DOE/OR/21548-484
CONTRACT NO. DE-AC05-86OR21548

INTERIM REPORT ON OPERATIONAL GROUNDWATER MONITORING DURING BULK WASTE REMOVAL

Weldon Spring Site Remedial Action Project
Weldon Spring, Missouri

DECEMBER 1994 **REV. 0**

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

Prepared by MK-Ferguson Company and Jacobs Engineering Group

120994

MK-FERGUSON
A MORRISON KNUDSEN COMPANY

Weldon Spring Site Remedial Action Project
Contract No. DE-AC05-86OR21548

Rev. No. 0

PLAN TITLE: Interim Report on Operational Groundwater Monitoring During Bulk Waste Removal

APPROVALS

Originator — Date: 12-22-94

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DOE/OR/21548-484

Weldon Spring Site Remedial Action Project

Interim Report on Operational Groundwater Monitoring During Bulk Waste Removal

Revision 0

December 1994

Prepared by

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for the

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

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1 INTRODUCTION

1.1 Objective

This report summarizes information collected to date from ongoing static water level (SWL) monitoring and the groundwater flow mechanism between the quarry pond, the downgradient monitoring wells, and the Femme Osage Slough in accordance with DOE Order 5400.1, *General Environmental Protection Program.* Changes in uranium[1] and sulfate concentrations that occurred during the monitoring period are also reviewed.

The water in the quarry pond has been further contaminated due to bulk waste removal activities in the quarry. Uranium concentrations increased by a factor of approximately 27, from an average of 969 pCi/l in 1991, to a May 1994 high of 27,700 pCi/l. Corresponding changes for sulfate are 68 mg/l in 1991 to a July 1994 high of 700 mg/l.

Concerns were raised regarding the possible detrimental effect on groundwater quality outside the quarry, specifically, in the groundwater of the Missouri River alluvium. The PMC has evaluated what proactive operational steps should be taken to prevent or minimize the potential excursion of pond water.

To prepare this report, existing SWL data and uranium and sulfate analyses were reviewed. The report discusses the actions taken to reduce possible impacts on the quality of the alluvial groundwater.

1.2 Background

Higher-than-historic uranium and sulfate levels were observed in the quarry pond water in late 1993 and early 1994. Since the end of April 1994, weekly sampling of the pond water for uranium and sulfate has been conducted (see Figure 1-1). Prior to this date, data were collected as part of the routine environmental programs and the operational data from the equalization basin. Average values for the two analytes are shown in Table 1-1.

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1 References to uranium refer to total uranium.

