INTERIM RECORD OF DECISION DOE/OR/21548-798

Interim Record of Decision for Remedial Action for the Groundwater Operable Unit at the Chemical Plant Area of the Weldon Spring Site

September 2000

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

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prepared by

U.S. Department of Energy, Oak Ridge Operations Office, Weldon Spring Site Remedial Action Project, Weldon Spring, Missouri

DECLARATION STATEMENT

Site Name and Location

Weldon Spring Chemical Plant
St. Charles County, Missouri

Statement of Basis and Purpose

This Interim Record of Decision (IROD) presents the selected interim remedial action for the Groundwater Operable Unit (GWOU) of the U.S. Department of Energy's (DOE's) Weldon Spring Site in St. Charles County, Missouri. This action was selected following requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan. National Environmental Policy Act (NEPA) issues related to the Chemical Plant Area have also been addressed and have been integrated into the CERCLA decision-making process for the GWOU to the extent practicable, in accordance with DOE's policy on NEPA (DOE 1994).

The selected interim remedial action provides for the remediation of trichloroethylene (TCE)-contaminated groundwater at the Chemical Plant Area. No decision is being made relative to other contaminants determined to be of concern. These other contaminants will be addressed, as necessary, in a final ROD that will be issued at a later time. This approach allows for TCE to be remediated in the near-term while further studies are planned and conducted to determine the effectiveness and practicability of remediating any remaining contaminants of concern.

This decision is based on the *Administrative Record* for the GWOU. Major documents include the (1) Remedial Investigation/Feasibility Study Work Plan, (2) Remedial Investigation and Baseline Risk Assessment Reports, (3) Feasibility Study Report and Supplemental Feasibility Study, and (4) Proposed Plan. Public comments received during the review period for the Proposed Plan were considered in the development of this decision document. Responses to significant public comments are provided in Appendix A.

The State of Missouri concurs with the proposed remedial action to implement treatment of TCE contaminated groundwater by a chemical oxidation process. We agree with DOE's proposal to design the system to meet the five parts per billion standard for TCE. Due to complex site conditions and the innovative nature of the treatment process, actual field performance may not meet design specifications. For this reason, the state believes a performance goal must be established. We recommend that chemical application should continue beyond design specifications for as long as the application is effectively reducing the TCE concentration or until the five parts per billion standard is achieved.

Although the State of Missouri agrees with this proposed remedial action to treat TCE, for the record, we disagree with some of the positions and statements presented in this Interim ROD. Consideration of matters beyond those specifically pertinent to the narrow issue of TCE treatment are outside the scope of this document, including issues related to institutional controls. The State of Missouri expects to revisit these issues when a final Groundwater Operable Unit ROD is developed and will reserve comment until that time.

Assessment of the Site

The response action selected by this IROD addresses actual or threatened releases of a hazardous substance from this site that were not addressed under previous response actions.

Description of the Selected Interim Remedy

The GWOU is the second of two operable units established for the Chemical Plant Area of the Weldon Spring site. The first operable unit, the Chemical Plant Operable Unit, addressed the treatment of sludges, excavation of soil, dismantlement of buildings, and removal of other source materials located at the chemical plant proper. The selected interim remedy for the GWOU provides for active in-place treatment of the TCE in groundwater at the Chemical Plant Area.

The selected interim remedy focuses on the TCE contamination only and is not the final remedy for the GWOU. A final ROD will be developed after further evaluation of the potential and need to remediate the remaining groundwater contaminants (nitrate, nitroaromatic compounds, and uranium). The final ROD will establish any necessary institutional controls and define long-term monitoring requirements.

A checklist providing the location of key information in support of the selected interim remedy presented in this ROD can be found at the end of this Declaration Statement.

Statutory Determinations

The selected interim remedy is protective of human health and the environment, complies with applicable or relevant and appropriate requirements to the extent practicable and is cost-effective. This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable for this site. This remedy satisfies the statutory preference for treatment as a principal element of the remedy, in that treatment is being conducted to eliminate TCE contamination, which is the highest contributor to potential risk from the groundwater at the site.

If necessary, review of this selected remedy will be included in the five-year review process conducted for the Weldon Spring site as required by CERCLA. Five-year reviews are developed in consultation with the U.S. Environmental Protection Agency (EPA) and the Missouri Department of Natural Resources (MDNR). These reviews are made available to the public.

Gene Gunn 9/29/00

for Superfund Division Director
U.S. Environmental Protection Agency Region VII

Date

9-29-00

Assistant Manager for Environmental Management
Oak Ridge Operations Office
U.S. Department of Energy

Date

Groundwater Operable Unit IROD Data Certification Checklist

The following information is included in this Interim Record of Decision. Additional information can be found in the Administrative Record file for this site.

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How source materials constituting principal threats are addressed.	7
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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 and abbreviations used only in tables and figures are defined in the respective tables and figures.

ACRONYMS, INITIALISMS, AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
BRA	baseline risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CSR	*Code of State Regulations*
DA	U.S. Department of the Army
DNT	dinitrotoluene
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FFA	Federal Facilities Agreement
FS	feasibility study
GWOU	groundwater operable unit
IROD	Interim Record of Decision
MCL	maximum contaminant level
MDNR	Missouri Department of Natural Resources
NEPA	National Environmental Policy Act
NPL	National Priorities List
PP	proposed plan
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
ROD	Record of Decision
TCE	trichloroethylene
TI	technical impracticability
TNT	trinitrotoluene
WSSRAP	Weldon Spring Site Remedial Action Project
WSTA	Weldon Spring Training Area

UNITS OF MEASURE

ft	foot (feet)	m	meter(s)
gpm	gallon(s) per minute	µg	microgram(s)
ha	hectare(s)	mi	mile(s)
km	kilometer(s)	min	minute(s)
L	liter(s)	pCi	picocurie(s)

INTERIM RECORD OF DECISION FOR REMEDIAL ACTION FOR THE GROUNDWATER OPERABLE UNIT AT THE CHEMICAL PLANT AREA OF THE WELDON SPRING SITE

1 SITE NAME, LOCATION, AND DESCRIPTION

Name and Location: Weldon Spring Site
St. Charles County, Missouri

U.S. Environmental Protection Agency (EPA) Database ID: M0321009004

Lead Agency: U.S. Department of Energy (DOE)

Site Type: Federal Facility-Former Uranium Processing Plant

1.1 SITE DESCRIPTION

The U.S. Department of Energy (DOE) Weldon Spring Site consists of two noncontiguous areas: the Chemical Plant Area and the Quarry Area. Both areas are located in St. Charles County, Missouri, about 48 km (30 mi) west of St. Louis (Figure 1). The 88-ha (217-acre) Chemical Plant Area lies within the boundaries of the Ordnance Works Area (Figure 2).

The sources of contamination at the Chemical Plant Area are those shown in the original layout of the Chemical Plant Area (Figure 3). These consisted of approximately 40 buildings, four waste retention ponds (referred to as raffinate pits), two ponds (Ash Pond and Frog Pond), and two former dumps (north and south). Remediation of these source areas has been completed. Burgermeister Spring, which is hydrologically connected to the Chemical Plant Area groundwater, is in the August A. Busch Memorial Conservation Area.

1.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The Chemical Plant Area was used for trinitrotoluene (TNT) and dinitrotoluene (DNT) production from 1941 to 1945, and later as a uranium processing facility from 1957 to 1966. The quarry was used to dispose of uranium and thorium residues (drummed and uncontained), radioactively contaminated building rubble and process equipment, and TNT and DNT residues from cleanup of the former ordnance works.

