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Proposed Plan for Remedial Action at the Quarry Residuals Operable Unit of the Weldon Spring Site

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U.S. Department of Energy
Weldon Spring Site Remedial Action Project
Weldon Spring, Missouri

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NOTATION

The following is a list of the acronyms, initialisms, and abbreviations (including units of measure) used in this document.

ACRONYMS, INITIALISMS, AND ABBREVIATIONS

ACL	alternate concentration limit
AEC	Atomic Energy Commission
ARAR	applicable or relevant and appropriate requirement
BRA	baseline risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FS	feasibility study
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
NCP	National Oil and Hazardous Substances Contingency Plan
NEPA	National Environmental Policy Act
NPL	National Priorities List
O&M	operation and maintenance
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
QROU	quarry residuals operable unit
QWTP	quarry water treatment plant
RD/RA	remedial design/remedial action
RI	remedial investigation
ROD	Record of Decision
TBC	to-be-considered (requirement)

Units of Measure

cm	centimeter(s)	m^3	cubic meter(s)
ft	foot (feet)	μg	microgram(s)
gal	gallon(s)	mi	mile(s)
gpm	gallon(s) per minute	mL	milliliter(s)
ha	hectare(s)	pCi	picocurie(s)
in.	inch(es)	ppm	part(s) per million
km	kilometer(s)	s	second(s)
L	liter(s)	yd^3	cubic yard(s)
m	meter(s)		

PROPOSED PLAN FOR REMEDIAL ACTION AT THE QUARRY RESIDUALS OPERABLE UNIT OF THE WELDON SPRING SITE

1 INTRODUCTION

This proposed plan addresses the management of contamination present in various components of the quarry residuals operable unit (QROU) of the Weldon Spring site, which is located in St. Charles County, Missouri (Figure 1). The QROU consists of (1) residual waste at the quarry proper; (2) the Femme Osage Slough, Little Femme Osage Creek, and Femme Osage Creek; and (3) quarry groundwater located primarily north of the slough. Potential impacts to the St. Charles County well field downgradient of the quarry area are also being addressed as part of the evaluations for this operable unit.

Remedial activities for the QROU will be conducted by the U.S. Department of Energy (DOE) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. As part of the remedial investigation/feasibility study (RI/FS) process required for the QROU under CERCLA, three major evaluation documents have been prepared to support cleanup decisions for this operable unit: (1) the RI report, which presents information on the nature and extent of contamination (DOE 1998a); (2) the baseline risk assessment (BRA) report, which evaluates potential impacts to human health and the environment that might occur if no cleanup action were taken (DOE 1998b); and (3) the FS report, which develops and evaluates remedial action alternatives (DOE 1998c). National Environmental Policy Act (NEPA) issues related to the quarry area have also been addressed as part of this evaluation process. The RI/FS is the source of the information presented in this proposed plan.

The purposes of the proposed plan are as follows:

- Present to the public a notice and a brief analysis of the remedial action activities being considered for the QROU, pursuant to Section 117(a) of CERCLA;
- Describe the alternatives for this remedial action;
- Identify the current preferred alternative and present the rationale for this preference;

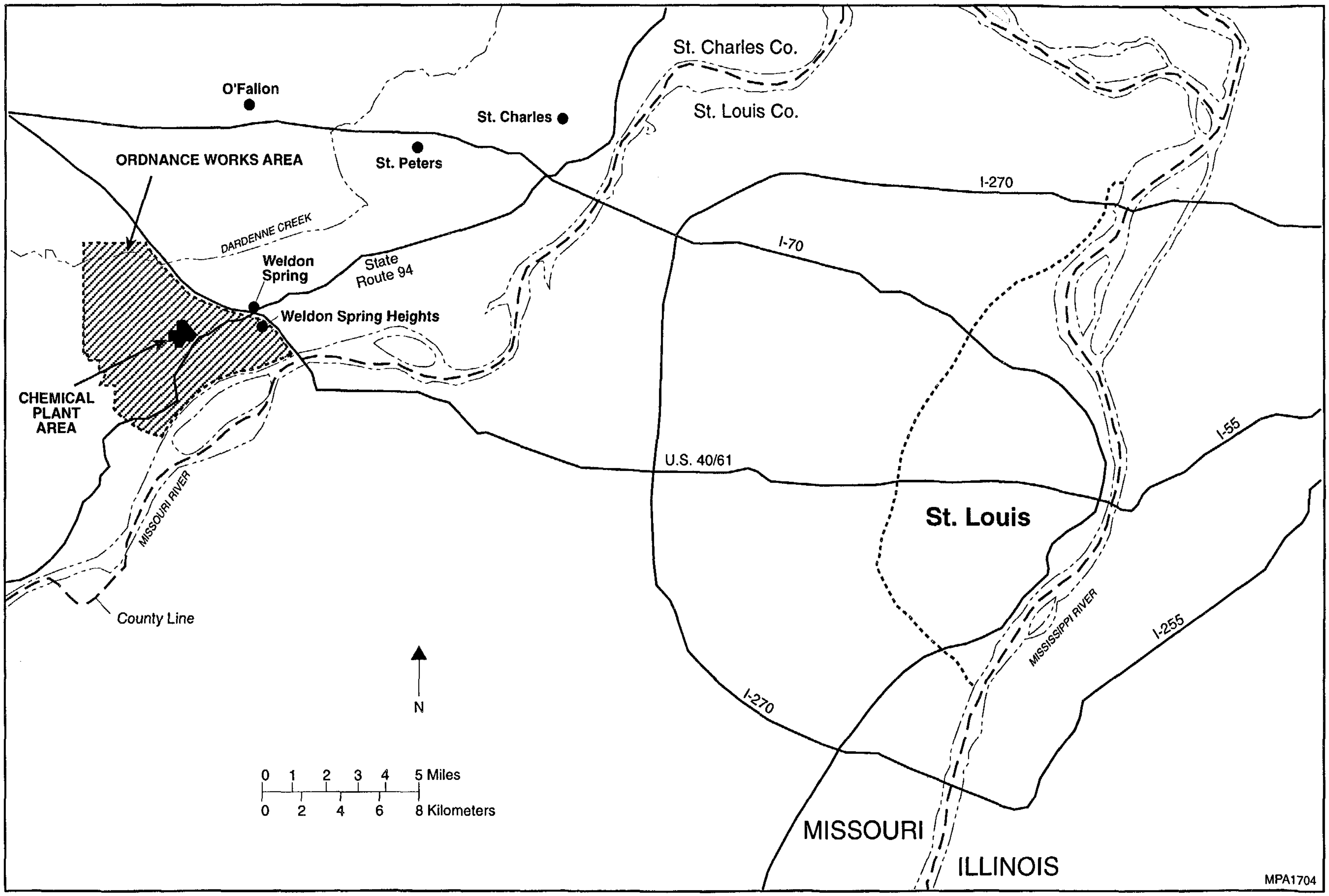

FIGURE 1 Location of the Weldon Spring Site

- Summarize key information from the RI, BRA, and FS; serve as a companion document for these reports; and support the Record of Decision (ROD) and administrative record for this action; and

- Provide information on the public's role in the decision-making process for this action.

The currently preferred alternative has been identified from an analysis of available data and an evaluation of the various alternatives for groundwater remediation at the quarry area. A final determination, however, has not yet been made; the alternative selected for implementation will be documented in the ROD, which will be issued following receipt and consideration of public comments and any significant new information that may become available. In publishing this proposed plan, DOE encourages public review and comment on the RI/FS. Information on the proposed remedial action may be found in the RI, BRA, and FS, and in supporting technical reports in the administrative record for this action (see Chapter 5). The remedial action alternatives are evaluated in detail in Chapters 3, 4, and 5 of the FS (DOE 1998c) and are summarized in Chapter 4 of this proposed plan.

Consideration of community input may result in modifications to the ultimate remedial action selected; consequently, the final decision may differ from the preferred alternative identified in this plan. Therefore, public comment on each alternative presented in this plan and on supporting information for the alternatives is an important element of the decision-making process for the remedial action for this operable unit, as it is for all cleanup decisions for the entire Weldon Spring site.

This proposed plan is organized as follows:

- Chapter 2 presents the history and setting of the QROU and briefly describes the nature and extent of contamination;

- Chapter 3 presents a summary of the results of the human health and ecological risk assessment conducted for the QROU;

- Chapter 4 provides a brief summary of the preliminary alternatives discussed in the FS;

- Chapter 5 briefly describes the final alternatives considered for the remedial action;

- Chapter 6 describes the proposed action;

- Chapter 7 presents the community's role in this action; and
- Chapter 8 lists the references cited in this proposed plan.

2 SITE BACKGROUND

2.1 DESCRIPTION AND HISTORY

The Weldon Spring quarry is located in St. Charles County, Missouri, about 8 km (5 mi) southwest of the city of Weldon Spring and 48 km (30 mi) west of the city of St. Louis. The quarry is about 6.4 km (4 mi) south-southwest of the chemical plant area. The quarry is surrounded by the Weldon Spring Conservation Area (Figure 2).

