRESENT IN THE WELDON SPRING AREA BASED ON GEOLOGIC LOGS.

GENERALIZED STRATIGRAPHY AND HYDROSTRATIGRAPHY OF THE WELDON SPRING AREA

FIGURE 7-1

REPORT NO.	EXHIBIT NO.	
DOE/GJ/79491-944	A/PI/047/0391	
ORIGINATOR: ML	DRAWN BY: GLN	DATE: 3/4/04

Groundwater is also monitored under the requirements of Department of Energy Order 5400.5, *Radiation Protection of the Public and the Environment*, which designates derived concentration guidelines (DCGs) for ingestion of water equivalent to 100 mrem (1.0 mSv) effective dose equivalent, based on the consumption of 730 liters/year (193 gal/year) (Table 7-2). As specified in Department of Energy Order 5400.5, liquid effluent from U.S. Department of Energy (DOE) activities may not cause private or public drinking waters to exceed the radiological limit of an effective dose equivalent greater than 4 mrem (0.04 mSv/year) per year or 4% of the DCG.

Table 7-2 Derived Concentration Guidelines for Discharge Waters

PARAMETER	DERIVED CONCENTRATION GUIDELINE
Natural Uranium	600 pCi/l
Ra-226	100 pCi/l
Ra-228	100 pCi/l
Th-230	300 pCi/l
Th-232	50 pCi/l

Note: 1 pCi/l = 0.037 Bq/l.

7.4 Weldon Spring Chemical Plant

Since remediation activities began in 1987, more than 100 monitoring locations have been used for groundwater observations and sampling. Each year, wells are installed and/or abandoned as necessary to support the changing needs of the project. During 2003, no wells were installed or abandoned. A total of 68 wells and 5 springs were routinely sampled to monitor the groundwater impacts of historical chemical plant operations, recent remedial activities, and ongoing field studies.

7.4.1 Hydrogeologic Description

The chemical plant site is in a physiographic transitional area between the Dissected Till Plains of the central lowlands province to the north and the Salem Plateau of the Ozark Plateaus province to the south. The chemical plant and raffinate pit area lithologies consist of two major geologic units; unconsolidated surficial material and carbonate bedrock. The unconsolidated surficial materials are clay-rich, mostly glacially derived units, which are generally unsaturated. Thicknesses range from 6.1 m to 15.3 m (20 ft to 50 ft) (Ref. 2).

The site is on a groundwater divide from which groundwater flows north toward Dardenne Creek and then ultimately to the Mississippi River, or south to the Missouri River. Regional groundwater flow for St. Charles County is toward the east. Localized flow is controlled largely by topographic highs and streams, and drainages. Groundwater movement is generally by diffuse flow with localized zones of discrete fracture-controlled flow.

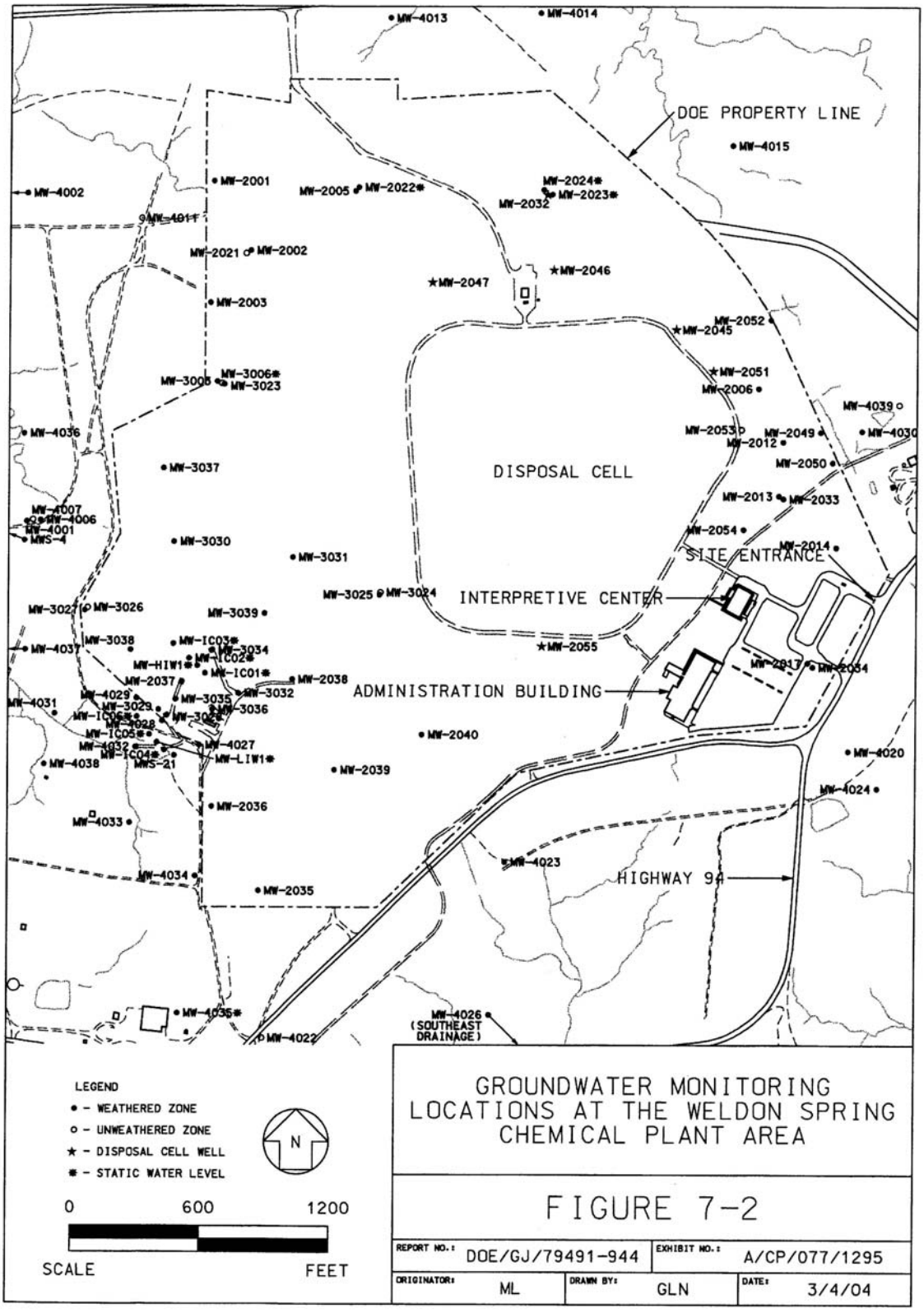
Potential groundwater impacts are assessed by monitoring groundwater from the monitoring well network at the site. The aquifer of concern beneath the chemical plant, raffinate pits, and vicinity properties is the shallow bedrock aquifer comprised of Mississippian-age Burlington-Keokuk Limestone (the uppermost bedrock unit). The Burlington-Keokuk Limestone is composed of two different lithologic zones, a shallow weathered zone underlaid by an unweathered zone. The weathered portion of this formation is highly fractured and exhibits solution voids and enlarged fractures. These features may also be found on a limited scale in the unweathered zone. The unweathered portion of the Burlington-Keokuk Limestone is thinly to massively bedded. Fracture densities are significantly less in the unweathered zone than in the weathered zone. Localized aquifer properties are controlled by fracture spacing, solution voids, and preglacial weathering, including structural troughs along the bedrock-unconsolidated material interface.

All monitoring wells are completed in the Burlington-Keokuk Limestone. Some wells that are screened in the unweathered zone of the Burlington-Keokuk Limestone are used to assess the vertical migration of contaminants. Most of the wells are completed in the weathered unit of the bedrock where groundwater has the greatest potential to be contaminated. Where possible, monitoring wells within the boundaries of the chemical plant area are located near potential contaminant sources to assess migration into the groundwater system. Additional wells are located outside the chemical plant boundary to detect and evaluate potential off-site migration of contaminants (Figure 7-2).

Upgradient-downgradient water quality comparisons are not practical for the chemical plant site because it is situated on the regional groundwater divide. Site-specific background levels established in the Groundwater Operable Unit (GWOU) *Remedial Investigation* are used as reference levels in lieu of these comparisons (Ref. 30).

Springs, a common feature in carbonate terrains, are present in the vicinity of the site. Four springs are monitored routinely as part of the EMP (Ref. 8). These springs, which are shown on Figure 7-3, have been historically influenced by chemical plant discharge water and/or groundwater that contained one or more of the contaminants of concern.

The presence of elevated total uranium and nitrate levels at Burgermeister Spring (SP-6301), which is 1.9 km (1.2 mi) north of the site, indicates that discrete flow paths are present in the vicinity of the site. Groundwater tracer tests performed in 1995 (Ref. 30) indicated that a discrete and rapid subsurface hydraulic connection exists between the northern portion of the chemical plant and Burgermeister Spring.


DOE PROPERTY LINE
DISPOSAL CELL
SITE ENTRANCE
INTERPRETIVE CENTER
ADMINISTRATION BUILDING
HIGHWAY 94
MW-4013
MW-4014
MW-4015
MW-4002
MW-2001
MW-2005
MW-2022
MW-2024
MW-2023
MW-2032
MW-4011
MW-2021
MW-2002
MW-2046
MW-2047
MW-2003
MW-2052
MW-2045
MW-2051
MW-3006
MW-3005
MW-3023
MW-2006
MW-4039
MW-4036
MW-2053
MW-2049
MW-4030
MW-2012
MW-3037
MW-2050
MW-2013
MW-2033
MW-4007
MW-4006
MW-4001
MWS-4
MW-2054
MW-3030
MW-3031
MW-2014
MW-3025
MW-3024
MW-3027
MW-3026
MW-3039
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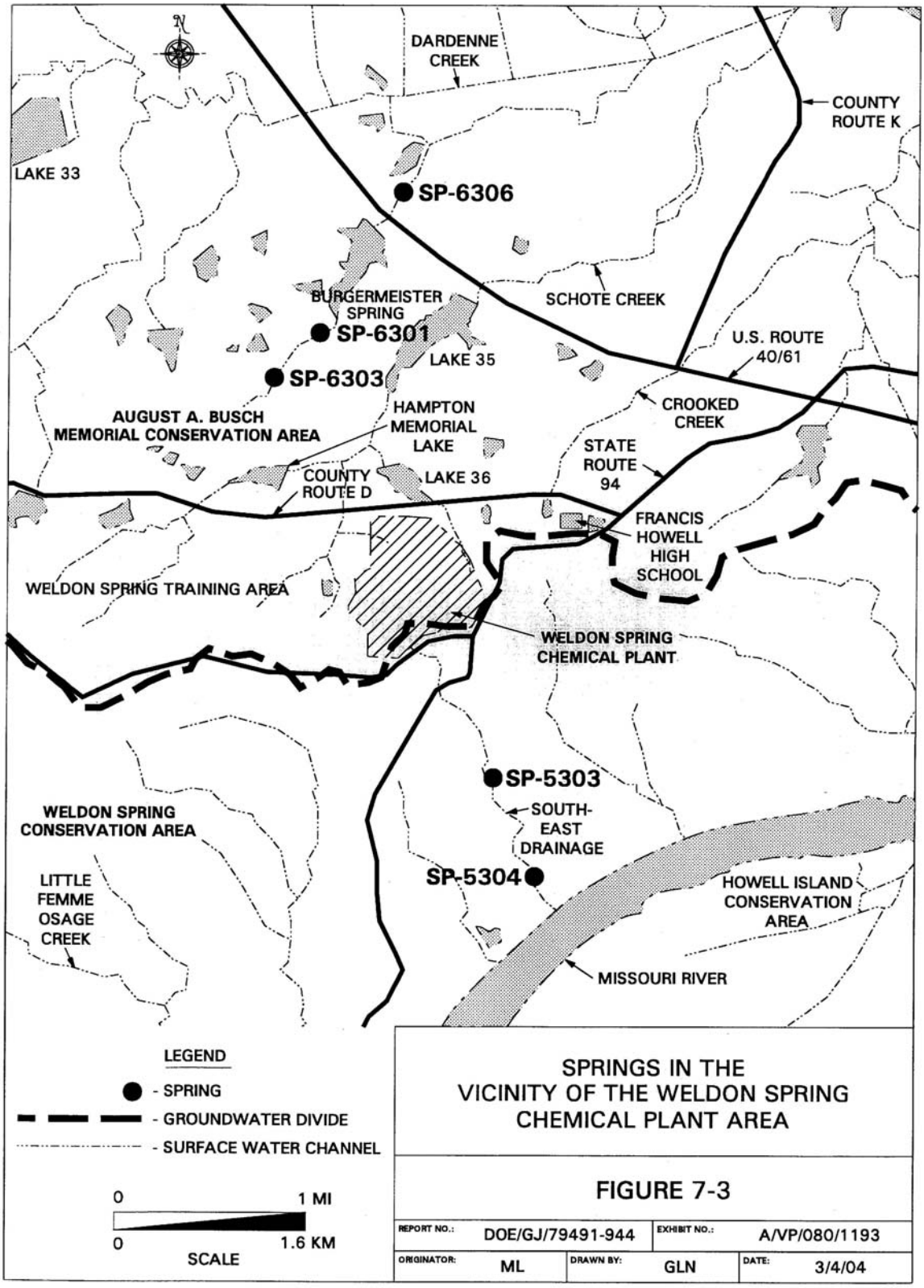
MW-3032
MW-4031
MW-3029
MW-3036
MW-IC06
MW-3028
MW-3024
MW-IC05
MW-2040
MW-4020
MW-4032
MW-IC04
MW-4027
MW-LIW1
MW-4038
MWS-21
MW-2039
MW-4024
MW-2036
MW-4033
MW-4023
MW-4034
MW-2035
MW-4035
MW-4022
MW-4026
(SOUTHEAST DRAINAGE)
LEGEND
● - WEATHERED ZONE
○ - UNWEATHERED ZONE
★ - DISPOSAL CELL WELL
✱ - STATIC WATER LEVEL
N
0
600
1200
SCALE
FEET
GROUNDWATER MONITORING LOCATIONS AT THE WELDON SPRING CHEMICAL PLANT AREA
FIGURE 7-2
REPORT NO.: DOE/GJ/79491-944
EXHIBIT NO.: A/CP/077/1295
ORIGINATOR: ML
DRAWN BY: GLN
DATE: 3/4/04


N
DARDENNE CREEK
COUNTY ROUTE K
LAKE 33
SP-6306
BURGERMEISTER SPRING
SP-6301
SCHOTE CREEK
U.S. ROUTE 40/61
LAKE 35
SP-6303
AUGUST A. BUSCH MEMORIAL CONSERVATION AREA
HAMPTON MEMORIAL LAKE
CROOKED CREEK
STATE ROUTE 94
COUNTY ROUTE D
LAKE 36
FRANCIS HOWELL HIGH SCHOOL
WELDON SPRING TRAINING AREA
WELDON SPRING CHEMICAL PLANT
SP-5303
SOUTH-EAST DRAINAGE
WELDON SPRING CONSERVATION AREA
SP-5304
LITTLE FEMME OSAGE CREEK
HOWELL ISLAND CONSERVATION AREA
MISSOURI RIVER
LEGEND
- SPRING
- GROUNDWATER DIVIDE
- SURFACE WATER CHANNEL
0 1 MI
0 1.6 KM
SCALE
SPRINGS IN THE VICINITY OF THE WELDON SPRING CHEMICAL PLANT AREA
FIGURE 7-3
REPORT NO.: DOE/GJ/79491-944
EXHIBIT NO.: A/VP/080/1193
ORIGINATOR: ML
DRAWN BY: GLN
DATE: 3/4/04

7.4.2 Monitoring Program

The 2003 groundwater monitoring program at the former chemical plant and raffinate pits area focused on monitoring known contaminants and assessing any groundwater impacts or improvements which may have resulted from remedial action (e.g., soil excavation and sludge removal) at the site. A summary of monitoring locations and parameters may be found in the *Environmental Monitoring Plan* (Ref. 8). The EMP includes provisions for initiation of special environmental studies if evidence or conditions arise that warrant investigation beyond the scope of the EMP sampling schedule.

Total uranium, nitroaromatic compounds, VOCs, and nitrate were monitored at selected locations throughout the chemical plant area. The frequency and type of sampling performed at each location were based on recent concentrations of contaminants in the groundwater at each location and on the likelihood of changes in contaminant concentrations due to remedial activities. Analytical results for all monitored parameters are summarized and discussed in Section 7.4.3.

Prior to construction of the chemical plant, the site was part of a Department of the Army Ordnance Works complex for production of the nitroaromatic compounds trinitrotoluene (TNT) and dinitrotoluene (DNT). The first four nitroaromatic production lines were located within the boundaries of the former chemical plant and raffinate pits area. Wastes generated from the initial operation of these early production lines were disposed of in open earthen pits which released contaminated seepage to groundwater. One such pit, Lagoon 1, was located along the northeast boundary of the chemical plant. Wastewater containing nitroaromatic compounds was initially discharged to surface drainages and then later transported through wooden pipe networks. Groundwater in the former areas known as Frog Pond, Ash Pond, and Raffinate Pit 4, was sampled for nitroaromatic compounds in 2003. These 3 areas coincide with the location of former TNT production lines.

Groundwater in the vicinity of the former raffinate pits has been impacted with elevated nitrate and uranium. The pits contained ore-refining wastes from uranium ore concentrates that were digested with nitric acid during the original chemical plant operations. During 2003, groundwater samples from selected locations near the former raffinate pits were analyzed for nitrate and total uranium.

Trichloroethene (TCE) was detected in groundwater southeast of the former Raffinate Pit 4 during 1996. VOC monitoring was conducted quarterly at selected wells during 2003 to monitor trends in the area of TCE impact, and evaluate the effect of remediation activities on VOC contamination levels.

Groundwater in the vicinity of the former Ash Pond has been impacted with elevated nitrate, as well as some uranium. Since remedial activities may have mobilized more of these

contaminants into the groundwater, wells in this area were monitored quarterly or semiannually for nitrate, uranium, and nitroaromatics.

Groundwater moves under the chemical plant by both diffuse and discrete flow components. In order to monitor the discrete flow component, five springs were monitored during 2003 for total uranium, nitrate, nitroaromatic compounds, and VOCs. The springs were sampled during high- and base-flow conditions to monitor the potential impacts from surface water runoff in the vicinity of the chemical plant.

7.4.3 Chemical Plant Monitoring Results

7.4.3.1 Groundwater Monitoring Wells

Analytical data for contaminants monitored during 2003 (e.g., uranium, nitrate, volatile organic compounds, and nitroaromatics) are summarized and compared with background levels and/or water quality standards. Comparisons to drinking water standards are for reference purposes only, and are not intended to imply that groundwater from WSSRAP monitoring wells must be in compliance with drinking water standards. Average annual concentrations are compared to background levels established during the GWOU remedial investigation (Ref. 30).

Uranium. Total uranium, which is measured at 60 monitoring wells, continues to be present in the groundwater near the former raffinate pits. In 2003, groundwater from 36 monitoring well locations exceeded the average background level of 0.93 pCi/l (0.03 Bq/l) established during the GWOU remedial investigation (Ref. 30). Only 2 wells exceeded the groundwater standard of 30 µg/l (20 pCi/l) (40 CFR 141). Average uranium concentrations are shown in Table 7-3.

Nitrate. In 2003, nitrate was monitored at 54 monitoring wells in the chemical plant area. Average nitrate concentrations exceeded the Missouri drinking water primary MCL (10 mg/l) at 38 of those locations (see Table 7-4).

