Department of Energy
Oak Ridge Operations
Weldon Spring Site
Remedial Action Project Office
Route 2, Highway 94 South
St. Charles, Missouri 63303

November 17, 1988

ADDRESSEES

ASSESSMENT OF DROUGHT CONDITIONS AT THE WELDON SPRING QUARRY

The Department of Energy completed an assessment of the effects of the drought on contaminant migration from the Weldon Spring Quarry. The results are presented in the final report entitled "Initial Assessment of the Effect of Drought Conditions on Contaminant Migration from the Weldon Spring Quarry" which is enclosed with this letter.

The report indicates that short term changes in groundwater velocity and flow patterns due to increased pumpage and low river stages do not appear to have a measurable impact on contaminant migration. Any long term effects will be evaluated as part of the ongoing environmental monitoring program.

If you have any questions, please feel free to call.

Sincerely,

R.R. Nelson

R.R. Nelson
Project Manager
Weldon Spring Site
Remedial Action Project

Enclosure:
As stated

cc w/o enclosure:
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Honorable Gerald Ohlms, St. Charles County

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United States Department Of Energy

INITIAL ASSESSMENT OF THE EFFECT OF DROUGHT CONDITIONS ON CONTAMINANT MIGRATION FROM THE WELDON SPRING QUARRY

REV. 0

WELDON SPRING SITE REMEDIAL ACTION PROJECT

INITIAL ASSESSMENT OF

THE EFFECT OF

DROUGHT CONDITIONS ON CONTAMINANT

MIGRATION FROM THE WELDON SPRING QUARRY

PREPARED FOR:

U.S. DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

UNDER CONTRACT NO. DE-AC05-86OR21548

PREPARED BY:

MK-FERGUSON COMPANY

AND

JACOBS ENGINEERING GROUP, INC.

NOVEMBER 1988

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1.0 INTRODUCTION

The drought of 1988 provided a unique opportunity to evaluate the short-term potential for increased contaminant migration from the Weldon Spring Quarry (WSQ) toward the St. Charles County Well Field. To evaluate this potential, additional sampling and groundwater level measurements have been performed. This brief report summarizes and interprets the initial data collected as a result of the increased monitoring efforts at the WSQ.

The additional monitoring at the WSQ consisted of two phases. The first, groundwater level monitoring, consisted of monitoring water levels in all available monitoring wells and surface water bodies. This information was interpreted and used in selecting monitoring wells to be sampled to assess potentially increased contaminant migration under the drought conditions. This sampling and analytical program comprises the second phase of this additional monitoring.

This study was performed to monitor the unique short-term effects of the drought on the well field. The information in this summary will be used in evaluating future monitoring strategies and will also be incorporated into future characterization activities at the WSQ.

The long-term effects of the drought will be evaluated under the routine monitoring that is currently performed under the Environmental Monitoring Program Plan.

2.0 WATER LEVEL MONITORING

Static water levels were measured on June 22, June 30 and July 13, 1988 in all monitoring wells that could be located. These monitoring wells included the Layne-Western, St. Charles County and the DOE networks, comprising a total of thirty-three usable wells. These static water level measurements were converted into groundwater elevations. Elevation measurements were also made on the Missouri River, two locations on the Femme Osage Slough and the WSQ Sump. All groundwater and surface water elevations collected during this study are presented in Table 1.

These elevations were used to generate groundwater contour maps. The contour maps for June 22, June 30 and July 13 are presented in Figures 1, 2, and 3 (pp. 15-17) respectively. These contour maps, coupled with the St. Charles County Well Field production data presented in Table 2, lead to the following interpretations.

Groundwater elevation analysis revealed variations in the potentiometric surface of the alluvial aquifer. Changes in water elevation ranged from a 1.7-foot drop in LW-14 to a 5.3-foot rise in LW-7 over the period from June 22 to July 13, 1988. Overall, the general trend was downward with an average decline of 0.8 foot in the alluvial aquifer and approximately 0.25 foot in the bedrock aquifer. These results are as expected since the alluvial aquifer is subjected to pumping and to greater evapotranspiration than the bedrock aquifer.