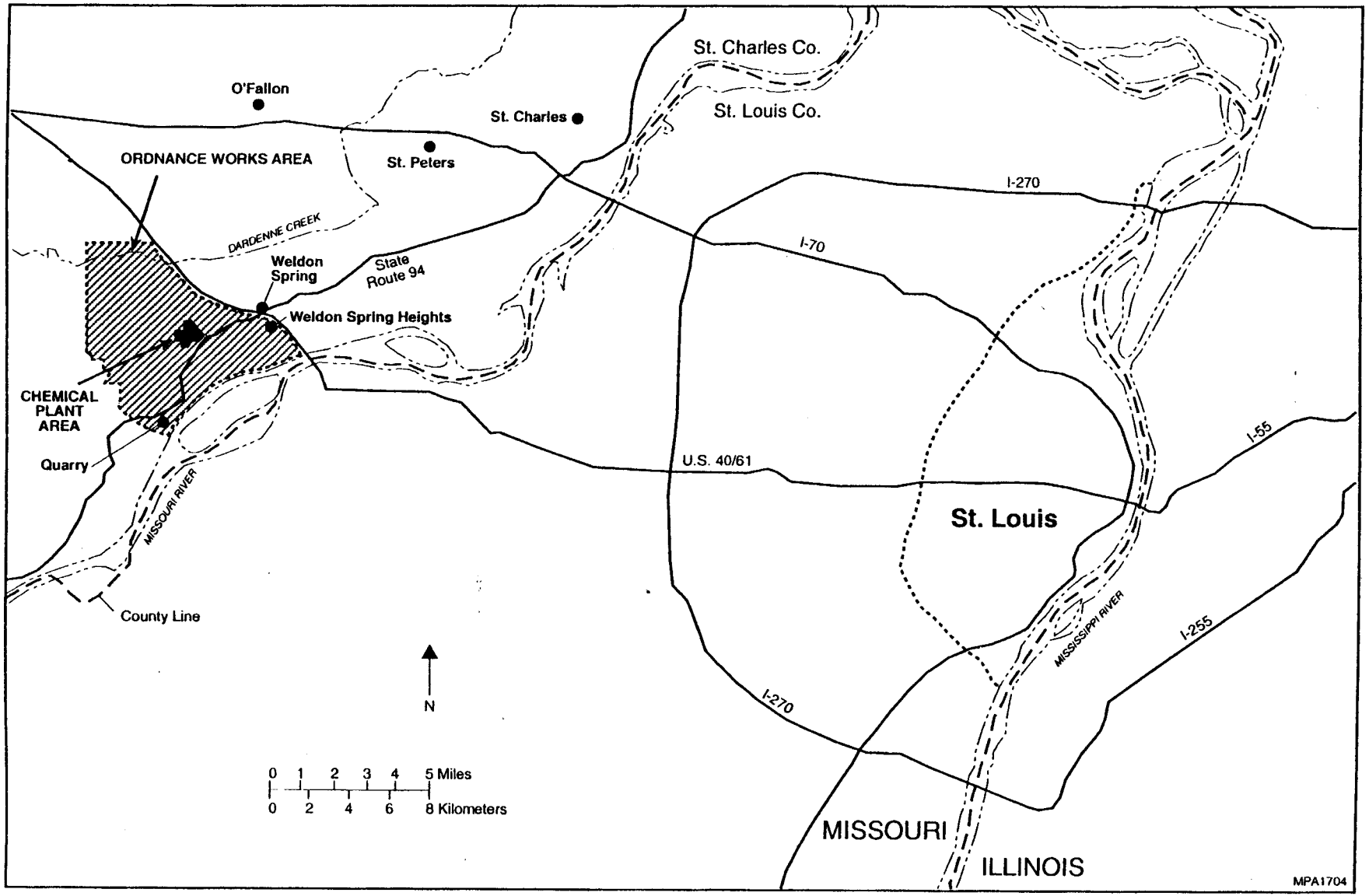


FIGURE 1 Location of the Weldon Spring Site

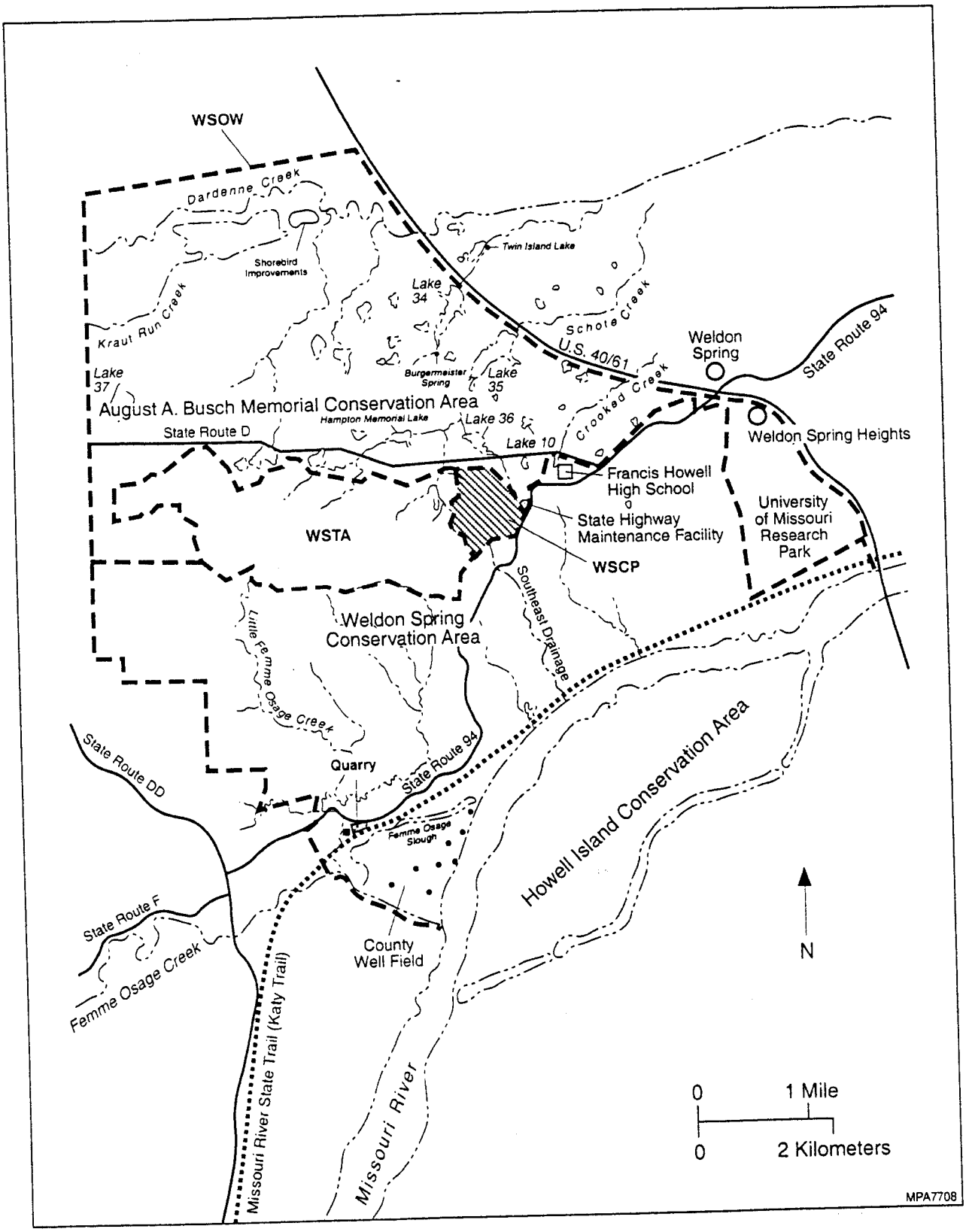


FIGURE 2 Map of the Chemical Plant Area and Immediate Vicinity

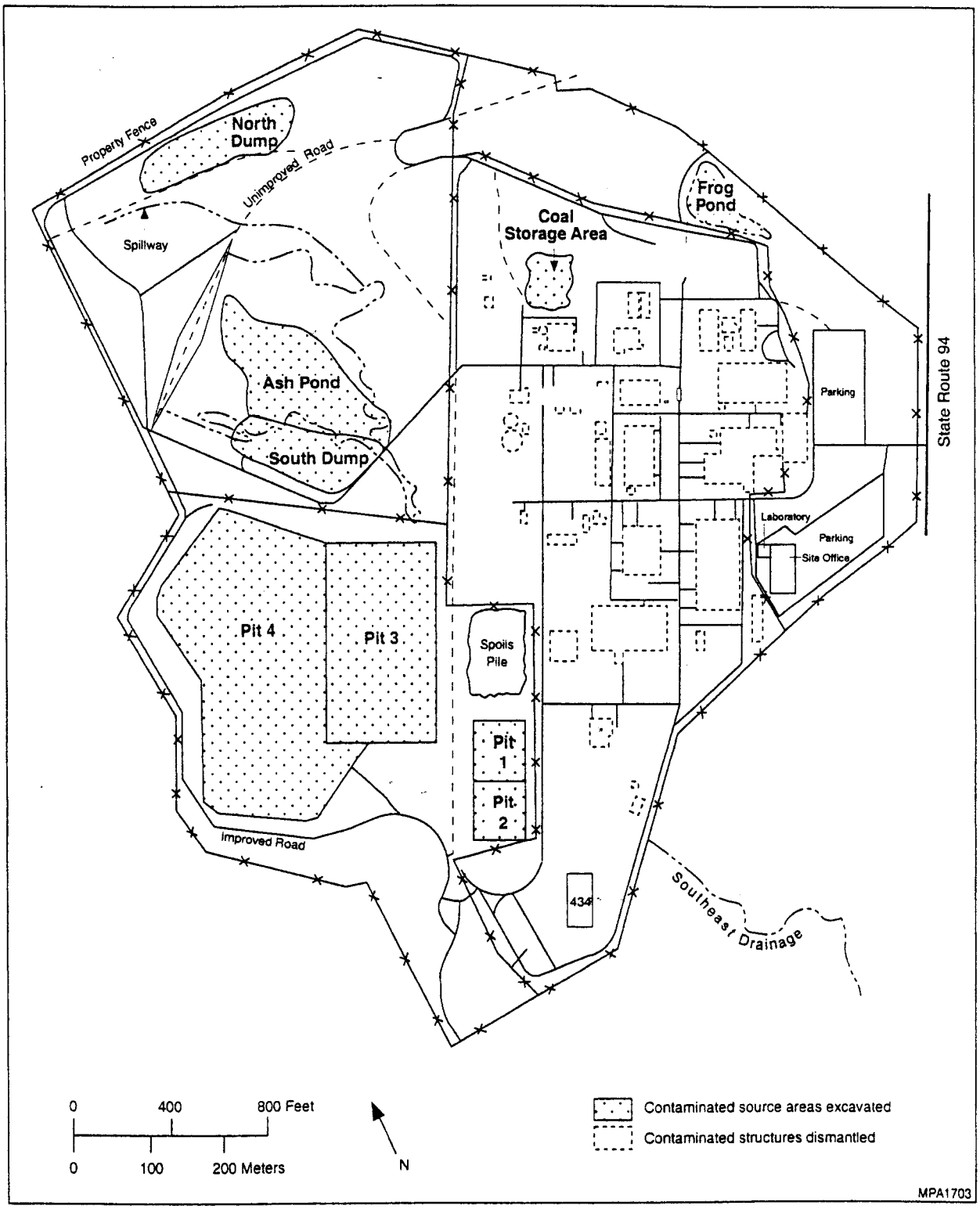


FIGURE 3 Original Layout of the Chemical Plant Area

The U.S. Environmental Protection Agency (EPA) listed the quarry on the National Priorities List (NPL) in 1987, and the chemical plant was added to the list in 1989. In 1986, the EPA and DOE entered into a federal facilities agreement (FFA). This agreement has since been amended and is consistent with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 120. The amended FFA (EPA 1992) includes agreements to ensure that the environmental impacts associated with past and present activities at the Weldon Spring site are thoroughly investigated and that appropriate remedial action is taken, as necessary, to protect public health and the environment. This FFA also facilitates the exchange of information among the EPA, DOE, and the State of Missouri and contains procedures for resolving disputes, assigning penalties for nonconformance, and ensuring public participation in the remedial action decision-making process.

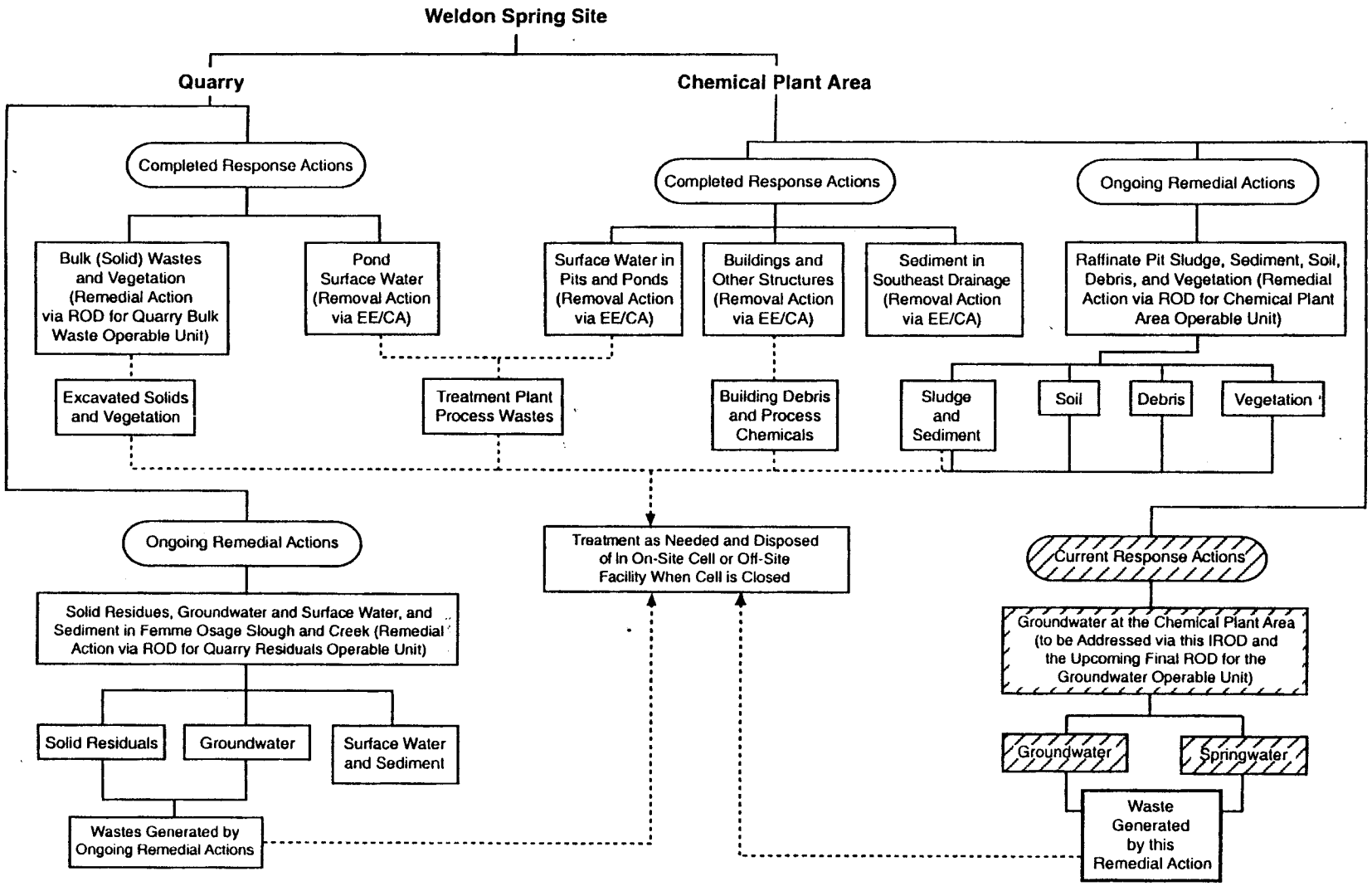
2 SCOPE AND ROLE OF THE INTERIM REMEDIAL ACTION

The selected interim remedial action addresses TCE contamination in the groundwater operable unit (GWOU).The GWOU is the final component of the cleanup process for the Weldon Spring Site Remedial Action Project (WSSRAP) (Figure 4). A final Record of Decision (ROD) for the GWOU will be developed after further evaluation of the effectiveness of the technologies as necessary for remediation of any other contaminants of concern to meet applicable or relevant and appropriate requirements (ARARs). The four planned operable units address the following components:

1. Quarry bulk waste materials,
2. Quarry residual contamination,
3. Chemical plant source control, and
4. Chemical plant groundwater contamination

The remedy for the quarry bulk waste materials was selected in a 1990 ROD (DOE 1990). Under this operable unit, bulk waste materials were excavated from the quarry, transported on a dedicated haul road, and placed in temporary storage at the Chemical Plant Area pending a final decision on source control. This action was completed in 1995. The remedy for the quarry residual contamination was selected in a September 1998 ROD (DOE 1998a). Under this operable unit, the quarry will be restored by backfilling with soils, and long-term monitoring of groundwater will be implemented to ensure continued protection of the nearby alluvial aquifer.