Table 7-3 Annual Averages for Total Uranium at the Weldon Spring Chemical Plant

LOCATION	AVERAGE (pCi/l)	NUMBER OF SAMPLES
MW-2001	0.7	1
MW-2002	0.53	1
MW-2003	3.45	2
MW-2005	0.74	1
MW-2017	6.16	2
MW-2021	0.36	1
MW-2032	2.54	2
MW-2034	2.78	2
MW-2035	0.45	1
MW-2036	0.75	1
MW-2037	0.58	1
MW-2038	2.10	2
MW-2039	3.46	2
MW-2040	2.54	2
MW-2046	0.95	2
MW-2047	1.19	2
MW-2051	0.75	2
MW-2055	14.1	4
MW-3003	1.49	2
MW-3006	1.49	2
MW-3023	9.33	4
MW-3024*	30.35	4
MW-3025	2.54	2
MW-3026	1.10	1
MW-3027	0.95	1
MW-3028	0.95	1
MW-3029	0.81	1
MW-3030*	53.05	4
MW-3031	2.58	2
MW-3032	0.32	1
MW-3034	2.07	2
MW-3035	1.02	1
MW-3036	1.42	1
MW-3037	2.91	1
MW-3038	0.95	1
MW-3039	1.26	2
MW-4001	0.41	2
MW-4002	0.48	1
MW-4006	0.3	1
MW-4007	1.59	2
MW-4011	0.52	1
MW-4013	1.90	1
MW-4014	0.04	1
MW-4020	9.40	2
MW-4022	4.27	1
MW-4023	2.20	2
MW-4024	3.96	2
MW-4026	0.04	1
MW-4027	0.6	1

Table 7−3 Annual Averages for Total Uranium at the Weldon Spring Chemical Plant (Continued)

LOCATION	AVERAGE (pCi/l)	NUMBER OF SAMPLES
MW-4028	0.81	1
MW-4029	0.7	1
MW-4031	0.6	2
MW-4032	0.81	1
MW-4033	0.75	1
MW-4034	0.52	1
MW-4036	18.8 [3]	5
MW-4037	11.9	1
MW-4038	2.17	1
MWS-4	0.37	1
MWS-21	1.15	1

* Average Concentration exceeds the groundwater standard of 30 µg/l (20 pCi/l).
Note 1: Background uranium concentration equals 0.93 pCi/l.
Note 2: 1 pCi/l = 0.037 Bq/l.
Note 3: Anomalous data point of 84.6 pCi/l reported. Resample of location reported at 2.4 pCi/l with annual average of 2.33 pCi/l.

Table 7-4 Annual Nitrate Averages at the Weldon Spring Chemical Plant

LOCATION	AVERAGE (mg/l)	NUMBERS OF SAMPLES
MW-2001*	140.5	2
MW-2002*	205.5	2
MW-2003*	406.5	2
MW-2005*	141.5	2
MW-2021*	818	1
MW-2032	3.6	2
MW-2035	0.48	1
MW-2036	2.05	2
MW-2037*	69.9	2
MW-2038*	523.3	3
MW-2039*	80.8	2
MW-2040*	147.5	2
MW-2046	2.09	2
MW-2047*	69.6	2
MW-2051	1.44	2
MW-2055	0.96	2
MW-3003*	404	2
MW-3006	0.007	2
MW-3023*	197.5	2
MW-3024*	287	2
MW-3025*	366	2
MW-3026*	99.5	2
MW-3027*	47.2	2
MW-3028*	212	2
MW-3029*	344	2
MW-3030*	305	2
MW-3031*	86.6	2
MW-3032	2.06	2
MW-3034*	569	2

Table 7-4 Annual Nitrate Averages at the Weldon Spring Chemical Plant (Continued)

LOCATION	AVERAGE (mg/l)	NUMBERS OF SAMPLES
MW-3035*	200.5	2
MW-3036*	46.5	2
MW-3037*	298.5	2
MW-3038	5.35	2
MW-3039*	776.5	2
MW-4001*	63.9	2
MW-4002	0.79	1
MW-4006*	10.2	2
MW-4007	0.04	2
MW-4011*	97.6	2
MW-4013*	111.3	2
MW-4014	5.91	2
MW-4026	0.02	1
MW-4027*	12.8	2
MW-4028*	152.5	2
MW-4029*	494.5	2
MW-4031*	190	2
MW-4032*	152.5	2
MW-4033	6.17	2
MW-4034	0.09	1
MW-4036*	33.2	2
MW-4037*	92.4	2
MW-4038*	406.5	2
MWS-4	4.11	2
MWS-21*	124	2

* Exceed the Missouri Drinking Water Standard for nitrate of 10 mg/l.

Nitroaromatic Compounds. Nitroaromatic compounds, which are not naturally occurring, were detected in 48 monitoring wells (Table 7-5). New historic highs were reported during 2003 at several wells in the vicinity of Frog Pond, most notably at MW-2012. Levels of nitroaromatics have increased at this well since 1997, most likely as a result of remedial activities by the DOE and Army in this area. Additional wells were installed in the vicinity of Frog Pond in 2000 and 2001 to further define the extent of contamination in this area; however, MW-2012 continues to demonstrate the highest concentrations of nitroaromatic compounds. The Missouri Water Quality Standard (MWQS) for 2,4-DNT of 0.11 µg/l was equaled or exceeded at 25 locations at the chemical plant and the MWQS for 1,3-DNB of 1.0 µg/l was exceeded at one location. The risk-based concentration of 2.8 µg/l for 2,4,6-TNT was exceeded at three locations and the risk-based concentration of 1.3 µg/l for 2,6-DNT was exceeded at ten locations. The MWQS for nitrobenzene of 17µg/l was not exceeded at any location. (see Table 7-5).

Fourteen monitoring locations in the Frog Pond area were also selected to monitor for the following breakdown products: 2-AM-4,6-DNT; 4-AM-2,6-DNT; 2-NT; 3-NT; and 4-NT. The breakdown product data was evaluated to try to determine whether the contaminants were originating from the area of Production Line #1 or from the area of Army Lagoon #1. Nitroaromatic contaminants at Army Lagoon #1 would have different breakdown products

associated with that source than Production Line #1 due to photodegradation processes. Wells downgradient from both of these previously remediated areas showed contamination consistent with both, although the higher concentrations at MW-2012 continue to point toward the area of Production Line #1 as the primary contributor to groundwater contamination. Results are presented in Table 7-6. The highest concentrations continue to be observed in MW-2012.

Table 7-5 Annual Averages for Nitroaromatic Compounds (μg/l) at the Weldon Spring Chemical Plant

LOCATION	1,3,5-TNB	1,3-DNB	2,4,6-TNT	2,4-DNT	2,6-DNT	NB
MW-2001	0.23	<0.05	<0.08	0.06	<0.10	<0.08
MW-2002	<0.04	0.06	<0.08	<0.06	0.29	<0.08
MW-2003	<0.04	<0.05	<0.08	0.13 *	0.74	<0.08
MW-2005	0.39	0.16	<0.08	<0.06	0.21	<0.08
MW-2006	6.60	<0.05	0.64	0.05	0.98	<0.08
MW-2012	322	3.98 *	268 *	1540 *	1220 *	<0.08
MW-2013	6.65	<0.05	1.07	0.18 *	1.80 *	<0.08
MW-2014	2.93	0.06	<0.08	0.19 *	0.63	<0.08
MW-2021	<0.08	<0.05	<0.08	0.07	<0.13	<0.08
MW-2032	<0.08	<0.05	<0.08	<0.06	<0.13	<0.08
MW-2033	6.60	<0.05	1.03	0.84 *	3.40 *	<0.08
MW-2035	<0.08	<0.05	<0.08	<0.06	<0.13	<0.08
MW-2036	<0.08	<0.05	<0.08	1.1 *	0.49	<0.08
MW-2037	<0.08	<0.05	<0.08	0.15 *	<0.13	<0.08
MW-2038	<0.08	<0.09	<0.08	0.31 *	0.09	<0.08
MW-2039	<0.08	<0.05	<0.08	<0.06	<0.13	<0.08
MW-2040	<0.08	<0.05	<0.08	<0.06	<0.13	<0.08
MW-2045	0.06	0.06	0.06	0.07	0.68	<0.08
MW-2046	2.85	<0.05	4.9 *	<0.06	1.9 *	<0.08
MW-2047	<0.08	<0.05	<0.08	0.12 *	0.29	<0.08
MW-2049	0.20	<0.05	0.59	0.41 *	47.5 *	<0.08
MW-2050	7.70	0.21	0.12	38.25 *	18.75 *	<0.08
MW-2051	0.32	<0.05	0.22	0.09	0.63	<0.08
MW-2052	3.15	<0.05	0.54	0.07	0.28	<0.08
MW-2053	6.9	0.08	7.83 *	<0.06	3.68 *	<0.08
MW-2054	0.32	0.05	<0.08	5.88 *	19.30 *	<0.08
MW-2055	<0.08	<0.05	<0.08	<0.06	<0.13	<0.08
MW-3003	<0.08	<0.05	<0.08	0.18 *	0.34	<0.08
MW-3006	<0.08	<0.05	<0.08	<0.06	<0.13	<0.08
MW-3023	<0.08	<0.05	<0.08	0.09	0.95	<0.08
MW-3024	<0.04	<0.05	<0.08	<0.06	<0.1	<0.08
MW-3025	<0.04	<0.05	<0.08	<0.06	<0.1	<0.08
MW-3026	0.30	<0.05	<0.08	0.08	0.12	<0.08
MW-3027	0.19	<0.05	<0.08	<0.06	<0.1	<0.08
MW-3028	0.21	0.08	<0.08	0.19 *	0.13	<0.08
MW-3029	0.48	0.13	<0.08	0.45 *	0.11	<0.08
MW-3030	<0.08	<0.05	<0.08	1.18 *	0.58	<0.08
MW-3032	<0.08	<0.05	<0.08	<0.06	<0.13	<0.08
MW-3034	0.17	0.10	<0.08	0.36 *	0.18	<0.08
MW-3035	<0.08	0.09	<0.08	0.17 *	0.11	<0.08
MW-3036	<0.08	<0.05	<0.08	0.05	<0.13	<0.08
MW-3037	<0.08	<0.05	<0.08	<0.06	<0.13	<0.08
MW-3038	0.08	<0.05	<0.08	<0.06	<0.13	<0.08

Table 7-5 Annual Averages for Nitroaromatic Compounds (μg/l) at the Weldon Spring Chemical Plant (Continued)

LOCATION	1,3,5-TNB	1,3-DNB	2,4,6-TNT	2,4-DNT	2,6-DNT	NB
MW-3039	0.40	0.09	<0.08	1.13 *	0.17	<0.08
MW-4001	40	<0.05	2.60	<0.06	2.25 *	<0.08
MW-4006	18.5	<0.05	<0.08	<0.06	2.95 *	<0.08
MW-4007	<0.08	<0.05	<0.08	0.16 *	0.15	<0.08
MW-4013	28	<0.05	<0.08	0.30 *	0.79	<0.08
MW-4014	0.13	<0.05	<0.08	0.06	<0.13	<0.08
MW-4015	3.65	<0.05	<0.08	0.19 *	0.89	<0.08
MW-4026	<0.04	<0.05	<0.08	<0.06	<0.1	<0.08
MW-4027	<0.08	0.07	<0.08	0.07	<0.13	<0.08
MW-4028	<0.08	0.05	<0.08	0.13 *	0.17	<0.08
MW-4029	1.35	0.14	<0.08	0.90 *	0.49	<0.08
MW-4030	5.58	0.04	1.78	0.08	0.57	<0.08
MW-4031	3.55	<0.05	0.84	0.12 *	0.30	<0.08
MW-4032	1.75	0.09	<0.08	0.09	0.12	<0.08
MW-4033	<0.04	<0.05	<0.08	<0.06	<0.10	<0.08
MW-4036	0.63	0.04	0.16	<0.06	0.62	<0.08
MW-4039	<0.08	<0.05	<0.08	<0.06	<0.13	<0.08
MWS-21	<0.08	0.06	<0.08	0.05	<0.13	<0.08

< All samples less than the highest detection limit.
* Exceed the referenced standards identified in Table 7-1

Table 7-6 Annual Averages for Nitroaromatic Breakdown Compounds (μg/l)

Location	2-AM-4,6-DNT	4-AM-2,6-DNT	2-NT	3-NT	4-NT
MW-2006	1.58	1.3	0.29	<0.07	<0.05
MW-2012	15.2	9.3	2020	144	417.8
MW-2013	1.45	1.52	0.32	<0.07	<0.05
MW-2014	0.41	0.64	0.22	<0.07	<0.05
MW-2033	1.43	1.7	2.30	0.22	0.11
MW-2045	0.66	0.64	<0.11	<0.07	<0.05
MW-2049	1.5	2.2	9.25	0.70	0.05
MW-2050	2.95	2.9	20.75	1.52	5.95
MW-2052	2.03	0.91	0.38	<0.07	0.12
MW-2053	3.33	2.4	0.12	0.07	<0.05
MW-2054	0.21	0.27	5.93	0.45	0.16
MW-4015	2.35	2.75	0.28	<0.07	<0.05
MW-4030	1.31	1.36	0.25	0.06	<0.05
MW-4039	<0.05	<0.07	<0.11	<0.07	<0.05

Volatile Organic Compounds. VOC monitoring continued through 2003 to monitor the extent of contamination and changes in concentration that may have resulted from remedial activities and groundwater field studies. Nineteen wells demonstrated detectable levels of at least one VOC. The analytical results for 1,2-DCE, PCE, TCE or vinyl chloride are summarized in Table 7-7. Eighteen of these wells exceeded the MCL of 5 μg/l for TCE.

Table 7-7 Annual Average VOC Concentrations at the Weldon Spring Chemical Plant

LOCATION	1,2-DCE (µg/l)	PCE (µg/l)	TCE (µg/l)	Vinyl Chloride (µg/l)	Number of Samples
MW-2013	4	<2	<2	<2	1
MW-2036	<2	<2	<2	<2	2
MW-2037*	2.6	<2	117	<2	4
MW-2038*	<2	<2	19.1	<2	3
MW-2039	<2	<2	<2	<2	1
MW-3003	<2	<2	<2	<2	2
MW-3006	<1	<1	<1	<1	1
MW-3023	<2	<2	<2	<2	2
MW-3024	<2	<2	7	<2	2
MW-3025	<2	<2	6	<2	2
MW-3026	<1	<1	<1	<1	1
MW-3027	<1	<1	<1	<1	1
MW-3028*	<2	<2	14.1	<2	4
MW-3029*	5.9	<2	243.8	<2	4
MW-3030*	26.4	<2	415.3	<2	3
MW-3031	<2	<2	<2	<2	1
MW-3032	<2	<2	<2	<2	2
MW-3034*	8	<2	298.8	<2	2
MW-3035*	2.5	<2	152.3	<2	4
MW-3036*	<2	<2	5.7	<2	2
MW-3037	<2	<2	<2	<2	1
MW-3038	<1	<1	<1	<1	1
MW-3039*	11.8	<2	189.3	<2	4
MW-4001*	<2	<2	7.5	<2	2
MW-4006	<2	<2	<2	<2	1
MW-4007	<2	<2	<2	<2	2
MW-4027	<2	<2	<2	<2	2
MW-4028*	<2	<2	<2	<2	4
MW-4029*	9.6	<2	558.3	<2	4
MW-4031*	<2	<2	136.5	<2	2
MW-4032*	<2	<2	55.5	<2	4
MW-4033	<2	<2	<2	<2	2
MW-4036	<2	<2	<2	<2	2
MW-4037*	<2	<2	31.2	<2	2
MW-4038*	<2	<2	21.7	<2	2
MWS-4	<2	<2	<2	<2	1
MWS-21*	<2	<2	60.3	<2	4

<DL All samples less than highest detection limit.

* Concentration exceeds the Missouri water quality standard of 5 µg/l for TCE.

7.4.3.2 Springs

Burgermeister Spring (SP-6301) is a perennial spring that represents a primary localized emergence of groundwater impacted by a recognizable contribution of contaminants from the chemical plant throughout the year. The highest contaminant concentrations occur during base flow stages. During high flow conditions, surface water recharge along the stream segments mixes with contaminated groundwater from the site, and the concentrations are effectively

lowered. This is a deviation from previous years for uranium and may indicate that residual contaminated sediment is being depleted. This spring (SP-6301) was monitored during both high and base stages.

Annual average concentrations for nitrate, uranium, and nitroaromatic compounds are presented in Table 7-8. Compared to concentrations reported for Burgermeister Spring in 2002, these concentrations were in the same general range, with uranium being slightly lower during base flow and slightly higher during high flow. Of the nitroaromatic compounds analyzed, only 2,4-DNT and 2,6-DNT were reported above detection limits. No VOCs were reported above detection limits at this spring.

Table 7-8 2003 Monitoring Data for Burgermeister Spring

PARAMETER	HIGH FLOW			LOW (BASE) FLOW		
	MIN	MAX	AVG	MIN	MAX	AVG
Nitrate (mg/l)	0.83	1.03	0.93	2.15	8.64	4.29
U-total (pCi/l)	10.06	10.06	10.06	17.9	62.5	37
2,4-DNT (µg/l)	<0.06	<0.06	N/A	<0.06	0.08	0.04
2,6-DNT (µg/l)	<0.13	<0.13	N/A	<0.13	0.16	0.10

< All samples less than the highest detection limit.

Four other springs, two of which are located in the Southeast Drainage (SP-5303 and SP-5304) and 2 located in the Burgermeister Spring Branch (SP-6303 and SP-6306), were monitored during 2003 to assess contaminated springwater at possible exposure points. Spring water in the Southeast Drainage is impacted by residual contamination deposited in the fractures in the bedrock. The source of this residual material was historical process sewer discharges from the chemical plant site and wastewater discharges from the former ordnance works. These locations were sampled during base flow for VOCs, uranium, and nitroaromatic compounds, and at high flow for uranium and nitroaromatic compounds. Annual average concentrations of parameters for which detection limits were exceeded are presented in Table 7-9. No VOCs were reported above detection limits at any of the springs.

Table 7-9 2003 Annual Average Monitoring Data for Springs

PARAMETER	HIGH FLOW				LOW (BASE) FLOW			
	SP-5303	SP-5304	SP-6303	SP-6306	SP-5303	SP-5304	SP-6303	SP-6306
Nitrate (mg/l)	0.31	0.91	2.59	0.04	0.33	0.54	2.51	0.01
U-total (pCi/l)	45.9	30.4	1.02	1.17	72.9	69.1	1.2	0.3
1,3,5-TNB (µg/l)	<0.08	<0.08	<0.08	NS	0.24	<0.08	<0.08	NS
1,3-DNB (µg/l)	<0.05	<0.05	<0.05	NS	0.04	<0.05	<0.05	NS
2,4,6-TNT (µg/l)	5.9	0.08	<0.08	NS	75.3	0.11	<0.08	NS
2,4-DNT (µg/l)	<0.06	<0.06	<0.06	NS	<0.06	0.05	0.04	NS
2,6-DNT (µg/l)	<0.13	<0.13	0.16	NS	0.38	<0.13	<0.13	NS

< All samples less than the highest detection limit.

7.4.4 Trend Analysis

Statistical tests for time-dependent trends at the Weldon Spring quarry and chemical plant were performed on historical and current data from select groundwater wells. Trending was performed on total uranium and 2,4-dinitrotuluene for the quarry area. Trending was performed on total uranium, nitrate, trichloroethene, and nitroaromatic compounds data for the chemical plant area. Trend analyses were performed at monitoring locations based on historical data or knowledge of the local groundwater system near the chemical plant and quarry areas.

The computer program TREND, developed at Pacific Northwest Laboratory, was used to perform the formal groundwater trend testing. The trend method employed was the nonparametric Mann-Kendall test. Results of the TREND analyses indicate the potential presence of statistically-significant trends and their direction upward or downward. The trend testing output data are to be interpreted as screening indicators based on existing cumulative data. Results of the analyses are not intended to be used for the prediction of future concentrations, but they may be used to indicate areas that should be more closely monitored in the future.