Well field production on June 22 exceeded 21 million gallons with Wells 2, 3, 4, 6, 7, 8 and 9 pumping 24 hours. June 30 production approached 8 million gallons and July 13 production exceeded 12 million gallons. The significant changes in groundwater elevation are attributable to changes in well field production. The monitoring wells showing the greatest increase

TABLE 1

GROUNDWATER AND SURFACE WATER ELEVATIONS AT THE WSQ
AND THE ST. CHARLES COUNTY WELL FIELD
JUNE - JULY, 1988

LOCATION	ELEVATION (ft NVGD) 6/22/88	6/30/88	7/13/88	CHANGE FROM 6/22 TO 7/13
MW-1002	466.27	466.09	466.05	-0.22
MW-1004	463.88	463.90	463.55	-0.33
MW-1005	464.25	464.17	464.02	-0.23
MW-1006	449.31	448.96	448.51	-0.80
MW-1007	449.31	448.45	448.33	-0.98
MW-1008	449.03	448.55	447.92	-1.11
MW-1009	447.43	446.86	446.25	-1.18
MW-1010	440.47	439.16	438.92	-1.55
MW-1011	440.32	439.63	440.03	-0.29
MW-1012	458.71	459.08	459.34	0.63
MW-1013	446.34	446.02	445.50	-0.84
MW-1014	446.54	445.99	445.59	-0.95
MW-1015	449.57	449.12	448.68	-0.89
MW-1016	449.18	449.13	448.76	-0.42
MW-1017	441.41	440.46	440.51	-0.90
MW-1018	442.85	442.20	442.02	-0.83
MW-1019	443.92	443.32	443.00	-0.92
LW-1	435.86	437.59	439.26	3.40
LW-2	439.11	439.38	439.55	0.44
LW-3	441.96	441.97	442.12	0.16
LW-4	440.37	440.18	439.23	-1.14
LW-5	442.83	442.33	442.74	-0.09
LW-7	433.87	438.11	439.20	5.33
LW-8	435.26	437.66	439.30	4.04
LW-9	439.39	440.14	440.62	1.23
LW-10	445.01	445.50	444.49	-0.52
LW-11	447.12	447.42	447.07	-0.05
LW-14	440.65	439.65	438.93	-1.72
LW-15	441.48	440.88	440.51	-0.97
RMW-1	439.19	437.98	437.73	-1.46
RMW-2	438.88	438.82	438.55	-0.33
RMW-3	439.18	438.41	438.80	-0.38
RMW-4	440.63	439.55	440.12	-0.51
WSQ SUMP	464.10	464.45	464.18	0.08
MO RIVER	443.18	442.63	442.73	-0.45
FO SLOUGH	450.29	449.68	449.23	-1.06
FO SLOUGH @ MW-1007	N.M.	449.17	448.74	-0.43

N.M. - NOT MEASURED
NVGD - NATIONAL GEODESIC VERTICAL DATUM

TABLE 2

ST. CHARLES COUNTY WELL FIELD WATER PRODUCTION

TOTAL PUMPING TIME

WELL NUMBER	RATE GAL/MIN	6/22/88	6/30/88	7/13/88
			(HOURS)	
2	1741	24	5.25	19.91
3	1874	24	11.75	19.91
4	2093	24	11.75	19.91
5	2368	OFF	5.25	19.91
6	2255	24	6.50	OFF
7	2255	24	11.75	19.91
8	2202	24	6.50	OFF
9	2255	24	OFF	OFF
TOTAL PRODUCTION (million gal)		21.1	7.9	12.7

TOTAL PRODUCTION FOR JUNE, 1988 WAS 503 MILLION GALLONS

are located near production wells that were not operating when water levels were measured. Specifically, monitoring wells numbers LW-1, LW-7 and LW-8 increased in static water elevation due to malfunction of County Production Well No. 8. This well broke suction and was rendered inoperable on June 30, 1988 at 2:05 p.m. The malfunction is attributed to two factors by personnel operating the water treatment plant: first, the unusually low water level in the aquifer surpassed the designed capability of the well, and second, the well screen was calcified. PW-5 was not used for production due to construction activities to upgrade the well. On June 23, PW-5 resumed service and the groundwater elevation changed noticeably. Note the increase in lateral extent of the contour labeled 440' National Vertical Geodetic Datum (NVGD) to the east in Figures 2 and 3 in comparison to Figure 1.

In general, the potentiometric surface of the alluvial aquifer did not change dramatically under the different pumping schedules presented in Table 2. The contour pattern remained relatively constant above elevation 440 feet. Production from wells PW-8 and -9 caused a lowering in the potentiometric surface surrounding Production Wells 6, 7, and 8. No changes in gradient or flow direction were observed to the north or west of wells 8 and 9. This indicates that these wells derive water from the eastern and southern portions of the alluvial aquifer, or the Missouri River side. These data further support previous studies indicating the Missouri River is the primary recharge source for the alluvial aquifer.