The chemical plant source control remedial action was documented in a September 1993 ROD (DOE 1993). Under this operable unit, raffinate sludges were treated using a chemical stabilization/solidification process, and approximately 1.48 million cubic yards of source materials, including the quarry bulk wastes, treated sludge, contaminated soils, buildings, drums, process equipment, and debris, were disposed of in a fully engineered on-site disposal cell.



Note: The boxes represent contaminated media addressed by the project's cleanup actions for the chemical plant area and the quarry; they are connected by solid lines to the appropriate phase of site cleanup. Dashed lines identify waste generated as a result of the completed response actions (e.g., plant treatment process wastes from treatment of quarry pond surface water) and that has been placed in the on-site cell. Boxes with cross-hatching constitute contaminated media that are being addressed as part of the GWOU and this IROD and the final ROD. The GWOU is the final of four operable units for the Weldon Spring site.

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FIGURE 4 Remediation Components for the Weldon Spring Site

3 COMMUNITY PARTICIPATION

A remedial investigation/feasibility study (RI/FS) process was conducted for the GWOU of the Weldon Spring site in accordance with the requirements of CERCLA, as amended, to document the nature and extent of contamination and to support the evaluation for remedial alternatives. Documents developed during the RI/FS process included the *Remedial Investigation* (DOE and DA 1997b), *Baseline Risk Assessment* (BRA) (DOE and DA 1997a), *Feasibility Study* (DOE and DA 1998), *Supplemental Feasibility Study* (DOE 1999b), and *Proposed Plan* (PP) (DOE 1999a). Together, the RI, BRA, FS, and PP constitute the required primary documents, consistent with the provisions of the *First Amended Federal Facility Agreement* entered into between DOE and the EPA. In accordance with Section 117 of CERCLA, copies of these final documents were released to the public on August 3, 1999.

The RI, BRA, FS, and PP, along with other documents in the *Administrative Record*, have been made available for public review at the Weldon Spring site. Copies also have been made available to the public in information repositories at Francis Howell High School and at four branches of the St. Charles City/County Library: Kathryn M. Linneman, Spencer Creek, Middendorf-Kradell, and Kisker Road. A notice of availability of these documents was published in the *St. Charles Journal* on August 4 and 8, 1999.

A public comment period for the PP was first held from August 3 through September 1, 1999. Subsequently, an additional comment period was held from November 8, 1999, through January 6, 2000, in response to the public's request for an extension. The PP identified the proposed action of active remediation of the trichloroethylene (TCE) and long-term monitoring for all other contaminants of concern. A public meeting was held on August 25, 1999, at the Administration Building of the WSSRAP as a part of the public participation process. This public meeting was advertised in the *St. Charles Journal* on August 22, 1999, and the *St. Charles Post* on August 23, 1999. At this meeting, representatives from DOE and EPA Region VII received comments from the public about the site and the remedial alternatives under consideration. Transcripts of the public meeting are included as part of the *Administrative Record* for this operable unit remedial action.

Following the first issuance of the PP on August 3, 1999, the Missouri Department of Natural Resources (MDNR) provided comments taking issue with certain aspects of the plan. To resolve these issues, the EPA, the DOE, and the MDNR mutually agreed to engage in a defined issue-resolution process similar to the dispute process provided for under the FFA. In addition, the public comment period was further extended to run concurrent with the dispute process. This process concluded with a decision letter from the EPA dated May 12, 2000 (Grams 2000) recommending that the DOE move forward with a final ROD based on the existing PP. All the documents generated

during the course of the dispute process were included in the *Administrative Record* and made available to the public.

Following the conclusion of the dispute process, the PP was reissued for public comment. On June 12, 2000, the DOE announced that there would be an additional public comment period so that the public could have another opportunity to review the PP, along with the documents generated during the issue resolution. This additional public comment period was originally scheduled to end on July 14, 2000, but was later extended through August 15, 2000, in response to the public's request for additional time.

The MDNR identified four outstanding issues to be addressed during the above referenced dispute process: (1) adequacy of the proposed groundwater remedy, (2) waiver of certain ARARs on the basis of technical impracticability, (3) need for specific institutional controls information, and (4) disagreement over the action leakage rate for the disposal cell.

Of the four issues brought forward, all parties determined that the last issue was outside the scope of the GWOU; however, they agreed to recalculate the action leakage rate for the disposal cell. The third issue was resolved with an agreement that more specific language be included in the final ROD regarding the type of institutional controls and enforcement mechanisms.

With regard to the first two issues, much of the discussions revolved around the MDNR's view that groundwater could be effectively extracted and treated to remove 2,4-DNT, nitrate, and uranium, and that drinking water standards-based ARARs should not be waived without first trying a localized field-scale study using enhanced groundwater extraction systems. No clear agreements were reached regarding the first two issues during the dispute discussions; however, consistent with the procedure established for this dispute process, the EPA concluded the dispute process and provided a decision and strategy for moving forward; this decision was contained in a letter dated May 12, 2000 (Grams 2000).

In the May 12 letter, the EPA recommended that DOE agree to perform a pilot-scale study designed to further define the level of application and effectiveness of groundwater pump and treat, consistent with the recommendation of the MDNR Division of Geology and Land Survey in a letter dated March 10, 2000 (cited in Grams 2000). The EPA concluded that a sufficient body of information exists to form the basis for a final decision on an appropriate groundwater remedy. The EPA went on to further conclude that this existing information strongly indicates there is a low probability that an appropriate measure of effectiveness can be achieved through groundwater extraction techniques. The EPA recommended that DOE move forward with a final ROD based on the existing PP. On June 12, 2000, the PP was reissued for public comments. Numerous public comment letters were received that expressed concern over the proposal not to actively treat all the groundwater contaminants of concern. In response to these comments, DOE has reconsidered the initial decision to move forward to a final ROD and has decided to postpone the final groundwater

decision and final groundwater ROD. Accordingly, the DOE is issuing this IROD, which provides for active remediation of TCE. In addition, independently of this IROD, DOE will conduct further field studies to re-examine the effectiveness and practicability of further active remediation (see Sections 9 and 10.7).

The *Administrative Record* includes the information considered in deciding upon the selected interim remedy presented in this IROD. All public comments, oral and written, were considered in the decision-making process for determining the selected interim remedy. DOE's responses to the comments received are provided in the Responsiveness Summary included with this IROD as Appendix A.

4 SITE CHARACTERISTICS

4.1 ENVIRONMENTAL SETTING

The geology and hydrogeology of the Weldon Spring area govern the rate and path of groundwater flow. Transport of contaminants within the groundwater depends on the geology and hydrogeology of the area, as well as on the physical and chemical properties of the contaminants. Land use in the surrounding areas affects the potential for human or ecological exposure to any contaminants the groundwater may contain.

4.1.1 Geology

Locally, the subsurface consists of porous, unconsolidated deposits that unconformably overlie bedrock. This unconsolidated overburden material consists primarily of modified loess, glacial drift, preglacial deposits, and residuum (DOE and DA 1997b). The thickness of these glacial and preglacial deposits, known as the "overburden," generally ranges from 4 to 18 m (13 to 59 ft) across the Chemical Plant Area.

The Burlington-Keokuk Limestone, the uppermost bedrock unit at the Chemical Plant Area, has been separated into two subunits, the weathered and unweathered. The weathered unit ranges in thickness from 3 to 17 m (10 to 55 ft). At the Chemical Plant Area, fracturing in the bedrock is predominantly horizontal. Solution features are common in the weathered portion of the Burlington-Keokuk Limestone and range from pinpoint vugs to small zones of core loss, typically less than 1.5 m (5 ft). The larger zones in many cases appear to be at least partially filled with clay or a clay mixture (DOE 1992). Significantly fewer horizontal and vertical fractures exist in the unweathered unit than in the weathered unit. Field data indicate a decrease in hydraulic conductivity with depth, which is attributed to decreased weathering. The size, abundance, and geometry of the open fractures within the bedrock affect the transport of groundwater and contaminants through the bedrock.

4.1.2 Hydrogeology

Three bedrock aquifers are present in the vicinity of the Weldon Spring site: a shallow unconfined aquifer (although it may be locally confined); a middle confined aquifer; and a deep confined aquifer. An additional shallow, alluvial aquifer is present near the Weldon Spring quarry adjacent to the Missouri River. In St. Charles County, the shallow and middle aquifers are used primarily for rural domestic water supply. This usage occurs outside of the influence of the groundwater contamination at the Chemical Plant Area. The shallow alluvial aquifer near the Missouri River supplies drinking water through the St. Charles County well field. Currently, no

groundwater is used at the Weldon Spring site. The impacted shallow portion of the aquifer is characterized by low yields, which are not sufficient for household purposes.

Because the shallow unconfined aquifer has been affected by former activities at the Chemical Plant Area, it is the groundwater system of primary interest in the Weldon Spring area. This aquifer consists of the Burlington-Keokuk Limestone and the Fern Glen Formation, both limestone units, and, in some locations, the overburden. The principal recharge to this shallow groundwater system is through infiltration of precipitation from the overburden or from losing streams. The water table elevation fluctuates with precipitation, but remains within the upper bedrock or overburden. An east-west trending groundwater divide, which coincides with the topographic highpoint of the area, results in two distinct drainage systems. Most of the groundwater from the Chemical Plant Area flows to the north of the divide (Figure 5).

At the Chemical Plant Area, shallow groundwater north of the divide flows to the north and into a karst conduit system that discharges at Burgermeister Spring (SP-6301) (Figures 6 and 7). Transport through this conduit is rapid. Water discharged at Burgermeister Spring then mixes with other surface water and with ponded water in Lake 34. Any dissolved contaminants in the discharged groundwater are then subject to extensive dilution and physical and chemical degradation. Because most of the shallow groundwater beneath the Chemical Plant Area discharges to the surface in the vicinity of Burgermeister Spring, the spring defines the northern-most extent of direct groundwater transport from the site and provides an ideal location for monitoring end-point contaminant concentrations.

Groundwater south of the divide at the Chemical Plant Area flows south to southeast toward the Missouri River, primarily through the Southeast Drainage. Because this drainage has losing stream segments in its upper reaches, mixing between groundwater and surface water occurs. As with Burgermeister Spring, springs in the Southeast Drainage act as end points of direct groundwater transport from the Chemical Plant Area and provide ideal locations for monitoring groundwater contamination. Data from groundwater (MW-4026) down gradient of the springs indicate no impact.

The shallow groundwater system beneath the Chemical Plant Area is hydrogeologically complex and is characterized by fractures, conduits, paleochannels, and dissolution/weathering features. Because of these features, the aquifer exhibits highly heterogeneous and anisotropic values in conductivity and transmissivity (ease with which a porous material allows water to flow) from place to place. Recent pump tests performed in July 1998 (MK-Ferguson 1998) to determine the effects of groundwater withdrawal on the aquifer further demonstrated the variability of the aquifer. In one location, pumping at a rate of less than 3.8 L/min (1 gallon per minute [gpm]) could not be sustained. In a second location approximately 30 m (100 ft) away, water could be pumped, but at a rate of less than 37.9 L/min (10 gpm), which is a low value from a pump and treat perspective. Even with this low rate of pumping, the shallow groundwater system could not recharge to sustain this rate, which resulted in the water level in the well falling below the depth of the pump. Once pumping