7.4.4.1 Statistical Methods

The TREND program was selected because it can easily facilitate missing data and does not require the data to conform to a particular distribution (such as a normal or lognormal distribution). The nonparametric method used in this program is valid for scenarios where there are a high number of non-detect data points. Data reported as trace concentrations or less than the detection limit can be used by assigning them a common value that is smaller than the smallest measured value in the data set (i.e., one-half the specified quantitation limit). This approach is valid since only the relative magnitudes of the data, rather than their measured values, are used in the method. The TREND program has been used in past analyses of the site groundwater data. Thus, use of the TREND program offered the advantage of maintaining continuity in the analysis methodology.

The two-tailed version of the Mann-Kendall test was employed to detect either an upward or downward trend for each data set. In this approach, a test statistic, Z, is calculated. A positive value of Z indicates that the data are skewed in an upward direction, and a negative value of Z indicates that the data are skewed in a downward direction. The alpha value (or error limit) used to identify a significant trend was 0.05. In the two-tailed test at the 0.05 alpha level of significance, the null hypothesis of "no trend" was rejected if the absolute value of the Z statistic was greater than Z_1-$\alpha/_2$, where Z_1-$\alpha/_2$ was obtained from a cumulative normal distribution table. In other words, the absolute value of the TREND output statistic, Z was compared to the table $Z_{.975}$ value of 1.96. If the absolute value of the Z output statistic was greater than 1.96, then a significant trend was reported.

The linear slope, which is calculated independently of the trend was estimated for all data sets in which an upward or downward trend was identified. The slope was estimated using a

nonparametric procedure included in the computer code for the TREND program. A 100% (1-α) two-sided confidence interval about the true slope was obtained by the nonparametric technique. The direction and magnitude of the slope, along with the upper and lower 95% confidence limit estimates, are included in the summary tables.

One-half the specified quantitation limit (on the date of analysis) was used in the trend analysis for all data reported as below the detection limit. The purpose of using one-half the quantitation limit for non-detect data was to minimize the potential bias of the data. However, a consequence of this approach may be that, in some instances, the results may have been impacted by quantitation limits changing over time. The affect of varying quantitation limits is more likely to impact the trending analysis in instances where a large number of non-detect data are present within a given time series. The summary tables include the total number of data observations and the total number of non-detect data points for each data set so that this factor may be considered.

In several cases, multiple samples (duplicates or replicates) were collected for the same location for the same time period. In these cases, all the sample data for each location for a specific date were averaged and the average value was used for that time period in the trend analysis. This approach was selected such that the multiple duplicate or replicate data did not bias the trend analyses for the 2000 to 2003 period.

In order to maintain sufficient power of the statistical tests, the analyses were limited to data sets with three or more data points. Therefore, if fewer than three detected concentrations were present in a given time series for a contaminant, the data set was not analyzed. These data sets are designated with a (a) in the summary tables.

7.4.4.2 Chemical Plant Trend Results

Selected wells from the chemical plant and nearby springs were trended for uranium, nitrate, nitroaromatic compounds, or TCE. The cumulative results for the time period 2000 through 2003 were evaluated using the TREND program and are summarized below.

Nitrate

Thirteen monitoring well locations at the chemical plant and Burgermeister Spring, at both high flow and low flow, were selected for nitrate trend analyses. The well locations consisted of weathered bedrock wells where nitrate is the primary contaminant of concern.

Nitrate trends for 2000-2003 data are stationary at eight locations, downward at six locations, and upward at one location as shown in Table 7-10. Three of the trend directions changed from last year's analyses. The trend direction for SP-6301-L changed from a stationary to a downward trend. The trend direction changed from a downward to a stationary trend for locations MW-2038 and MW-3024. Ten of the 15 locations were not trended for nitrate in last year's analyses, thus no comparison to past trend results can be made.

Table 7-10 Chemical Plant Groundwater Wells Nitrate Trend Analysis Summary For 2000-2003

Well ID	Location	No. of Samples 2000-2003	No. of Non-Detect Data 2000-2003	Trend Direction (Alpha = 0.05) 2000-2003	Slope (mg/l/yr) 2000-2003	95% Upper & Lower Confidence Intervals On Slope (mg/l/yr) 2000-2003	2003 New High Concentration (mg/l) 2000 to Date
MW-2037	Weathered bedrock, west of disposal cell	28	0	D	-81.750	-139.229, -29.858	No
MW-2038	Weathered bedrock, west of disposal cell	45	0	S	-55.000	-137.066, 36.520	No
MW-3003	Weathered bedrock, west of disposal cell	27	0	S	20.500	-19.680, 54.420	No
MW-3024	Weathered bedrock, west of disposal cell	13	0	S	-49.000	-104.227, 3.089	No
MW-3034[1]	Weathered bedrock, southwest of disposal cell	38	0	D	-115.000	-195.207, -48.000	No
MW-3036[1]	Weathered bedrock, southwest of disposal cell	38	0	D	-29.350	-52.883, -9.300	No
MW-3037[1,3]	Weathered bedrock, west of disposal cell	3	0	S	73.500	N to small, N to small	316
MW-3039	Weathered bedrock, west of disposal cell	6	0	U	145.000	87.472, 204.523	785
MW-4007	Weathered bedrock, west of site	9	0	S	-0.036	-0.146, 0.208	No
MW-4013[1,2]	Weathered bedrock, north of site	3	0	S	44.200	N to small, N to small	136
MW-4029	Weathered bedrock, southwest of site	44	0	S	1.000	-38.785, 40.570	No
MW-4036[1,3]	Weathered bedrock, west of site	3	0	S	-7.875	N to small, N to small	No
MWS-4	Weathered bedrock, southwest of disposal cell	10	0	D	-1.143	-2.010, -0.427	No

Table 7-10 Chemical Plant Groundwater Wells Nitrate Trend Analysis Summary For 2000 to 2003 (Continued)

Well ID	Location	No. of Samples 2000-2003	No. of Non-Detect Data 2000-2003	Trend Direction (Alpha = 0.05) 2000-2003	Slope (mg/l/yr) 2000-2003	95% Upper & Lower Confidence Intervals on Slope (mg/l/yr) 2000-2003	2003 New High Concentration (mg/l) 2000 to Date
SP-6301-H	Burgermeister Spring High Flow	14	0	D	-2.045	-5.500, -0.740	No
SP-6301-L	Burgermeister Spring Low Flow	32	0	D	-1.620	-3.100, -0.288	No

D = Downward
S = Stationary
U = Upward

[1]Data from 2000 are not available for wells MW-3034, MW-3036, MW-3037, MW-3039, MW-4013, MW-4036.
[2]Data from 2001 are not available for well MW-4013.
[3]Data from 2002 are not available for wells MW-3037 and MW-4036.

Three of the 15 locations that were evaluated for the 2000-2003 time frame have a reported concentration in 2003 that exceed all past 2000, 2001, and 2002 data for their respective sampling locations. These nitrate levels are 316 mg/l at MW-3037, 785 mg/l at MW-3039, and 136 mg/l at MW-4013. Each of these locations is downgradient of the areas of highest nitrate impact and it is expected that some upward trends will be observed due to dispersion of the plume as it attenuates over time.

Nitroaromatic Compounds

Nineteen locations near the chemical plant were selected for trend analyses of nitroaromatic compounds. These 19 locations are all weathered bedrock wells. Because there were no 2003 data for MW-3031 and MWS4, trending was not performed at these two locations. The following five locations were included in both this and last year's scope of work: MW-2012, MW-2014, MW-2032, MW-2050, and MW-4015.

The results of the nitroaromatic compound analyses for the monitoring wells near the chemical plant are presented in Table 7-11. Each of these locations were trended for the following nitroaromatic compounds: 2,4-DNT, 2,6-dinitrotoluene (2,6-DNT), 1,3,5-trinitrobenzene (1,3,5-TNB), and 2,4,6-trinitrotoluene (2,4,6-TNT). A total of 44 trend analyses were performed on the nitroaromatic compounds at the 17 groundwater monitoring well locations.

Trending was not performed at well locations MW-2032, MW-3037, and MW-4014 because fewer than three detected concentrations were reported for the time period between 2000 and 2003 for each of the four nitroaromatic compounds. For the same reason, trending for 2,4-DNT was not conducted at MW-4013 and MW-4036; 1,3,5-TNB was not conducted at MW-2003; and 2,4,6-TNT was not conducted at MW-2003, MW-2014, MW-2054, MW-3029, MW-3036, MW-4013, MW-4015, MW-4029, and MW-4036.

Eight locations have upward trends indicated for at least one nitroaromatic compound. Most of these locations are in the Frog Pond area where increases in nitroaromatic compounds have been investigated for some time. Two locations in the Raffinate Pits area have shown upward trends and may be showing rebound from previous remedial activities. Three locations, MW-2012, MW-2050, and MW-2051, have upward trends indicated for all four of the nitroaromatic compounds. This is consistent with last year's analyses for MW-2012 and MW-2050 with one exception. Trending was not performed last year for 2,4,6-TNT at well location MW-2050 because fewer than three detected concentration were reported for the time period between 1999 and 2002. A change in trend direction from last year's analyses from stationary to upward was identified in 2,6-DNT for well location MW-2014. All other upward trends as presented in Table 7-11 were from well locations which were not included in last year's scope of work, thus no comparison to past trend results can be made.

Table 7-11 Chemical Plant Groundwater Nitroaromatics Trend Analysis Summary for 2000 to 2003

Well ID	Location	Compound	No. of Samples 2000-2003	No. of Non-Detect Data 2000-2003	Trend Direction (Alpha = 0.05) 2000-2003	Slope (µg/l/yr) 2000-2003	95% Upper & Lower Confidence Intervals on Slope (µg/l/yr) 2000-2003	2003 New High Concentration (µg/l) 2000 to Date
MW-2003	Weathered bedrock – West of Former Ash Pond	2,4-DNT	11	1	S	-0.036	-0.082, 0.000	No
		2,6-DNT	11	1	S	-0.330	-0.475, -0.067	No
		1,3,5-TNB	11	11	(a)	(a)	(a)	No
		2,4,6-TNT	11	11	(a)	(a)	(a)	No
MW-2012	Weathered bedrock - Former frog pond	2,4-DNT	22	0	U	325	275.000, 414.647	1,800
		2,6-DNT	22	0	U	215	174.113, 276.915	No
		1,3,5-TNB	22	0	U	88.667	73.994, 110.000	350
		2,4,6-TNT	22	0	U	36.667	20.000, 50.000	310
MW-2014	Weathered bedrock - Southeast of disposal cell	2,4-DNT	19	1	S	0.010	-0.010, 0.030	0.34
		2,6-DNT	19	1	U	0.110	0.044, 0.155	0.73
		1,3,5-TNB	19	0	S	0.200	-0.259, 0.600	No
		2,4,6-TNT	19	18	(a)	(a)	(a)	No
MW-2032	Weathered bedrock - North of disposal cell	2,4-DNT	8	7	(a)	(a)	(a)	No
		2,6-DNT	8	7	(a)	(a)	(a)	No
		1,3,5-TNB	8	8	(a)	(a)	(a)	No
		2,4,6-TNT	8	7	(a)	(a)	(a)	No
MW-2050	Weathered bedrock - Former frog pond area	2,4-DNT	18	0	U	14.350	8.612, 19.637	47
		2,6-DNT	18	0	U	5.500	2.517, 8.765	26
		1,3,5-TNB	18	1	U	2.500	1.885, 3.190	11
		2,4,6-TNT	18	15	U	0.012	0.000, 0.025	No
MW-2051[2]	Weathered bedrock- Northeast of disposal cell	2,4-DNT	9	6	U	0.032	0.010, 0.055	0.10
		2,6-DNT	9	0	U	0.273	0.098, 0.336	0.65
		1,3,5-TNB	9	4	U	0.117	0.025, 0.275	0.39
		2,4,6-TNT	9	2	U	0.076	0.041, 0.110	0.22
MW-2052[2,3]	Weathered bedrock- Northeast of disposal cell	2,4-DNT	11	3	S	-0.015	-0.090, 0.016	No
		2,6-DNT	11	3	S	0.050	-0.135, 0.270	0.39
		1,3,5-TNB	11	0	S	0.450	-0.266, 0.833	No
		2,4,6-TNT	11	0	S	0.080	-0.043, 0.220	0.65

Table 7-11 Chemical Plant Groundwater Nitroaromatics Trend Analysis Summary for 2000 to 2003 (Continued)

Well ID	Location	Compound	No. of Samples 2000-2003	No. of Non-Detect Data 2000-2003	Trend Direction (Alpha = 0.05) 2000-2003	Slope (µg/l/yr) 2000-2003	95% Upper & Lower Confidence Intervals on Slope (µg/l/yr) 2000-2003	2003 New High Concentration (µg/l) 2000 to Date
MW-2053[2,3]	Weathered bedrock-Northeast of disposal cell	2,4-DNT	11	6	S	-0.170	-0.190, 0.000	No
		2,6-DNT	11	1	S	-0.600	-2.823, 3.073	No
		1,3,5-TNB	11	0	S	-0.950	-2.082, 0.800	No
		2,4,6-TNT	11	1	S	1.000	-0.974, 3.068	No
MW-2054[2,3]	Weathered bedrock-East of disposal cell	2,4-DNT	11	1	S	3.326	-1.364, 9.911	13
		2,6-DNT	11	3	U	12.950	4.773, 27.320	32
		1,3,5-TNB	11	3	S	0.160	0.075, 0.440	0.48
		2,4,6-TNT	11	11	(a)	(a)	(a)	No
MW-3029[2]	Weathered bedrock-Southwest of Disposal Cell	2,4-DNT	40	6	S	0.001	-0.057, 0.024	1.40
		2,6-DNT	39	27	U	0.020	0.010, 0.020	0.18
		1,3,5-TNB	39	0	S	-0.027	-0.127, 0.058	No
		2,4,6-TNT	39	39	(a)	(a)	(a)	No
MW-3036[2]	Weathered bedrock-Southwest of disposal cell	2,4-DNT	39	6	S	-0.020	-0.067, 0.007	No
		2,6-DNT	39	32	U	0.017	0.010, 0.020	No
		1,3,5-TNB	39	8	D	-0.040	-0.065, -0.010	No
		2,4,6-TNT	39	39	(a)	(a)	(a)	No
MW-3037[2,4]	Weathered bedrock-West of disposal cell	2,4-DNT	2	2	(a)	(a)	(a)	0.03[5]
		2,6-DNT	2	2	(a)	(a)	(a)	0.06[5]
		1,3,5-TNB	2	2	(a)	(a)	(a)	0.04[5]
		2,4,6-TNT	2	2	(a)	(a)	(a)	0.04[5]
MW-4013[2,3]	Weathered bedrock-North of site	2,4-DNT	3	1	(a)	(a)	(a)	0.33
		2,6-DNT	3	0	S	0.210	N to small, N to small	0.80
		1,3,5-TNB	3	0	S	9.000	N to small, N to small	28.00
		2,4,6-TNT	3	3	(a)	(a)	(a)	0.04[5]
MW-4014[2,3]	Weathered bedrock-North of site	2,4-DNT	3	2	(a)	(a)	(a)	0.09
		2,6-DNT	3	3	(a)	(a)	(a)	0.06[5]
		1,3,5-TNB	3	2	(a)	(a)	(a)	0.22
		2,4,6-TNT	3	3	(a)	(a)	(a)	0.04[5]

Table 7-11 Chemical Plant Groundwater Nitroaromatics Trend Analysis Summary for 2000 to 2003 (Continued)

Well ID	Location	Compound	No. of Samples 2000-2003	No. of Non-Detect Data 2000-2003	Trend Direction (Alpha = 0.05) 2000-2003	Slope (µg/l/yr) 2000-2003	95% Upper & Lower Confidence Intervals on Slope (µg/l/yr) 2000-2003	2003 New High Concentration (µg/l) 2000 to Date
MW-4015	Weathered bedrock - North of chemical plant	2,4-DNT	11	3	S	0.009	0.000, 0.053	0.47
		2,6-DNT	11	0	S	0.095	-0.031, 0.199	1.10
		1,3,5-TNB	11	0	S	-0.183	-1.204, 0.903	No
		2,4,6-TNT	11	10	(a)	(a)	(a)	No
MW-4029	Weathered bedrock- Southwest of Site	2,4-DNT	43	2	S	0.036	-0.010, 0.173	1.10
		2,6-DNT	42	3	U	0.105	0.050, 0.150	0.54
		1,3,5-TNB	42	0	U	0.270	0.180, 0.330	1.50
		2,4,6-TNT	42	40	(a)	(a)	(a)	No
MW-4036[2,4]	Weathered bedrock - West of site	2,4-DNT	3	2	(a)	(a)	(a)	No
		2,6-DNT	3	0	S	0.065	N to small, N to small	0.69
		1,3,5-TNB	3	0	S	0.237	N to small, N to small	0.70
		2,4,6-TNT	3	1	(a)	(a)	(a)	0.18

S = Stationary
U = Upward
D = Downward

2,4 DNT 2,4-Dinitrotoluene
2,6 DNT 2,6-Dinitrotoluene
2,4,6 TNT 2,4,6-Trinitrotoluene
1,3,5 TNB 1,3,5-Trinitrobenzene

(a) Fewer than three detected concentrations were reported for the time period; therefore, no trending was performed.

[1]Trending was not performed on wells MW-3031 and MWS4 because there were no data for 2003.
[2]Data from 2000 are not available for wells MW-2051, MW-2052, MW-2053, MW-2054, MW-3029, MW-3036, MW-3037, MW-4013, MW-4014, and MW-4036
[3]Data from 2001 are not available for wells MW-2052, MW-2053, MW-2054, MW-4013 and MW-4014.
[4]Data from 2002 are not available for wells MW-3037 and MW-4036.
[5]The value listed is computed from one-half the detection limit. Due to a change in quantitation limits from year to year, this computed value is higher than any previous detected concentration

One downward trend was identified for 1,3,5-TNB at well location MW-3036. This well location was not included in last year's scope of work, thus no comparison to past trend results can be made.

All other results of the trend analyses indicate stationary trends. Most of these results are from well locations which were not included in last year's scope of work. However, the trend directions are consistent with last year's analyses of 2,4-DNT and 1,3,5-TNB at well location MW-2014 and also from 2,4-DNT, 2,6-DNT, and 1,3,5-TNB from well location MW-4015.

As shown in Table 7-11, thirteen of the well locations have reported concentrations in 2003 that exceed all past 2000, 2001, and 2002 data for at least one nitroaromatic compound for its respective sampling location. However, several of these "new high" concentrations, found at the well locations MW-3037, MW-4013, and MW-4014, are actually values computed from half the detection limit. Due to a change in detection limits from year to year, the computed value is higher than any previously detected (or computed) concentration.

Uranium

Six monitoring well locations at the chemical plant and two springs, at both high flow and low flow, were selected for trend analyses for uranium. The well locations consisted of 5 weathered bedrock wells and 1 overburden well where uranium is a contaminant of concern. Burgermeister spring (SP-6301) and a spring located in the SE Drainage (SP-5304), were the springs chosen for trending.

Total uranium trends for 2000-2003 data were stationary for six of these locations as shown in Table 7-12. This is consistent with last year's analyses for locations MW-3003, MW-3030, SP-5304-L, and SP-6301-H. This is a change in trend direction for SP-6301-L which previously indicated a downward trend. The well location MW-4036 was not included in last year's analyses.

Trending was not performed at MW-4026 and MWS4 because fewer than three detected concentrations were reported for the time period between 2000 and 2003. These two wells were not included in last year's analyses.

The other two locations, SP-5304-H and MW-3024, have downward trends. This is consistent with last year's analyses of SP-5304-H. This is a change in direction for MW-3024 which indicated a stationary trend in last year's analysis**.**

As shown in Table 7-12, MW-4036 has a reported concentration of 84.60 pCi/l in 2003 that exceeds all past 2000, 2001, and 2002 data for that location. This value was considered suspect since previous and subsequent sampling have shown similar values of 2 pCi/l.