Previous studies have indicated that contaminated groundwater north of the Femme Osage Slough has not migrated south of the slough. Groundwater level monitoring supports the previous data, indicating that groundwater north of the slough in the WSQ vicinity discharges slowly to the slough. Alluvial groundwater levels north of the slough showed approximately the same rate of change as the upper Femme Osage Slough exhibited. Groundwater

elevations in the wells north of the slough were essentially equal to the water elevation in the slough. Wells immediately south of or slightly lower than the slough had water elevations from 5 to 8 feet lower than the slough. These data indicate the alluvium near the WSQ and north of the slough is in better hydraulic communication with the Femme Osage Slough than alluvium south of the slough and that low permeability sediments impede migration of slough water into the alluvial aquifer south of the slough. The Femme Osage Slough apparently acts as a shallow no (or low) flow boundary to the alluvial aquifer. Therefore, the primary migration pathway available for contaminated groundwater north of the slough is under the slough.

The monitoring wells located immediately south of the slough have been installed to detect contaminants migrating under the slough. These monitoring wells have not shown contamination south of the slough. Historical data (Berkeley Geosciences, Inc., DOE, 1984, 1986, 1987) also indicate no elevated uranium concentrations south of the slough; contaminants do not appear to migrate beyond the slough under normal conditions. The conditions presented by this summer's drought provide a mechanism to intensify efforts to model this scenario. The drought conditions represent a potential "worst case" scenario. Water level analysis indicated which monitoring wells had the highest potential for detecting contaminant migration south of the slough. These monitoring wells were selected to be sampled to assess contaminant migration during low river stage and high water usage.

Further water level analysis yielded additional data supporting isolation of the Femme Osage Slough from the alluvial aquifer and the Missouri River. The slough elevations were approximately 6.5 feet above the Missouri River and up to 10 feet above the potentiometric surface in the alluvial aquifer, further indicating poor hydraulic communication between the slough and the Missouri River and the alluvial aquifer.

Water elevation analysis supported another historical trend indicating the low permeability of WSQ bedrock below an elevation of approximately 465 feet mean sea level (msl). All historical records during non-pumping (of the WSQ Sump) periods indicate that the WSQ Sump has an elevation of approximately 465 feet NVGD. Even during the drought conditions with water levels up to 26 feet lower in the alluvial aquifer, the WSQ Sump maintains an elevation of 464 feet msl. This indicates poor hydraulic communication between the WSQ Sump and the alluvial aquifer due to the low permeability of the aquifer materials. This information also supports the Berkeley Geosciences report (1984) which notes that the fractures tighten with depth and appear to transmit very little water to the alluvium.

3.0 GROUNDWATER SAMPLING AND ANALYSIS

Groundwater sampling is performed quarterly at the WSQ under the Environmental Monitoring Program Plan (EMPP). Samples were collected from all WSQ monitoring wells under the EMPP in late May after approximately two months of drought conditions. As the drought persisted, concern grew as the river elevation lowered and pumping rates increased from the St. Charles County Well Field. Water level monitoring was performed in late June and early July. The data were analyzed and interpreted and monitoring wells were selected for sampling. The selected wells sampled on July 15, 1988, are: MW-1010, MW-1017, MW-1018, and MW-1019. Also during mid-July, St. Charles County sampled their four monitoring wells and production wells as outlined in their Groundwater Monitoring Program submitted to the Missouri Department of Natural Resources - Public Drinking Water Program. Samples were split during their sampling effort and analyzed.

The analytical results from monitoring wells located south of the Femme Osage Slough are presented in Table 3, along with the annual averages presented in the 1987 Environmental Monitoring

TABLE 3

URANIUM CONCENTRATIONS IN MONITORING WELLS SOUTH OF THE FEMME OSAGE SLOUGH

	URANIUM ACTIVITY (pCi/L)		
WELL NO.	2ND QUARTER 1988	JULY 14-15 1988	ANNUAL AVERAGE 1987
MW-1010	<3	<1	<3
MW-1017	<3	<1	<3
MW-1018	<3	<1	<3
MW-1019	<3	<1	<3
RMW-1	NS	1.5 ± 0.6	NR
RMW-2	NS	9.4 ± 1.4	NR
RMW-3	NS	1.2 ± 0.6	NR
RMW-4	NS	1.1 ± 0.6	NR

NS - Not Sampled

NR - Not Reported

Report. Historical data for the St. Charles County monitoring wells are listed in Table 4.