The quarry is about 300 m (1,000 ft) long by 140 m (450 ft) wide and covers an area of approximately 3.6 ha (9 acres). It was used by the Army for disposal of chemically contaminated (explosive) materials beginning in the 1940s and was transferred to the U.S. Atomic Energy Commission (AEC) in July 1960 for use as a disposal site for radioactively contaminated materials.

In October 1995, approximately 107,037 m^3 (140,000 yd^3) of soil and waste material was removed from the quarry. This material was transported to the chemical plant area for final placement in the disposal cell, which will soon be completed.

Before bulk waste removal, an estimated 11,000 m^3 (3 million gal) of contaminated water contained in the quarry pond was also removed and treated. Although the quarry pond is technically considered a surface water body, it is actually isolated from the surface water system. The quarry pond collects rainwater and surface water runoff from the rim and higher levels of the quarry proper. The pond also receives some groundwater discharge along its northern, upgradient wall and discharges to the groundwater via horizontal partings near the Kimmswick Limestone/Decorah Formation contact along its southern wall.

Currently, routine monitoring is performed for uranium. Since April 1996, uranium levels have fluctuated between 400 and 550 pCi/L but have never exceeded the 600 pCi/L criterion (DOE 1998a). In addition, restoration of the quarry itself is currently being planned. Plans include removal of remaining potentially contaminated soils and structures, backfilling the quarry, final grading, and haul road restoration. One of the first tasks of restoration is the removal of existing structures (e.g., the quarry water treatment plant [QWTP] and associated structures) and contaminated soils remaining in the quarry proper, primarily soils in the North Slope area. Preliminary characterization of the North Slope area has been performed; results indicate the presence of potentially contaminated soil. Because the area is fairly steep, a complete determination has not been possible. The potential, if any, for exposure to these contaminated soils is low because they are inaccessible. However, a final determination regarding accessibility and potential exposure to these soils will be made once the restoration is completed. Then any remaining contamination that could result in potentially unacceptable exposure will be removed. Some minor residual

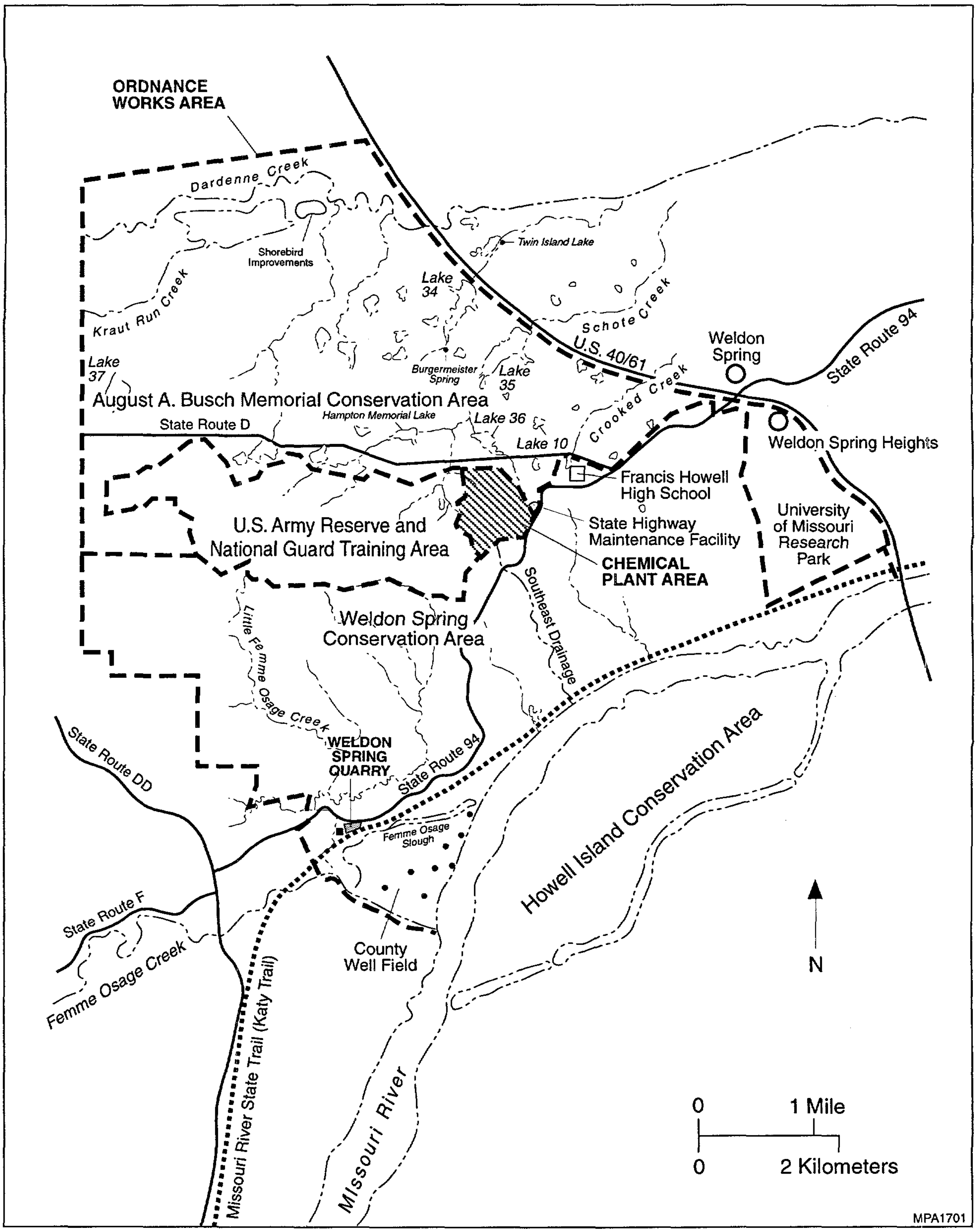

FIGURE 2 Area near the Weldon Spring Quarry

contamination present within the drainage ditch near the transfer station and possibly soils underneath the transfer station will also be removed.

The current restoration design plan includes backfilling the quarry with soil to reduce fall hazards and to stabilize the north and south highwalls. The backfill will cover and fill all floor fractures at the 152-m (500-ft) bench and below with at least 2 m (5 ft) of material. The material used for backfill will be engineered to reduce the potential for mobilization of residual contaminants into the groundwater. Restoration will be designed to either force groundwater flow around the inner quarry area, or alternatively, cause the groundwater within the footprint of the inner quarry area to pass through an attenuation layer to prevent the flow of contamination. More definitive specifications for the backfill will be determined during the quarry restoration design. The design will also effectively prevent residual contaminants in the cracks and fissures (i.e., flakes of yellowcake) from mobilizing to the surface through erosion and/or freeze/thaw action, further reducing the low potential risks associated with external gamma radiation and ingestion. Mobilization of contaminants into the groundwater will not be likely, because the benches are in the unsaturated portions of the bedrock, and infiltration of precipitation will be prevented by the final grading designed to promote sheetflow. Restoration will be designed to prevent ponding of water in the quarry and to minimize erosion. Final grading of the quarry will be accomplished to leave the area compatible with sheetflow and to return the area to conditions that are as close as possible to its natural contours. Haul road restoration is expected to be minimal. Restoration activities are currently planned for the fall of 1999.

2.2 SITE ENVIRONMENTAL SETTING

2.2.1 Soil and Geology

Unconsolidated surficial materials are present in the area of the Weldon Spring quarry: loess deposits and residual soils cover the upland regions and alluvium that occurs along the stream and river valleys. Coarse-grained deposits constitute the bottom 6 to 24 m (20 to 80 ft) of the Missouri River floodplain. Fine-grained deposits constitute the upper 4.6 to 7.6 m (15 to 25 ft) of the Missouri River floodplain and the full thickness of Little Femme Osage Creek and the Femme Osage Creek alluvium (DOE 1998a).

The uppermost bedrock unit in the vicinity of the quarry is the Kimmswick Limestone. The Kimmswick Limestone is underlain in descending order by the Decorah Group, Plattin Limestone, Joachim Dolomite, and St. Peter Sandstone. The sides of the quarry expose the Kimmswick Limestone, whereas the bedrock floor of the quarry lies in the upper portion of the Decorah Group. The contact between the Kimmswick Limestone and Decorah Group, which may provide the primary pathways for migration of contaminants from the quarry area, is in contact with fine-grained soils, silty clay, and organic silt and clay north of Femme Osage Slough (DOE 1998a).

2.2.2 Hydrogeology

Groundwater in the vicinity of the quarry occurs in alluvium, fractured limestone, and sandstone (Berkeley Geosciences Associates 1984). The uppermost groundwater unit is composed of carbonate rocks near the quarry, tributary alluvium near Little Femme Osage Creek, and Missouri River alluvium between the quarry bluff and the Missouri River. Water-table (unconfined) conditions typically occur in the alluvium; confined to semiconfined conditions occur in the bedrock and alluvium where layers of varying permeability are present. The St. Peter Sandstone, about 90 m (300 ft) below the floor of the quarry, constitutes the deeper aquifer.

In the vicinity of the quarry, groundwater flows primarily from north to south, and a westward gradient runs from the quarry to Little Femme Osage Creek. South of the quarry rim, the direction of the groundwater flow is generally south to southeast toward Femme Osage Slough. In the alluvium south of the slough, groundwater is within 3 m (10 ft) of the ground surface, although the depth to water varies with seasonal pumping demands in the nearby St. Charles County well field and with water levels in the Missouri River.