Table 7-12 Chemical Plant Groundwater Uranium Trend Analysis Summary for 2000-2003

Well ID	Location	No. of Samples 2000-2003	No. of Non-Detect Data 2000-2003	Trend Direction (Alpha = 0.05) 2000-2003	Slope (pCi/l/yr) 2000-2003	95% Upper & Lower Confidence Intervals On Slope (pCi/l/yr) 2000-2003	2003 New High Concentration (pCi/l) 2000 to Date
MW-3003	Weathered bedrock, west of disposal cell	26	0	S	-0.400	-0.800, -0.050	No
MW-3024	Unweathered bedrock, south of disposal cell	15	0	D	-8.067	-15.200, -2.413	No
MW-3030[1]	Weathered bedrock, west of disposal cell	27	0	S	0.200	-0.800, 1.139	No
MW-4026	Alluvium – SE Drainage	5	5	(a)	(a)	(a)	No
MW-4036[1,2]	Weathered bedrock-West of Raffinate Pits	5	0	S	-6.382	N to small, N to small	84.60
MWS4	Weathered bedrock- West of Raffinate Pits	6	4	(a)	(a)	(a)	No
SP-5304H[1]	Southeast drainage spring – high flow	13	0	D	-25.450	-46.646, -12.225	No
SP-5304L[1]	Southeast drainage spring – low flow	19	0	S	-8.525	-17.387, 3.015	No
SP-6301H	Burgermeister spring – high flow	15	0	S	-2.950	-7.400, 0.898	No
SP-6301L	Burgermeister spring – low flow	32	0	S	-4.200	-9.514, 2.643	No

D = Downward
S = Stationary

(a) Fewer than three detected concentrations were reported for the time period; therefore, no trending was performed.

[1]Data from 2000 are not available for wells MW-3030, MW-4036, SP-5304H and SP-5304L.
[2]Data from 2002 are not available for MW-4036.

TCE

Ten locations at the chemical plant were selected for trend analyses of TCE data. The well locations consisted of nine bedrock wells in the vicinity of the former Raffinate Pits where TCE is a primary contaminant of concern.

Trichloroethene trends for 2000-2003 data are stationary at one location, downward at three locations, and upward at one location as shown in Table 7-13. The downward trend identified at MW-2038 and the upward trend identified at MW-3030 remain unchanged from last year's analyses. The downward trend at location MW-4029 is a change from last year's stationary direction. Location MW-3030 is located downgradient of the areas of higher contamination and some upward trends are expected due to dispersion.

Trending was not performed at the following five locations: MW-3031, MW-3037, MW-4007, MW-4036, and MWS-4. Fewer than three detected concentrations were reported for the time period between 2000 and 2003 at these locations.

As shown in Table 7-13, MW-3030 has a reported concentration of 451 µg/l in 2003 that exceeds all past 2000, 2001, and 2002 data. This location is downgradient of the area of highest TCE impact and it is expected that some temporary upward trends will be observed due to dispersion of the plume as it attenuates over time.

Table 7-13 Chemical Plant Groundwater TCE Trend Analysis Summary for 2000-2003

Well ID	Location	No. of Samples 2000-2003	No. of Non-Detect Data 2000-2003	Trend Direction (Alpha = 0.5) 2000-2003	Slope (µg/l/yr) 2000-2003	95% Upper & Lower Confidence Intervals on Slope (µg/l/yr) 2000-2003	2003 New High Concentration (µg/l) 2000 to Date
MW-2038	Weathered bedrock, south of disposal cell	45	0	D	-9.000	-13.942, -6.000	No
MW-3030[1]	Weathered bedrock, west of disposal cell	26	0	U	84.500	60.000, 108.000	451
MW-3031[1]	Weathered bedrock, West of disposal cell	16	16	(a)	(a)	(a)	No
MW-3034[1]	Weathered bedrock, Southwest of disposal cell	40	5	D	-193.500	-419.500, -101.500	No
MW-3036[1]	Weathered bedrock, Southwest of disposal cell	38	2	S	-2.500	-5.100, 0.500	No
MW-3037[1]	Weathered bedrock, West of disposal cell	4	4	(a)	(a)	(a)	No
MW-4007	Unweathered bedrock, west of site	10	10	(a)	(a)	(a)	No
MW-4029	Weathered bedrock, west of site	47	0	D	-40.000	-74.477, -5.784	No
MW-4036[1]	Weathered bedrock, west of site	5	5	(a)	(a)	(a)	No
MWS-4	Weathered bedrock, Southwest of disposal cell	12	12	(a)	(a)	(a)	No

D = Downward
S = Stationary
U = Upward

(a) Fewer than three detected concentrations were reported for the time period; therefore, no trending was performed.

[1]Data from 2000 are not available for wells MW-3030, MW-3031, MW-3034, MW-3036, MW-3037 and MW-4036.

7.5 Weldon Spring Quarry

7.5.1 Hydrogeologic Description

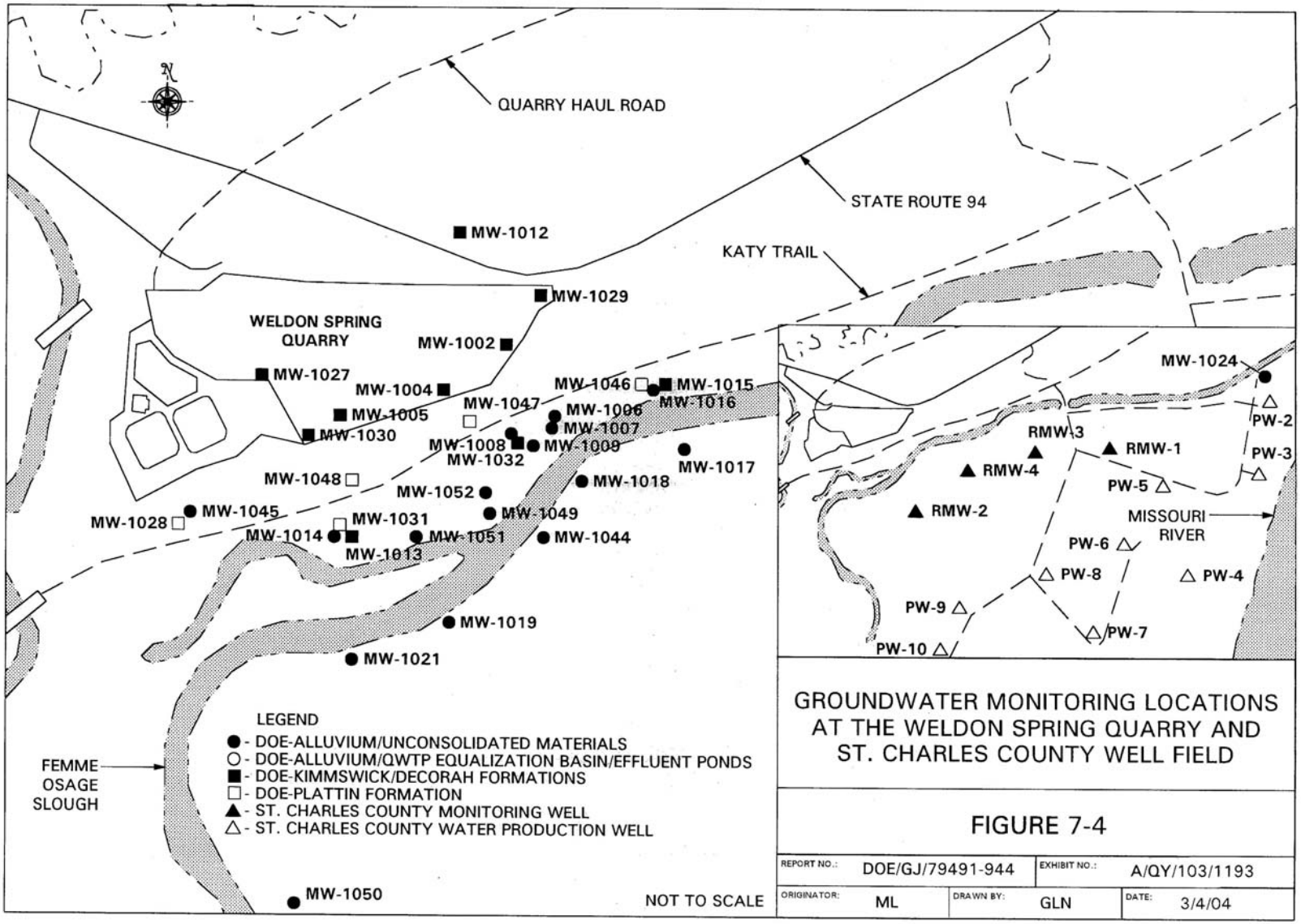
The geology of the quarry area is separated into three units; upland overburden, Missouri River alluvium, and bedrock. The unconsolidated upland material overlying bedrock consists of up to 9.2 m (30 ft) of silty clay soil and loess deposits and is not saturated (Ref. 1). Three Ordovician-age formations comprise the bedrock: the Kimmswick Limestone, the limestone and shale of the Decorah Group, and the Plattin Limestone. The alluvium along the Missouri River consists of clays, silts, sands, and gravels 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 Ordovician bedrock bluff (Kimmswick, Decorah, and Plattin formations), which also composes the rim wall of the quarry. The bedrock unit underlying the alluvial materials north of the Femme Osage Slough is the Decorah Group. Primary sediments between the bluff and the Femme Osage Slough are intermixed and interlayered clays, silts, and sands. Organic materials are intermixed throughout the sediments.

The uppermost groundwater flow systems at the quarry are composed of alluvial and bedrock aquifers. The alluvial aquifer is predominantly controlled by recharge from the Missouri River, and the bedrock aquifer is chiefly recharged by precipitation and overland runoff.

At the quarry, 15 monitoring wells are screened within either the Kimmswick-Decorah (upper unit) or Plattin Formations (lower unit) to monitor contaminants near the quarry within the bedrock (Figure 7-4). Ten of the 15 monitoring wells were installed to monitor contaminants within the Kimmswick-Decorah Formations comprising and surrounding the quarry. The remaining five monitoring wells are located south of the quarry within the Plattin Limestone to assess vertical contaminant migration.

There are 15 monitoring wells completed into the alluvium near the quarry and the Missouri River. Those north of the Femme Osage Slough monitor contaminant migration south of the quarry, while those south of the slough monitor for possible migration of contaminants toward the well field.

The St. Charles County monitoring wells, the RMW series wells, were designed to provide an early warning of contaminant migration toward the county production well field. The county production wells were monitored to verify the quality of the municipal well field water supply.


N
QUARRY HAUL ROAD
STATE ROUTE 94
KATY TRAIL
MW-1012
MW-1029
WELDON SPRING QUARRY
MW-1002
MW-1027
MW-1004
MW-1046
MW-1015
MW-1016
MW-1005
MW-1047
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MW-1007
MW-1030
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MW-1014
MW-1051
MW-1044
MW-1013
MW-1019
MW-1021
FEMME OSAGE SLOUGH
LEGEND
● - DOE-ALLUVIUM/UNCONSOLIDATED MATERIALS
○ - DOE-ALLUVIUM/QWTP EQUALIZATION BASIN/EFFLUENT PONDS
■ - DOE-KIMMSWICK/DECORAH FORMATIONS
□ - DOE-PLATTIN FORMATION
▲ - ST. CHARLES COUNTY MONITORING WELL
△ - ST. CHARLES COUNTY WATER PRODUCTION WELL
MW-1050
NOT TO SCALE
MW-1024
PW-2
RMW-3
RMW-1
PW-3
RMW-4
PW-5
RMW-2
MISSOURI RIVER
PW-6
PW-8
PW-4
PW-9
PW-7
PW-10
GROUNDWATER MONITORING LOCATIONS AT THE WELDON SPRING QUARRY AND ST. CHARLES COUNTY WELL FIELD
FIGURE 7-4
REPORT NO.: DOE/GJ/79491-944
EXHIBIT NO.: A/QY/103/1193
ORIGINATOR: ML
DRAWN BY: GLN
DATE: 3/4/04

Eight groundwater monitoring wells once located in the Darst Bottom area approximately 1.6 km (1 mi) southwest of the St. Charles County well field were utilized to study the upgradient characteristics of the Missouri River alluvium in the vicinity of the quarry. These wells provided a reference for background values in the well field area and have been sampled by both the USGS (1992) and the DOE (1994). These wells have since been abandoned. A summary of background values used at the quarry is provided in Table 7-14 (Ref. 35).

Table 7-14 Average Background Values for Quarry Monitoring Locations

PARAMETER	ALLUVIUM [a]	KIMMSWICK/DECORAH[b]	PLATTIN [c]
Total Uranium (pCi/l)	2.77	3.41	12.30
Nitroaromatics (μg/l)	NA	NA	NA
Sulfate (mg/l)	44.20	95.90	165.00
Iron (μg/l)	8,405	1,177	9,272

(a) Darst Bottom Wells (USGS and DOE)
(b) MW-1034 and MW-1043 (DOE)
(c) MW-1042 (DOE)
NA Not analyzed.

7.5.2 Monitoring Program

Monitoring at the quarry was conducted in accordance with the *Remedial Design/Remedial Action Work Plan for the Quarry Residuals Operable Unit* (Ref. 13). Two separate programs were employed in 2002 to monitor groundwater near the quarry. The first program involved sampling the Department of Energy wells in the quarry area to continue monitoring the effects of quarry dewatering and bulk waste removal on groundwater quality. These activities began in mid-1993 and were completed in late-1995.

The frequency of sampling for each location was based on the distance of the well from the source or migration pathway. Monitoring wells on the quarry rim were sampled quarterly for total uranium, due to the changes in concentrations over time, to establish the trend in concentrations at these locations, and to monitor the effects of quarry dewatering and bulk waste removal activities on the groundwater system. All quarry locations were sampled at least annually for uranium, nitroaromatic compounds, and sulfate.

The second program monitors the St. Charles County well field. The St. Charles County RMW-series monitoring wells, were sampled annually for selected parameters.

7.5.3 Weldon Spring Quarry Monitoring Results

7.5.3.1 Quarry

Uranium. The uranium values continue to indicate that the highest levels occur in the bedrock downgradient from the quarry and in the alluvial material north of the Femme Osage Slough. The 2003 annual averages for total uranium are summarized in Table 7-15. Sixteen

locations exceeded background. No locations south of the Femme Osage Slough exceeded background.

Table 7-15 Annual Groundwater Averages for Total Uranium at the Weldon Spring Quarry

LOCATION	AVERAGE (pCi/l)	NUMBER OF SAMPLES
MW-1002[1]	3.98	4
MW-1004[1]	971.65*	4
MW-1005[1]	980.95*	4
MW-1006[2]	1385*	4
MW-1007[2]	10.03	4
MW-1008[2]	2734*	4
MW-1009[2]	0.65	4
MW-1012[1]	2.52	4
MW-1013[1]	506.5*	4
MW-1014[2]	886.83*	4
MW-1015[1]	136.25*	4
MW-1016[2]	94.95*	4
MW-1017[2]	<0.07	2
MW-1018[2]	0.31	4
MW-1019[2]	<0.07	2
MW-1021[2]	<0.07	2
MW-1027[1]	227.75*	4
MW-1028[3]	1.05	2
MW-1030[1]	9.43	4
MW-1031[3]	11.9	4
MW-1032[1]	1121.25*	4
MW-1044[2]	<0.07	2
MW-1045[2]	2.65	4
MW-1046[3]	2.74	4
MW-1047[3]	1.23	4
MW-1048[3]	374.25*	4
MW-1049[2]	<0.07	4
MW-1050[2]	<0.07	2
MW-1051[2]	418.95*	4
MW-1052[2]	190.63*	4

NOTE: 1 pCi/l = 0.037 Bq/l * Annual average exceeds groundwater standard of 30 µg/l (20 pCi/l).

Note 1: This well is completed in the Kimmswick/Decorah. Compare to the background concentration of 3.41 pCi/l as shown in Table 7-14.

Note 2: This well is completed in the alluvium. Compare to the background concentration of 2.77 pCi/l as shown in Table 7-14.

Note 3: This well is completed in the Plattin. Compare to the background concentration of 12.30 pCi/l as shown in Table 7-14.

The groundwater standard of 30 µg/l (20 pCi/l) (40 CFR 141) was exceeded at thirteen locations. All of these monitoring wells are located north of the Femme Osage Slough and have no direct impact on the drinking water sources in the Missouri River alluvium. The standard, while used as a reference level, is not applicable to groundwater north of the slough because this area is not considered a usable groundwater source. Locations exceeding background remained the same as those reported for 2002.

The attainment objective for the long-term monitoring for the groundwater north of the slough is that the 90th percentile of the data within a monitoring year is below the target level of 300 pCi/l for uranium (Ref. 13). Based on the 2003 data, the 90th percentile of the data is 1,110 pCi/l. This is a slight decrease from 2002, when the 90th percentile of the uranium data was 1,144 pCi/l. Uranium monitoring will continue in 2004.

Nitroaromatic Compounds. In 2003, samples from quarry monitoring wells were analyzed for nitroaromatic compounds. The monitoring wells, which have historically been impacted with nitroaromatics, are situated in the alluvial materials or bedrock downgradient of the quarry and north of the Femme Osage Slough. Results were similar to those reported in 2002. No detectable concentrations were observed south of the Femme Osage Slough. A summary of the annual averages for all locations is provided in Table 7-16. The 2,4-DNT average concentration for location MW-1027 remained above the Missouri Water Quality Standard of 0.11 µg/l during 2003. Background comparisons are not discussed since nitroaromatics are not naturally occurring compounds.

Table 7-16 Annual Groundwater Averages for Nitroaromatic Compounds (µg/l) at the Weldon Spring Quarry

LOCATION	2,4,6-TNT	1,3-DNB	1,3,5-TNB	2,4-DNT	2,6-DNT	NB	NUMBER OF SAMPLES
MW-1002	1.19	<0.09	2.12	<0.06	1.75	<0.08	4
MW-1004	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4
MW-1005	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4
MW-1006	0.12	<0.09	0.19	<0.06	0.13	<0.08	4
MW-1007	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4
MW-1008	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4
MW-1009	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4
MW-1012	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4
MW-1013	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4
MW-1014	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4
MW-1015	0.36	0.05	0.43	<0.06	<0.13	<0.08	4
MW-1016	0.06	<0.09	0.05	<0.06	<0.13	<0.08	4
MW-1017	<0.08	<0.05	<0.08	<0.06	<0.13	<0.08	2
MW-1018	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4
MW-1019	<0.08	<0.05	<0.08	<0.06	<0.13	<0.08	2
MW-1021	<0.08	<0.05	<0.08	<0.06	<0.13	<0.08	2
MW-1027	0.34	<0.09	<0.08	5.19*	2.48	<0.08	4
MW-1028	<0.08	<0.05	<0.08	<0.06	<0.13	<0.08	2
MW-1030	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	3
MW-1031	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4
MW-1032	<0.08	<0.09	<0.08	0.06	<0.13	<0.08	4
MW-1044	<0.08	<0.05	<0.08	<0.06	<0.13	<0.08	2
MW-1045	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4
MW-1046	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4
MW-1047	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4
MW-1048	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4
MW-1049	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4

Table 7-16 Annual Groundwater Averages for Nitroaromatic Compounds (μg/l) at the Weldon Spring Quarry (Continued)

LOCATION	2,4,6-TNT	1,3-DNB	1,3,5-TNB	2,4-DNT	2,6-DNT	NB	NUMBER OF SAMPLES
MW-1050	<0.08	<0.05	<0.08	<0.06	<0.13	<0.08	2
MW-1051	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4
MW-1052	<0.08	<0.09	<0.08	<0.06	<0.13	<0.08	4

< All samples less than highest detection limit.

* Exceeds the Missouri Water Quality Standard of 0.11 μg/l for 2,4-DNT.

The attainment objective for the long-term monitoring for the groundwater north of the slough is that the 90th percentile of the data within a monitoring year is below the target level of 0.11 μg/l for 2,4-DNT (Ref. 13). Based on the 2003 data, the 90th percentile of the data is 0.03 μg/l; however, an upward trend has been observed in MW-1032. Monitoring for 2,4-DNT will continue in 2004.