As the analytical results indicate, no elevated uranium activities were observed in the monitoring wells immediately south of the Femme Osage Slough. Monitoring wells MW-1010, -1017, -1018 and -1019 did not contain measurable uranium concentrations. Three of the four St. Charles County monitoring wells also exhibited background uranium activities confirming historical data. The fourth St. Charles County monitoring well, RMW-2, contained 9.4 pCi/L of uranium. This above background level is consistent with historical uranium activities listed in Table 4 for RMW-2 and does not appear to indicate increased contaminant migration due to drought conditions. Although no drinking water standards for uranium currently exist, proposed limits range from 10 to 40 pCi/L. The concentrations observed in RMW-2 have always been below the lowest proposed standard. Since monitoring wells located directly between the slough and RMW-2 have not shown contamination, a more tortuous migration pathway may be present. Additional monitoring wells were installed in August 1988 to improve the understanding of potential migration pathways.

4.0 SUMMARY

The increased monitoring to assess the effects of the drought and increased pumpage from the St. Charles County Well Field yielded information which confirmed and generally agreed with historical data.

No additional contaminant migration was observed during the drought. This indicates that short-term changes in groundwater velocity and flow directions due to increased pumpage and low river stages do not appear to have a measurable impact on contaminant migration. Long-term effects will be detected during routine monitoring. The additional monitoring

TABLE 4
SUMMARY OF RADIOLOGICAL RESULTS FROM ST. CHARLES COUNTY MONITORING WELLS

LOCATION NO.	DATE SAMPLED	SAMPLED BY	ACTIVITY (pCi/L) GROSS ALPHA	GROSS BETA	NATURAL URANIUM	RADIUM 226	RADIUM 228	THORIUM 230	THORIUM 232
RMW-1	08/27/86	S.C. Co(WESTER)	<2	<3	- -	1.2 ± 1.1	<1	<0.6	<0.6
RMW-1	09/86	MoDNR	2.2	5.8					
RMW-1	03/09/87	MoDNR	4.3 ± 1.6	9.4 ± 3.4	- -	0.9	1.4 ± 0.9	- -	- -
RMW-1	03/09/87	WSSRAP	<5	13 ± 6	<1	<1	<3	<4	<4
RMW-1	04/16/87	WSSRAP	- -	- -	0.8 ± 0.5	- -	- -	- -	- -
RMW-1	05/27/87	SCCAHW/	<7						
		SC CO.	2.6	<7	<1	<5	<5	- -	- -
RMW-1	07/30/87	S.C. Co(HEATH)	<4	4 ± 2	- -	- -	- -	- -	- -
RMW-1	07/31/87	WSSRAP	<3	5.5 ± 3.0	3.2 ± 1.3	<1	<1	<1	<1
RMW-1	10/87	MoDNR	4			0.6	<1		
RMW-1 (UNFILTERED)	04/12/88	SCCAHW	4.3	- -	- -	- -	- -	- -	- -
		MoDNR	4.5		<1	.5	<1		
RMW-1 (FILTERED)	04/12/88	SCCAHW	2.0	- -	- -	- -	- -	- -	- -
		MoDNR	2.3						
RMW-1	05/19/88	S.C. Co(HEATH)	<3	5.8 ± 3.7	<1				
RMW-1	07/15/88	WSSRAP	- -	- -	1.5 ± 0.6	- -	- -	- -	- -
RMW-2	08/27/86	S.C. Co(WESTER)	<2	<3	- -	<0.6	<1	<0.6	<0.6
RMW-2	09/86	MoDNR	4.1	6.2					
RMW-2	03/09/87	MoDNR	7.4 ± 1.9	3.6 ± 2.8	- -	0.3	<1	- -	- -

TABLE 4

SUMMARY OF RADIOLOGICAL RESULTS FROM ST. CHARLES COUNTY MONITORING WELLS (cont.)