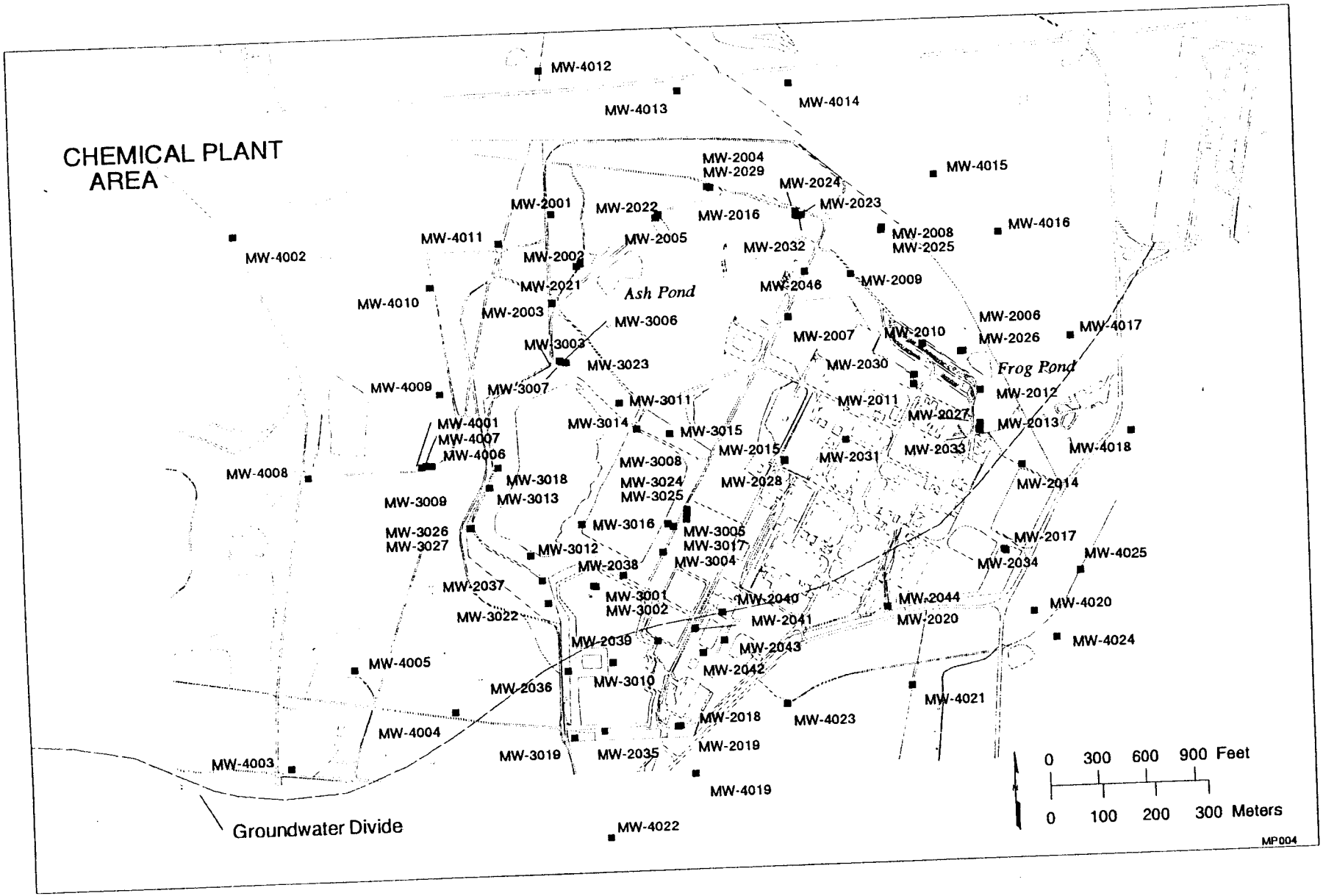

FIGURE 5 Monitoring Network and Groundwater Divide at the Chemical Plant Area

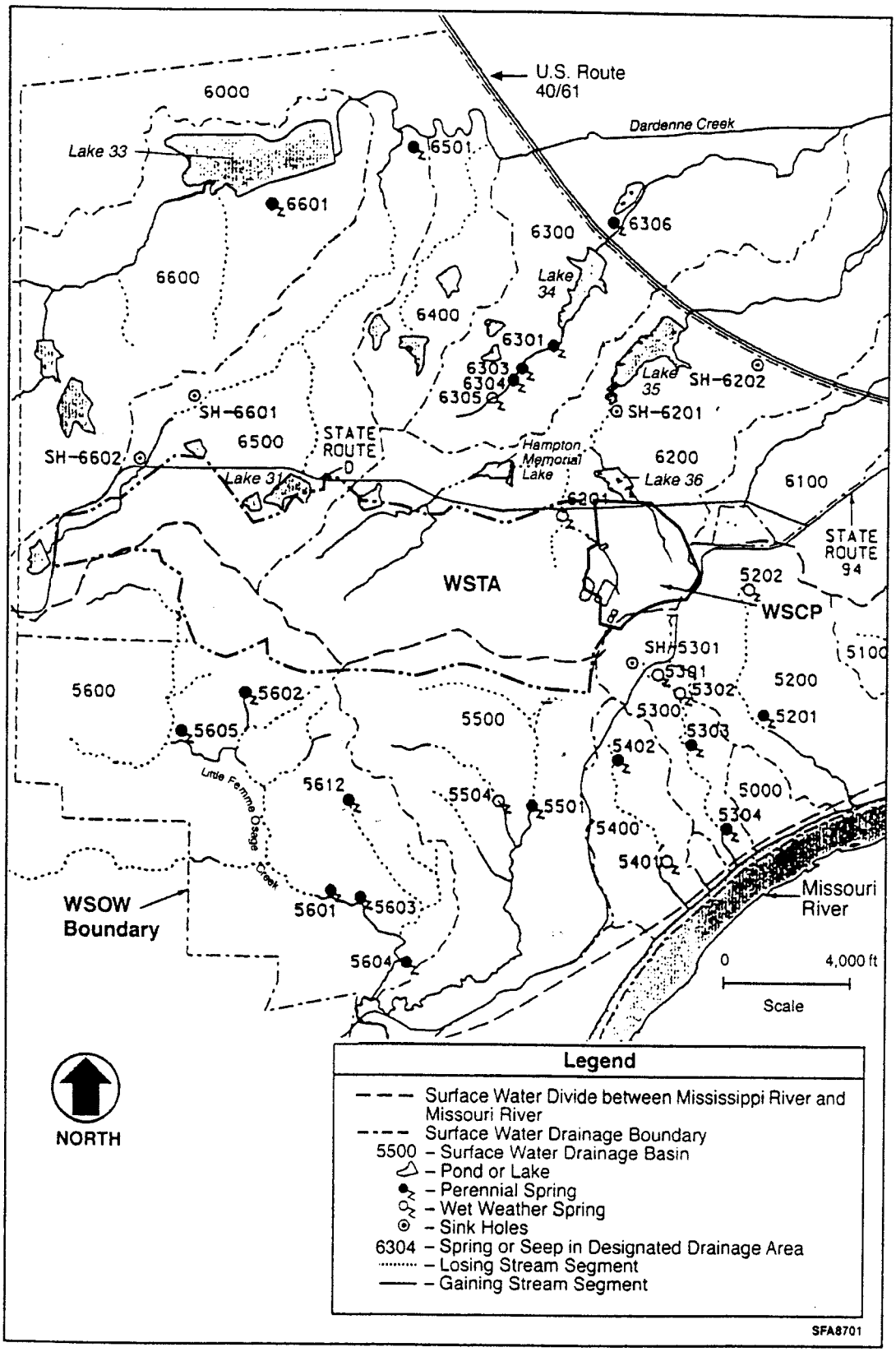

FIGURE 6 Springs and Drainage Areas in the Chemical Plant Area and the Ordnance Works Area

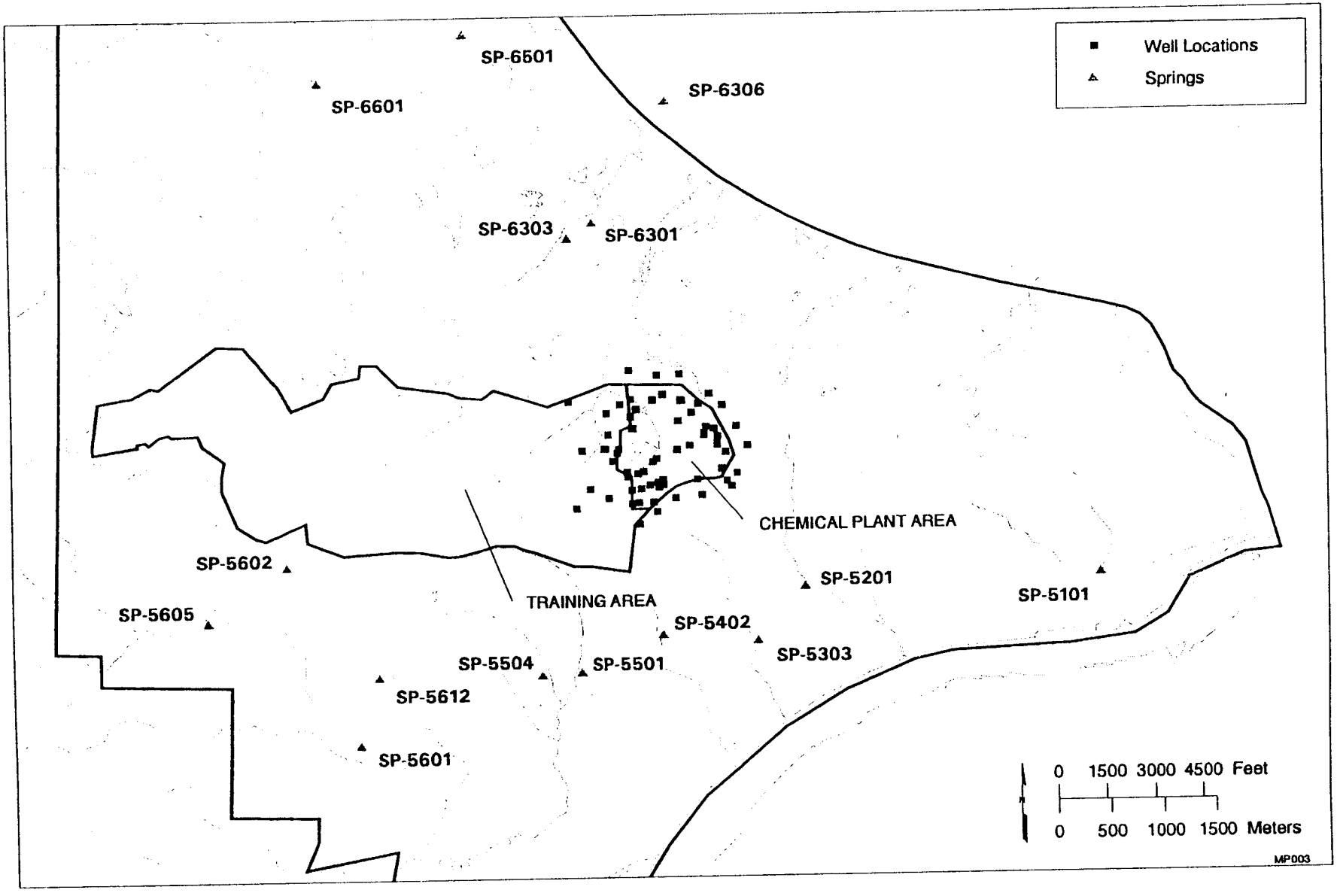

FIGURE 7 Locations of Springs at the Chemical Plant Area and the Ordnance Works Area

stopped, recovery of the groundwater level was very slow, and, as of the date of this IROD, full recovery to water levels prior to testing still has not been achieved.

4.1.3 Surface Water

The Chemical Plant Area is located on an east-west drainage divide between the Missouri and Mississippi watersheds. Surface drainage to the south of the divide generally flows through the Southeast Drainage and discharges to the Missouri River. Surface drainage to the north of the divide flows toward Dardenne Creek and its tributaries, primarily Schote Creek, the largest of the tributaries. Dardenne Creek flows east to the Mississippi River. Most of the drainage in the Chemical Plant Area drains to the north.

4.1.4 Groundwater and Surface Water Interaction

The MDNR Division of Geology and Land Survey conducted an investigation starting in 1987 to characterize the interaction between shallow groundwater and surface water in the Weldon Spring Area. The results of this investigation identified that the shallow aquifer beneath the Chemical Plant Area has characteristics typical of a carbonate groundwater system (e.g., weathered bedrock and solution-enlarged joints and fractures). Two general patterns of subsurface drainage were identified:

- Groundwater in drainages of the Missouri River watershed (south of the groundwater divide) does not cross into other drainages, and

- Groundwater in drainages of the Mississippi River watershed (north of the groundwater divide) can cross surface water divides and emerge into other drainages.

Overland flow from the northwestern portion of the chemical plant was lost in a losing reach of an unnamed tributary of Schote Creek about 305 m (1,000 ft) northwest of Ash Pond (MDNR 1991; DOE 1992). The results of the MDNR water-tracing studies indicate that a subsurface conduit is present between the unnamed tributary of Schote Creek and Burgermeister Spring. The travel time for the 1,981-m (6,500-ft) straight-line distance was estimated to be 48 to 72 hours, depending on previous rainfall (MDNR 1991).