Sulfate. Groundwater analyses in 2003 continued to indicate elevated sulfate levels in the monitoring wells in the bedrock of the quarry rim and in the alluvial materials north of the Femme Osage Slough. Sulfate is monitored as an indicator of the geochemistry of the groundwater. Higher sulfate concentrations generally coincide with elevated uranium levels since both are in dissolved form in an oxidizing environment. Annual sulfate averages are summarized in Table 7-17. Overall, eleven monitoring wells had averages above background, which is similar to 2002.

Table 7-17 Annual Groundwater Averages for Sulfate at the Weldon Spring Quarry

LOCATION	ANNUAL AVERAGE (mg/l)	NUMBER OF SAMPLES
MW-1002[1]	109.6	4
MW-1004[1]	100.3	4
MW-1005[1]	263	4
MW-1006[2]	97.3	4
MW-1007[2]	11.9	4
MW-1008[2]	99.7	4
MW-1009[2]	38.7	4
MW-1012[1]	48.9	4
MW-1013[1]	116.3	4
MW-1014[2]	134	4
MW-1015[1]	103.9	4
MW-1016[2]	86.9	4
MW-1017[2]	0.17	2
MW-1018[2]	11.1	4
MW-1019[2]	0.16	2
MW-1021[2]	0.16	2
MW-1027[1]	66.1	4
MW-1028[3]	63.7	2
MW-1030[1]	73.3	4
MW-1031[3]	23.6	4

Table 7-17 Annual Groundwater Averages for Sulfate at the Weldon Spring Quarry (Continued)

LOCATION	ANNUAL AVERAGE (mg/l)	NUMBER OF SAMPLES
MW-1032[1]	133	4
MW-1044[2]	0.17	2
MW-1045[2]	42	4
MW-1046[3]	65.3	4
MW-1047[3]	95.5	4
MW-1048[3]	71.6	4
MW-1049[2]	0.48	4
MW-1050[2]	1.79	2
MW-1051[2]	63.7	4
MW-1052[2]	20.9	4

Note 1: This well is completed in the Kimmswick/Decorah. Compare to the background concentration of 95.90 mg/l as shown in Table 7-14.

Note 2: This well is completed in the alluvium. Compare to the background concentration of 44.20 mg/l as shown in Table 7-14.

Note 3: This well is completed in the Plattin. Compare to the background concentrations of 165 mg/l as shown in Table 7-14.

Iron. Iron was monitored at the quarry on a quarterly and semi-annual basis. The averages are summarized in Table 7-18. Iron is also monitored as an indicator of the geochemistry of the groundwater. Higher iron concentrations generally occur in a reducing environment and do not coincide with elevated uranium levels, which generally occur in an oxidizing environment. Results are similar to those reported during 2002, and continue to confirm that a geochemical reducing zone is inhibiting migration of uranium contaminated groundwater.

Table 7-18 Annual Groundwater Averages for Iron at the Weldon Spring Quarry

LOCATION	ANNUAL AVERAGE (µg/l)	NUMBER OF SAMPLES
MW-1002[1]	24.2	4
MW-1004[1]	18.8	4
MW-1005[1]	901.6	4
MW-1006[2]	1,946	4
MW-1007[2]	31,775	4
MW-1008[2]	178	4
MW-1009[2]	29,025	4
MW-1012[1]	43.5	4
MW-1013[1]	3,383	4
MW-1014[2]	703	4
MW-1015[1]	21.1	4
MW-1016[2]	13.6	4
MW-1017[2]	29,900	2
MW-1018[2]	25,175	4
MW-1019[2]	16,100	2
MW-1021[2]	15,650	2
MW-1027[1]	8.1	4
MW-1028[3]	1,915	2
MW-1030[1]	3,028	4
MW-1031[3]	7.2	4

Table 7-18 Annual Groundwater Averages for Iron at the Weldon Spring Quarry (Continued)

LOCATION	ANNUAL AVERAGE (µg/l)	NUMBER OF SAMPLES
MW-1032[1]	175.5	4
MW-1044[2]	19,300	2
MW-1045[2]	10.0	4
MW-1046[3]	0.11	4
MW-1047[3]	16.7	4
MW-1048[3]	575.3	4
MW-1049[2]	46,375	4
MW-1050[2]	19,700	2
MW-1051[2]	157	4
MW-1052[2]	27,140	4

Note 1: This well is completed in the Kimmswick/Decorah. Compare to the background concentration of 1,177 µg/l as shown in Table 7-14.
Note 2: This well is completed in the alluvium. Compare to the background concentration of 8,405 µg/l as shown in Table 7-14
Note 3: This well is completed in the Plattin. Compare to the background concentration of 9,272 µg/l as shown in Table 7-14.

7.5.3.2 St. Charles County Well Field

Uranium. The RMW-series monitoring wells are analyzed annually for total uranium. The uranium results are provided in Table 7-19. The results for total uranium remain at background.

Table 7-19 Annual Groundwater Results for Total Uranium in the St. Charles County Well Field (RMW Wells)

LOCATION	RESULTS (pCi/l)	NUMBER OF SAMPLES
RMW-1	0.75	1
RMW-2	4.27	1
RMW-3	0.24	1
RMW-4	0.95	1

Nitroaromatic Compounds. The RMW-series monitoring wells were sampled annually for six nitroaromatic compounds. No detectable concentrations were observed at these locations.

Sulfate and Iron. The RMW-series monitoring wells were sampled annually for sulfate and iron. The 2003 annual averages for the well field are summarized in Table 7-20.

Table 7-20 Groundwater Results for Sulfate and Iron in the St. Charles County Well Field (RMW Wells)

	SULFATE (mg/l)		IRON (µg/l)	
LOCATION	AVERAGE	NUMBER OF SAMPLES	AVERAGE	NUMBER OF SAMPLES
RMW-1	33.8	1	8.36	1
RMW-2	7.92	1	6.58	1
RMW-3	21.6	1	15.2	1
RMW-4	26.6	1	0.96	1

7.5.4 Trend Analysis

Statistical tests for time-dependent trends at the quarry were performed on historical data from select groundwater wells. Trending was performed on total uranium and nitroaromatic data collected from 2000 to 2003. Total uranium trends were analyzed at all of the locations north of the slough. Nitroaromatic compounds were analyzed for locations that have historically shown 2,4-DNT impact.

The computer program, TREND, which is described in detail in Section 7.4.4, was used for this trend analysis. The method employed was the nonparametric Mann-Kendall test.

7.5.4.1 Quarry Trend Results

The cumulative results for the period 2000 through 2003 for each parameter that was evaluated using the TREND program are summarized below. The trending results for the quarry area during this period were compared to past trending results performed for the period 1999 through 2002. The results of these analyses are summarized below.

Total Uranium

Twenty-one locations near the quarry were selected for total uranium trend analyses. Of these, 13 were bedrock wells and eight were alluvial wells. These locations have been designated as long-term monitoring wells and were included in last year's analyses.

Total uranium trends for 2000-2003 data were downward for 11 locations and stationary for the other 10 locations as shown in Table 7-21. This is a change in trend direction from last year's analyses for seven locations. The wells MW-1005, MW-1007, MW-1015, MW-1027, MW-1030, MW-1045, and MW-1046 have changed from a stationary to a downward trend.

As shown in Table 7-21, three of the 21 locations that were evaluated for the 2000 through 2003 time frame have reported uranium concentrations in 2003 that exceed all past 2000 through 2002 data for the specific sampling locations. These uranium levels are 5,057 pCi/l at MW-1008 and 1,110 pCi/l at MW-1014, and 112 pCi/l at MW-1016. While these locations had new highs since 2000, these values do not represent historical highs. These locations also reported stationary trends.

Table 7-21 Quarry Groundwater Uranium Trend Analysis Summary for 2000 to 2003

Well ID	Location	No. of Samples 2000-2003	No. of Non-Detect Data 2000-2003	Trend Direction (Alpha = 0.05) 2000-2003	Slope (pCi/l/yr) 2000-2003	95% Upper & Lower Confidence Intervals On Slope (pCi/l/yr) 2000-2003	2003 New High Concentration (pCi/l) 2000 to Date
MW-1002	Bedrock – east rim	14	0	S	-0.082	-0.410, 0.170	No
MW-1004	Bedrock – rim	14	0	D	-327.000	-419.373, -151.587	No
MW-1005	Bedrock – south rim	13	0	D	-204.475	-297.445, -145.113	No
MW-1006	Alluvium – north of slough	14	0	S	128.000	0.424, 224.546	No
MW-1007	Alluvium - north of slough	14	1	D	-14.370	-50.374, -4.151	No
MW-1008	Alluvium – north of slough	29	0	S	31.667	-164.354, 315.000	5,057
MW-1009	Alluvium - north of slough	31	18	S	0.030	-0.106, 0.243	No
MW-1013	Bedrock – north of slough	31	0	D	-37.833	-77.365, -7.604	No
MW-1014	Alluvium - north of slough	31	0	S	53.217	-12.632, 104.966	1,110
MW-1015	Bedrock – north of slough	14	0	D	-17.000	-38.396, -4.125	No
MW-1016	Alluvium - north of slough	14	0	S	6.300	-3.150, 13.198	112
MW-1027	Bedrock – west of quarry	14	0	D	-70.000	-89.937, -38.764	No
MW-1028	Bedrock – north of slough	7	1	S	-0.395	-0.880, 0.560	No
MW-1030	Bedrock – south rim	14	0	D	-3.000	-7.162, -1.556	No
MW-1031	Bedrock - north of slough	18	1	D	-7.150	-11.180, -4.116	No
MW-1032	Bedrock – north of slough	31	0	S	-25.000	-53.280, 2.187	No
MW-1045	Bedrock – north of slough	12	0	D	-1.588	-3.158, -0.927	No
MW-1046	Bedrock – north of slough	13	0	D	-1.415	-1.837, -0.731	No
MW-1048	Bedrock – north of slough	30	0	D	-41.167	-61.281, -23.039	No
MW-1051	Alluvium - north of slough	25	0	S	57.183	-110.521, 118.425	No
MW-1052	Alluvium - north of slough	25	0	S	0.115	-5.656, 2.427	No

D = Downward
S = Stationary

Nitroaromatic Compounds

Eight locations near the quarry were selected for trend analyses of 2,4-dinitrotoluene (2,4-DNT). Of these locations, seven are bedrock wells and one is an alluvial well. All eight of these locations were also included in last year's analyses.

The results of the 2,4 DNT analyses for the monitoring wells near the quarry are presented in Table 7-22. Based on the results of the analyses, one upward trend was identified in groundwater from the bedrock well MW-1032. This upward trend of MW-1032 is a change from last year's analyses which had indicated a stationary trend.

Trending was not performed at MW-1002, MW-1005, MW-1015, and MW-1030 because fewer than three detected concentrations were reported for the time period between 2000 and 2003. Last year's analyses for well location MW-1002 indicated a downward trend, while locations MW-1005 and MW-1015 previously indicated stationary trends.

The other three well locations MW-1004, MW-1006, and MW-1027 have stationary trends. These trend directions remain unchanged from last year's analyses.

As shown in Table 7-22, MW-1032 has a reported concentration of 0.16 µg/L in 2003 that exceeds all past 2000, 2001, and 2002 data for that location.

7.6 Disposal Cell Monitoring

Five groundwater monitoring wells and one spring were monitored during 2003 to detect contaminants in the uppermost water unit beneath the permanent disposal cell in order to meet the substantive requirements of 40 CFR 264, Subpart F; 10 CSR 25-7.264(2)(F); and 10 CSR 80-3.010(8). These Federal and State hazardous and/or solid waste regulation were identified as applicable or relevant and appropriate requires (ARARs) for the selected remedy in the *Record of Decision for the Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (Ref. 9). Monitoring of these wells and spring were performed in accordance with the *Weldon Spring Site Disposal Cell Groundwater Monitoring Plan, Rev. 1* (Ref. 37).

7.6.1 Monitoring Program

The disposal cell groundwater detection monitoring network consists of one upgradient well (MW-2055), four downgradient wells (MW-2032, MW-2046, MW-2047, and MW-2051), one downgradient spring (SP-6301), and the leachate collection and removal sump (LCRS). Semiannual detection monitoring began in mid-1998, after cell construction had begun and waste placement activities were initiated.

Table 7-22 Quarry Groundwater Nitroaromatic Trend Analysis Summary for 2000-2003

Well ID	Location	Compound	No. of Samples 2000-2003	No. of Non-Detect Data 2000-2003	Trend Direction (Alpha = 0.05) 2000-2003	Slope (µg/l/yr) 2000-2003	95% Upper & Lower Confidence Intervals on Slope (µg/l/yr) 2000-2003	2003 New High Concentration (µg/l) 2000 to Date
MW-1002	Bedrock – east rim	2,4-DNT	12	10	(a)	(a)	(a)	No
MW-1004	Bedrock – south rim	2,4-DNT	12	9	S	0.000	-0.036, 0.005	No
MW-1005	Bedrock – south rim	2,4-DNT	11	9	(a)	(a)	(a)	No
MW-1006	Alluvium - north of slough	2,4-DNT	12	9	S	-0.002	-0.022, 0.005	No
MW-1015	Bedrock – north of slough	2,4-DNT	12	12	(a)	(a)	(a)	No
MW-1027	Bedrock – rim	2,4-DNT	14	0	S	0.400	-0.450, 2.060	No
MW-1030	Bedrock – south rim	2,4-DNT	9	9	(a)	(a)	(a)	No
MW-1032	Bedrock – north of slough	2,4-DNT	19	16	U	0.005	0.002, 0.007	0.16

S = Stationary 2,4-DNT 2,4-Dinitrotoluene
U = Upward

(a) Fewer than three detected concentrations were reported for the time period; therefore, no trending was performed.

The detection monitoring program for the disposal cell consisted of semiannual sampling for the following parameters:

- Total uranium.
- Anions (chloride, fluoride, nitrate (as N), and sulfate).
- Metals (arsenic, barium, chromium, cobalt, iron, lead, manganese, nickel, selenium, and thallium).
- Nitroaromatic compounds.
- Radiochemical parameters (Ra-226, Ra-228, Th-228, Th-230, and Th-232).
- Volatile organic compounds (VOCs)
- Polychlorinated biphenyls (PCBs) and polyaromatic hydrocarbons (PAHs).
- Miscellaneous indicator parameters (chemical oxygen demand, total dissolved solids, and total organic carbon).

Under the detection monitoring program, signature parameter (barium, iron, manganese, and uranium) data from each monitoring event are compared to baseline tolerance limits (BTLs), to trace general changes in groundwater quality and determine whether statistically significant evidence of contamination due to cell leakage exists. BTLs were calculated for each sampling event using the last eight data points from each location, using 95% confidence and 95% coverage, based on the assumptions that the data are normally distributed. In the case of the newer wells (MW-2051 and MW-2055) the available data set was used in these calculations (Ref. 37). This moving average approach of using the most recent data points has been used to provide representative comparison values for detection monitoring data. This approach better reflects naturally occurring changes in site hydrology, minimizes temporal variability, and accounts for the natural attenuation of contaminants in the shallow aquifer.

For signature parameters that are determined to exceed the BTLs, locations are resampled to verify exceedances and, if confirmed, historical leachate analytical data and volumes are evaluated to assess the integrity of the disposal cell. Previously, all parameters that were evaluated against BTLs and exceedances were attributable to several causes such as variation in existing groundwater quality, interference from suspended solids in the sample, and leaching of metals from the stainless steel well materials.

7.6.2 Monitoring Results

The 2003 monitoring results for the signature parameters are presented in Table 7-23. The BTLs for each sampling event are also included in the table.

Table 7-23 Signature Parameter Results and Associated BTLs

Parameter	Location	June 2003		December 2003	
		Result	BLT	Result	BTL
Barium (µg/l)	MW-2032	173	240	187	232
	MW-2046	169	258	203	258
	MW-2047	348	532	376	516
	MW-2051	145	270	144	165
	MW-2055	21.2	89.8	20.9	80.1
	SP-6301	115	160	114	158
Iron (µg/l)	MW-2032	71.7	1,130	53.1	973
	MW-2046	103	2,424	37.2	2,427
	MW-2047	13.2	1,162	27.4	1,239
	MW-2051	123	2,484	515	1,977
	MW-2055	264	9,375	58.9	8,249
	SP-6301	227	2,412	672	2,405
Manganese (µg/l)	MW-2032	5.7	62.2	8	58.6
	MW-2046	9	229	3.4	230
	MW-2047	1.6	89.8	3.8	99.1
	MW-2051	10	218	12.5	186
	MW-2055	7.2	160	4.5	140
	SP-6301	3.2	7.5	7	7.1
Uranium (pCi/l)	MW-2032	2.30	2.83	2.78	2.86
	MW-2046	0.95	1.30	0.95	1.24
	MW-2047	1.15	5.55	1.22	5.55
	MW-2051	0.75	3.94	0.75	3.41
	MW-2055	2.3	7.07	1.69	6.28
	SP-6301	39.1	145	27.6	138

Results of the sampling, as shown in Table 7-23, indicated no statistically significant evidence of groundwater impact resulting from potential leakage from the disposal cell. Values for MW-2051 and MW-2055 are slightly higher than the other wells due to few available data points to calculate BTLs.

Results of general groundwater quality monitoring for the disposal cell wells in June 2003 (Table 7-24) indicated two locations downgradient from the LCRS (MW-2032 and MW-2046) had elevated levels of chloride and total organic carbon. These locations were resampled to verify the results. Results from the resampling performed in October 2003 showed concentrations returned to within historical ranges for MW-2032. Concentrations for these two parameters were still elevated in MW-2046.

Table 7-24 Summary of Monitoring Data for Cell Well Network (June 2003)

PARAMETER	CONCENTRATION					
	MW-2032	MW-2046	MW-2047	MW-2051	MW-2055	SP-6301
Chloride (mg/l)	10.5	25.3	7.75	38.1	4.51	16.5
Fluoride (mg/l)	NS	ND	ND	0.09	ND	0.12
Nitrate-N (mg/l)	5.06	2.14	67.2	1.39	0.89	4.16
Sulfate (mg/l)	65.7	58.5	27.1	50.5	340	24.5
Arsenic (µg/l)	0.25	ND	ND	ND	ND	0.3

Table 7−24 Summary of Monitoring Data for Cell Well Network (June 2003) (Continued)

PARAMETER	CONCENTRATION					
	MW-2032	MW-2046	MW-2047	MW-2051	MW-2055	SP-6301
Chromium (μg/l)	3	1.2	3.7	0.89	2.3	ND
Cobalt (μg/l)	ND	ND	1.3	1.2	ND	ND
Lead (μg/l)	0.69	2.5	0.25	0.26	0.44	0.3
Nickel (μg/l)	4.3	5.2	3.6	34.5	9.9	1.1
Selenium (μg/l)	0.52	3.2	2.7	0.2	11.7	0.4
Thallium (μg/l)	ND	ND	ND	ND	ND	ND
COD (mg/l)	7	6	ND	6	ND	9
TDS (mg/l)	448	560	802	360	860	280
TOC (mg/l)	1.8	2.6	1.6	1.8	1.5	2.5
1,3,5-TNB (μg/l)	ND	2.4	ND	0.25	ND	ND
1,3-DNB (μg/l)	ND	ND	ND	ND	ND	ND
2,4,6-TNT (μg/l)	ND	4.7	ND	0.22	ND	ND
2,4-DNT (μg/l)	ND	ND	0.14	0.09	ND	ND
2,6-DNT (μg/l)	ND	1.9	0.33	0.65	ND	0.14
Nitrobenzene (μg/l)	ND	ND	ND	ND	ND	ND
Radium-226 (pCi/l)	ND	ND	0.19	0.32	ND	ND
Radium-228 (pCi/l)	ND	ND	ND	ND	ND	ND
Thorium-228 (pCi/l)	ND	ND	ND	ND	ND	ND
Thorium-230 (pCi/l)	0.05	0.06	0.04	0.17	0.07	0.11
Thorium-232 (pCi/l)	ND	ND	ND	ND	ND	ND
VOCs (μg/l)	ND	ND	ND	ND	ND	ND
PCBs/PAHs (μg/l)	ND	ND	ND	ND	ND	ND

ND Non-detect.