LOCATION NO.	DATE SAMPLED	SAMPLED BY	ACTIVITY (pCi/L) GROSS ALPHA	GROSS BETA	NATURAL URANIUM	RADIUM 226	RADIUM 228	THORIUM 230	THORIUM 232
RMW-2	03/09/87	WSSRAP	<5	<8	7.6 ± 1.6	<1	<4	<4	<4
RMW-2	04/16/87	WSSRAP	- -	- -	2.1 ± 0.6	- -	- -	- -	- -
RMW-2	05/27/87	SCCAHW/	<9						
		SC CO.	9.0 ± 2.7	<9	<1	<5	<5	- -	- -
RMW-2	07/30/87	S.C. Co(HEATH)	3 ± 2	3 + 2	- -	- -	- -	- -	- -
RMW-2	10/87	MoDNR	10.6 ± 2.2			.5	<1		
RMW-2	07/31/87	WSSRAP	6.1 ± 2.7	5.8 ± 3.0	5.4 ± 1.4	<1	<1	<1	<1
RMW-2 (FILTERED)	04/12/88	SCCAHW	7.4 ± 1.8	- -	- -	- -	- -	- -	- -
		MoDNR	7.4 ± 1.8						
RMW-2	05/19/88	S.C. Co(HEATH)	<3	5.6 ± 3.7	7.4 ± 1.3				
RMW-2 (UNFILTERED)	04/12/88	SCCAHW	6.2 ± 1.7	- -	- -	- -	- -	- -	- -
		MoDNR	8.6 ± 1.9		5.8	0.2	<1		
RMW-2	07/14/88	WSSRAP	- -	- -	9.4 ± 1.4	- -	- -	- -	- -
RMW-3	08/27/86	S.C. Co(WESTER)	<2	<3	- -	<0.6	<1	<0.6	<0.6
RMW-3	03/09/87	MoDNR	3.9 ± 1.6	4.8 ± 2.9	- -	0.4	<1	- -	- -
RMW-3	03/09/87	WSSRAP	<5	<8	<1	<1	<4	<3	<3
RMW-3	05/27/87	SCCAHW/	<11						
		SC CO.	4.3	<11	<1	<7	<7	- -	- -
RMW-3	07/30/87	S.C. Co(HEATH)	<3	<4	- -	- -	- -	- -	- -
RMW-3	07/31/87	WSSRAP	<3	<5	<2	<1	<1	<1	<1

TABLE 4

SUMMARY OF RADIOLOGICAL RESULTS FROM ST. CHARLES COUNTY MONITORING WELLS (cont.)

LOCATION NO.	DATE SAMPLED	SAMPLED BY	ACTIVITY (pCi/L) GROSS ALPHA	GROSS BETA	NATURAL URANIUM	RADIUM 226	RADIUM 228	THORIUM 230	THORIUM 232
RMW-3	10/87	MoDNR	2.6		0.4 ± 0.1	1.1 ± 0.7			
RMW-3 (FILTERED)	04/12/88	MoDNR	5.4 ± 1.7	- -	- -	- -	- -	- -	- -
RMW-3 (UNFILTERED)	04/12/88	MoDNR	7.3 ± 2.0		4.6	.05	2.2 ± 0.9		
RMW-3	05/19/88	S.C. Co(HEATH)	<4	<7	1.0 ± 0.6				
RMW-3	07/14/88	WSSRAP	- -	- -	1.2 ± 0.6	- -	- -	- -	- -
RMW-4	08/27/86	S.C. Co(WESTER)	<2	<3	- -	<0.6	<1	<0.6	<0.6
RMW-4	03/09/87	MoDNR	5.5 ± 1.7	4.2 ± 2.9	- -	0.3	<1	- -	- -
RMW-4	09/86	MoDNR	5.2 ± 2.6	5.7					
RMW-4	03/09/87	WSSRAP	<5	<8	<1	<1	<6	<2	<2
RMW-4	04/16/87	WSSRAP	- -	- -	1.3 ± 0.5	- -	- -	- -	- -
RMW-4	05/27/87	SCCAHW/ S.C. Co(HEATH)	6 ± 2 6.5 ± 2.6	<3	<1	<5	<5	- -	- -
RMW-4	07/30/87	S.C. Co(HEATH)	2 ± 1	5 ± 2	- -	- -	- -	- -	- -
RMW-4	07/31/87	WSSRAP	<3	7.3 ± 3.1	<2	<1	<1	<1	<1
RMW-4	10/87	MoDNR	3.8			0.9	1.1 ± 0.8		
RMW-4 (FILTERED)	04/88	MoDNR	4.4						
RMW-4 (UNFILTERED)	04/88	MoDNR	4.3		1.9	.3	1.9 ± 0.9		

TABLE 4

SUMMARY OF RADIOLOGICAL RESULTS FROM ST. CHARLES COUNTY MONITORING WELLS (cont.)