As part of the RI, dye tracing was conducted to determine whether a subsurface hydraulic connection could be detected between Burgermeister Spring and the northern and western portions of the Chemical Plant Area. On the basis of data from previous aquifer testing (high values of hydraulic conductivity) and the presence of specific contaminants detected at Burgermeister Spring,

it was suspected that these sections of the Chemical Plant Area are directly connected with the conduit system that discharges to Burgermeister Spring. Three springs in the 6300 drainage were monitored for resurgence of the dye; however, the dye was only detected in Burgermeister Spring. The time required for the tracer to travel from the injection point to the recovery point (i.e., Burgermeister Spring) was used to calculate estimated groundwater velocities. These velocities were specific to the prevailing flow conditions during each dye trace. The travel times were considered with those determined by the MDNR's Division of Geology and Land Survey.

To address the concern about the potential for contaminated water entering the deep aquifer from directly beneath the Chemical Plant Area, in 1990 the U.S. Geological Survey completed a modeling study to quantitatively assess the groundwater flow among the shallow, middle, and deep aquifer systems in St. Charles County. The results of the survey indicate that 75% of the inflow to the upper, shallow aquifer (Burlington/Keokuk Limestones and the Fern Glenn Formation) in the immediate vicinity of the Chemical Plant Area is derived from precipitation. The remaining 25% is derived from lateral inflow into the layer. About 21% of this recharge leaks downward into the middle aquifer (Kimmswick Limestone) (Kleeschulte and Imes 1994). About 94% of the total recharge to the middle aquifer in the immediate vicinity of the Chemical Plant Area is derived from vertical leakage (Kleeschulte and Imes 1994). The remaining 6% is derived from lateral inflow. Approximately 80% of this water recharges the deep aquifer (top of the St. Peter Sandstone to the base of the Potosi Dolomite); the other 20% is lateral outflow.

The quantity of water infiltrating from the shallow aquifer to the deep aquifer is small, and the time required for water to travel this distance is measured in hundreds of years (Kleeschulte 1991).

4.2 NATURE AND EXTENT OF CONTAMINATION

As presented in the RI report (DOE and DA 1997b), the nature and extent of contamination within the groundwater system for the Chemical Plant Area were jointly evaluated with those of the Ordnance Works Area by using data collected during DOE and U.S. Department of the Army (DA) monitoring programs from 1987 through 1995 and a joint sampling effort conducted in 1995. Data obtained since 1995 from the Chemical Plant Area monitoring wells and springs were also reviewed.

The RI was designed to address the full scope of groundwater contamination at the site; however, this IROD generally focuses on presenting information relevant to remediation of TCE in the Chemical Plant Area.

Groundwater - On the basis of the results of the evaluation in the RI (DOE and DA 1997b) and BRA (DOE and DA 1997a), the primary contaminants in Chemical Plant Area groundwater are TCE, nitrate, nitroaromatic compounds, and uranium.

TCE contamination in groundwater was initially observed in 1996, probably as a result of drum remediation in the raffinate pits. Contamination is localized at the Chemical Plant Area, primarily in the vicinity of the raffinate pits. The horizontal extent of contamination extends from east of Raffinate Pit 3 to the south and southeast of Raffinate Pit 4, just beyond the adjacent boundary with the Weldon Spring Training Area (WSTA) (see Figure 5). Table 1 presents a summary of the TCE data in groundwater.

Springwater - The primary contaminants in the springwater at surface springs around the Chemical Plant Area are uranium, nitrate, and nitroaromatic compounds. Low levels (less than 2 µg/L) of TCE have been detected only in one spring, Spring 6303, in 1997 and 1998 samples.

TABLE 1 Summary of Data on TCE in Chemical Plant Area Groundwater[a]

	TCE Concentrations (µg/L)[b]				
Well No.	1996	1997	1998	1999	2000
MW-3024[c]	60	ND[d]	ND	ND	ND
MW-2037	1,100	1,300	1,000	1,010	870
MW-2038	9,000[e]	790	380	145	68
MW-3025	29	50	24	12	<10
MW-4028[e]	–[f]	–	–	620	490
MW-4029[e]	–	–	–	610	620
MWS-21	–	800	470	180	140
MWS-04	–	ND	21	2.4	ND

[a] The list of monitoring wells includes only wells where TCE has been detected.

[b] The values presented are maximum values reported.

[c] Observation well for the 1998 pump test that was later converted to a monitoring well.

[d] ND = nondetect.

[e] This value has been determined to be suspect on the basis of subsequent consistently lower measurements reported for 1996 (i.e., at 1,050 µg/L, 1,000 µg/L, 910 µg/L, and 860 µg/L, for four subsequent sampling periods in 1996).

[f] A hyphen indicates that TCE data were not collected. MW-4028 and MW-4029 were installed as observation wells for the pump test conducted in 1998. These two wells were subsequently included in the monitoring network. MWS-21 and MWS-04 are Army wells that were not sampled in 1996 when sampling was focused on DOE wells only.

5 SUMMARY OF SITE RISKS

The BRA (DOE and DA 1997a) prepared for the Chemical Plant Area provides an estimate of the potential human health and ecological risk the site poses if no remedial action were taken. Current and future land and resource (groundwater and springwater) use information was used to develop the use assumptions that were incorporated into the risk assessment. Section 5.1 presents information regarding the current and future land and resource use for the Chemical Plant Area and its vicinity; Section 5.2 summarizes the human health risk assessment and results; and Section 5.3 summarizes the ecological risk assessment that was performed for the GWOU.

Although the BRA was designed to address all of the GWOU contaminants of concern, the information presented in this IROD is generally limited to information relevant to TCE.

5.1 CURRENT AND FUTURE LAND AND RESOURCE USE

Current and potential future land use and groundwater and springwater use are described in this section to provide the basis for the exposure assumptions presented in subsequent sections of this IROD.

5.1.1 Current Land Use

The Weldon Spring site is located in St. Charles County (Figure 2), which has a population of approximately 285,600. The largest city in the county is St. Charles, which is located approximately 24 km (15 mi) northeast of the site and has a population of about 58,156 (DOE 1998b).

Adjacent to the Chemical Plant Area, portions of the WSTA that are within the Ordnance Works Area are currently used for field training and outdoor maneuvers by the U.S. Army reserve, the Missouri Army National Guard, and other military and police units. An estimated 3,300 local Army reservists and 3,400 other reserve troops use the training area each year. The DA intends to continue using the WSTA for training activities.

A large portion of the Ordnance Works Area has been converted into conservation areas. The August A. Busch Memorial Conservation Area and the Weldon Spring Conservation Area (see Figure 2) are managed by the Missouri Department of Conservation and are open throughout the year for recreational use. These areas receive an estimated 1.2 million visitors each year.

A state highway maintenance facility just east of the Chemical Plant Area employs nine full-time staff and one mechanic. The former staff housing complex for the Ordnance Works Area, located southeast of the intersection of State Route 94 and U.S. Route 40/61, is currently a private housing development known as Weldon Spring Heights; it has about 80 residents.

Francis Howell High School, located about 1 km (0.6 mi) east of the Chemical Plant Area, employs about 120 faculty and staff (including employees at the Francis Howell Administration Annex) and is attended by about 1,478 students.

5.1.2 Future Land Use

The 88-ha (217-acre) chemical plant is expected to remain under the control and ownership of DOE. As currently planned, only three buildings will remain within the chemical plant proper after project completion and site closure. The administration building may be leased to the Francis Howell School District for use in the expansion of its administrative offices.

The access control building may contain the DOE maintenance equipment storage area and the Weldon Spring site interpretive center. The center is expected to be a place where members of the public can obtain information about the site after the project office closes. A small water treatment enclosure will be located over the leachate sump.

The disposal cell facility, which encompasses about a 24-ha (60-acre) area of the chemical plant, will be maintained and monitored by DOE. The land outside of the disposal cell perimeter road will remain under DOE control.

The WSTA will continue to be used for field training. The Missouri Department of Conservation will continue to maintain the remaining surrounding areas for recreational use.

5.1.3 Current Groundwater and Springwater Use

Groundwater beneath the Chemical Plant Area and the adjacent Ordnance Works Area is not currently used for drinking or other domestic purposes. The majority of the residents in the nearby communities are supplied with municipal water.

Several springs and seeps that receive groundwater discharge are present in the Chemical Plant and Ordnance Works Areas. The Burgermeister Spring (SP6301) (Figure 6), located 1.6 km (1 mi) northwest of the Chemical Plant Area is considered a major discharge point for groundwater migrating from both the Chemical Plant and Ordnance Works Areas. Recreational visitors to the August Busch Memorial Conservation Area have access to this spring. Groundwater south of the

groundwater divide at the Chemical Plant Area primarily flows toward the Southeast Drainage. The Southeast Drainage is also accessible to the recreational visitor in the area.

5.1.4 Potential Future Groundwater and Springwater Use

A municipal water supply is currently available to serve the household needs of the area communities. Thus, for the foreseeable future, it is unlikely that the impacted groundwater beneath the Chemical Plant Area would be used for household purposes. In addition, the impacted shallow portion of the aquifer is characterized by low yields. The deeper, unaffected higher yielding aquifers would more likely serve as a groundwater source in the unlikely event groundwater use were to ever occur. Despite the unlikelihood of the impacted groundwater actually ever being used for household purposes, in accordance with EPA guidelines and for purposes of making this remedial action determination, this shallow groundwater is categorized as a potentially usable resource.

Access to springwater will remain similar to current conditions, consistent with recreational land use.

5.2 HUMAN HEALTH RISK ASSESSMENT

Potential risks to human health and the environment from groundwater and springwater contamination were evaluated for the Chemical Plant Area and the Ordnance Works Area as part of the joint DOE and DA RI/FS. Foreseeable future land use (i.e., the next 30 years or so) at both the Chemical Plant Area and the Ordnance Works Area is likely to be recreational, as discussed above, which is the same as current land use. Accordingly, consistent with CERCLA, potential risks were estimated with reference to current and likely foreseeable future recreational users. The assessment presented in the BRA (DOE and DA 1997a) also included risk estimates for a hypothetical future resident exposed to groundwater contaminants.

Recreational Visitor - The most likely receptor for site-related groundwater contamination is a recreational visitor to the area coming into contact with springwater discharged from groundwater. TCE is not considered a contaminant of concern in springwater. TCE was reported at low levels (less than 2 μg/L) in Spring 6303 in sampling that occurred in 1997 and 1998; this low TCE concentration would not pose an unacceptable risk to the recreational visitor.

The assessment presented in the BRA assumed that for 30 years the recreational visitor would visit the area 20 times a year for 4 hours each visit and each time ingest or drink about 2 cups of springwater. The dermal pathway was also evaluated. The recreational visitor was assumed not to have any exposure to the contaminated groundwater itself. This assumption is consistent with land

use conditions at the chemical plant, where a recreational visitor would not have direct access to the groundwater.

Hypothetical Resident - Risk calculations were also performed for a hypothetical resident with access to the groundwater at the Chemical Plant Area. The calculations were performed to obtain estimates of potential risk in the unlikely event the groundwater is used. Standard assumptions recommended by the EPA for a resident scenario were incorporated into the calculations. Risk calculations were performed for each well. The primary pathway of concern considered is the ingestion pathway; the inhalation pathway (while showering) was also evaluated for TCE because it is a volatile compound.

The risk of developing chemically induced cancer due to TCE was estimated to range from 2 in 10,000,000 (2×10^{-7}) to 1 in 1,000 (1×10^{-3}). The highest risk estimate of 1×10^{-3} results from the conservative approach of incorporating the highest ever detected value of 9,000 μg/L for MW-2038; this high value is suspect because of subsequent consistently lower values reported for this well in 1996 (see Table 1). These risk estimates are based on data reported for 1996 and 1997, because the BRA was finalized in 1997. Lower risk estimates would result if more current data (see Table 1) were considered.

5.3 ECOLOGICAL ASSESSMENT

The ecological assessment for this action is based on low levels (less than 2 μg/L) of TCE in SP 6303. A level of 2 μg/L resulted in a hazard quotient of 0.006 for aquatic biota. This hazard quotient is calculated using a surface water guideline value of 350 μg/L recommended by the EPA (EPA 1996). The low hazard quotient combined with the low frequency of detection indicates that TCE is unlikely to cause adverse ecological effects at the springs.