Between Katy Trail and the slough, shallow groundwater flows through fine sediments that have low hydraulic conductivities. Well yields in this area typically range from less than 0.03 to 0.16 L/s (0.5 to 2.5 gpm). With increasing distance from the slough, the sediments become more coarse and the hydraulic conductivity increases. The St. Charles County wells pump an average of 10.5 million gallons per day for the typical five-well production scheme.

The hydraulic gradient between Katy Trail and the slough is generally southward toward the slough. In general, the groundwater elevation data indicate a southeasterly gradient across the slough. At most locations, the slough is a source of recharge to the shallow groundwater. However, at some locations north of the slough, groundwater levels are higher, indicating discharge to the slough (DOE 1998a).

Recharge to the bedrock in the vicinity of the quarry is limited to infiltration from precipitation or storm runoff. The bedrock discharges to the Missouri River alluvium. Recharge to the alluvium south of the slough occurs primarily from the Missouri River, intermittent surface flooding, infiltration of precipitation, and discharge from the bedrock.

2.2.3 Biotic Resources

Much of the land surrounding the quarry consists of state-owned conservation areas containing second-growth forest. Nonforested areas, which cover much of St. Charles County, are largely used for crop production and pasture or are old-field habitat.

Aquatic habitats in the vicinity of the quarry include the Missouri River, Little Femme Osage Creek, Femme Osage Slough, and numerous small, unnamed creeks, drainage areas, and ponds throughout the Weldon Spring Conservation Area. In addition, the nearby August A. Busch Memorial Conservation Area contains more than 35 ponds and lakes; however, these ponds and lakes are in the Mississippi drainage and are not influenced by the quarry area.

The U.S. Fish and Wildlife Service (Frazer 1995) has identified the potential for five federal-listed threatened or endangered species to occur in the vicinity of the quarry area: three birds (bald eagle, peregrine falcon, and interior least tern), one fish (pallid sturgeon), and one plant (decurrent false aster). The Fish and Wildlife Service has also identified several candidate species as possibly occurring in the area. The Missouri Department of Conservation has identified 13 state endangered and 19 state rare species for St. Charles County (Dickneite 1995). However, many of these species are not expected to occur at the quarry area; some only pass through the area during migration. For other species, suitable habitat is absent from the quarry. To date, only the bald eagle has been observed in the vicinity of the quarry (DOE 1998a), and all of those birds were sighted near the Missouri River and away from the quarry proper.

2.2.4 Nature and Extent of Contamination

The nature and extent of contamination at the QROU are discussed in detail in the RI (DOE 1998a). Contaminated media at the QROU can be generally divided into three separate categories: (1) residual soil inside the quarry proper and alluvial soil outside the quarry proper, (2) contaminated surface water and sediment at Femme Osage Slough and nearby creeks (Little Femme Osage Creek and Femme Osage Creek), and (3) contaminated groundwater in the shallow aquifer system (primarily north of the slough). Samples were also collected for each medium of concern from areas that have not been affected by site operations to determine naturally occurring (background) concentrations of chemical and radiological constituents in the site vicinity.

2.2.4.1 Soil

At the quarry proper, soil was sampled from the rims and slopes, and sediment was sampled from wall and floor fractures and from the ramp and floor of the quarry sump. Potential contaminants identified in soil samples from the rims and slopes included several metals, radionuclides, nitroaromatic compounds, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). In disturbed soil on the rim and knoll of the quarry, only selenium, silver, zinc, radium-226, thorium-230, and uranium-238 were detected at concentrations significantly higher than background levels. In samples from the quarry fractures, lower levels of contamination were found in the wall fractures than in floor fractures. Radium, thorium, and uranium isotopes and aluminum, selenium, and silver were detected at low (but greater than background) levels. Samples collected from the sump area were primarily contaminated with radium-226, thorium-230, uranium, and low levels of PAHs. In addition, results from a radiological survey of the quarry rock surfaces indicated readings at background levels.

Outside the quarry proper, surface and subsurface soil samples were collected; the focus was on the area south of the quarry between the Katy Trail and Femme Osage Slough. The area sampled included Vicinity Property 9, which was remediated in 1996 under the ROD for the chemical plant area (DOE 1993). Low concentrations (but higher than background levels) of uranium are sorbed onto soils located between the quarry and the slough. Lead and zinc were detected at low levels (above background) in shallow soils south and east of the quarry. Elevated levels of metals in this area may have been transported in groundwater from the quarry. They may also have been derived from flood-related overbank deposits of fine sediment carried by the Missouri River or from runoff from the Ordnance Works area. Low levels (i.e., less than 1.7 ppm) of nitroaromatic compounds were detected in soils to the east, west, and south of the quarry. Contamination was generally found in the shallow soil, but was also detected in a few locations in the deeper intervals. Nitroaromatic contamination in soils is likely a result of groundwater transport and sorption on organic material.

2.2.4.2 Femme Osage Slough and Creeks

Surface water and sediment from the upper and lower reaches of the Femme Osage Slough, Little Femme Osage Creek, and downstream portion of Femme Osage Creek have been characterized for radiological and chemical contamination. Contaminants detected at concentrations higher than background levels in surface water in both the slough and creeks included aluminum, chromium, iron, and zinc. Uranium, sulfate, nitrate, and slightly elevated levels of arsenic, manganese, nickel, and strontium were detected only in the slough. Silver and low levels (i.e., less than 0.1 μg/L) of nitroaromatic compounds were detected in surface water in the creek only. Nitroaromatic compounds were detected in Little Femme Osage Creek upgradient of the quarry; the source of this contamination is believed to be runoff from the Weldon Spring Ordnance Works area.

Contaminants detected at concentrations above background levels in slough sediment include uranium, sulfate, nitroaromatic compounds, aluminum, beryllium, cadmium, calcium, chromium, copper, magnesium, manganese, mercury, molybdenum, nickel, selenium, strontium, and vanadium. Uranium, calcium, magnesium, and strontium concentrations were also elevated in creek sediment, but in general, contaminant concentrations were lower than in the slough. An exception was antimony, which was not detected in the slough.

Contamination in the creek may be attributable to past site activities or flood deposition from the Missouri River. Low levels of uranium in sediment may be the result of runoff from former Vicinity Property 8. Plausible sources of contamination in the slough include groundwater seepage, runoff from Vicinity Property 9 prior to remediation, and mixing with Missouri River water. Concentrations of several metals that were elevated in the creek and slough were also elevated in the river.

Fish from Femme Osage Slough were collected and analyzed to investigate any potential impacts from site contaminants. Species sampled from the slough included white and black crappie, largemouth bass, sunfish, and several bottom feeders such as bigmouth buffalo, yellow bullhead, and common carp. Fish samples were analyzed for uranium, radium, thorium, arsenic, lead, and mercury. Samples were prepared as fillets, fishcakes, and whole body samples. Analyses indicated low concentrations of metals (i.e., lead, arsenic, and mercury) and uranium, similar to concentrations detected in the background samples collected from Busch Lakes 33 and 37. Radium and thorium isotopes were not detected in any samples.

2.2.4.3 Groundwater

Groundwater underlying the quarry area has been characterized on the basis of data collected from a network of monitoring wells. This network includes 19 wells that monitor groundwater in the bedrock system and 30 wells that monitor groundwater in the alluvium; the latter include the St. Charles County wells (see Figure 3). Ten years of data were evaluated in determining the nature and extent of contamination. The primary contaminants in groundwater are uranium and nitroaromatic compounds. These contaminants were likely derived from contaminated bulk wastes that were previously disposed of in the quarry. Although other contaminants were present in quarry bulk wastes, these contaminants are more soluble and leached from the bulk wastes into the bedrock and alluvial aquifer.

Contamination in groundwater is primarily limited to the area north of the slough. Over the 10 years of monitoring, nitroaromatic compounds at concentrations greater than 1 µg/L have been detected in only six wells: four shallow bedrock wells and two alluvial wells located north of the slough. Nitroaromatic compounds have not been detected south of the slough. Uranium contamination extends from the southern margin of the quarry eastward and southward to the slough. The highest concentrations of uranium have been detected in wells along the southern rim of the quarry and southward in the alluvium near Vicinity Property 9. South of the slough, slightly elevated uranium levels (i.e., less than 10 pCi/L) have been detected at monitoring well RMW-2. Measured concentrations of radioactive and chemical contaminants in wells at the St. Charles County well field are at background levels.