Results of general groundwater quality monitoring for the disposal cell wells in December 2003 (Table 7-25) indicated the two locations again had elevated levels of chloride and total organic carbon. Comparison of the concentration of these parameters in groundwater to the concentrations in the leachate (Table 7-26) indicates that the concentrations present in the leachate are not sufficiently high to contribute to the concentrations observed in the groundwater. These locations will continue to be monitored to identify trends in the concentrations.

Table 7-25 Summary of Monitoring Data for Cell Well Network (December 2003)

PARAMETER	CONCENTRATIONS					
	MW-2032	MW-2046	MW-2047	MW-2051	MW-2055	SP-6301
Chloride (mg/l)	9.72	26.3	7.4	35	5.71	11.1
Fluoride (mg/l)	NS	0.38	ND	0.23	0.31	0.21
Nitrate-N (mg/l)	2.17	2.04	71.9	1.49	1.04	2.2
Sulfate (mg/l)	76.9	57.2	24.7	45.7	227	19.5
Arsenic (μg/l)	0.23	ND	ND	0.17	ND	0.4
Chromium (μg/l)	2.6	0.75	3.7	28.7	6.8	1.4
Cobalt (μg/l)	ND	ND	ND	ND	ND	ND
Lead (μg/l)	0.3	0.31	0.31	0.49	0.29	0.7
Nickel (μg/l)	2.6	14.9	2.7	30.1	45.8	ND
Selenium (μg/l)	0.68	3.2	2.8	0.3	12.5	0.3
Thallium (μg/l)	ND	ND	ND	ND	ND	ND
COD (mg/l)	11	11	ND	12	17	21
TDS (mg/l)	455	603	702	330	700	230
TOC (mg/l)	1.33	3	1.6	1.8	1.7	3.1
1,3,5-TNB (μg/l)	ND	3.3	ND	0.39	ND	ND
1,3-DNB (μg/l)	ND	ND	ND	ND	ND	ND
2,4,6-TNT (μg/l)	ND	5.1	ND	0.22	ND	ND
2,4-DNT (μg/l)	ND	ND	0.1	0.1	ND	ND
2,6-DNT (μg/l)	ND	1.9	0.25	0.61	ND	ND
Nitrobenzene (μg/l)	ND	ND	ND	ND	ND	ND
Radium-226 (pCi/l)	ND	ND	0.22	0.32	ND	ND
Radium-228 (pCi/l)	ND	ND	ND	0.98	ND	ND
Thorium-228 (pCi/l)	ND	ND	ND	ND	ND	ND
Thorium-230 (pCi/l)	0.24	0.22	0.32	0.15	0.26	0.23
Thorium-232 (pCi/l)	ND	ND	ND	0.02	ND	ND
VOCs (μg/l)	ND	ND	ND	ND	ND	ND
PCBs/PAHs (μg/l)	ND	ND	ND	ND	ND	ND

ND Non-detect.

The 2003 monitoring results for the leachate are presented in Table 7-26. The LCRS is sampled semiannually and the data are used for comparison if elevated concentrations of constituents are identified in the groundwater.

Table 7-26 Summary of Leachate Monitoring Data for Cell Well Network

PARAMETER	CONCENTRATIONS	
	JUNE 2003	DECEMBER 2003
Chloride (mg/l)	35.7	33.8
Fluoride (mg/l)	ND	0.26
Nitrate-N (mg/l)	0.51	0.06
Sulfate (mg/l)	50.1	31.4
Arsenic (μg/l)	1.5	3.4
Barium (μg/l)	784	1,030
Chromium (μg/l)	ND	ND
Cobalt (μg/l)	8.2	7.1
Iron (μg/l)	6,140	14,200

Table 7-26 Summary of Leachate Monitoring Data for Cell Well Network (Continued)

PARAMETER	CONCENTRATIONS	
	JUNE 2003	DECEMBER 2003
Lead (μg/l)	1.0	ND
Manganese (μg/l)	2,070	1,630
Nickel (μg/l)	5.5	9.0
Selenium (μg/l)	0.57	2.5
Thallium (μg/l)	NS	1.4
COD (mg/l)	20.0	44.0
TDS (mg/l)	823	747
TOC (mg/l)	11.1	9.4
1,3,5-TNB (μg/l)	NS	ND
1,3-DNB (μg/l)	ND	ND
2,4,6-TNT (μg/l)	ND	ND
2,4-DNT (μg/l)	ND	ND
2,6-DNT (μg/l)	ND	ND
Nitrobenzene (μg/l)	ND	ND
Radium-226 (pCi/l)	0.42	0.60
Radium-228 (pCi/l)	ND	ND
Thorium-228 (pCi/l)	ND	ND
Thorium-230 (pCi/l)	0.14	ND
Thorium-232 (pCi/l)	ND	ND
Uranium (pCi/l)	25.5	13.8
VOCs (μg/l)	ND	ND[1]
PCBs/PAHs (μg/l)	ND	ND

Note 1: Acetone, a typical laboratory contaminant, was detected at 6.9 μg/l.
ND Non-detect.

7.6.3 Groundwater Flow

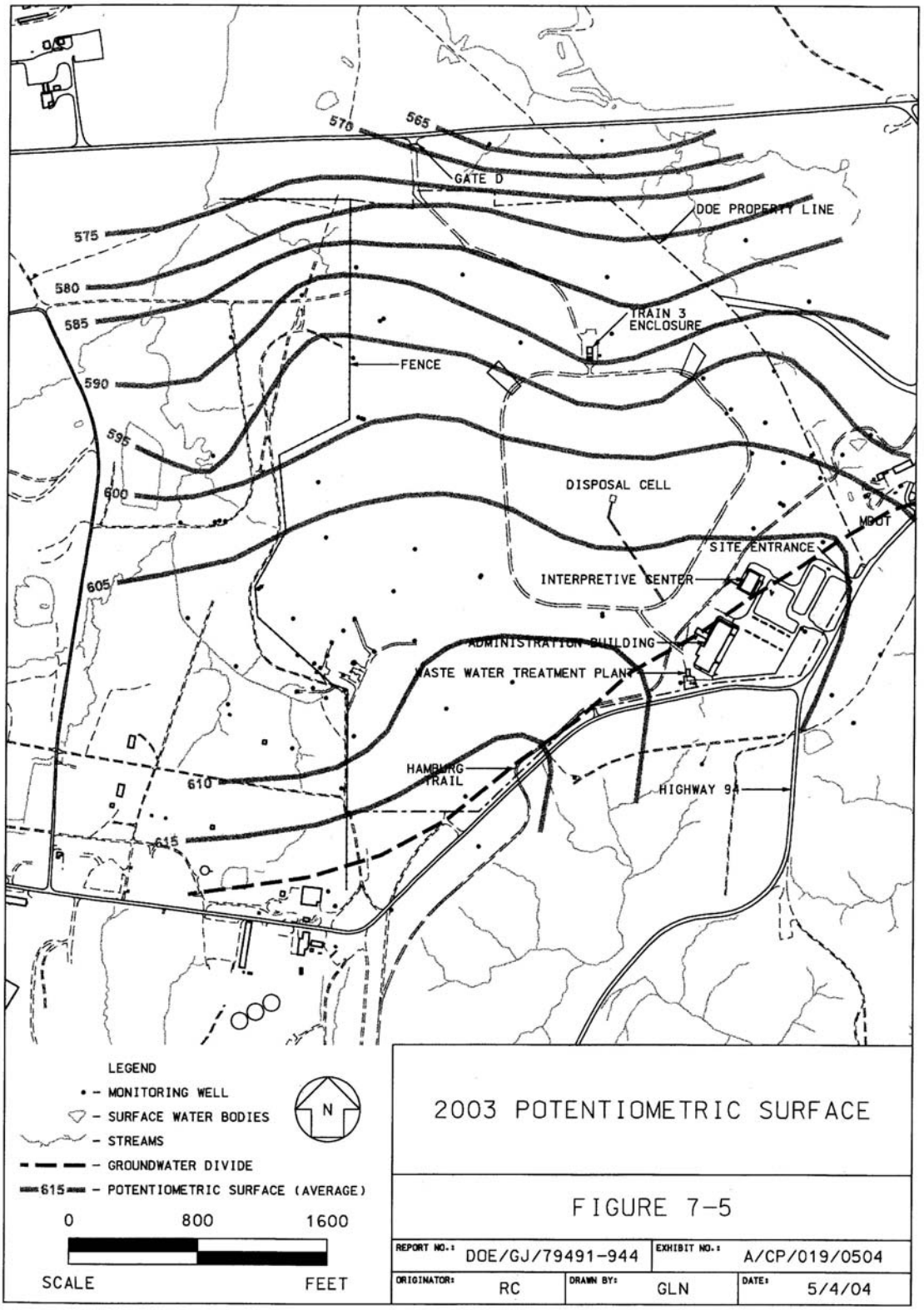
Groundwater flow rate and direction are evaluated annually as specified in the *Disposal Cell Groundwater Monitoring Plan* (Ref. 37). The groundwater flow direction was determined by construction and potentiometric surface map of the shallow aquifer using the available wells at the chemical plant (Figure 7-5). The potentiometric surface has remained relatively unchanged since the construction of the disposal cell. The groundwater flow direction is generally to the north. A groundwater divide is present along the southern boundary of the site.

The average groundwater flow rate (average linear velocity) is calculated using the following equation:

$$v = -Ki/n_e$$

The average hydraulic conductivity (K) using data from the cell monitoring wells is 7 x 10^{-3} cm/s. An effective porosity (n_e) of 0.10 was selected to estimate the maximum groundwater flow rate in this area. The hydraulic gradient (i) in the disposal cell area is 0.011 ft/ft and is based on data from MW-2032 and MW-2055, located 2,100 ft apart. This approach is consistent

with the calculations presented in the *Disposal Cell Groundwater Monitoring Plan* (Ref. 37). The average flow rate for 2003 was 2.2 ft/day, which is similar to the average flow rates calculated since 1998 (Ref. 37).


570
565
GATE D
DOE PROPERTY LINE
575
580
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TRAIN 3
ENCLOSURE
FENCE
590
595
600
DISPOSAL CELL
MOUT
SITE ENTRANCE
605
INTERPRETIVE CENTER
ADMINISTRATION BUILDING
WASTE WATER TREATMENT PLANT
HAMBURG
TRAIL
610
HIGHWAY 94
615
LEGEND
• – MONITORING WELL
– SURFACE WATER BODIES
– STREAMS
– GROUNDWATER DIVIDE
615 – POTENTIOMETRIC SURFACE (AVERAGE)
N
0
800
1600
SCALE
FEET
2003 POTENTIOMETRIC SURFACE
FIGURE 7-5
REPORT NO.: DOE/GJ/79491-944
EXHIBIT NO.: A/CP/019/0504
ORIGINATOR: RC
DRAWN BY: GLN
DATE: 5/4/04

8. BIOLOGICAL MONITORING PROGRAM

DOE Order 5400.5 has requirements for monitoring contaminant levels in terrestrial foodstuffs as well as in aquatic biota in the water column and sediments of affected surface waters. Past monitoring focused primarily on properties that received effluent from the site such as Busch Lakes 34, 35, and 36; Femme Osage Slough, and associated drainages.

Historical calculations have shown that the radiation dose to native aquatic organisms in water influenced by the Weldon Spring site has never exceeded 0.1 rad/day, which is well within the protective guidelines of <1 rad/day established in DOE Order 5400.5. Over the past few years, biological monitoring was reduced to surveillance levels, with air and surface water results being used to determine the need for additional sampling. Statistical analyses of annual effluent sample results for both air and surface water indicated there was no need for further biological sampling. In addition, the total uranium migrating off site in surface water has steadily decreased since 1987 and is approaching background levels. The air monitoring program has been discontinued since the WSSRAP has no remaining sources of airborne radiological emissions.

9. ENVIRONMENTAL QUALITY ASSURANCE PROGRAM INFORMATION

9.1 Highlights of the Quality Assurance Program

- Quality Assurance programs for 2003 were changed to follow the *Sampling and Analysis Plan for GJO Projects* (Ref. 21).

- Average relative percent differences calculated for groundwater, surface water, National Pollutant Discharge Elimination System (NPDES) samples, and springs were generally within the 20% criterion recommended by the Contract Laboratory Program (CLP).

- The data validation program accepted 99.9% of the data in 2003.

9.2 Program Overview

The environmental quality assurance program includes management of the quality assurance and 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 environmental quality assurance program provides 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 are evaluated and utilized. Key elements in achieving the goals of this program are compliance with the quality assurance program and environmental quality assurance program procedures; use of quality control samples; complete documentation of field activities and laboratory analyses; and review of data documentation for precision, accuracy, and completeness.

9.2.1 Quality Assurance Program

The *Quality Assurance Manual* establishes the quality assurance program for activities performed by the contractor. The manual requires compliance with the criteria of DOE Order 414.1A, *Quality Assurance* and 10 CFR 830.120, Quality Assurance.

9.2.2 Sampling and Analysis Plan

The *Sampling and Analysis Plan for GJO Projects* (Ref. 21) summarizes the data quality requirements for collecting and analyzing environmental data. The *Environmental Monitoring Plan* (Ref. 8) lists the sampling locations and provides site specific detail for quality control samples. These plans describe administrative procedures for managing environmental data, data validation, database administration, and data archiving.

9.2.3 Evaluation and Presentation of Data

Analytical data are received from subcontracted analytical laboratories. Uncensored data have been used in reporting and calculations of annual averages where available. Uncensored data are data that do not represent an ND (nondetect) and instead report instrument responses that quantitate to values below the reported detection limit. These types of data are designated by parentheses around the data value, for example "(1.17)". When there was no instrument response, nondetect data were used in calculations of averages at a value of one-half the detection limit (DL/2), as specified in the Above Normal Reporting requirements identified in the Environmental Monitoring Plan (Ref. 8).

9.2.4 Subcontracted Off-Site Laboratories Programs

Subcontracted off-site laboratories that performed analyses used for the preparation of this report use EPA SW-846 methodologies when applicable. For certain analyses (such as radiochemical and wet chemistry) the laboratories use EPA 600 (drinking water), or methods that are reviewed prior to analysis. Each of the subcontracted off-site laboratories has controlled copies of their SOPs. The SOPs are reviewed before any samples are shipped to the laboratory. Changes to the standard analytical protocols or methodology are documented in the controlled SOPs.

9.3 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; and (4) preservation and security of all applicable documents and records pertinent to the environmental monitoring programs.

9.3.1 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 SW-846 requirements and the EPA drinking water and radiochemical methodologies or methods that are reviewed prior to analysis of each sample. Field measurement methodologies typically follow the American Public Health Association *Standard Methods for the Examination of Water and Wastewater* (Ref. 17).

9.3.2 Quality Control Samples

Quality control samples for environmental monitoring are collected in accordance with the required sampling plan, which specifies the frequency of quality control sample collection. Quality control samples are normally collected in accordance with guidelines in the EPA CLP (Ref. 16). Descriptions of the Quality Control samples collected at the WSSRAP are detailed in Table 9-1.

Table 9-1 Quality Control Sample Description

TYPE OF QC SAMPLE	DESCRIPTION
Water Blank	Monitors the purity of distilled water used for field blanks and decontamination of sampling equipment. Water blanks are collected directly from the distilled water reservoir in the WSSRAP laboratory.
Equipment Rinsate Blank	Monitors the effectiveness of decontamination procedures used on non-dedicated sampling equipment. Equipment blanks include rinsate and filter blanks.
Trip Blank	Monitors volatile organic compounds that may be introduced during transportation or handling at the laboratory. Trip blanks are collected in the WSSRAP laboratory with distilled water.
Field Duplicate	Monitors field conditions that may affect the reproducibility of samples collected from a given location. Field replicates are collected in the field at the same location.
Matrix Spike*	Assesses matrix and 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*	Assesses matrix and 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*	Assesses matrix and 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.

* A laboratory sample is split from the parent sample.

9.4 Quality Assurance Sample Results

The quality assurance program is assessed by analyzing quality control sample results and comparing them to actual samples using the following methodology.

9.4.1 Duplicate Results Evaluation

Field duplicate analyses were evaluated in 2003. The matrix duplicate analyses were performed at subcontracted laboratories from aliquots of original samples collected at the Weldon Spring site and are not summarized in this document. Matrix duplicates were used to assess the precision of analyses and also to aid in evaluating the homogeneity of samples or analytical interferences of sample matrixes. Matrix duplicates were assessed during data validation process for each sample group.

Generally, field duplicate samples were analyzed for the same parameters as the original samples at the rate of approximately one for every 20 samples. Twenty field duplicates were collected in 2003 from 438 sample locations (4.6%). Typically, duplicate samples were analyzed for more common parameters (e.g., uranium, inorganic anions, and metals).

When field duplicate samples were available, the average relative percent difference was calculated. This difference represents an estimate of precision. The equation used, (RPD) as specified in the *USEPA Contract Laboratory Program, Inorganic Scope of Work*, (Ref. 16), was:

$$RPD = |S-D| / ((S+D) /2) \times 100\%$$

where S = concentration in the normal sample
D = concentration in the duplicate analysis

Table 9-2 summarizes the data of calculated RPD for groundwater, springs, leachate and surface water (including National Pollutant Discharge Elimination System [NPDES]) samples. Parameters that were not commonly analyzed for and/or were not contaminants of concern were not evaluated. The RPD was calculated only for samples whose analytical results exceeded five times the detection limit and did not have any quality control problems, (i.e., blank contamination).

Table 9-2 Summary of Calculated Relative Percent Differences

PARAMETER	NUMBER OF SAMPLES	AVG. RPD	MIN. RPD	MAX. RPD
Arsenic	2	11.04	7.79	14.29
Barium	2	0.86	0	1.77
Iron	7	16.7	0.46	66.67
Lead	2	28.64	20.0	37.28
Manganese	2	16.81	8.96	24.66
Selenium	2	3.19	2.74	3.64
Nitrate-N	10	4.5	0.46	24.47
Chloride	2	2.45	1.22	3.67
Sulfate	9	7.46	0.97	31.15
Total Organic Carbon	2	5.34	4.08	6.67
Total Dissolved Solids	2	2.09	1.08	3.09
Trichloroethene	3	2.29	0	4.13
Gross Alpha	3	12.28	7.13	16.42
Gross Beta	3	13.0	10.05	15.58
Uranium, Total	17	5.32	0	35.9
Nitroaromatics	16	18.7	0	73.17

The results in Table 9-2 demonstrate that most average relative percent differences (RPDs) calculated were within the 20% criterion as recommended in the CLP (Ref. 23 and Ref. 16). Only Lead exceeded the 20% criteria. All other average RPDs were acceptable, however, several outliers were present in the data sets. As a result, field duplicate sample analyses in 2003 were of acceptable quality.

9.4.2 Blank Sample Results Evaluation

Various types of blanks are collected to assess the conditions and/or contaminants that may be introduced during sample collection and transportation. These conditions and contaminants are monitored by collecting blank samples to ensure that environmental samples are not being contaminated. Blank samples evaluate the:

- Environmental conditions under which the samples (i.e., volatile analyses) were shipped (trip blanks).
- Ambient conditions in the field that may affect a sample during collection (trip blanks).
- Effectiveness of the decontamination procedure for sampling equipment used to collect samples (equipment blanks).
- Quality of water used to decontaminate sampling equipment and/or assess the ambient conditions (distilled water blanks).

Sections 9.4.2.1 through 9.4.2.3 discuss the sample blank analyses and the potential impact of blank contamination upon the associated samples.