6 REMEDIAL ACTION OBJECTIVES

The evaluations performed for the FS (DOE and DA 1998) focused on identifying technologies and developing alternatives that could reduce or remove the groundwater contaminants (including TCE) at the Chemical Plant Area to the extent practicable. Alternatives that could indicate the beneficial impacts of source controls performed under the Chemical Plant ROD (DOE 1993) were also identified. Because this IROD is only addressing TCE contamination, the only relevant remedial action objective retained from the FS is remediation of TCE.

The risk results presented in Section 5 for TCE indicate that the groundwater and springwater at the Chemical Plant Area do not pose an unacceptable risk or hazard to the most likely future receptor, the recreational visitor. The recreational visitor has no access to the groundwater, and therefore no potential exposure is expected to occur. However, the hypothetical future resident consuming water from an on-site well could be exposed to unacceptable levels of TCE.

Although shallow groundwater at the Chemical Plant Area is currently not used and future use is considered unlikely, this shallow groundwater is categorized as potentially usable under EPA guidelines. Therefore, the goal for developing alternatives for the GWOU FS encompasses remediating the groundwater to remove, or as technically practicable, to reduce TCE concentrations in the contaminated shallow groundwater system. The preliminary alternatives included for screening in the FS (DOE and DA 1998) considered a broad range of remediation technologies, both in-situ and ex-situ.

7 DESCRIPTION OF REMEDIAL ALTERNATIVES

While seven of nine preliminary alternatives were retained for detailed analysis in the FS (DOE and DA 1998), only six are described in this chapter. The FS was developed to address final remedial action alternatives for all contaminants of concern within the GWOU. However, this IROD focuses only on TCE contamination. Thus, the following summary descriptions of the six alternatives have been tailored to address factors relevant to TCE contamination located primarily at the raffinate pits area. These alternatives are being considered in the context of follow-on activities after source removal and control response actions have been implemented at the Chemical Plant Area (DOE 1993).

7.1 ALTERNATIVE 1: NO ACTION

This alternative is used as a baseline against which to compare the other alternatives being considered. Under the No Action Alternative, groundwater at the Chemical Plant Area would remain "as is." No containment, removal, treatment, or other mitigating actions for TCE in groundwater would be implemented.

The No Action Alternative does not include groundwater monitoring under the scope of the GWOU or any active or passive institutional controls that may prevent the use of the groundwater.

Under Alternative 1, it is assumed that current groundwater monitoring for the GWOU would be discontinued. However, the groundwater monitoring being conducted to gauge performance of the disposal cell and any other site remediation activity planned under the Chemical Plant ROD (DOE 1993) would continue. TCE concentrations are expected to decrease as a result of dilution from infiltration of rainwater and runoff, and source removal per the chemical plant ROD (DOE 1993). Unacceptable impacts to human health and the environment would not be expected to occur. Monitoring would not be performed to verify the decrease in contaminant concentrations.

The No Action Alternative would not be effective in the long-term in the unforeseen event that impacted shallow groundwater is used for drinking purposes. However, this groundwater use is considered unlikely. It should be noted that this alternative would be effective for the recreational user since TCE is not a contaminant of concern at the springs. The chemical-specific ARAR for TCE would likely not be attained in the foreseeable future. This alternative has the lowest cost of all the alternatives.

7.2 ALTERNATIVE 2: LONG-TERM MONITORING

Under Alternative 2, no active remediation of TCE would take place; however, long-term monitoring of the groundwater would be performed. TCE concentrations in groundwater at the Chemical Plant Area are expected to decrease with time. This decrease could result from source removals and dilution from infiltration of rainwater and runoff. Further evaluation through long-term monitoring and associated activities would determine whether these processes in fact decreased contaminant levels.

Monitoring activities conducted would provide data to verify protection of human health and the environment. Unacceptable impacts to human health and the environment would not be expected to occur. Institutional controls, such as deed and access restrictions, would be implemented to prohibit access to the groundwater. TCE concentrations are expected to attenuate to levels equivalent to the ARAR.

Groundwater monitoring would be conducted by using the existing monitoring well network. It is possible that this network would be expanded or reduced on the basis of subsequent design of an optimal network. Monitoring would be performed for an appropriate period of time that would be defined in the remedial design/remedial action (RD/RA) phase. As required by CERCLA, a review would be conducted every five years because TCE concentrations would remain in site groundwater at levels above those that allow for unlimited use and unrestricted exposure for a residential user.

Capital cost is estimated to be $0.3 million, primarily for the construction of additional wells if needed. The annual monitoring costs are estimated to be $0.4 million.

7.3 ALTERNATIVE 3: MONITORED NATURAL ATTENUATION

This alternative involves the use of monitoring to verify the effectiveness of naturally occurring processes in reducing TCE concentrations at the GWOU. Dilution and dispersion are the primary natural processes identified that are acting to reduce TCE concentrations in groundwater at the Chemical Plant Area (DOE 1999b). Conditions do not appear favorable for significant degradation of TCE through biological processes. Because of the wide range in hydraulic conductivities and the karst nature of the aquifer across the contaminated areas, it is difficult to predict the remedial time frame.

Performance monitoring to determine continued occurrence of dilution and dispersion would be essentially the same as that performed under Alternative 2. Monitoring activities would essentially be implemented to verify TCE concentration decreases at the various monitoring wells. Concentrations are expected to attenuate to levels equivalent to the ARAR. Institutional controls,

such as deed and access restrictions, would be implemented to ensure that no domestic wells would be installed in the area of TCE-contaminated groundwater. The long-term monitoring effort, combined with the institutional controls that would be enforced, would be effective in the protection of human health and the environment.

As in Alternatives 1 and 2, the chemical-specific ARAR for TCE would not be attained for a long period of time. Cost estimates for this alternative are similar to those for Alternative 2.

As required by CERCLA, a review would be conducted every five years because contaminants would remain in site groundwater at levels above those that allow for unlimited use and unrestricted exposure for a residential user.

7.4 ALTERNATIVE 7: REMOVAL AND ON-SITE TREATMENT OF GROUNDWATER IN ZONES 1 AND 2

This alternative involves the extraction of groundwater in the vicinity of the raffinate pits of the Chemical Plant Area that is primarily contaminated with TCE. In the evaluation presented in the Supplemental FS (DOE 1999b), approximately 15 vertical extraction wells were estimated to be required to achieve a reasonable extraction rate and to provide wide enough coverage to prevent any bypass of the contaminants in Zones 1 and 2. It was not possible to incorporate into the evaluations all the site hydrogeologic complexities such as heterogeneity, fractures, and weathering. Consequently, the results presented are not representative of actual site conditions and may indicate that this alternative is more effective and implementable than it really is. The extracted groundwater would be pumped and treated at an aboveground treatment system. TCE would be removed by using the well-established granular activated carbon adsorption technology.

Uncertainties are associated with this alternative relative to the capacity for groundwater removal or extraction. Uncertainties with the effectiveness and implementability of this alternative are associated with hydrogeologic data, which indicate dewatering and very slow recovery of the aquifer as observed by a pump test performed in 1998. Assuming the alternative is implementable, the chemical-specific ARAR for TCE would not be attained for a long period of time (i.e., no sooner than at least 30 years). The capital costs are estimated to be approximately $5 million; the present worth cost is estimated to range between $14 million and $20 million.

As required by CERCLA, a review would be conducted every five years because TCE would remain in site groundwater at levels above those that allow for unlimited use and unrestricted exposure for a residential user.

7.5 ALTERNATIVE 8: IN-SITU TREATMENT OF TCE USING IN-WELL VAPOR STRIPPING

In-well vapor stripping technology involves the creation of a groundwater circulation pattern and simultaneous aeration within the vapor stripping well to volatilize the TCE from the circulating groundwater. This alternative is focused on remediating the TCE-contaminated groundwater in Zones 1 and 2 that has been identified near the raffinate pits area of the chemical plant.

The in-well vapor stripping technology consists primarily of a screened well submerged beneath the water table and an air line within the well extending to below the water table. A compressor delivers air or an inert gas such as nitrogen to the water column aerating the water within the well. The gas bubbles cause the water within the well to be less dense than the nonaerated water outside. As a result, the dense water flows in through the well screen and forces the aerated water upward within the well. The result is a rising column of aerated water within the well, which forms an air-lift pumping system.

Uncertainties that would affect the effectiveness and implementability of this alternative involve the capacity to generate a vertical circulation pattern in the system. Because of these uncertainties, it is difficult to estimate how long it would take to attain the ARAR for TCE under this alternative. Capital cost is estimated to be between $1 million and $3 million.

As required by CERCLA, a review would be conducted every five years because contaminants would remain in site groundwater at levels above those that allow for unlimited use and unrestricted exposure for a residential user.

7.6 ALTERNATIVE 9: IN-SITU CHEMICAL OXIDATION OF TCE USING FENTON-LIKE REAGENTS

This alternative involves in-situ chemical oxidation of the TCE-contaminated groundwater that has been identified near the raffinate pits area of the Chemical Plant Area. Because this technology has been proven to address organic compounds only, this alternative would primarily address TCE.

The application of this technology consists of injecting aqueous solutions such as hydrogen peroxide, ferrous sulfate, and other chemicals (e.g., acetic acid) into the shallow bedrock aquifer through a series of injection wells. Preliminary engineering estimates indicate the need for the installation of approximately two sets of nested application or injection wells, with multiple rounds (at least two) of chemical reagent application.

While the objective for implementing this alternative is to achieve the ARAR for TCE, uncertainties are associated with the effectiveness and implementability of the technology due to complexities imposed by the site hydrogeology. Capital cost is estimated to be about $0.5 million.

A bench- or pilot-scale test may be performed to determine the appropriate chemical reagent formulation. The results from these tests would be important for the remedial design in determining the optimum number of application wells and the number of application rounds of chemical reagent.

8 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

8.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment engineering controls, and/or institutional controls.

All of the alternatives, except for the No Action Alternative, are protective of human health and the environment by reducing or eliminating potential risk from ingestion or drinking of groundwater containing TCE through extraction, treatment, monitoring and institutional controls. The No Action Alternative would be protective if groundwater is not used for residential purposes (i.e., for drinking). Alternatives 2 and 3 would provide protection with additional certainty because monitoring data would be available to verify that TCE contamination levels have decreased and are not expanding to other areas. Alternatives 7, 8, and 9 would provide protection to human health and the environment in addition to that afforded by Alternatives 2 and 3 because TCE would be extracted and/or treated and, therefore, would eliminate or reduce TCE concentrations in groundwater at the Chemical Plant Area.

Alternatives 2, 3, 7, 8, and 9 would provide adequate protection from TCE; however, the protection afforded by Alternatives 2 and 3 would depend primarily on slow occurring natural processes and the implementation of institutional controls. With Alternative 7, the protection afforded depends on the ability to extract or remove the impacted groundwater. The complex hydrogeology at the site may affect the ability to meet the drinking water standard. The probability of gaining protection through Alternative 8 would be limited by the site hydrogeology as well as by the difficulty of attaining a vertical circulation pattern, which is required for successful implementation. Alternative 9 provides protection through treatment that is expected to occur in the shortest time period.

8.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This criterion addresses compliance with federal and state environmental requirements.

All alternatives will attain the chemical-specific ARAR for TCE of 5 µg/L. However, it would take a long period of time (over 100 years) for Alternatives 1, 2, and 3 to attain this ARAR. Alternative 7, involving pump and treat, would take about 30 to 70 years, on the basis of calculations presented in the FS (DOE and DA 1998). However, the effectiveness and implementability of this

alternative are uncertain because of the complex site hydrogeology which could not be fully incorporated into the evaluations. It is uncertain how much time would be required for Alternative 8 to attain this ARAR because of uncertainties imposed by the complex site hydrogeology. Alternative 9 is projected to attain the ARAR for TCE in the shortest period of time (one to several years), as compared with all the other alternatives, although some uncertainty is still associated with the effectiveness and implementability of this alternative because of the complex site hydrogeology.

All alternatives except for the No Action Alternative are expected to comply with any action-specific ARAR.

8.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Long-term effectiveness and permanence address the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met.

Alternative 1, no action, would not be effective for the long-term if the groundwater is used. Alternatives 2 and 3 provide long-term effectiveness through monitoring data that would be acquired to verify protectiveness. If implementable, Alternatives 7, 8, and 9 provide long-term effectiveness by removing and treating the TCE in groundwater to levels equivalent to the ARAR. No additional contamination is expected to occur because source removals have been performed, and current levels of TCE would be removed or reduced to meet the chemical-specific ARAR for TCE.