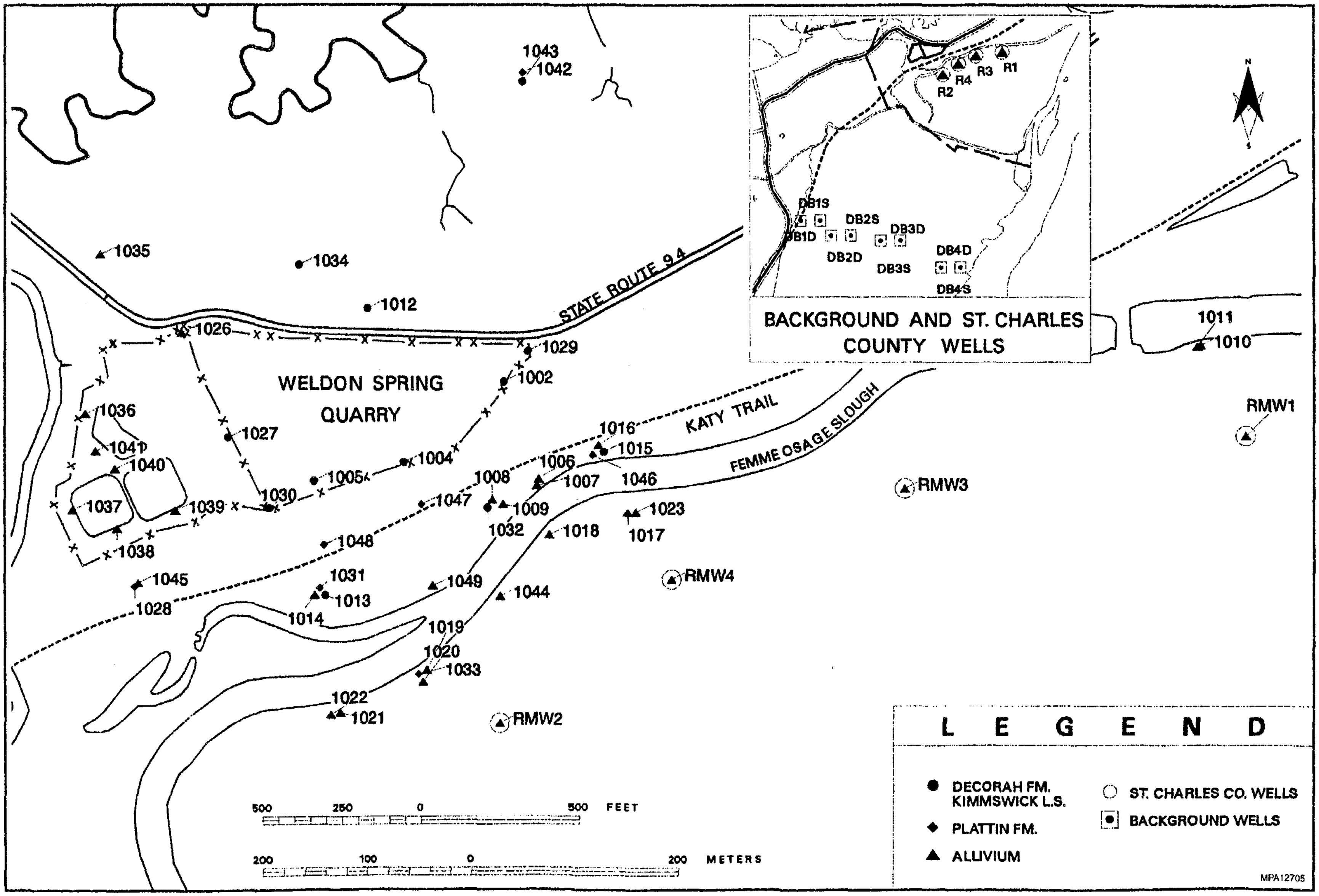

FIGURE 3 Locations of Background Wells, DOE Wells, and St. Charles County Wells

3 SUMMARY OF SITE RISKS AND REMEDIATION GOALS

Potential impacts to humans, biota, and other environmental resources that might occur at the quarry area if no remedial actions are conducted were assessed as part of the process for selecting an appropriate remedial action. The complete assessment is discussed in the BRA (DOE 1998b) and the key results are summarized in Sections 3.1 and 3.2 below.

3.1 HUMAN HEALTH ASSESSMENT

Potential cancer risks posed by exposure to radiation and chemicals were assessed using standard methods developed by the U.S. Environmental Protection Agency (EPA) and other agencies. To limit the likelihood of an individual getting cancer from exposure to contamination at a site included on the National Priorities List, the EPA established a range — 1 in 1 million to 1 in 10,000 — as the incremental lifetime risk of cancer associated with possible exposures (EPA 1990). This "acceptable range" provides a point of reference for discussing the results of the carcinogenic risk assessment for the QROU.

To put this risk range in context, it is estimated that about one in three Americans will develop cancer during their lifetime from all sources (American Cancer Society 1992) and that the risk from exposure to radiation naturally present in the environment (primarily radon) is about 1 in 100 (EPA 1989a). Thus, the acceptable range is a very small percentage of the cancer risk expected in the general U.S. population from everyday exposures. For example, the incremental risk at the upper end of EPA's range means that if all persons in a population of 10,000 were assumed to be repeatedly exposed to site contaminants, one additional person might get cancer as a result of those exposures compared with the estimated 3,000 cancer cases expected from all other exposures; that is, the number of persons who would be expected to develop cancer in that population would be 3,001 instead of 3,000.

Potential health effects other than cancer that could result from exposure to chemical contaminants were also assessed. The quantitative measure of noncarcinogenic health effects is the hazard index. The EPA has defined a hazard index of greater than 1 as indicating possible adverse noncarcinogenic health effects.

A recreational visitor scenario was used to project potential human exposures to contaminants identified in the RI for the quarry area (DOE 1998a). This scenario is considered representative of current land use at the quarry area (primarily north of the slough and the slough itself); future land use is expected to remain similar to current use. Groundwater from the well field is used for residential purposes; however, monitoring data indicate that concentrations at the well field are similar to background levels. The contaminated quarry groundwater is not accessible to either current and future recreational users. For informational purposes, calculations for groundwater were also performed for hypothetical residential use. The various exposure pathways and associated risks estimated for the quarry proper, Femme Osage Slough and creeks, and quarry groundwater are summarized in the BRA report prepared to support this proposed plan (DOE 1998b).

- *Recreational visitor scenario.* The results of the risk calculations for the recreational visitor at the quarry proper and at Femme Osage Slough indicate that cancer risks from exposure to radiation and chemicals are below to within the EPA's acceptable risk range of 1 in 1 million to 1 in 10,000 (EPA 1989b). Hazard indices are also less than 1, indicating that noncarcinogenic health effects would not likely result from exposure to chemicals at the quarry area. The risk of developing radiation-induced cancer is 3 in 100,000 for the recreational visitor exposed to contaminants at the various locations (i.e., cumulative risk from exposure to contaminants at the quarry proper and at Femme Osage Slough and creeks); this estimate incorporates multiple contaminants, media, and pathways. The risk of developing cancer from exposure to chemicals is 4 in 1 million for recreational visitors. The hazard index for recreational visitors is estimated to be 0.05.

- *Hypothetical residential use scenario.* As discussed previously, for informational purposes, carcinogenic health risks and hazard indices were also estimated for a hypothetical resident for ingestion of and dermal contact with quarry groundwater. Calculations were performed assuming exposure at each of the monitoring wells that have been sampled. The risk of developing cancer from exposure to chemicals is estimated to range from 1 in 10 million to 1 in 10,000. The risk of developing radiation-induced cancer (from uranium) is estimated to range from 2 in 10 million to 6 in 1,000. Risks greater than 1 in 10,000 were estimated for wells located south of the quarry and north of the slough. Hazard indices greater than 1 were also estimated for a few wells located in this area.

3.2 ECOLOGICAL ASSESSMENT

Femme Osage Slough and Little Femme Osage Creek are the principal habitats at the quarry area where biota could be exposed to quarry-related contaminants. A screening level assessment employing very conservative exposure scenarios was conducted for these habitats. This assessment revealed that current levels of aluminum, barium, manganese, and uranium in the surface water of Femme Osage Slough and Little Femme Osage Creek pose a potential risk to aquatic biota using these habitats. Risk estimates or quotients for these contaminants were greater than 1, indicating the potential for risk and a need for further ecological evaluations of the aquatic habitats in the slough and creek. No or low risks were identified for other contaminants in surface water at the quarry area. Arsenic, cadmium, lead, manganese, mercury, nickel, and zinc are present in sediments at concentrations estimated to result in low risk to aquatic biota. No risks from nitroaromatic compounds were indicated in either surface water or sediment. Modeling results indicated no risks to modeled terrestrial wildlife receptors foraging in Femme Osage Slough or drinking from Little Femme Osage Creek.

Because screening risk estimates for several metals indicated potential risks, as discussed above, surveys of aquatic and terrestrial biota were conducted at the quarry area to further evaluate actual impacts. The survey results indicate that the existing aquatic and terrestrial communities consist of species that would be expected to occur in the area. No impacts to abundance or species diversity of aquatic invertebrates were detected. Internal and external examinations of small mammals collected from the site showed no abnormalities that might indicate adverse effects from exposure to site contaminants. Analyses of tissues from fish and small mammals indicated uranium concentrations within the range reported in the literature for North America for which no adverse effects have been observed. Concentrations of radionuclides in the tissue of small mammals collected from the quarry area were comparable to concentrations detected in specimens from reference sites.

3.3 RISK ASSESSMENT CONCLUSION

The current levels of contamination in surface water and sediments from Femme Osage Slough and Little Femme Osage Creek do not appear to have affected ecological resources at these habitats and do not pose a future risk to biota at the site. This conclusion is supported by the absence of any observable adverse effects to aquatic or terrestrial biota, the generally low levels of potential risk estimated for aquatic biota, and the lack of risks estimated for terrestrial biota. Thus, remediation of these habitats is not indicated on the basis of potential ecological concerns.