LOCATION NO.	DATE SAMPLED	SAMPLED BY	ACTIVITY (pCi/L) GROSS ALPHA	GROSS BETA	NATURAL URANIUM	RADIUM 226	RADIUM 228	THORIUM 230	THORIUM 232
RMW-4	05/19/88	S.C. Co(HEATH)	<3	7.9 ± 3.9	3.1 ± 0.9				
RMW-4	07/14/88	WSSRAP	- -	- -	1.1 ± 0.6	- -	- -	- -	- -

activities, well installation and sampling, and water level monitoring are the logical next steps in determining the source of anomalous uranium concentrations in RMW-2. These activities will also lead to a better understanding of the hydrologic regime in the WSQ vicinity.

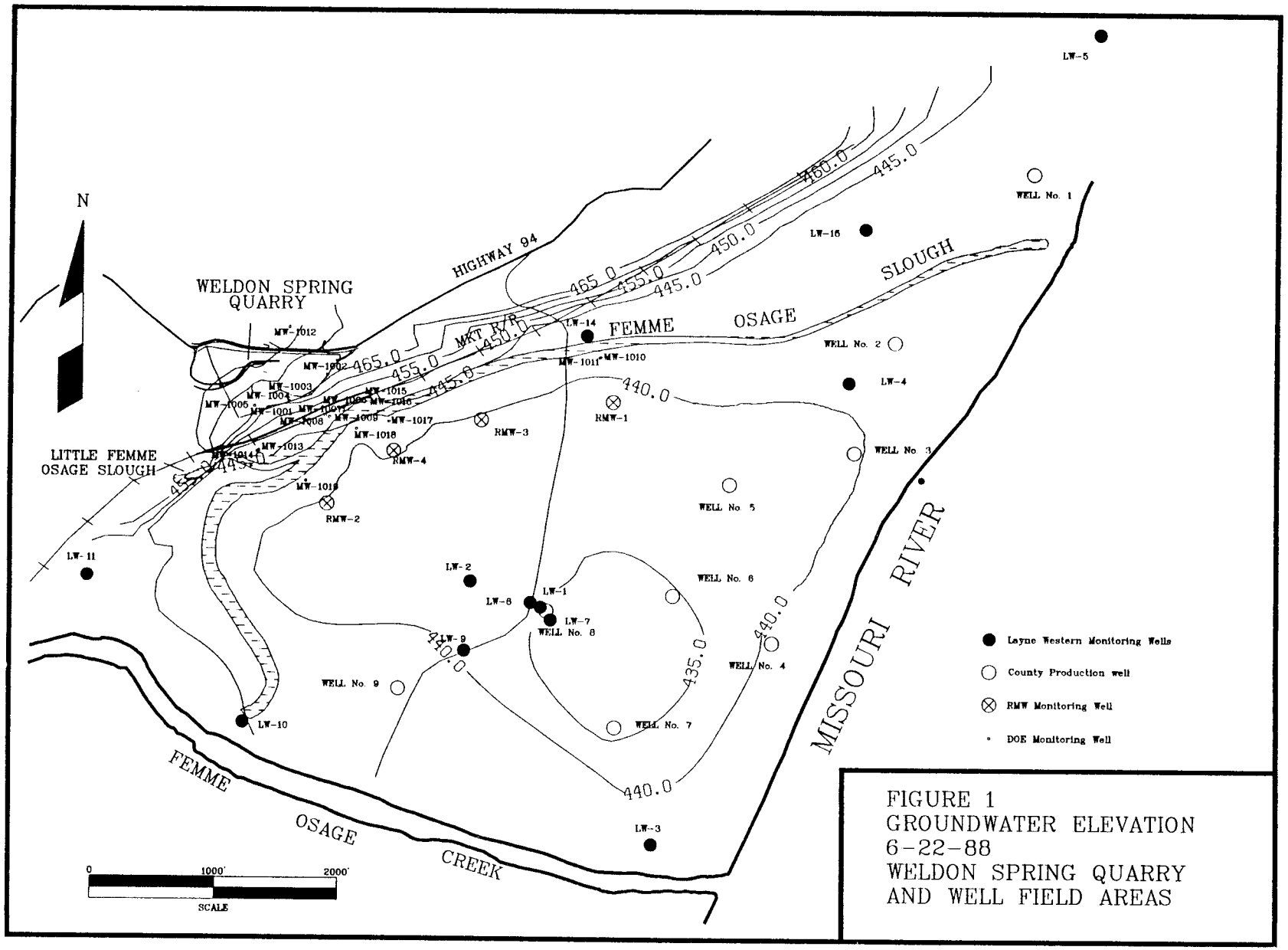

FIGURE 1
GROUNDWATER ELEVATION