8.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

This criterion refers to the anticipated performance of the treatment technologies that may be included as part of the alternatives.

Alternatives 1, 2, and 3 do not involve treatment technologies. Alternatives 7, 8, and 9 involve treatment via different technologies. The overall performance of the treatment technologies associated with Alternative 7 is dependent on the ability for groundwater extraction. Although reduction of the toxicity, mobility, or volume associated with TCE contamination is afforded by Alternative 8, its performance is uncertain because of limitations imposed by site hydrogeology. Treatment via Alternative 9 is expected to be less uncertain because the capacity to introduce or inject material into Zone 1 was indicated during the pump test performed in 1998.

8.5 SHORT-TERM EFFECTIVENESS

This criterion addresses the period of time needed to implement the remedy or alternatives and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.

No potential impacts are expected with Alternatives 1, 2, and 3. Monitoring activities associated with Alternatives 2 and 3 are routine, and any potential short-term environmental impacts would be limited to the immediate vicinity of the Chemical Plant Area.

Potential impacts associated with construction of extraction or injection wells for Alternatives 7, 8, and 9 are expected to be low, with estimates indicating no more than seven cases of occupational injury and less than one occupational fatality. As with Alternatives 2 and 3, any potential short-term environmental impacts associated with Alternatives 7, 8, and 9 would be limited to the immediate vicinity of the Chemical Plant Area.

8.6 IMPLEMENTABILITY

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation.

No implementability concerns exist with Alternative 1, because no action would be taken. Few implementability concerns are associated with Alternatives 2 and 3 because currently available monitoring resources could be used. For Alternative 7, the ability to extract groundwater may be limited by the complex hydrogeology of the site; implementability concerns are associated with the ability to generate a circulation pattern for Alternative 8. For Alternative 9, although the ability to introduce materials in Zones 1 and 2 was indicated by the pump test performed in 1998, and implementation of Alternative 9 requires the introduction of chemical reagents into the aquifer, uncertainties are associated with the implementation of Alternative 9 because of the karst and weathered characteristics indicated for Zones 1 and 2.

8.7 COST

Alternative 1	Lowest cost.
Alternatives 2 and 3	Capital cost of $0.3 million. Annual monitoring cost of $0.4 million. Present-worth cost to range between $3 million and $4 million.

Alternative 7	Capital cost of $5 million. Present-worth cost to range between $14 million and $20 million. Annual monitoring costs are estimated to be $0.4 million.
Alternative 8	Capital cost of between $1 million to $3 million. Present-worth cost is estimated to be between $6 million and $7 million. Annual costs of $0.4 million for monitoring.
Alternative 9	Capital cost of $0.5 million. The present-worth cost is on the order of $5 million. Annual costs of about $0.4 million for monitoring. Lowest cost of all active treatment alternatives (i.e., Alternatives 7, 8, and 9).

8.8 STATE ACCEPTANCE

The State has expressed its support for Alternative 9 for the treatment of TCE.

8.9 COMMUNITY ACCEPTANCE

During the public comment periods, the public did not object to the implementation of Alternative 9 for remediation of TCE.

9 SELECTED INTERIM REMEDY

The selected interim remedy provides for active remediation of the TCE-contaminated groundwater in Zones 1 and 2 via in-situ chemical oxidation as described in Alternative 9.

The TCE-contaminated groundwater will be treated using an in-situ chemical oxidation process. The method involves introducing oxidizing agents, such as Fenton reagents (e.g., hydrogen peroxide and a ferrous compound), into the groundwater as a means of treating TCE in place. Once introduced into the aquifer, the chemicals will produce hydroxyl radicals under controlled acidic conditions. These highly reactive radicals will then be expected to react with the TCE in the groundwater to form innocuous end products (i.e., chloride salts, carbon dioxide, and water). This chemical reaction can be completed in a relatively short period of time (days), once injection is achieved. However, there are uncertainties associated with this alternative that may affect the effectiveness and implementability. These uncertainties are due to the complex site hydrogeology. The period of time required for remediation by using this technology is estimated to be on the order of a few months to several years. The remediation will be designed to achieve the 5-µg/L maximum contaminant level (MCL) for TCE. Performance monitoring will be used to measure the effectiveness of this process.

The selected interim remedy was developed after careful consideration of a full range of treatment technologies and remedial options. When evaluated against the remedy selection criteria defined in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (EPA 1990), Alternative 9 (in-situ chemical oxidation of the TCE in Zones 1 and 2) is considered the best option for remediating TCE. It offers the greatest potential for short-term reduction of the TCE, which is the primary driver of potential risk, is cost effective, and has greater prospects for success relative to pump and treat options. Although current site conditions are protective for recreational use (the most likely future use), successful in-situ treatment of the TCE will eliminate or decrease TCE concentrations and will result in risk estimates falling within the acceptable range for the hypothetical residential scenario as well.

Details of the in-situ chemical oxidation process will be presented in remedial design planning documents developed subsequent to this IROD. Because of the innovative nature of this technology, combined with the complex hydrogeology of the site, the implementation of the design would be monitored for actual field versus expected performance. The performance of the selected interim remedy will be documented in the remedial action report that will be prepared for this action.

10 STATUTORY DETERMINATIONS

In accordance with the statutory requirements of Section 121 of CERCLA, as amended, remedial actions shall be selected that:

- Are protective of human health and the environment,
- Comply with ARARs to the extent practicable,
- Are cost-effective, and
- Utilize permanent solutions and alternative treatment technologies to the maximum extent practicable.

The selected interim remedy is discussed below in relation to how it fulfills the requirements. In addition, the preference cited in CERCLA Section 121 for treatment as a principal element is discussed.

10.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected interim remedy will be protective of human health and the environment under current conditions, because the contaminated groundwater is not used as a drinking water source. Although it is not a likely source of drinking water in the future, it is considered a potentially usable source; remediation of TCE in groundwater will contribute to the restoration of the groundwater.

In addition, because source removal has been accomplished under the chemical plant ROD (DOE 1993), no new migration of contaminants to the groundwater system should occur. Reduction of TCE levels in Zones 1 and 2 will also be accomplished under this action.

10.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

As required by Section 121(d)(4) of CERCLA, the selected interim remedy will comply with all ARARs (chemical-and action-specific) to the extent practicable.

10.2.1 Chemical-Specific ARARs

Chemical-specific ARARs set concentration limits or ranges in various environmental media for specific hazardous substances, pollutants, or contaminants of concern. The MCL for TCE of 5 µg/L is a chemical-specific ARAR. Current concentrations in groundwater in Zones 1 and 2 at the Chemical Plant Area exceed this ARAR.

10.2.2 Action-Specific ARARs

Action-specific ARARs are standards that restrict or control specific remedial activities related to the management of hazardous substances or pollutants for a variety of media. These requirements are triggered by a particular activity, not by specific chemicals or the location of the activity. Several action-specific ARARs may exist for any given action. These action-specific ARARs do not in themselves determine the appropriate remedial alternative, but indicate performance levels to be achieved for the activities performed under the selected remedy. On-site actions must comply with all substantive provisions of an ARAR but not with related administrative and procedural requirements (e.g., filing reports or obtaining a permit). The term "on-site" includes the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary to implement the response action. No permit applications will be necessary for any on-site activities. The selected interim remedy will comply with all pertinent action-specific ARARs, which are listed in Appendix A of the FS (DOE and DA 1998). Missouri requirements for well construction will be an ARAR for any newly installed wells or for the plugging of wells under the selected interim remedy (10 CSR 23-4.050).

Appendix A of the FS (DOE and DA 1998) also lists several regulations that set occupational exposure limits for activities involving contaminated media, including the Occupational Safety and Health Administration Environmental Controls (29 CFR 1910, Subpart G). These regulations are not ARARs because they are not environmental or siting regulations; however, as employee protection regulations, employees working with contaminated media or in contaminated areas must comply with these requirements.

10.3 COST-EFFECTIVENESS

The selected interim remedy will be cost-effective because it provides overall protection of human health and the environment at a reasonable cost.

10.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

The selected interim remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the site.

10.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

By treating TCE in the groundwater, the selected interim remedy addresses principal threats posed by the groundwater at the Chemical Plant Area through the use of treatment technologies. By utilizing treatment, the statutory preference for remedies that employ treatment as a principal element is satisfied.

The selected interim remedy provides the best balance of trade-offs in terms of the balancing criteria, while also considering the statutory preference for treatment as a principal element, the bias against off-site treatment and disposal, and state and community acceptance.

10.6 SIGNIFICANT CHANGES

This section describes significant changes made to the selected interim remedy from the preferred remedy identified in the PP (DOE 1999a) released for public comment on August 3, 1999. The PP identified the preferred alternative as active remediation of TCE-contaminated groundwater via in-situ chemical oxidation, combined with long-term monitoring of the remaining contamination and institutional controls to restrict groundwater use. The preferred alternative was to meet the chemical-specific ARARs (drinking water standards) for TCE and waive the ARARs for nitrate, 2,4-DNT, and uranium based on a finding of technical impracticability (TI), consistent with Office of Solid Waste and Emergency Response (OSWER) Directive 9234.2-25: "Guidance for Evaluating the Technical Impracticability of Groundwater Restoration." Extensive study was performed in conjunction with this evaluation.

Extensive public comment was received on the PP; in general, the public objected to the ARAR waivers and asked for more extensive groundwater remediation (see the Responsiveness Summary in Appendix A). DOE continues to believe that the remedy described in the PP is the most effective approach at this site and is consistent with the expectations of CERCLA. However, in response to public comment, the remedial strategy for contaminated groundwater has been changed to accommodate stakeholder concerns (see Selected Interim Remedy, Section 9). By issuing an IROD rather than a final ROD, progress can be made on groundwater cleanup by moving forward with the in-situ treatment of TCE. The final groundwater decision is being deferred until further field study can be performed to re-examine the effectiveness of the technologies to remediate the other contaminants of concern.

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APPENDIX A:

RESPONSIVENESS SUMMARY

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RESPONSIVENESS SUMMARY

The Proposed Plan (PP) (DOE 1999) for the Groundwater Operable Unit (GWOU) was issued to the public for review and comment on August 3, 1999. The U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) held a public meeting to discuss the proposed action on August 25, 1999, at the Administration Building of the Weldon Spring Site Remedial Action Project (WSSRAP) located at 7295 Highway 94 South, St. Charles, Missouri. Representatives of the State of Missouri were also in attendance. At this meeting, DOE and the EPA responded to oral comments made on the PP (DOE 1999); those responses are included in the meeting transcript. The meeting transcript is part of the *Administrative Record* for the GWOU and is on file at the information repositories for the WSSRAP. The repositories are located in the project office reading room at Francis Howell High School and at four branches of the St. Charles City/County Library, as listed in Section 3 of this Interim Record of Decision (IROD).

The initial 30-day public comment period for the PP (DOE 1999) ended on September 1, 1999. However, an additional comment period was held from November 8, 1999, to January 6, 2000, in response to the public's request for an extension. Following the issuance of the PP on August 3, 1999, the Missouri Department of Natural Resources (MDNR), the EPA, and DOE agreed to a dispute resolution process to address and resolve outstanding issues. All parties agreed to give the public an additional opportunity to comment on the PP, so that the proposal could be reviewed in context with the information from the dispute process. Following the conclusion of the dispute process, the PP was reissued for public comment. DOE announced an additional public comment period, which was held from June 12, 2000, to July 14, 2000. This review period was subsequently extended to August 15, 2000, to accommodate public request for additional time.

In addition to oral comments received and responded to at the public meeting held on August 25, 1999, comment letters were received from various state and local agencies and organizations and members of the local public. These letters are also part of the *Administrative Record* for the GWOU and are tabulated in Tables A.1 (for letters received during the first comment period, which ended January 6, 2000) and A.2 (for letters received from the recent comment period that ended August 15, 2000).

The majority of comment letters expressed concern that aside from the proposed in-place treatment of trichloroethylene (TCE) and long-term monitoring, no active remediation is planned for any of the remaining radioactive and chemical contaminants. The letters also contained requests for DOE to remediate more extensively or in full, if possible, and to conduct further studies and evaluations so that additional remediation could be performed. The majority of the letters also

objected to the use of waivers on the basis of technical impracticability (TI), opining that this approach is premature and not acceptable.