Similarly, on the basis of the risk estimates reflecting current and foreseeable future land use, remediation is not indicated at the quarry proper, Femme Osage Slough and creeks, and the quarry groundwater primarily north of the slough. However, because of the proximity of the St. Charles County well field, applicable response options to reduce or remove the uranium in quarry groundwater are being considered.

3.4 OBJECTIVES OF THE FEASIBILITY STUDY

As discussed previously, remediation to reduce human health and environmental risks is not indicated. Concentrations of uranium appear to be elevated in quarry groundwater primarily north of the slough; concentrations in groundwater south of the slough, including those at the well field, are similar to background levels. Nevertheless, it was considered prudent to identify an option that could reduce or remove uranium from quarry groundwater. A reduction in the amount of uranium north of the slough would reduce the amount that could migrate to the well field — if migration is occurring or could occur. A *Well Field Contingency Plan* (DOE 1998d) was developed to ensure the safety of drinking water supplied to residents of St. Charles County from this well field. Any remedial actions performed for this operable unit would be integrated with pertinent aspects of this contingency plan.

The remaining components of the QROU (i.e., quarry proper, Femme Osage Slough, and creeks) have been determined not to require remediation, either from the perspective of contamination present at these components or from consideration of cumulative risk for an individual who is exposed to contaminants at the various components or areas constituting the QROU. Residual contaminants at the quarry proper have been determined to be at concentrations that are within the acceptable risk range of 1 in 1 million to 1 in 10,000 as prescribed by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Likewise, at Femme Osage Slough and the creeks, contaminant levels are low and do not pose unacceptable risks to human health and ecological receptors.

Quarry groundwater is not currently used, and future use is unlikely. The low permeability of the alluvial aquifer where contamination exists should discourage groundwater use in the area. The low pump rates and low yields would not be expected to support any sustained human use of the groundwater.

Although migration of uranium to the county well field is possible and could be occurring (probably at very low rates), the impact from this migration, if any, is not indicated by monitoring data obtained from wells south of the slough, with the exception of one well (RMW-2). Ten years of monitoring data from wells south of the slough, including the production wells in the well field, indicates uranium concentrations similar to background. Data from RMW-2 have consistently been slightly greater than background since the well was installed (average of 6 pCi/L, maximum of 10 pCi/L, compared to a background value of 2.77 pCi/L that was statistically determined for the QROU). Natural levels of uranium at nearby (off-site) areas have been measured and are similar or higher than the background level established for the QROU and those of RMW-2. For example, at Darst Bottoms, a maximum value of 14 pCi/L has been measured.

3.5 REMEDIATION GOALS FOR QUARRY GROUNDWATER

The primary remediation goal for the QROU is to reduce the amount of uranium in quarry groundwater north of the slough, thereby reducing the amount of uranium that could potentially migrate to the St. Charles County well field.

Current concentrations in three monitoring wells slightly exceed the applicable or relevant and appropriate requirement (ARAR) of 0.11 µg/L for 2,4-DNT. Current data indicate that the ARAR of 17 µg/L for nitrobenzene is not exceeded. Current data also indicate only one exceedence of the 1.0 µg/L standard for 1,3-dinitrobenzene; a maximum concentration of 3.5 µg/L was reported for one well. This data point could be an anomaly because in this same sample, concentrations of other chemical constituents were also higher than typically reported for this well.

No federal or state maximum contaminant level (MCL) or maximum contaminant level goal (MCLG) exists for uranium in drinking water. In 1991, the EPA published a proposed rule setting an MCL for uranium at 20 µg/L (EPA 1991). The proposed MCL corresponds to 14 pCi/L for the activity concentration ratio of uranium isotopes found in the groundwater at the quarry area. However, this proposed rule has never been finalized and, therefore, cannot be an ARAR. The proposed rule may be a "to-be-considered" (TBC) requirement that can be used to assist in the formulation of goals for groundwater in the quarry area. It should be noted that MCLs and MCLGs apply to concentrations at the point at which the water is consumed, that is, at the tap; they are not applicable to contaminated groundwater in environmental settings such as at the quarry area.

In 1995, the EPA promulgated a final rule setting groundwater standards for remedial actions at inactive uranium processing sites (Title 40, Part 192, of the *Code of Federal Regulations* [40 CFR Part 192]). Although the rule is applicable only at 24 specified inactive uranium processing sites, it may be considered relevant and appropriate to the actions being evaluated in the FS. The NCP outlines a process to determine whether a standard is relevant and appropriate to a particular remediation activity or site. The 30 pCi/L standard is relevant because it applies to the same contaminant (uranium) in the same medium (groundwater). However, this standard was developed for environmental conditions different than those in the quarry area. The 30 pCi/L uranium standard for groundwater at the 24 designated inactive uranium processing sites addressed under 40 CFR Part 192 was developed for sites generally located in arid regions of the western United States where water is a scarce resource. The cost of remediating contaminated groundwater at these sites to meet drinking water standards was justified by the EPA because of the general lack of readily available alternate sources of potable water. This is not the case for the quarry area, given the proximity of the Missouri River. So this standard may not be applicable.

Although the appropriateness of the 30 pCi/L standard to quarry area groundwater is questionable, the standard does provide a metric for evaluating remedial action alternatives in the FS. This standard was promulgated to provide an adequate margin of safety against both carcinogenic and systemic toxicity effects of uranium in groundwater. It is equivalent to a risk level of approximately 1 in 100,000, if the water is consumed at a rate of 2 L/day for 350 days per year over a period of 30 years. The average high concentration of uranium north of the slough is estimated to be approximately 2,800 pCi/L. Modeling of uranium transport in groundwater from the area north of the slough to the nearest production well indicates that the uranium concentration would be reduced to approximately 21 pCi/L, which is below the 30 pCi/L metric (DOE 1998a). So, the metric would be met at the well field with no remediation of the contaminated quarry groundwater.

The remediation goal for the QROU — to reduce the amount of uranium that could potentially migrate to the St. Charles County well field — will be achieved by removing as much uranium from this groundwater as is reasonably possible by means of standard engineering approaches. No remediation is warranted on the basis of current or hypothetical future risks from exposure to nitroaromatic compounds in quarry groundwater. This conclusion is supported by the fact that concentrations of nitroaromatic compounds have decreased significantly since bulk waste removal, and by recent data indicating that only a few concentrations slightly exceed Missouri water quality standards. These concentrations are expected to continue to decrease over time. A detailed discussion of ARARs is presented in Appendix A of the FS (DOE 1998c).

4 SUMMARY OF PRELIMINARY ALTERNATIVES

Remedial action alternatives addressing contaminated groundwater at the quarry area were developed for the QROU by identifying potentially applicable remedial technologies and process options. A broad range of remediation technologies, both in situ and ex situ, were considered for application at the QROU to address the contaminated groundwater. In situ technologies considered included containment approaches such as barrier walls or immobilization methods and in situ treatment approaches such as uranium mining, natural processes, or newer innovative technologies such as electrokinetics, phytoremediation, and treatment walls. Groundwater removal technologies, including conventional and nonconventional well extraction, interceptor trenches, and excavation were considered for ex situ treatment. Conventional and newer innovative technologies for ex situ groundwater treatment using physical, chemical, and biological methods were also evaluated. From these technologies, six broad alternatives were developed in the FS that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste. The following six alternatives are based on the assumption that groundwater monitoring would be conducted for each of the preliminary action alternatives throughout the cleanup period to evaluate whether the groundwater action was achieving, or would achieve, the intended response objectives. Monitoring would be continued as needed for those alternatives not involving active removal of contaminants from the groundwater.

Alternative 1 (No Action Alternative), as required by CERCLA regulations, is intended to provide a baseline for comparison with the other alternatives being evaluated. No further action would be taken at the site, and any existing ongoing maintenance and monitoring would be discontinued.

Alternative 2 (Monitoring with No Active Remediation) would involve routine sampling and analyses (to monitor for continued contaminant migration) and the potential construction of new monitoring wells, conservatively assumed to be 15% of the number of existing wells. This alternative would rely upon the groundwater's natural ability to reduce contaminant concentrations through physical, chemical, and biological processes to achieve cleanup goals. This approach is considered at sites where groundwater removal has been determined to be technically impracticable and where it has been determined that active remedial measures would be unable to significantly speed remediation.

Alternative 3 (Groundwater Removal, On-Site Treatment) would involve the removal of contaminated groundwater by means of interceptor trenches. The groundwater would then be pumped to and treated, using a sequence of physical and chemical unit operations, at either the existing QWTP or a similar facility and subsequently be released to an appropriate discharge point. The analysis assumed that an interceptor trench, measuring 1 m (3 ft) in width and about 600 m

(2,000 ft) in length, located north and east of Femme Osage Slough, would be required to achieve a reasonable extraction rate and to contain any potential migration of contaminants to the slough.

Alternative 4 (Containment) would involve isolating the subsurface contamination by using vertical barriers to contain and prevent contaminated groundwater near the quarry area from migrating to the St. Charles County well field, thereby reducing the associated potential for exposure. A 600-m (2,000-ft) vertical slurry wall containing bentonite for containment purposes was assumed to be based (keyed in) about 0.6 to 0.9 m (2 to 3 ft) into the bedrock to provide an effective foundation with minimum potential for leakage.