6-22-88
WELDON SPRING QUARRY
AND WELL FIELD AREAS

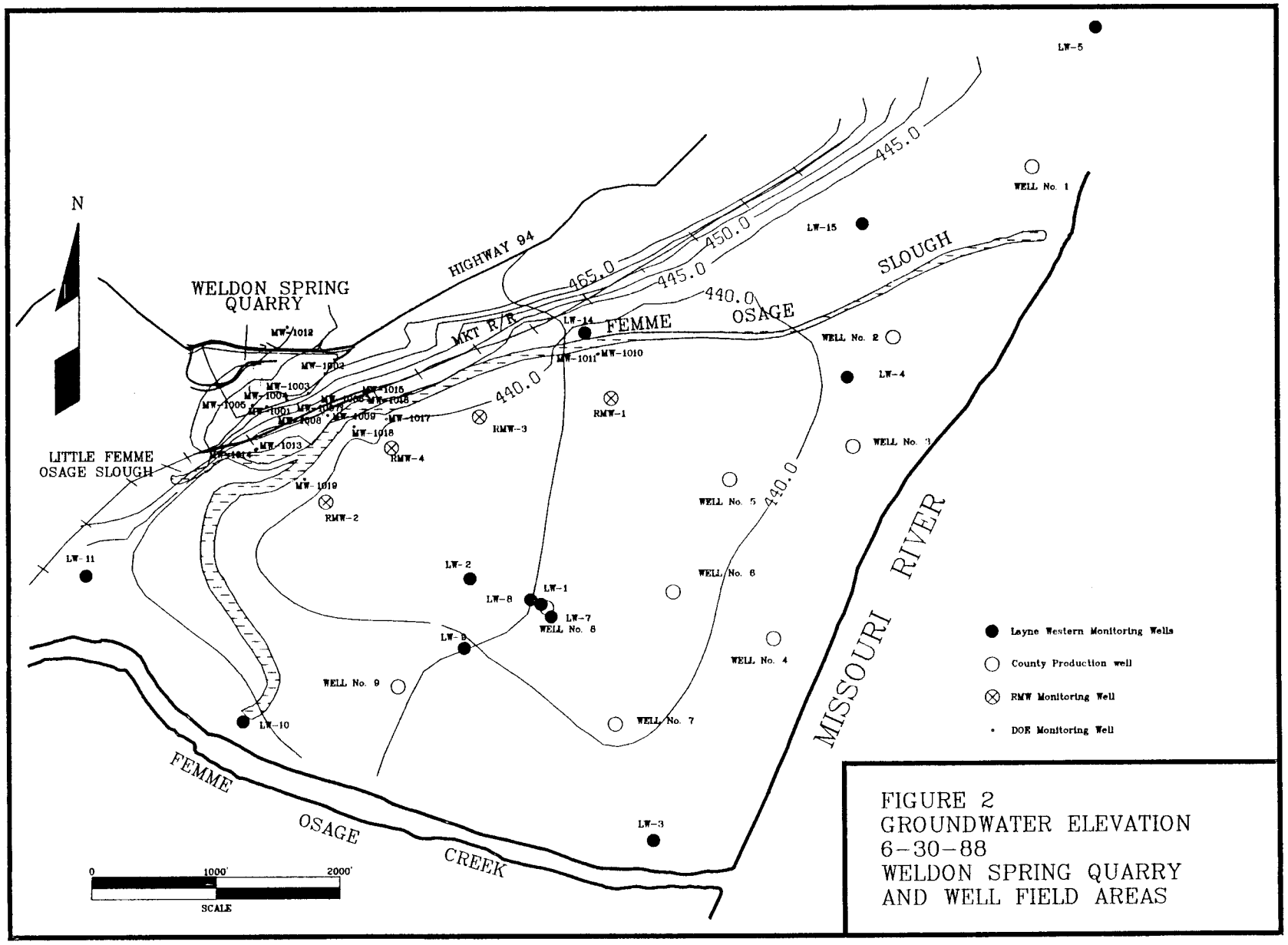

FIGURE 2
GROUNDWATER ELEVATION
6-30-88
WELDON SPRING QUARRY
AND WELL FIELD AREAS

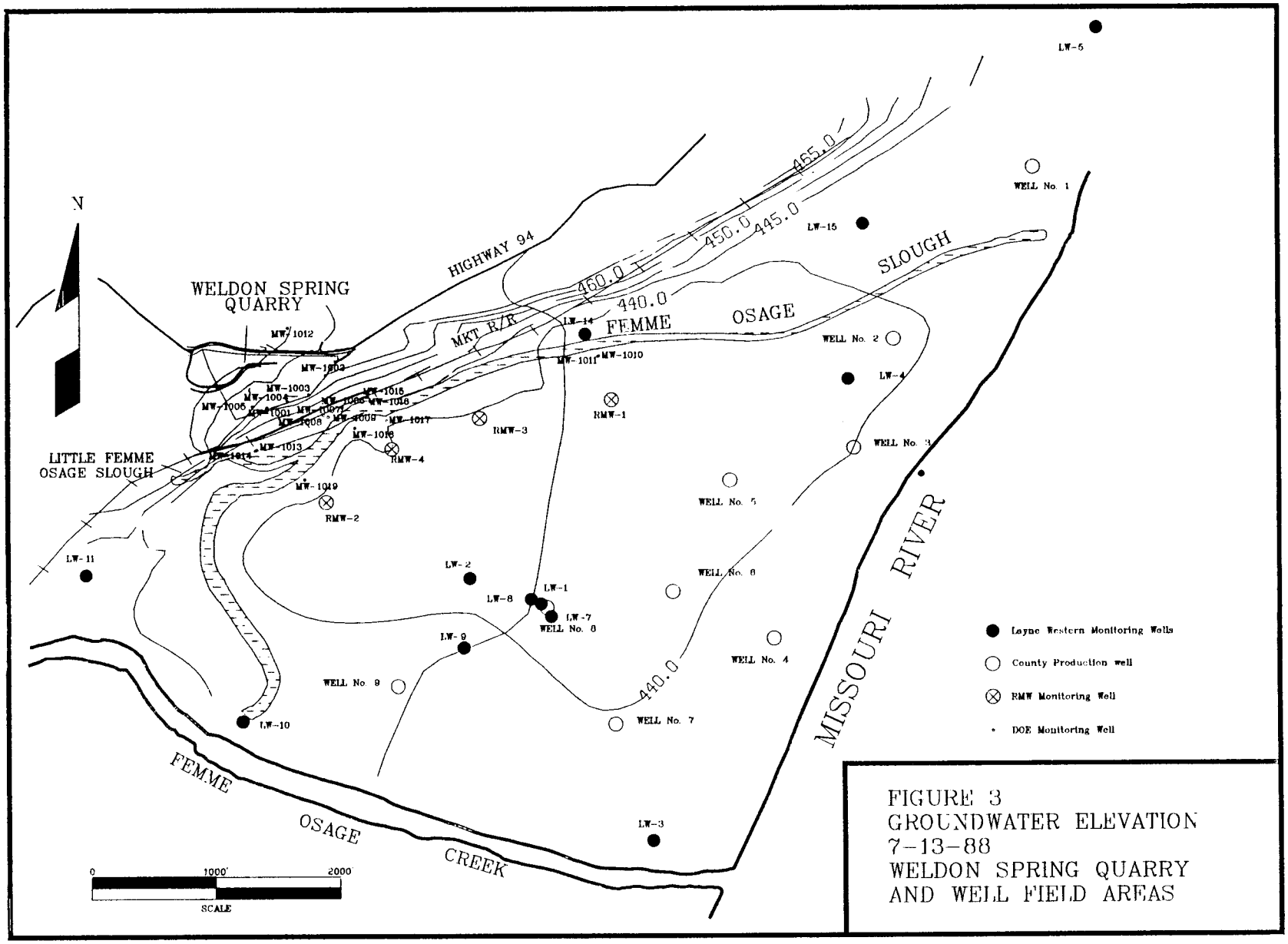

FIGURE 3
GROUNDWATER ELEVATION
7-13-88
WELDON SPRING QUARRY
AND WELL FIELD AREAS