As discussed in this IROD, DOE has decided to postpone the final decision for remediation of the GWOU in response to public comment and concerns expressed during the comment periods. Through this IROD, the DOE will move forward and implement active remediation of the TCE but will postpone the final decision so that additional field studies to re-examine the effectiveness of technologies to remediate the other contaminants of concern can be conducted independently of the IROD. DOE will work closely with the EPA and the MDNR to identify, plan, and implement these field studies. A final ROD will be prepared at a later date that will reflect the outcome of the TCE treatment and these field studies.

The following key information regarding the Chemical Plant Area GWOU is reiterated in this responsiveness summary to provide further clarification and response to the majority of the comments received.

- The contaminants of concern that have been found in the shallow portion of the aquifer are TCE, nitrate, nitroaromatic compounds, and uranium. Uranium has been the only radioactive contaminant observed to be elevated over background in groundwater at the Chemical Plant Area. This conclusion is based on over a decade of groundwater sampling at the Chemical Plant Area. In addition, uranium groundwater contamination is limited to the raffinate pits area, and current levels are generally low, with concentrations only in one well reported to be greater than the 30-pCi/L standard. The most recent uranium concentration (as of early 2000) reported for this well is 47 pCi/L.

- Monitoring data are available for the deeper portion of the aquifer. These data indicate that contamination is primarily limited to the shallow weathered portion of the aquifer.

- The impacted groundwater beneath the Chemical Plant Area is not currently being used. In addition, it is unlikely that the groundwater would be used in the foreseeable future given the availability of municipal water. The shallow impacted groundwater is characterized by low yields that would not be sufficient to support household uses.

- The intent of the evaluations for technologies and alternatives presented in the Feasibility Study report (DOE and DA 1998) was to provide a thorough identification of technologies and alternatives that could reduce or remove the

groundwater contaminants at the Chemical Plant Area to the extent technically practicable.

- The complex hydrogeology of the site imposed limitations on the performance of most of the technologies currently available (including the pump and treat option). This condition may warrant consideration of TI waivers.

- The Southeast Drainage and Burgermeister Spring are primary discharge points for contaminated groundwater at the chemical plant. Uranium levels downstream of these areas are not distinguishable from natural background levels. This indicates there is no impact to the Missouri or Mississippi River drinking water supplies.

TABLE A.1 Public Comment Letters Received for the Comment Period Ending January 6, 2000

Name	Address
Missouri Department of Health (MDOH)	P.O. Box 570 Jefferson City, MO 65102-0570
Michael V. Garvey, D.D.S.	2967 Old Hwy. 94 St. Peters, MO 63376
Missouri Department of Natural Resources (MDNR)	P.O. Box 176 Jefferson City, MO 65102-0176
Kay Drey	515 West Point Ave. University City, MO 63130
Mary A. Halliday St. Charles County Government	201 North Second Street, Suite 433 St. Charles, MO 63301
Kay Drey	515 West Point Ave. University City, MO 63130

TABLE A.2 Public Comment Letters Received for the Comment Period Ending August 15, 2000

Name	Address
Andy Ayers	6307 Delmar University City, MO 63130
Leland Nadler	130 Church Road Augusta, MO 63332
Yvonne Logan	36 S. Gore St. Louis, MO 63119
Charles Davidson Associate Executive Director Conservation Federation of Missouri	728 West Main Street Jefferson City, MO 65101-1559
Chris McClarren	3936 Fillmore St. Louis, MO 63116
Mike Dudley, Alderman Weldon Spring Board of Aldermen	7 Whitmoor Court Weldon Spring, MO 63304
Leonard A. Sonnenschein, President St. Louis Children's Aquarium	416 Hanley Industrial Court Brentwood, MO 63144
Daniel Carlin	6120 Kingsbury Ave. St. Louis, MO 63112
Byron Clemens	100 Arundel Place St. Louis, MO 63105
Tom and Jane Mendelson	110 Arundel Place St. Louis, MO 63105
Dr. Michael V. Garvey, Vice-President Greenway Network, Inc.	P.O. Box 513 St. Charles, MO 63302-0513
Ruthmary K. Deuel, M.D.	6423 San Bonita Ave. St. Louis, MO 63105
Becky Denney	625 Angenette Ave. Kirkwood, MO 63122-6220
Jim Young	905 Lami St. St. Louis, MO 63104
Jackie Greenleaf Schirn Robert E. Drzymala	137 Sylvester Webster Groves, MO 63119

TABLE A.2 (Cont.)

Name	Address
Kathie Molyneaux	6701 Bradley, Apt. 6 St. Louis, MO 63139
Brigid K. McCauley	6309 Pershing Avenue University City, MO 63130
Sandra Delcoure Water Creek MO Stream Team No. 30	3029 Willow Creek Florissant, MO 63031
Charles J. Guenther, Jr. Prof., Engineering & Technology St. Louis Community College Margaret P. Gilleo Prof., Environmental Ethics Maryville University of St. Louis	40 Willow Hill Road St. Louis, MO 63124
St. Louis County Resolution	County Government Center 41 S. Central Avenue Clayton, MO 63105
City of St. Louis Resolution St. Louis Board of Aldermen	Room 230, City Hall 1200 Market St. St. Louis, MO 63103
Weldon Spring Citizens Commission	7295 Highway 94 South St. Charles, MO 63304
Pamela Hosler	6571 Arsenal St. St. Louis, MO 63139
Ed Mahr, Jr.	7480A Wise Ave. St. Louis, MO 63117
Kay Drey	515 West Point Ave. University City, MO 63130
William Murray Underwood, P.E.	415 Parkwood Ave. Kirkwood, MO 63122-4655
Alice Donaldson	522 N. Kirkwood Rd., 2B St. Louis, MO 63122
Virginia Druhe	Address unknown

TABLE A.2 (Cont.)

Name	Address
Jean M. Lucy	16016 Canterbury Estates Dr. Ellisville, MO 63021
Marvin J. Lucy	16016 Canterbury Estates Dr. Ellisville, MO 63021
Elaine and Harold Glassman	7 Hacienda Dr. St. Louis, MO 63124
Melody Trausch	1840 Shiloh Wood Road Chesterfield, MO 63005
Susan and Jay Jaffe	15322 Broeker Place Chesterfield, MO 63017
Milton Schlesinger, Ph.D. Prof. Emeritus Washington University Sondra Schlesinger, Ph.D. Dept. Mol. Microbiology Washington University	6320 McPherson Ave. St. Louis, MO 63130-4701
Roy Hengerson Environmental Policy Director Missouri Coalition for the Environment	6267 Delmar Blvd., 2-E St. Louis, MO 63130
Nancy Burris	2516 Bremerton Road Brentwood, MO 63144-2204
Sharon Smith	4366 Maryland Ave. #105 St. Louis, MO 63108
Timothy Breeze	7261 Delmar Blvd. University City, MO 63130
Jill Williams	1002 Redemption Way St. Louis, MO 63039
Andrew Neuman	Address unknown
Elizabeth Summer	Clayton, MO
Pam Bleckredge	59 Rear Maryland Plaza St. Louis, MO 63108

TABLE A.2 (Cont.)

Name	Address
Jean and David Weinstock	7731 Lacorn Ct. St. Louis, MO 63121
Margaret Stacy Goal	1126 Childress St. Louis, MO 63139
Jim Scheff	20 Crabapple Ct. St. Louis, MO 63132
Laura Carpenter Balding	61 Wolfram Road St. Charles, MO 63304
Daniel W. McKeel, Jr., M.D. Assoc. Prof., Pathology & Immunology Washington Univ. School of Medicine	5587-C Waterman Blvd. St. Louis, MO 63112
Vicki L. Burton	Address unknown
Daniel F. Havens	8401 Cornell Ave. St. Louis, MO 63132
Marilyn Lipman	122 Plantation Dr. Creve Coeur, MO 63141
Susan Klarfeld	333 Falaise Drive St. Louis, MO 63141
M.M. Kleba	3929 Gusine Ave. St. Louis, MO
Cynthia C. Lomboty	229 W. Jewel Ave. Kirkwood, MO 63122
Becky Denny	625 Angenette Ave. Kirkwood, MO 63122-6220
Stephen Culver	202 Wolfram Rd. Weldon Spring, MO 63304
Kim Kitson	4927 Quincy St. St. Louis, MO 63109
Virginia Harris	556 Oakhaven Lane Creve Coeur, MO 63141
Kathy Collins	26 South Joyce Ellen Way St. Peters, MO 63376

TABLE A.2 (Cont.)

Name	Address
Arlene Kendle	6947 Columbia Ave. St. Louis, MO 63130
Dorothy M. Moore	Three Creek Farm 71 Wolfram Road Weldon Spring, MO 63304
Ellen Sue Goodman	12892 Castletault St. Louis, MO 63141
Mike Duvall St. Charles County Government Director, Division of Environmental Services	201 North Second Street, Room 433 St. Charles, MO 63301
Judith Medoff, Ph.D. Prof., Biology St. Louis University	3507 Laclede Ave. St. Louis, MO 63103-2010
Mary T. Dzieniuk	5054 Potomac St. St. Louis, MO 63139
Saundra A. Lowes	7425 Teasdale St. Louis, MO 63130
Pamela Loderovick	8 Fair Oaks St. Louis, MO 63124
Mary A. Halliday	97 Wildlife Lane Defiance, MO 63341-1512
Caroline Pufalt	13415 Land O Woods #3 Chesterfield, MO 63141-6078
Pat Harlan	26 Rolling Rock Ct. St. Louis, MO 63124
Debbie Cole	346 Woodmere Dr. St. Charles, MO 63303
Fran Sontag	6671 Kingsbury St. Louis, MO 63130
Kathleen O'Keefe	634 Sherwood Dr. Webster Groves, MO 63119
Janet and Bernard Becker	4498 Laclede Ave. St. Louis, MO 63108

TABLE A.2 (Cont.)

Name	Address
Thomas W. Brown Mayor St. Peters, MO	City of St. Peters One St. Peters Centre Blvd. St. Peter, MO 63376
Laura Ellsworth	Address unknown
Name illegible	Address unknown
Jim Goodwin	Address unknown
Thelma J. Schaefe	Address unknown
Mary Lou S. Ryan	6 Wakefield Dr. St. Louis, MO 63124
Dorothy C. Poor	8173 Stratford Dr. St. Louis, MO 63105
Margie Kohn	Address unknown
Helene Frankel	116 Lake Forest St. Louis, MO 63117
Garth F. Fort	31 Briarcliff St. Louis, MO 63124
James M. Talent Kenny Hulshof Members of U.S. Congress	1022 Longworth HOB Washington, DC 20616-2502
Rebecca W. Wright Missouri Coalition for the Environment	2011 Rutger St. St. Louis, MO 63104
Kay Drey	515 West Point Ave. University City, MO 63130
Richard A. Dreyer	P.O. Box 6933 St. Louis, MO 63123-0233
G. Clare Laune	16651 Caulks Creek Ridge Chesterfield, MO 63005
Rebecca Wiederkehr	1514 Robin Hood Ct. St. Louis, MO 63122-5549
Louise Green	11 Litzsinger Lane St. Louis, MO 63124

TABLE A.2 (Cont.)

Name	Address
Lee Potts	1514 Robinhood Court St. Louis, MO 63122-5549
Claire L. Schosser	5304 Fletcher Ave. St. Louis, MO 63136
George Boniface	6306 Southwood Avenue 3W St. Louis, MO 63105
Mary Louise Porcelli	2378 Half Moon St. Louis, MO 63114
Chris McClarren	3936 Fillmore St. Louis, MO 63116
Diana Holman	11 Rutherglen Dr. Valley Park, MO 63088
Judith Medoff, Ph.D. Prof., Biology St. Louis University	3507 Laclede Ave. St. Louis, MO 63103-2010
Virginia Harris	556 Oakhaven Lane Creve Coeur, MO 63141
Kathy Lewis	120 Cornelia Ave. St. Louis, MO 63122
Louise McKeon Belt	18318 Rieger Rd. Wildwood, MO 63005-8429
Garth Fort	31 Briarcliff St. Louis, MO 63124
Leonard Weinstock, M.D. Specialist in Gastroenterology	10287 Clayton Road, Suite 200 St. Louis, MO 63124
Donovan Larson, P.E.	9819 Mar-Ann Court St. Louis, MO 63128
Rick Cox	Address unknown
Roberta J. Gutwein	7415 York Drive St. Louis, MO 63105

REFERENCES FOR APPENDIX A

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