Alternative 5 (In-Situ Treatment Using Permeable Barriers) would involve in situ treatment of the quarry groundwater using a permeable barrier to reduce uranium concentrations in groundwater to 30 pCi/L and below immediately north of Femme Osage Slough. The analysis assumed that a permeable barrier 1 m (3 ft) in width and about 600 m (2,000 ft) in length, composed of clinoptilolite (a hydrated sodium-potassium-calcium aluminosilicate natural mineral in the zeolite family), would be used to treat/remove uranium while allowing passage of the groundwater.

Alternative 6 (Groundwater Removal at Selected Areas, On-Site Treatment) would involve the removal of groundwater at selected areas where contaminant concentrations are relatively high. As part of this alternative, an interceptor trench would be placed between wells MW-1014 and MW-1016. Data from monitoring wells located in the approximate area of the proposed trench have indicated uranium concentrations from 200 to 3,000 pCi/L. It is estimated that between 10 and 20 million gallons per year could be collected at the trench and treated at either the existing QWTP or at a portable treatment facility on-site. Treated groundwater would then be released at an appropriate discharge point (e.g., Missouri River). Sampling and analysis of groundwater samples at specific locations would also be performed in order to measure the performance of the alternative.

The evaluation of each alternative in accordance with the three criteria defined in 40 CFR Part 300 (effectiveness, implementability, and cost) is presented in Table 3.1 of the FS (DOE 1998c). On the basis of the screening process, the following alternatives were not retained for further consideration:

- Alternative 3: Groundwater Removal, On-Site Treatment;
- Alternative 4: Containment; and
- Alternative 5: In-Situ Treatment Using Permeable Barriers.

Alternative 3 was not retained because preliminary simulation results indicate that remediation time frames on the order of hundreds of years would be necessary to restore the groundwater system using interceptor trench technology. These projected remediation time frames would require groundwater treatment capacity to extend considerably beyond the design life of the QWTP and would require replacement plants for many years into the future to satisfy long-term removal and treatment needs.

Alternative 4 was not retained for further consideration because the performance of the remediation process is highly uncertain. This alternative may require continuous replacement of the slurry wall. The contamination would be contained within the quarry area without subsequent treatment and thus could migrate toward the St. Charles County well field following wall failure. The projected restoration time frame is indefinite.

Alternative 5 was not retained for further consideration because the technology is not mature. The unavailability of specific application and performance data may contribute to high uncertainty during the remedial design phase. The projected remediation time frame is on the order of hundreds of years.

On the basis of the screening process, the following alternatives were retained for detailed evaluation:

- Alternative 1: No Action;
- Alternative 2: Monitoring with No Active Remediation; and
- Alternative 6: Groundwater Removal at Selected Areas, with On-Site Treatment.

5 DESCRIPTION AND ANALYSIS OF FINAL ALTERNATIVES

The six preliminary alternatives summarized in Chapter 4 were screened on the basis of effectiveness, implementability, and cost. Three alternatives were retained through the screening process:

Alternative 1: No Action;

Alternative 2: Monitoring with No Active Remediation; and

Alternative 6: Groundwater Removal at Selected Areas, with On-Site Treatment.

These final alternatives are described in Section 5.1, evaluated in Section 5.2, and compared in Section 5.3. The preferred alternative is briefly summarized in Section 5.4. The technology options discussed in this proposed plan are considered representative of the general technologies that define the alternatives. Representative components that have been evaluated for this analysis, such as types of equipment and material, will be specified in the ROD or in subsequent remedial design/remedial action (RD/RA) reports, as appropriate.

5.1 DESCRIPTION OF FINAL ALTERNATIVES

5.1.1 Alternative 1: No Action

Under Alternative 1, no further action would be taken at the QROU. No containment, removal, treatment, or other mitigative measures would be implemented. This alternative does not include groundwater monitoring or any active or passive institutional controls (e.g., physical barriers, deed restrictions). Under this alternative, it was assumed that all existing activities, including monitoring by DOE, would be discontinued. However, existing land use and natural conditions and processes are expected to continue to provide protection to the downgradient well field.

5.1.2 Alternative 2: Monitoring with No Active Remediation

Under Alternative 2, long-term monitoring of groundwater in the quarry area would be performed. Contaminant concentrations in the groundwater north of Femme Osage Slough are expected to decrease with time as a result of (1) chemical reaction of the uranium with iron-manganese hydroxide, and (2) precipitation in the area of the slough where decaying organic matter maintains reducing conditions. These reducing conditions convert uranium to the +4 state, forming uranium dioxide (UO_2), which is highly insoluble. Continued migration of uranium in the groundwater to the St. Charles County well field is probable, but a concentration greater than background has not been detected. Monitoring data from wells south of the slough and from the production wells have indicated uranium concentrations at background levels except at RMW-2. Contaminated groundwater migrating south of the slough would be significantly diluted with uncontaminated water from the Missouri River. Infiltration from rainwater, runoff, and sporadic local flooding could also dilute the groundwater at the quarry area north of the slough.

Groundwater monitoring would be conducted in the existing well network, as appropriate. This network could be expanded or reduced, depending on the results of future efforts to optimize the network for long-term monitoring. The evaluation of Alternative 2 was based on the conservative assumption that the construction and operation of additional monitoring wells would be equivalent to approximately 15% of the number of existing wells (i.e., about seven additional wells). The exact monitoring network and details regarding frequency of sampling and parameters analyzed will be identified in the ROD or subsequent RD/RA reports for the QROU if this alternative is selected. The current groundwater monitoring program for the quarry area consists of 45 DOE monitoring wells, 4 monitoring wells owned by St. Charles County, and 8 municipal production wells. Of these wells, 19 monitor groundwater in the bedrock system (Kimmswick Limestone, Decorah Formation, or Plattin Limestone). The remaining wells and all county-owned monitoring and production wells are screened in the alluvium.

Under Alternative 2, monitoring would continue for a period of time specified in the ROD. Because contamination would remain on-site above levels that allow for unlimited use and unrestricted exposure, reviews would be conducted at least every five years to ensure that the remedy continued to provide adequate protection of human health and the environment.

5.1.3 Alternative 6: Groundwater Removal at Selected Areas, with On-Site Treatment

Under Alternative 6, an interceptor trench approximately 1 m (3 ft) wide and about 5 m (16 ft) deep would be installed north of the Femme Osage Slough in a selected area bounded by and encompassing monitoring wells MW-1014 and MW-1016 (approximately 340 m [1,100 ft]). The saturated zone of the trench would be backfilled with a high-permeability material such as gravel. A perforated pipe would be installed horizontally in the base of the trench to transport water to a series of underground sumps. The purpose of the trench is to create a high-permeability channel through the native soil, to recover more groundwater than is possible via a vertical extraction well.

The groundwater collected by the interceptor trench would discharge into several underground sumps, each 0.9 m (3 ft) in diameter and constructed of reinforced pipe. A single submersible pneumatically driven groundwater extraction pump would be installed inside each sump to deliver the extracted groundwater to a piping network connecting each sump to a manifold. From the manifold, a single pipeline would bring contaminated groundwater to a 30,000-L (8,000-gal) single-walled aboveground storage tank located on a 20-cm-(8-in.)-thick reinforced concrete pad with engineered berms for secondary containment. A double-wall polyvinyl chloride pipeline (diameters of about 10 cm and 15 cm [4 and 6 in.]) would be constructed to transfer the water from the interceptor trench storage tank for treatment (double-walled construction is used to ensure leak protection).

Two options currently exist for treatment of the extracted groundwater: the existing QWTP or a portable unit. If the extracted groundwater is treated at the existing QWTP, a double-wall pipeline would be constructed connecting the discharge point of the interceptor trench with the QWTP. Groundwater would be pumped from the interceptor trench to the equalization basin at the QWTP. The existing water treatment system at the quarry consists of an equalization basin, a water treatment plant, and two effluent ponds. The equalization basin serves as a reservoir to provide consistent flow and uniform contaminant concentration at the QWTP. The water then goes through five major steps—lime mix, clarification, multimedia filter, activated alumina, activated carbon and ion exchange—each conducted to further reduce the amount of chemicals and radioactive materials (DOE 1998c). The on-site QWTP would be operated on a campaign mode, that is, whenever the equalization basin contained sufficient groundwater for continuous operation of the water treatment process. The extracted groundwater would be treated at the QWTP for up to two years, depending on the technical feasibility of this alternative.

Portable treatment units would be used if the QWTP was unavailable. A trailer-mounted unit was assumed in this analysis to facilitate ease of transportation of the unit to the area north of the Femme Osage Slough and to allow removal of the trailer-mounted system in the event of flooding of the Missouri River in the region of the quarry.

5.2 DETAILED ANALYSIS OF FINAL ALTERNATIVES

The detailed analysis of these three final alternatives consisted of an assessment of each alternative relative to the following nine evaluation criteria, as specified in the NCP:

1. *Overall protection of human health and the environment.* Addresses whether each alternative provides adequate protection of human health and the environment. Evaluation focuses on a specific alternative's ability to achieve adequate protection and describes how site risks posed by each pathway are eliminated, reduced, or controlled through natural processes, treatment, engineering, or institutional controls. This evaluation also allows for consideration of any unacceptable short-term impacts associated with each alternative. Because of its broad scope, this criterion also reflects the focus of criteria 2 through 5.