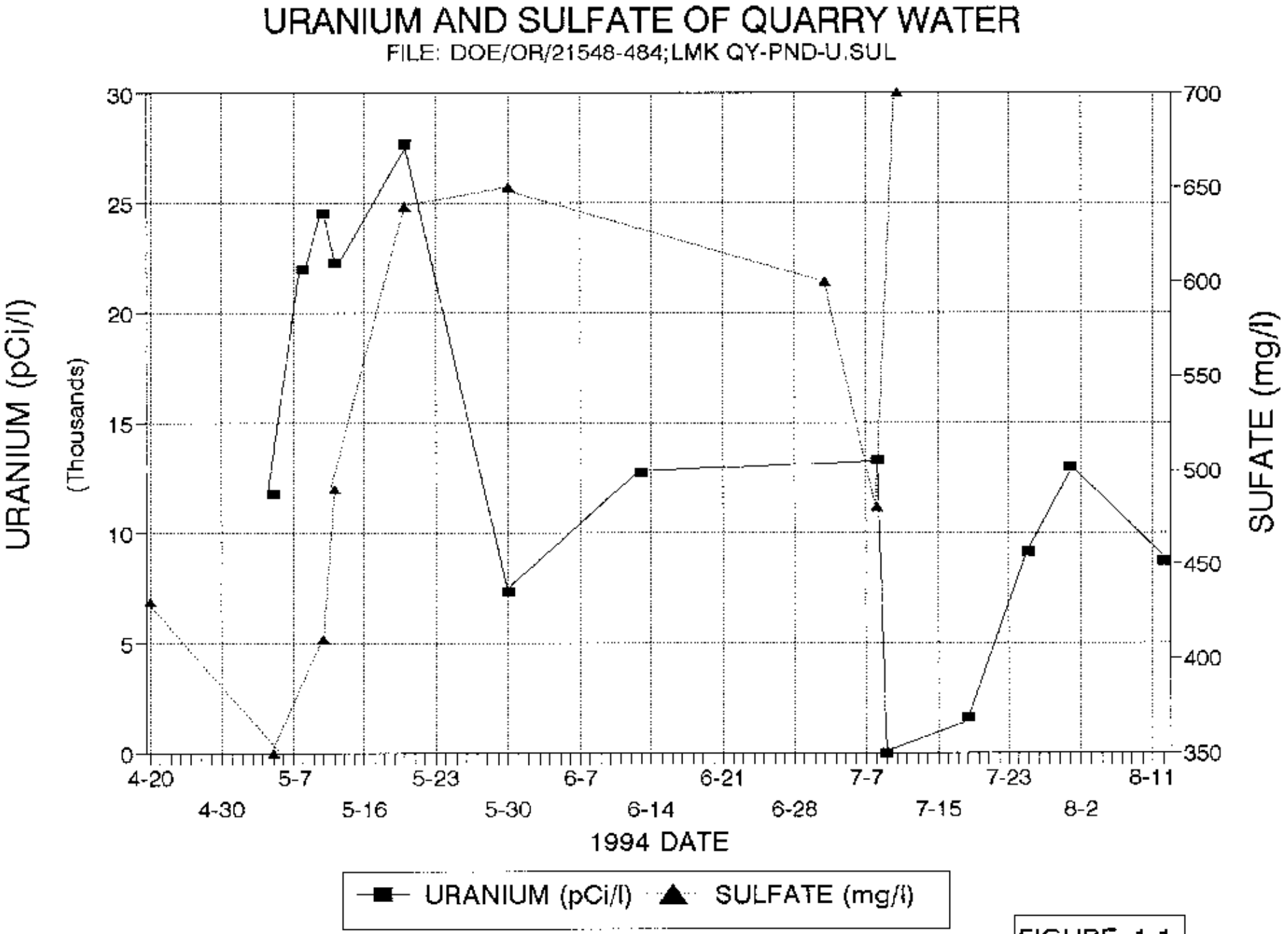

URANIUM AND SULFATE OF QUARRY WATER
FILE: DOE/OR/21548-484;LMK QY-PND-U.SUL
URANIUM (pCi/l)
(Thousands)
SUFATE (mg/l)
30
25
20
15
10
5
0
700
650
600
550
500
450
400
350
4-20
5-7
5-23
6-7
6-21
7-7
7-23
8-11
4-30
5-16
5-30
6-14
6-28
7-15
8-2
1994 DATE
URANIUM (pCi/l)
SULFATE (mg/l)

FIGURE 1-1

TABLE 1-1 Uranium and Sulfate Concentration of Quarry Pond

	Uranium (pCi/l)			Sulfate (mg/l)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
1991	629	1950	969	57	80	68
1992	13	1431	753	58	78	70
1993	360	9000	3867	51	199	122
1994	N/A	27,700*	N/A	N/A	700*	N/A

* Results from operations; other values from annual reports.

SWLs have been recorded since September 1992, at 12 hour intervals for the quarry pond and MW-1027 using one electronic data recorder and two transducers. A second recorder and two additional transducers were added to MW-1004 and MW-1005 in December 1993. These wells were selected for SWL monitoring to test for hydrological connections of these downgradient wells to the quarry pond. Initial monitoring results are shown in Figure 1-2. The general layout of the quarry and surrounding monitoring wells is shown in Figure 1-3.

Daily precipitation data are obtained at the quarry using a manual rain gauge. The gauge is read at approximately 7:00 a.m. each work day and on weekends when construction is active. Therefore, quarry rain data can lag up to 7 hours during the work week when compared to the regular midnight to midnight cycle of site or governmental rain gauges. For weekends and holidays, this log can increase by an additional 24 hours for each day the gauge is not read. Some significant differences have been noticed between the quarry and the site rain gauges.

Quarry pond pumpage data were added to the analysis of SWL data in May 1993, when water was first withdrawn from the pond. SWL data from transducers and precipitation and pumpage data have been summarized in monthly summary reports. Graphs from some of these recent monthly reports are shown in Figures 1-4 and 1-5. For further details see Appendix A.