9.4.2.1 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 2003, 23 trip blanks were analyzed for volatile organic compounds. No compounds were detected in 22 trip blanks and acetone was found in one sample. All environmental samples associated with this blank sample were evaluated. One sample was potentially impacted where acetone had been detected. However, acetone found in the trip blanks were associated with common laboratory solvents and are probably not associated with transportation or field contamination.

9.4.2.2 Equipment and Bailer Blank Evaluation

Equipment and bailer blanks are collected by rinsing decontaminated equipment and bailers with distilled water and collecting the rinse water. This procedure is used to determine the effectiveness of the decontamination process. 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. Three equipment rinsate blanks were collected in 2003 for surface water sampling and were analyzed for total uranium. Uranium was not detected in these blanks.

9.4.2.3 Distilled 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. In 2003, no water blanks were collected. The distilled water system was replaced in 2003 with a sealed carbon/ion exchange system.

9.5 Data Validation Program Summary

In 2003, the data validation program at the WSSRAP was changed to follow the *Sampling and Analysis Plan for GJO Projects* (Ref 21). This program involves reviewing and qualifying 100% of the data collected during a calendar year. 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 9-3 identifies the number of quarterly and total data points that were validated in 2003, and indicates the percentage of those selected that were complete. Data points in this table include all sample types.

Table 9-3 WSSRAP Validation Summary for Calendar Year 2003

CALENDAR QUARTER	NO. OF DATA POINTS VALIDATED	NO. OF VALIDATED DATA POINTS REJECTED	COMPLETENESS[(a)]
Quarter 1	2796	3	99.8
Quarter 2	1548	1	99.9
Quarter 3	1170	1	99.9
Quarter 4	1316	1	99.9
2003 Total	6830	6	99.9

(a) Completeness is a measure of acceptable data. The value is given by:

$$\text{Completeness} = \frac{(\#\text{ validated} - \#\text{ rejected})}{\#\text{ validated}}$$

Reflects all validatable data for the calendar year.

Table 9-4 identifies validation qualifiers assigned to the selected data points as a result of data validation. The WSSRAP validation technical review was performed in accordance with the *Sampling and Analysis Plan for GJO Projects* (Ref. 21). For calendar year 2003, 100% of data validation has been completed. Data points in this table include groundwater, leachate, surface water, spring water, and NPDES samples.

Table 9-4 WSSRAP Validation Qualifier Summary for Calendar Year 2003

NUMBER OF DATA POINTS								
	ANIONS	METALS	MISC.	NITRO-AROMATICS	RADIO-CHEMICAL	SEMI-VOLATILES[a]	VOLATILES	TOTAL
Accepted	285	819	203	605	256	1830	2807	6824
Rejected	0	3	0	0	1	0	2	6
Not Validatable	0	0	0	0	0	0	0	0
Total	285	822	203	605	257	1830	2809	6830
PERCENTAGES								
Accepted	100%	99.6%	100%	100%	99.6%	100%	99.9%	99.9%
Rejected	0%	0.4%	0%	0%	0.4%	0%	0.1%	0.1%
Not Validatable	0%	0%	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%

(a) includes Pesticides/PCB

10. SPECIAL STUDIES

10.1 Frog Pond Groundwater Investigation

Historical highs for nitroaromatic compounds have been reported over the past several years in wells in the vicinity of Frog Pond, most notably MW-2012. Concentrations of nitroaromatic compounds have increased at this location since 1997. Initial increases were attributed to soil remediation activities performed at the Department of Energy in this area and possibly remedial activities performed by the Corps of Engineers in nearby Army Lagoon 1.

The purpose of this groundwater investigation was to obtain data from existing and newly installed monitoring wells in order to delineate the areal extent of groundwater contamination in the Frog Pond area. Figure 10-1 shows the locations of these monitoring wells. The data was also used in an effort to identify the source(s) of nitroaromatic impact to the groundwater in this area and to determine the areal extent of groundwater impact in this area.

Core drilling, well installation, hydraulic conductivity testing, and groundwater sampling were conducted in the Frog Pond area where nitroaromatic compounds have impacted the groundwater. Seven monitoring wells were drilled at the locations identified in the *Frog Pond Groundwater Investigation Sampling Plan* (Ref. 22). Drilling and well installation were performed to supplement the existing monitoring well network and to provide additional hydrogeologic characterization data related to the study area. Subsurface data indicate the presence of linear bedrock lows on the surface of the Burlington-Keokuk Limestone. These lows resemble surface drainages and appear to be preglacial channels formed by surface erosion of the exposed Mississippian limestone. Testing indicates that hydraulic conductivity is typically highest in wells completed in these bedrock lows.

As the coring progressed, hydraulic packer testing was performed at successive intervals in the borehole to determine the hydraulic conductivity for discrete intervals of the limestone. The results from the testing followed trends noted from previous packer testing at the site, such as decreasing permeability with depth and the highest permeability exhibited in the strongly weathered portion of the Burlington-Keokuk Limestone.

Groundwater sampling was performed as the monitoring wells were completed and developed. Analytical data showed elevated nitroaromatic compound concentrations in the vicinity of MW-2012. Analytical results from wells installed during this program were also used to evaluate potential source areas for the nitroaromatic compound contamination in groundwater. Six primary nitroaromatic compounds and 5 breakdown products were monitored in the new monitoring wells and other nearby existing wells to establish the areal extent of groundwater impact and to determine possible sources for this impact. A summary of the data for the new wells and the existing nearby wells are presented in Tables 10-1 and 10-2, respectively.

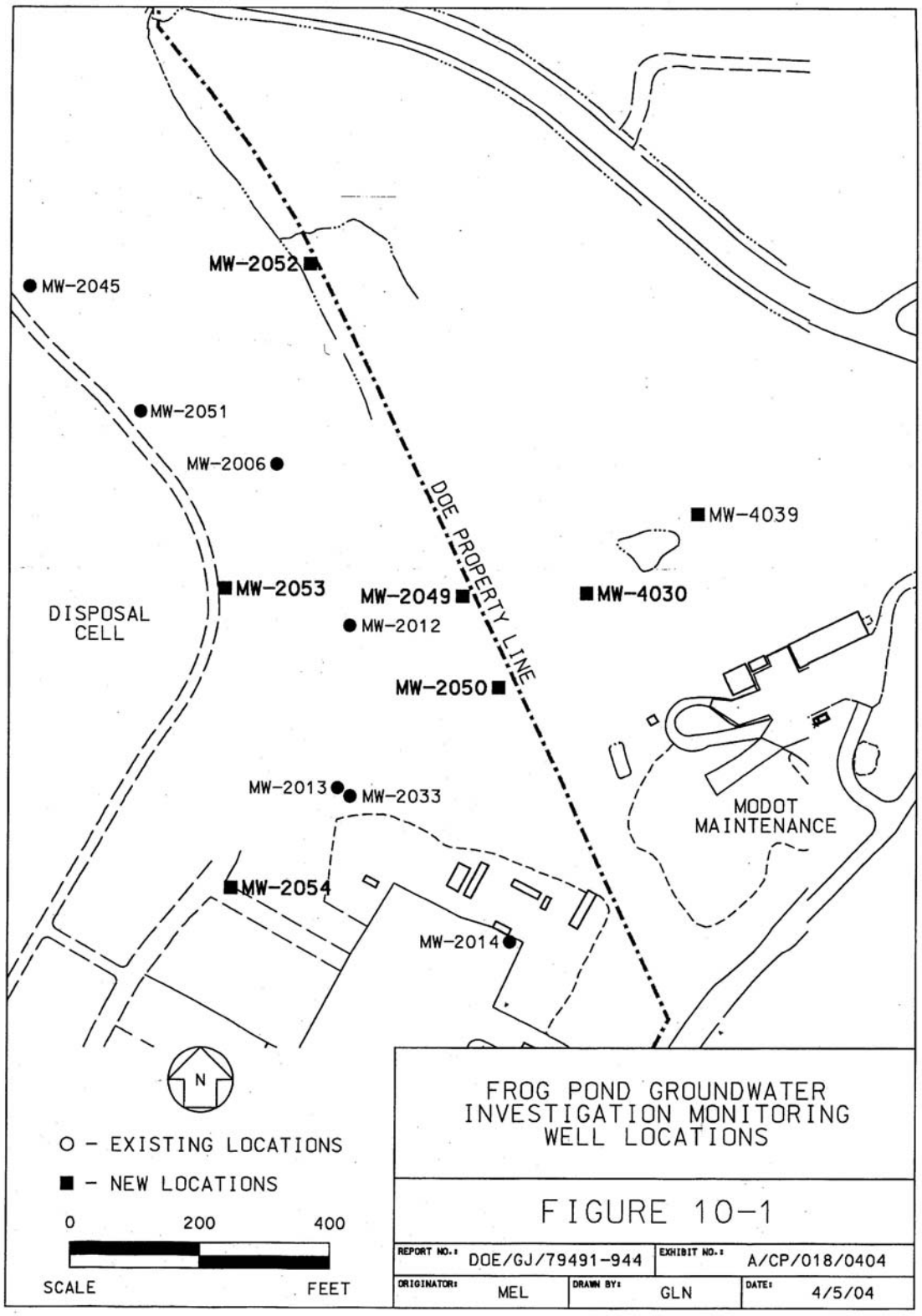

MW-2052
MW-2045
MW-2051
MW-2006
DOE PROPERTY LINE
MW-4039
MW-2053
MW-2049
MW-4030
DISPOSAL CELL
MW-2012
MW-2050
MW-2013
MW-2033
MODOT MAINTENANCE
MW-2054
MW-2014
N
O - EXISTING LOCATIONS
■ - NEW LOCATIONS
0 200 400
SCALE FEET
FROG POND GROUNDWATER INVESTIGATION MONITORING WELL LOCATIONS
FIGURE 10-1
REPORT NO.: DOE/GJ/79491-944
EXHIBIT NO.: A/CP/018/0404
ORIGINATOR: MEL
DRAWN BY: GLN
DATE: 4/5/04

Table 10-1 Nitroaromatic Compound Means[(a)] for the New Monitoring Wells

Parameter	Well Number						
	2049	2050	2052	2053	2054	4030	4039
Nitroaromatic Compounds (µg/l)							
1,3,5-TNB	0.28	4.3	2.9	7.3	0.16	3.1	---
1,3-DNB	0.20	0.12	0.05	0.07	0.04	0.07	---
2,4,6-TNT	0.81	0.11	0.47	6.6	---	1.3	0.04
2,4-DNT	21	22	0.09	0.12	3.4	0.18	---
2,6-DNT	72	6.1	0.24	5.4	8.3	0.42	0.08
NB	0.23	0.04	0.04	0.27	0.09	---	0.04
Breakdown Products (µg/l)							
2-amino-4,6-DNT	1.4	1.9	2.3	2.4	0.13	1.0	0.03
4-amino-2,6-DNT	2.4	2.0	1.1	2.2	0.19	1.1	0.11
2-NT	87	9.0	0.36	0.28	5.5	0.16	0.03
3-NT	3.7	1.0	---	0.05	0.36	0.04	0.04
4-NT	2.0	2.6	0.08	---	0.16	---	---

(a) Data from December 2001 through October 2003

Table 10-2 Nitroaromatic Compound Means[(a)] for the Existing Nearby Monitoring Wells

Parameter	Well Number						
	2006	2012	2013	2014	2033	2045	4015
Nitroaromatic Compounds (µg/l)							
1,3,5-TNB	4.9	191	2.6	2.2	2.4	0.08	4.0
1,3-DNB	0.07	2.8	0.06	0.05	0.04	0.08	---
2,4,6-TNT	0.25	216	0.33	0.04	0.50	0.07	0.04
2,4-DNT	0.08	1127	0.12	0.12	0.20	0.07	0.10
2,6-DNT	0.81	947	1.1	0.44	1.2	0.61	0.78
NB	0.12	3.9	---	0.11	---	0.04	0.06
Breakdown Products (µg/l)							
2-amino-4,6-DNT	1.5	13	1.1	0.38	1.0	0.57	2.4
4-amino-2,6-DNT	1.3	5.3	1.2	0.60	1.2	0.59	2.8
2-NT	0.31	2014	0.18	0.14	1.5	0.05	0.17
3-NT	0.04	143	---	---	0.11	---	---
4-NT	---	531	---	---	0.09	---	---

(a) Data from December 2001 through October 2003

The distribution of nitroaromatic compounds in groundwater in the impacted area was further defined as a result of this study and shows evidence of strong control by the paleochannel located in the area. The areas of greatest contamination are centered on MW-2012, located south of Frog Pond, which appears to be within the paleochannel itself. Elevated concentrations also occur in MW-2050 and MW-2053 that are located in bedrock lows that intersect the paleochannel. Nitroaromatic compounds extend to the north along the bedrock low as shown by elevated levels measured in MW-4015. The compounds 1,3,5-TNB, 2,6-DNT, and 2-Amino-4,6-DNT cover the larger areal extent. The remainder of the nitroaromatic compounds are centered primarily on MW-2012. Groundwater impact extends off-site to MW-4015, located north of the Frog Pond area. The horizontal extent of nitroaromatic compound impact in the weathered Burlington-Keokuk has been better defined through the installation of these wells.

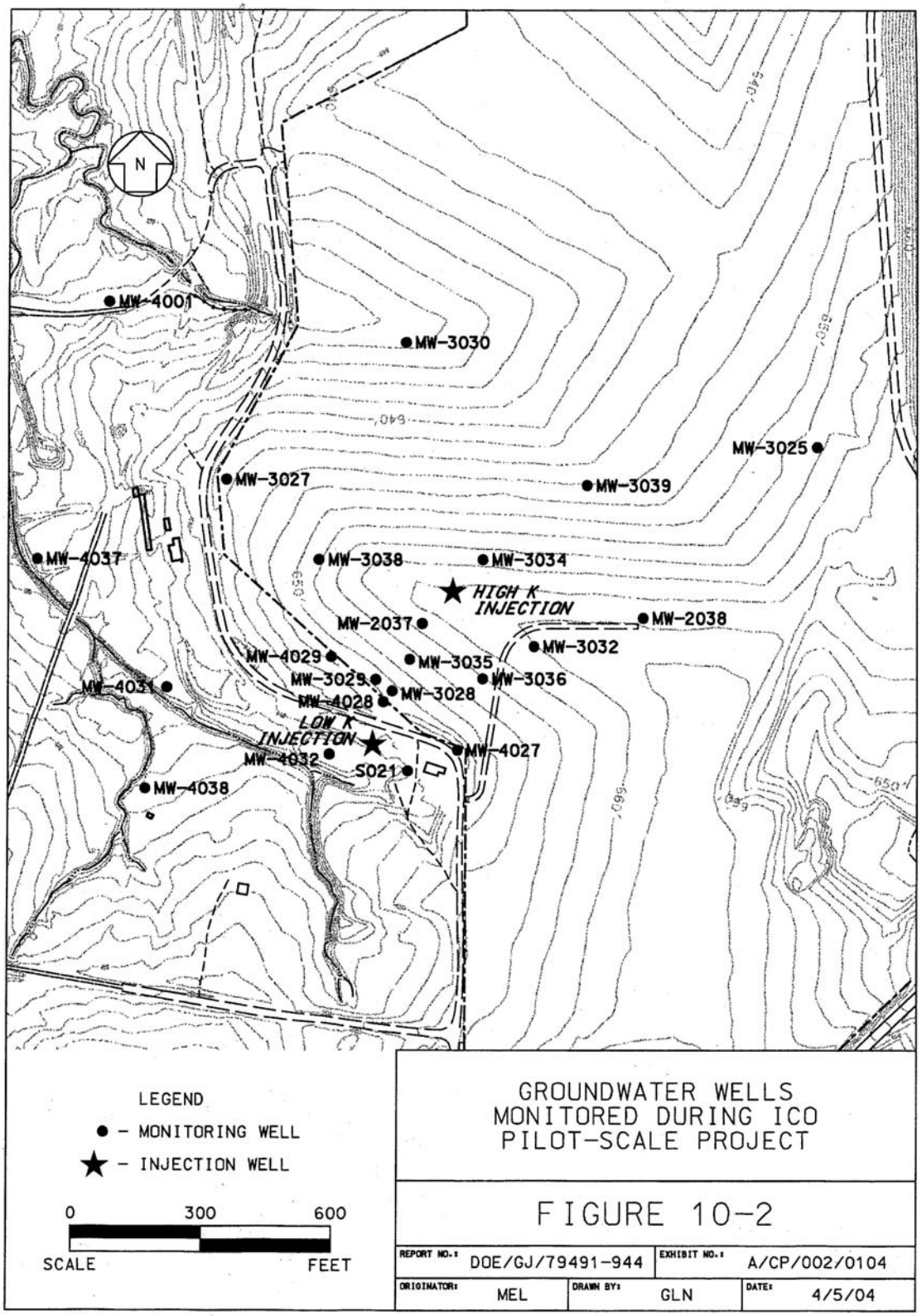
In conclusion, the objectives for the Frog Pond groundwater investigation program were accomplished. The program provided significant additional geologic, hydrologic, and water quality data in the vicinity of the site impacted by nitroaromatic compounds in groundwater. The areal extent of nitroaromatic compound impact on the groundwater in the northeastern portion of the chemical plant was better defined through the installation and sampling of the additional monitoring wells. Furthermore, the hydrogeologic and analytical data has provided an increased understanding of how the natural setting beneath the site controls the contaminant migration and fate. More complete details of this study can be found in the *Completion Report for the Frog Pond Groundwater Investigation* (Ref. 29).

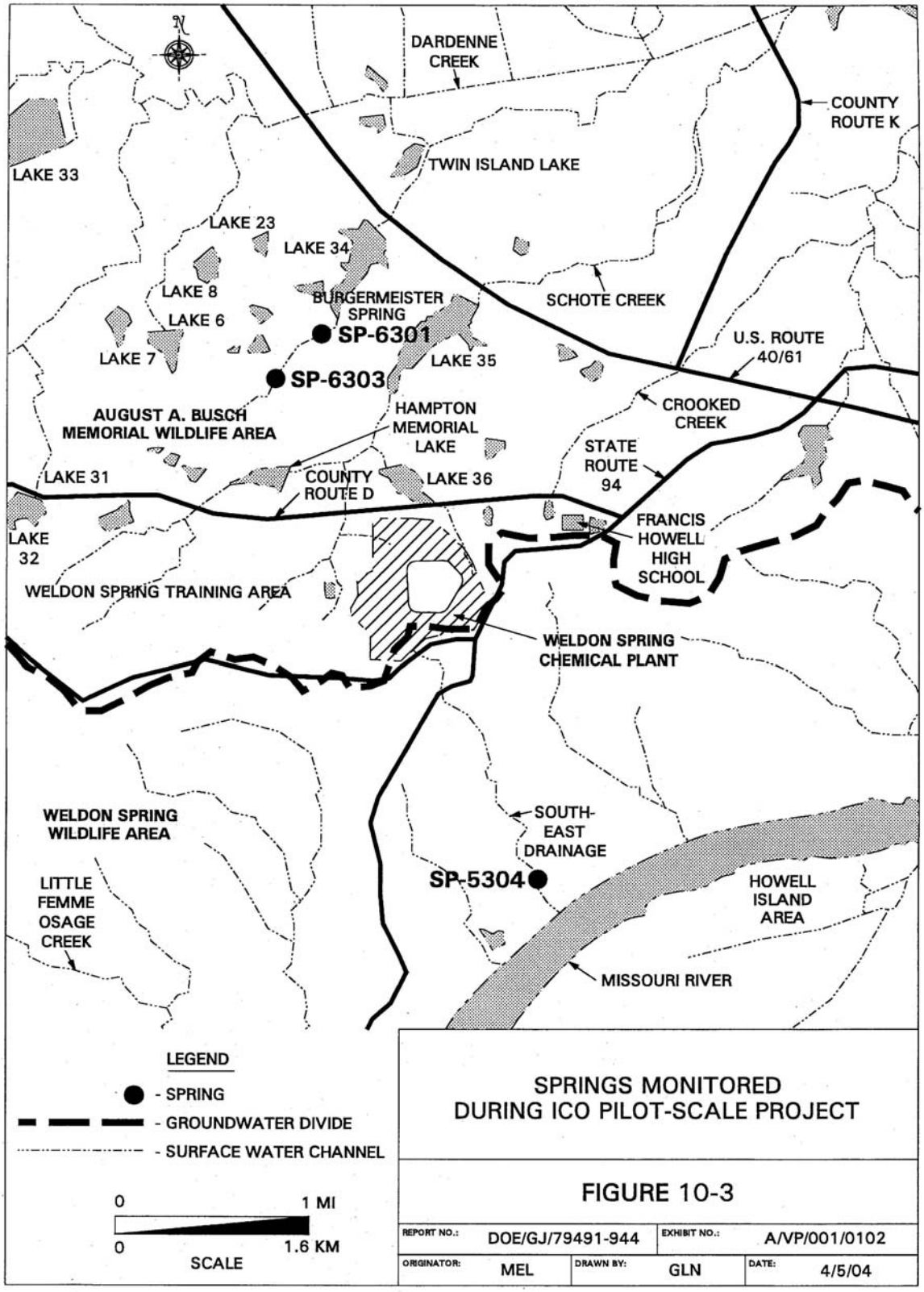
10.2 Pilot Phase ICO Project

Design, installation, and operation of the pilot phase in situ chemical oxidation (ICO) system was conducted by ATC Associates, Inc. and GeoCleanse International. The field activities were conducted at two pilot areas (high-K and low-K) from January to June 2002, and were comprised of the following tasks at each location: installation of one injection well and three monitoring wells; performing baseline geological, geophysical, and hydrological investigations; performing two chemical oxidation injections; and collecting samples before, during, and after treatment. The two pilot areas were selected by the Project Management Contractor (PMC) to provide a representative range of subsurface conditions that may be encountered in the area of trichloroethylene (TCE) impact. A summary of the field activities performed by the subcontractor is provided in *Pilot Scale Test Completion Report, In-Situ Chemical Oxidation of TCE in Groundwater* (Ref. 24).