2. *Compliance with ARARs.* Addresses whether all applicable or relevant and appropriate state and federal laws and regulations are met. Evaluation focuses on whether each alternative will meet federal and state ARARs and TBCs, or whether there is justification for an ARAR waiver. Various ARARs and the waiver conditions are identified in Appendix A of the FS (DOE 1998c); key requirements for each alternative are discussed .

3. *Long-term effectiveness and permanence.* Addresses the risk remaining at the operable unit after remediation goals have been met. Evaluation focuses upon the ability of an alternative to maintain reliable protection of human health and the environment over time, once these goals have been met.

4. *Reduction of toxicity, mobility, or volume.* Addresses the statutory preference for selecting alternatives that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances at a site. Evaluation focuses upon the extent to which this is achieved by each alternative.

5. *Short-term effectiveness.* Addresses the potential impacts to workers, the general public, and the environment during implementation of each alternative.

6. *Implementability.* Addresses technical and administrative feasibility, including the availability and reliability of required resources or materials required during implementation, and the need to coordinate with other agencies.

7. *Cost.* Addresses both capital costs and annual operation and maintenance (O&M) costs, as well as the combined net present worth, for each alternative.

8. *State acceptance.* Addresses the statutory requirements for substantial and meaningful state involvement. Evaluation of this criterion will be addressed in the responsiveness summary and ROD that will be prepared following the public comment period.

9. *Community acceptance.* Assesses the community's apparent preference for, or concerns about, the alternatives being considered. Evaluation of this criterion will be addressed in the responsiveness summary and ROD that will be prepared following the public comment period.

The three alternatives retained through the screening process were evaluated on the basis of criteria 1 through 7 relative to potential health and environmental impacts. The results of this comprehensive analysis are presented in Sections 5.2.1 through 5.2.7.

5.2.1 Overall Protection of Human Health and the Environment

The No Action Alternative would be adequately protective of human health and the environment over the long term. Under current conditions, the groundwater north of the slough poses no imminent risk to human health from the St. Charles County well field or the area south of the slough. Future conditions are expected to be similar to current conditions, if not better, because the source of contamination (i.e., bulk waste) has been removed; quarry restoration activities are expected to prevent further infiltration of any residual contamination to the groundwater.

Alternative 2 would also be adequately protective of human health and the environment over the long term. Under current conditions, the groundwater north of the slough poses no imminent risk to human health at the St. Charles County well field or the environment south of the slough. Potential migration of the contamination toward the production wells would be monitored, and investigative activities would enable identification of any plume migration and variations in local geochemical conditions (e.g., Eh and pH). These variations could adversely affect the removal of contaminants from the groundwater by natural processes such as absorption, adsorption, precipitation, and biodegradation. Under Alternative 2, monitoring would be used to identify plume migration and to verify that concentrations in the well field are still protective of human health and the environment. Contingency measures discussed in the *Well Field Contingency Plan* (DOE 1998d) would be considered to prevent unacceptable exposure concentrations at the St. Charles County well field. Reduction of contaminant concentrations north of the slough would be provided by natural processes including dilution.

Alternative 6 would provide protection of human health and the environment similar to that provided by Alternatives 1 and 2. In addition, some removal of uranium would also be achieved, reducing the amount that could migrate to the downgradient well field and providing additional overall protection of human health.

5.2.2 Compliance with Potential ARARs

Potential regulatory requirements that might be applicable or relevant and appropriate to the final remedial action alternatives are identified and evaluated in Appendix A of the FS (DOE 1998c). For all three alternatives, the standards for uranium in groundwater given in 40 CFR Part 192 have been preliminarily identified as potentially relevant but not appropriate to groundwater in environmental settings such as those of the quarry area north of the slough. However, because of the proximity of the St. Charles County well field (where the standard is applicable), the 30 pCi/L standard is used as a metric for the evaluation of alternatives in the FS. Therefore, a waiver from meeting a particular concentration end-point for uranium (such as the 30 pCi/L standard [40 CFR Part 192]) could be requested. Such a waiver would be supported by performance data from the site. The concentrations of contaminants in quarry area groundwater are expected to slowly decrease with time because of source (bulk waste) removal and other natural processes that have been and are occurring. In addition, evaluations of alternatives with active components indicate that this reduction is not hastened significantly because of limitations imposed by the complex hydrogeology of the site.

5.2.3 Long-Term Effectiveness and Permanence

Under current and assumed future land use conditions for all three alternatives, the contaminated groundwater north of the slough poses no imminent risk to the St. Charles County well field or the environment south of the slough. Although under Alternative 1, contaminant concentrations would not be monitored by DOE in the future, on the basis of current conditions, unacceptable impacts to human health and the environment would not be expected to occur.

Under Alternative 2, monitoring and maintenance activities would be carried out by DOE for a period specified in the ROD. Protection of human health and the environment in the extended future would be ensured because investigative and monitoring activities by DOE would continue and allow consideration of contingency measures consistent with the *Well Field Contingency Plan* (DOE 1998d); that is, if future migration of residual contamination could result in unacceptable exposure concentrations at the well field. However, unacceptable impacts to human health and the environment would not be expected to occur.

Under Alternative 6, removal and treatment of some amount (mass or volume) of contaminated quarry groundwater would also be achieved, thereby reducing the potential for migration and providing additional protection to the well field.

5.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment is not applicable to either Alternative 1 or 2 because the contaminated groundwater would not be treated under either alternative. However, under Alternative 6, some reduction of toxicity or volume is expected, consistent with the amount of groundwater expected to be removed via the trench and then treated. Calculations indicate that the extraction system can reduce the mass of uranium currently in quarry area groundwater by 8 to 10% at the end of a two-year period (DOE 1998c).

5.2.5 Short-Term Effectiveness

Under Alternative 1, no short-term impacts to human health or the environment would occur because no remedial action would be conducted. Under Alternatives 2 and 6, some short-term impacts could occur, primarily associated with the potential installation of the trench and new monitoring wells.

5.2.6 Implementability

No implementability concerns would be posed by Alternative 1, because no action would be taken. No technologies or management strategies would be implemented, nor would any permits, licenses, or approvals associated with undertaking a remedial action be needed.

Only a few implementability concerns would be posed by Alternatives 2 and 6 because of the limited actions to be taken. The installation of a trench and ultimate treatment of collected contaminated groundwater involves standard, conventional technologies. Site operations would continue using readily available resources for monitoring. Construction of any proposed monitoring wells would simply require mobilization of a drilling rig to install them. Minimal administrative complexities, such as permit applications, would be associated with monitoring well installation. Groundwater monitoring would be easy to implement.

The administrative components of Alternatives 2 and 6 would be relatively straightforward. Remedial activities at the Weldon Spring site are coordinated with the State of Missouri and EPA Region VII. That coordination would continue for the duration of this action, and no additional coordination with any other agencies beyond that already occurring would be needed. No permits or licenses would be required for Alternative 2. License acquisition (for temporary possession of the uranium removed in the portable treatment unit) may be required for an off-site contractor.

5.2.7 Cost

No net present-worth, capital, or annual O&M costs would be associated with Alternative 1 because no activities would be undertaken. Costs for Alternative 2 would be associated with continuing the existing environmental monitoring program, constructing and operating possible additional monitoring wells, and conducting a performance review at least every five years. For Alternative 2, the capital cost is estimated to be $0.2 million, and the O&M cost is estimated to be $0.6 million per year. The capital cost for Alternative 6 is estimated to be between $1 to $2 million, depending on whether the QWTP and lower-cost single-pass trench construction are used. The capital cost would be primarily for installation of the interceptor trench. The O&M cost for Alternative 6 is estimated to be approximately $0.6 to $1 million per year (including the annual operating cost of groundwater treatment and monitoring).

5.3 COMPARATIVE ANALYSIS OF THE FINAL ALTERNATIVES

Comparison of the final remedial action alternatives for the QROU was carried out by categorizing the nine evaluation criteria listed in Section 5.2 into the following three groups, as stipulated in the NCP: threshold criteria, primary balancing criteria, and modifying criteria.

The threshold category contains the two criteria that each alternative must meet in order to be eligible for selection: overall protection of human health and the environment and compliance with ARARs (unless a waiver condition applies). These threshold criteria ensure that the remedial action selected will be protective of human health and the environment, and that the action will either attain the ARARs identified at the time of the ROD or provide grounds for obtaining a waiver.

The primary balancing category contains the five criteria that are used to assess the relative advantages and disadvantages of each alternative to determine which is most appropriate:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

The first two criteria consider the preference for treatment as a principal element and the bias against off-site land disposal of untreated waste. Cost-effectiveness is determined by evaluating the following three of the five balancing criteria: long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; and short-term effectiveness. Overall effectiveness is then compared with cost to ensure that the costs are proportional to the overall effectiveness of a remedial action.