Sampling was also performed by the PMC to complement the subcontractor's sampling plan by monitoring the same analytical parameters at the same frequency but over a larger geographic area. A total of 22 monitoring wells within the TCE impact area and 3 springs that have demonstrated a hydraulic connection to the chemical plant area were sampled. The subcontractor's observation wells were also sampled by the PMC for this study (Figures 10-2 and 10-3). The results from the additional sampling were used in conjunction with the subcontractor's results to: 1) evaluate the effectiveness of the pilot-phase ICO project in reducing TCE concentrations in the study area, 2) identify the effect of the ICO process on other site contaminants, 3) identify potential impacts of the ICO process on other physical and chemical characteristics of the aquifer, and 4) assess the feasibility of implementing the ICO process on a larger scale.

Five sampling events, which were closely coordinated with the chemical injections, were performed in support of the pilot-scale ICO test. The initial sampling was performed to establish baseline concentrations in the monitoring wells prior to the injection of oxidants into the shallow aquifer. Sampling was then conducted approximately 10 days after the first injection and then 10, 30, and 60 days following the second injection. The second injection occurred approximately 30 days after the first injection.


N
MW-4001
MW-3030
MW-3025
MW-3027
MW-3039
MW-4037
MW-3038
MW-3034
HIGH K INJECTION
MW-2037
MW-2038
MW-3032
MW-4029
MW-3035
MW-3029
MW-3036
MW-4031
MW-3028
MW-4028
LOW K INJECTION
MW-4027
MW-4032
S021
MW-4038
LEGEND
● - MONITORING WELL
★ - INJECTION WELL
0 300 600
SCALE FEET
GROUNDWATER WELLS MONITORED DURING ICO PILOT-SCALE PROJECT
FIGURE 10-2
REPORT NO.: DOE/GJ/79491-944
EXHIBIT NO.: A/CP/002/0104
ORIGINATOR: MEL
DRAWN BY: GLN
DATE: 4/5/04


N
DARDENNE CREEK
COUNTY ROUTE K
TWIN ISLAND LAKE
LAKE 33
LAKE 23
LAKE 34
LAKE 8
BURGERMEISTER SPRING
SCHOTE CREEK
LAKE 6
SP-6301
U.S. ROUTE 40/61
LAKE 7
LAKE 35
SP-6303
CROOKED CREEK
AUGUST A. BUSCH MEMORIAL WILDLIFE AREA
HAMPTON MEMORIAL LAKE
STATE ROUTE 94
LAKE 31
COUNTY ROUTE D
LAKE 36
FRANCIS HOWELL HIGH SCHOOL
LAKE 32
WELDON SPRING TRAINING AREA
WELDON SPRING CHEMICAL PLANT
WELDON SPRING WILDLIFE AREA
SOUTH-EAST DRAINAGE
SP-5304
LITTLE FEMME OSAGE CREEK
HOWELL ISLAND AREA
MISSOURI RIVER
LEGEND
- SPRING
- GROUNDWATER DIVIDE
- SURFACE WATER CHANNEL
0 1 MI
0 1.6 KM
SCALE
SPRINGS MONITORED DURING ICO PILOT-SCALE PROJECT
FIGURE 10-3
REPORT NO.: DOE/GJ/79491-944
EXHIBIT NO.: A/VP/001/0102
ORIGINATOR: MEL
DRAWN BY: GLN
DATE: 4/5/04

An additional sampling event was performed during September 2003 (18 months after treatment) at selected locations to determine the effectiveness of TCE destruction and long-term impacts on groundwater quality due to injection of sodium permanganate into the subsurface. Locations selected were those that had exhibited significant impacts from the ICO process. Other data from 2003 were also used to determine effects on the contaminants of concern in groundwater.

The results of the study show that TCE destruction was observed in ICO-2 and MW-3034 in the high-K area 10 days after the first injection. No TCE destruction was observed in the low-K area after the first injection. After the second injection, TCE destruction was observed in ICO-1, ICO-2, and MW-3034 in the high-K area and in ICO-4, ICO-5, and MW-4028 in the low-K area. The results of the first injection demonstrated that TCE could be oxidized to non-detectable concentrations with sodium permanganate. The key factor for successful TCE destruction is effective distribution of sodium permanganate in the aquifer. Where sodium permanganate was observed during or after injection, the results indicated large reductions.

Sixty days after the second injection, sodium permanganate was detected in ICO-2 and MW-3034 in the high-K area and in MW-4028 in the low-K area and TCE destruction was still reported for two of these wells. Monitoring data collected in March 2003 (1 year after injection) and September 2003 indicates that TCE levels rebounded to near baseline concentrations in MW-3034 (Table 10-3). Rebound in these wells is the result of upgradient dissolved TCE in groundwater migrating to these locations. A substantial delayed decrease in TCE was reported in MW-3028, which is downgradient from the MW-4028 and indicates possible migration of sodium permanganate in the preferential flow path in this area. Continued decreases in MW-4032 and MWS-21 are likely the result of residual sodium permanganate in the low-K area.

Table 10-3 TCE Concentrations in Selected Wells

Location	TCE (µg/l)						
	Baseline	1st Injection	2nd Injection	30-days	60-days	1-year	18-months
ICO-2	230	< 1	< 1	< 1	< 1	NS	199
MW-2037	31	34	34	40	42	105	130
MW-3028	170	130	180	100	150	NS	17
MW-3030	230	180	270	280	320	NS	451
MW-3034	470	< 1	< 1	< 1	< 1	203	307
ICO-5	170	160	27	140	99	NS	144
MW-4028	210	180	5.5	< 1	< 1	< 1	< 2
MW-4029	470	460	480	340	530	NS	548
MW-4032	91	92	65	86	71	63	56
MWS-21	63	76	76	67	75	74	50

NS – Not sampled

The effect of the ICO process on the other contaminants of concern was also studied. While measurements of uranium activity and nitrate concentrations throughout and after the study did not indicate any impact from the in situ chemical oxidation process, the results from monitoring indicated that the ICO process had some impact on nitroaromatic compounds in the study area. Trinitrobenzene (TNB), dinitrobenzene (DNB), and nitrobenzene (NB) appeared to be more readily destroyed than dinitrotoluene compounds. By the end of the 60-day monitoring, some locations were showing decreases of 2,4-dinitrotoluene (DNT) or 2,6-DNT. Fifteen to eighteen months after injection, nitroaromatic compound concentrations were rebounding to baseline concentrations. It appears that nitroaromatic compounds may be destroyed before TCE. At several locations, nitroaromatic compound concentrations were reduced below detection limits or lowered below baseline concentrations and TCE was not impacted. A summary of nitroaromatic compound concentrations throughout the field study in selected wells is presented in Table 10-4.

Table 10-4 Nitroaromatic Compound Concentrations in Selected Wells

Well ID	Event	Nitroaromatic Compounds (µg/l)					
		1,3,5-TNB	1,3-DNB	2,4,6-TNT	2,4-DNT	2,6-DNT	NB
MW-2037	Baseline	ND	ND	ND	ND	ND	ND
	Injection 1	ND	ND	ND	ND	ND	ND
	Injection 2	ND	ND	ND	ND	ND	ND
	30-day	ND	ND	ND	0.11	ND	ND
	60-day	ND	ND	ND	ND	ND	ND
	15-month	ND	ND	ND	0.12	ND	ND
	18-month	ND	ND	ND	0.17	ND	ND
MW-3028	Baseline	0.20	ND	ND	0.12	ND	ND
	Injection 1	0.22	ND	ND	0.14	ND	ND
	Injection 2	0.22	ND	ND	0.085	ND	ND
	30-day	0.12	0.13	ND	0.067	ND	ND
	60-day	0.32	(0.089)	ND	ND	ND	ND
	15-month	0.24	0.072	ND	0.18	ND	ND
	18-month	0.17	0.097	ND	0.19	0.20	ND
MW-3030	Baseline	ND	ND	ND	1.2	0.49	ND
	Injection 1	ND	ND	ND	0.99	0.34	ND
	Injection 2	ND	ND	ND	1.1	0.36	ND
	30-day	ND	ND	ND	1.1	0.45	ND
	60-day	ND	ND	ND	0.98	ND	ND
	15-month	ND	ND	ND	1.2	0.57	ND
	18-month	ND	ND	ND	1.1	0.50	ND
MW-3034	Baseline	0.10	0.09	ND	0.38	0.30	ND
	Injection 1	0.12	ND	ND	0.23	0.20	ND
	Injection 2	ND	ND	ND	0.25	0.30	ND
	30-day	ND	ND	ND	0.29	ND	ND
	60-day	ND	ND	ND	ND	ND	ND
	15-month	0.15	0.097	ND	0.36	0.17	ND
	18-month	0.14	0.097	ND	0.29	0.17	ND

Table 10-4 Nitroaromatic Compound Concentrations in Selected Wells (Continued)

Well ID	Event	Nitroaromatic Compounds (μg/l)					
		1,3,5-TNB	1,3-DNB	2,4,6-TNT	2,4-DNT	2,6-DNT	NB
MW-4028	Baseline	0.53	0.07	ND	0.12	0.13	ND
	Injection 1	0.56	0.095	ND	0.14	0.15	ND
	Injection 2	0.11	ND	ND	0.098	0.22	ND
	30-day	ND	ND	ND	0.20	ND	ND
	60-day	ND	ND	ND	ND	ND	ND
	15-month	ND	0.075	ND	0.13	ND	ND
	18-month	ND	ND	ND	0.13	0.29	ND
MW-4029	Baseline	0.98	0.13	ND	0.10	0.37	ND
	Injection 1	0.80	0.13	ND	0.13	0.42	ND
	Injection 2	0.89	ND	ND	0.12	0.45	ND
	30-day	0.76	ND	ND	0.084	0.31	ND
	60-day	0.91	0.10	ND	0.12	ND	ND
	15-month	1.4	0.13	ND	0.62	0.54	ND
	18-month	1.5	0.15	ND	1.0	0.50	ND
MW-4032	Baseline	1.2	0.06	ND	ND	0.18	ND
	Injection 1	1.2	0.10	ND	0.11	0.19	ND
	Injection 2	0.57	ND	ND	ND	ND	ND
	30-day	1.0	0.097	ND	0.15	0.19	ND
	60-day	1.4	(0.077)	ND	ND	ND	ND
	15-month	1.8	0.081	ND	0.083	ND	ND
	18-month	1.7	0.090	ND	0.092	0.19	ND
MW-S021	Baseline	0.09	ND	ND	0.13	ND	ND
	Injection 1	0.12	ND	ND	0.18	ND	ND
	Injection 2	0.10	ND	ND	0.11	ND	ND
	30-day	ND	ND	ND	0.26	ND	ND
	60-day	ND	ND	ND	ND	ND	ND
	15-month	ND	ND	ND	ND	ND	ND
	18-month	ND	0.094	ND	0.072	ND	ND

ND – Not detected

In summary, the pilot-phase in situ chemical oxidation (ICO) project appears to have achieved reduction of TCE concentrations for a period of time in the area of influence. However, data collected from some of these locations in 2003 indicated reappearance of the TCE concentration to the same levels before implementation. The sodium permanganate solution was distributed to a distance of about 100 ft from the injection point with the dispersion of the sodium permanganate favoring a downgradient direction toward the paleochannel features of the site. Uniform distribution of the injected chemicals was not achieved. The area bounded by the wells indicating impact by sodium permanganate was irregularly shaped indicating that homogeneous dispersion in each direction from the injection well did no occur. Dispersion of the sodium permanganate in groundwater was most likely affected by the hydrogeology of the area, with the permanganate following the preferential groundwater gradient toward the paleochannel.

The results of the pilot-phase ICO project could not be directly applied to the whole TCE area because of the nonuniform, heterogeneous nature of the site hydrogeology. The study was designed to perform the field tests at two locations within the impacted area: the first location was at a lower conductivity area with high TCE concentrations, and the second location was at a higher conductivity area with high TCE concentrations. However, this objective may not have been achieved during implementation, as other areas with lower conductivities and with TCE concentrations that exceed the MCL are known to be present. Consequently, uncertainties associated with defining the zone of influence of the injection points and defining the volume of oxidants needed to achieve the required reduction of TCE across the impacted area would still have to be addressed during the design of a full-scale remediation effort. The scope of the remedy described in the Interim Record of Decision (IROD) indicated that two sets of wells and two injections would achieve the MCL (these specifications were based on the understanding of the site and the knowledge regarding the innovative nature of the ICO technology at the time). However, preliminary remedial designs based on the results of the pilot-phase work indicated that at least 20 times as many injection wells would be needed and therefore, at least 20 times as much volume of the oxidant would need to be injected for a full-scale implementation. These estimates address the amounts needed at the initial phase of the implementation; additional injection wells and a greater volume of oxidants may be needed to attain the MCL. The limitations imposed by site hydrogeology on the design for full-scale implementation, coupled with concerns regarding potentially large increases in metals concentrations in groundwater associated with a large oxidant volume, and the persistence of the chemical in the aquifer were primary factors in the overall decision not to go forward with full-scale implementation of ICO.

More complete details of this study can be found in the *Completion Report for the Groundwater Sampling Performed in Support of the Pilot Phase ICO Project* (Ref. 19).

11. LONG-TERM SURVEILLANCE AND MAINTENANCE

The project transferred surveillance and maintenance responsibility for the Weldon Spring Site Remedial Action Project from DOE-Oak Ridge to DOE-Grand Junction on October 1, 2002. DOE-Grand Junction is responsible for the Long-term Surveillance and Maintenance (LTSM) Program at DOE facilities, providing long-term care for low-level radioactive material disposal sites.

During 2003, surveillance and maintenance activities primarily focused on issuing the next drafts of the *Long-Term Surveillance and Maintenance Plan for the Weldon Spring, Missouri, Site* (Ref. 38) and obtaining input from the public and regulators, and conducting the first annual site inspection. The following timeline highlights the long-term surveillance and maintenance events during 2003 and first quarter 2004.

Surveillance and Maintenance Timeline

January 30, 2003 — New resources available on the Weldon Spring LTSM Program website at www.gjo.doe.gov include:

- Availability of on-line viewing of all site documents listed in the *Long-Term Surveillance and Maintenance Plan* and key documents contained in the completed Administrative Records.
- Availability of on-line viewing of historical water-quality and water-level data for existing wells.

February 5, 2003 — Third Focus Area Work Session: Monitoring and Maintenance

May 30, 2003 — Issued the second draft of the *Long-Term Surveillance and Maintenance Plan for the Weldon Spring, Missouri, Site*. This plan reflected changes based upon written comments received on the first draft, input during the focus sessions, and any new information that has become available since the last draft.

October 28-29, 2003 — Conducted the first annual site inspection. A summary of the inspection has been provided at the end of this section.

March 12, 2004 — Issued the third draft of the *Long-Term Surveillance and Maintenance Plan for the Weldon Spring, Missouri, Site*. This plan reflects updates regarding institutional controls, the *Disposal Cell Groundwater Monitoring Plan*, and the Groundwater Operable Unit.

March 25, 2004 — Held the first annual LTS&M Informational Meeting.

Annual Inspection Summary

The Weldon Spring Site was inspected on October 28 and 29, 2003. This was the first annual surveillance and maintenance inspection at the Weldon Spring site and serves as a baseline for future inspections. The inspection was conducted in accordance with the draft *Long-Term Surveillance and Maintenance Plan for the Weldon Spring, Missouri, Site* (May 30, 2003), and associated inspection checklist. Representatives from the U.S. Environmental Protection Agency (EPA) and the Missouri Department of Natural Resources (MDNR) participated in the inspection. A representative of the Missouri Department of Conservation (MDC) participated in a half-day portion of the inspection.

The main areas inspected at the site were areas where future institutional controls will be established, the quarry, the disposal cell, Leachate Collection and Recovery System (LCRS), monitoring wells and assorted general features.

The Institutional Control areas were inspected to ensure the pending restrictions such as excavating soil, groundwater withdrawal, residential use, etc., were not being violated. Each area was inspected and no indications of violations of future restrictions were observed.

The disposal cell was inspected by walking ten transects over the cell and around the cell perimeter at the grade break and the base. No unusual settlement or other unusual observations were noted. Five areas of the cell were marked for annual observations of rock degradation. The LCRS was also inspected and found to be in good condition. Sixty-five of 120 groundwater monitoring wells were inspected and found to be in generally good condition. A few of the wells needed to be labeled with the proper identification numbers and/or repainted. Other site features including prairie, site markers and roads were also inspected.

Details of the inspection can be found in the *2003 Annual Inspection Report for the Weldon Spring Site St. Charles, Missouri* (Ref. 20).

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DOE ORDERS

231.1A, *Environment, Safety, and Health Reporting*
450.1, *Environmental Protection Program*
414.1A, *Quality Assurance*
5400.5, *Radiation Protection of the Public and the Environment*

REGULATIONS

10 CFR 835, *Occupational Radiation Protection*
29 CFR 1926.59, *Hazard Communication*
40 CFR 61, Subpart H, *National Emission Standards for Hazardous Air Pollutants*
40 CFR 141, *National Primary Drinking Water Regulations*
40 CFR 264, Subpart F, *Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*
10 CSR 20-7.031, *Water Quality Standards*
10 CSR 25-7, *Hazardous Waste Management Commission - Rules Applicable to Owners/Operators of Hazardous Waste Facilities*
10 CSR 60-4, *Public Drinking Water Program – Contaminant Levels and Monitoring*
10 CSR 80-3, *Solid Waste Management – Sanitary Landfill*

APPENDIX A
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Except for individual stakeholders, this distribution list is composed of people representing organizations, which have expressed interest in site activities. When individual turnover occurs in these positions, DOE will revise the list to reflect the current holder of these positions. This type of revision is considered minor and not subject to review. All individuals on this list will receive notices of upcoming meetings or the availability of certain documents such as the annual site inspection report, the 5-Year Review and proposed revisions of this Long-Term Surveillance and Maintenance Plan. If a document is the subject of the notice, then those individuals without an asterisk will also receive the document with notice.

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