The modifying category consists of two criteria that are considered in remedy selection and that will be addressed in the responsiveness summary and ROD to be prepared following the public comment period: state acceptance and community acceptance. The two modifying criteria are not addressed in this comparative analysis.

The results of the comparative analysis of alternatives are summarized in Table 1.

TABLE 1 Comparative Analysis of Alternatives

Evaluation Criterion	Alternative 1: No Action	Alternative 2: Monitoring with No Active Remediation	Alternative 6: Groundwater Removal at Selected Areas, On-Site Treatment
Overall protection of human health and the environment	Would be protective of human health and the environment in both the short and long term.	Would provide protection similar to Alternative 1. In addition, monitoring data would be collected to verify that conditions continue to be protective of human health and the environment.	Would provide protection similar to Alternative 2. In addition, removal and treatment of a percentage of the contaminated volume of groundwater north of the slough would lead to a reduction in the amount of uranium that could potentially further migrate south of the slough toward the St. Charles County well field.
Compliance with ARARs	Uranium concentrations would not be below 30 pCi/L for a long period of time (i.e., >1,000 years). The concentrations of contaminants (uranium and nitroaromatic compounds) in quarry groundwater will continue to decrease with time because of the removal of the original source of the contamination and dilution from infiltration of rainwater and runoff and from sporadic local flooding. Therefore, all pertinent ARARs may be attained by the time the plume reaches the well field.	Similar to Alternative 1.	Similar to Alternative 2. In addition, for Alternative 6, pertinent ARARs associated with construction and relevant activities would be met.
Long-term effectiveness and permanence	Future conditions are expected to be similar to current, if not better, because of the expected decrease (albeit slow) in contaminant concentrations as a result of source removal. In addition, contingency measures are provided in the *Well Field Contingency Plan* (DOE 1998d).	Similar to Alternative 1. In addition, data would be available to verify that conditions at the quarry area continue to be protective of human health and the environment.	Would be similar if not better than that of Alternative 2 because of the reduction in the amount of uranium that could potentially migrate toward south of the Femme Osage Slough into the St. Charles County well field.

TABLE 1 (Cont.)

Evaluation Criterion	Alternative 1: No Action	Alternative 2: Monitoring with No Active Remediation	Alternative 6: Groundwater Removal at Selected Areas, On-Site Treatment
Reduction of toxicity, mobility, or volume through treatment	No immediate reduction of toxicity, mobility, or volume because no treatment would be performed. However, slow reduction of contaminant concentrations is expected as a result of natural processes occurring (i.e., sorption and dilution).	Same as for Alternative 1.	Would satisfy the statutory preference for treatment as a principal element of remediation and would provide reduction in the toxicity, mobility, and volume of the contaminated groundwater through treatment. The effects of the extraction system may reduce the mass of uranium within the alluvial aquifer by 8 to 10% relative to the baseline (no action).
Short-term effectiveness	No potential impacts on workers or the environment, because no activities would be undertaken.	Expected to be low, with less than one case of occupational injury and no occupational fatalities during proposed monitoring well construction. Any potential short-term environmental impacts would be limited to the immediate vicinity of the quarry area, and mitigative measures would be applied to minimize potential impacts.	Similar to Alternative 2. Expected to be low, with less than two cases of occupational injury and no occupational fatalities during proposed construction activities.
Implementability	No implementability concerns because no action would be taken.	Few implementability concerns because of the limited actions taken. Current monitoring operations would continue with the use of readily available resources.	Few implementability concerns. Groundwater extraction and treatment are well-developed technologies. Further development of these technologies would not be required. New permits or licenses for on-site activities might be required for potential use of portable treatment units.
Cost	No cost is expected to be associated with this alternative.	Can be considered to be cost-effective, because it would provide overall protection of human health and the environment for a reasonable cost. Costs are associated with continuing the existing environmental monitoring program, potential construction and operation of additional monitoring wells, and conducting a performance review at least every five years. Could be implemented with existing resources and maintained at a relatively low cost.	Can be considered to be more cost-effective compared with Alternatives 1 and 2, because some uranium would be removed from the groundwater at a reasonable cost. Minimizes capital and annual cost expenditures by making use of existing structures. Given site experience with the QWTP and the SWTP, Alternative 6 could be primarily implemented with existing resources and maintained at a long-term cost similar to that of Alternative 2.

6 PROPOSED ACTION

The objective of the FS (DOE 1998c) was to identify an alternative that provided a feasible option for removing or reducing the amount of uranium present in quarry area groundwater north of the slough. The attainment of this objective is expected to provide further protection to the nearby St. Charles County well field by reducing the amount of uranium that could migrate to the well field. Conditions at the St. Charles County well field are protective and not expected to change. Although a few data points exceed the Missouri water quality standards for 2,4-DNT and 1,3-DNB, these concentrations are within acceptable levels. A continued decreasing trend in concentrations of nitroaromatic compounds is expected to result from bulk waste removal. A significant decrease in concentrations has already been observed since the fall of 1995, when bulk waste removal was completed.

Although uranium concentrations in quarry groundwater north of the Femme Osage Slough are relatively high (average high of about 2,800 pCi/L), concentrations at monitoring wells south of the slough (with the exception of RMW-2) and at the production wells in the St. Charles County well field have been similar to background levels. In addition, projections based on the fate and transport model for uranium in the area indicate that the potential for adverse impact to the well field is minimal. Further, evaluations in the FS indicate that all alternatives, including those with active components such as Alternative 6, require a long time period before achieving the 30 pCi/L metric for uranium. However, in recognizing the inherent uncertainties in these types of evaluations and the importance of providing as much additional protection to the well field as possible, an action is being proposed to address quarry area groundwater contamination. This proposed action is similar to that described for Alternative 6 — Groundwater Removal at Selected Areas with On-Site Treatment. However, some additional activities, to be conducted prior to implementation of Alternative 6, are proposed. These are described below.

Alternative 6 provides for removal of uranium at locations where concentrations are highest, thereby reducing uranium concentrations in a shorter time frame than the other alternatives discussed. Any reduction achieved is expected to result in a decreased amount of uranium that could potentially migrate to the St. Charles County well field.

Although the performance of Alternative 6 has been predicted on the basis of as much available site-specific data as possible, uncertainties are still associated with the implementation of this alternative. Actual site characteristics, primarily associated with groundwater flow, will determine the ultimate implementability and effectiveness of this alternative. To optimize this proposed remediation activity, initial phases of the remedial design and remedial action would include additional testing to establish site-specific parameters such as effective porosity, storativity, and hydraulic conductivity in the areas selected for remediation. Once these data have been collected, the feasibility of the alternative can be more fully determined to support final remedial designs and decisions, including consideration of any appropriate waivers. Evaluations for Alternative 6 presented in the FS are based on implementation for a two-year period. It is expected that field determinations necessary to gauge the performance of this proposed action will be obtained within the two-year period. Concentrations of nitroaromatic compounds would also be reevaluated at that time to allow for consideration of waivers, if appropriate.

Under the current proposed action, contaminated groundwater at selected locations would be collected via a trench, removed, and then treated at either the existing QWTP or at a portable treatment unit on-site. Sampling and analysis of groundwater contaminant concentrations (primarily uranium and nitroaromatic compounds) and other hydrogeologic and geochemical parameters would be performed during and after implementation of the remedial action. Monitoring activities would be correlated with those conducted as part of the *Well Field Contingency Plan* (1998d).

7 COMMUNITY PARTICIPATION

Input from the public is an important element of the decision-making process for cleanup actions at the Weldon Spring site. Comments on the proposed remedial action for the QROU will be received during the public review period following issuance of the RI/FS documents. Oral comments will be received at the public meeting to be held on April 16, 1998, at 7:00 p.m. at the Weldon Spring Site Remedial Action Project Administration Building. Written comments may be either submitted at the public meeting or mailed before the close of the comment period on April 21, 1998, to:

Stephen H. McCracken, Project Manager
U.S. Department of Energy
Weldon Spring Site Remedial Action Project Office
7295 Highway 94 South
St. Charles, Missouri 63304

Information relevant to the proposed remedial action is located in the administrative record and public document room at the Weldon Spring Site Remedial Action Project Office. Additional information repositories have been established at the following five locations:

Kathryn M. Linneman Branch
St. Charles City/County Library
2323 Elm Street
St. Charles, Missouri 63301

Francis Howell High School
7001 Highway 94 South
St. Charles, Missouri 63304

Spencer Creek Branch
St. Charles City/County Library
427 Spencer Road
St. Peters, Missouri 63376

Middendorf-Kredell Library
St. Charles City/County Library
2750 Highway K
O'Fallon, Missouri 63366

Kisker Road Branch
St. Charles City/County Library
1000 Kisker Road
St. Peters, Missouri 63304

Information on file at these repositories includes the RI, BRA, FS, and this proposed plan for remedial action at the QROU. Supporting technical reports are available in the public reading room located at the site. For additional information, the lead agency may be contacted at the Weldon

Spring Site Remedial Project Office at the address provided above; the telephone number is (314) 441-8086. The remedial project manager for the EPA who can supply additional information is:

Mr. Daniel Wall
U.S. Environmental Protection Agency
Region VII
726 Minnesota Avenue
Kansas City, Kansas 66101
(913) 551-7710

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DOE: see U.S. Department of Energy.

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