QY POND, MW-1027, -04, and -05 SWL

FILE: DOE/OR/21548-484;LMK:1027-4GR.A93

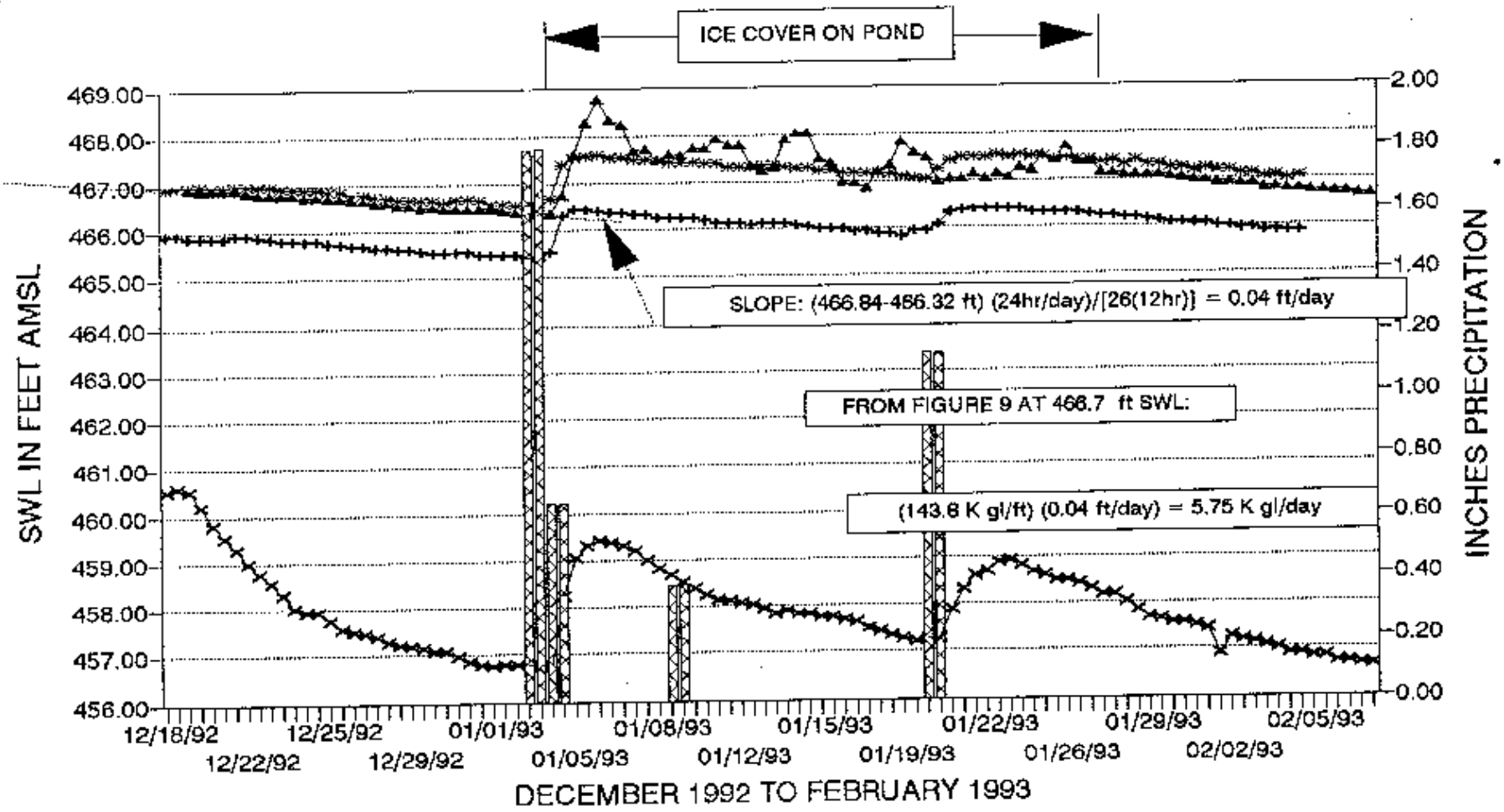
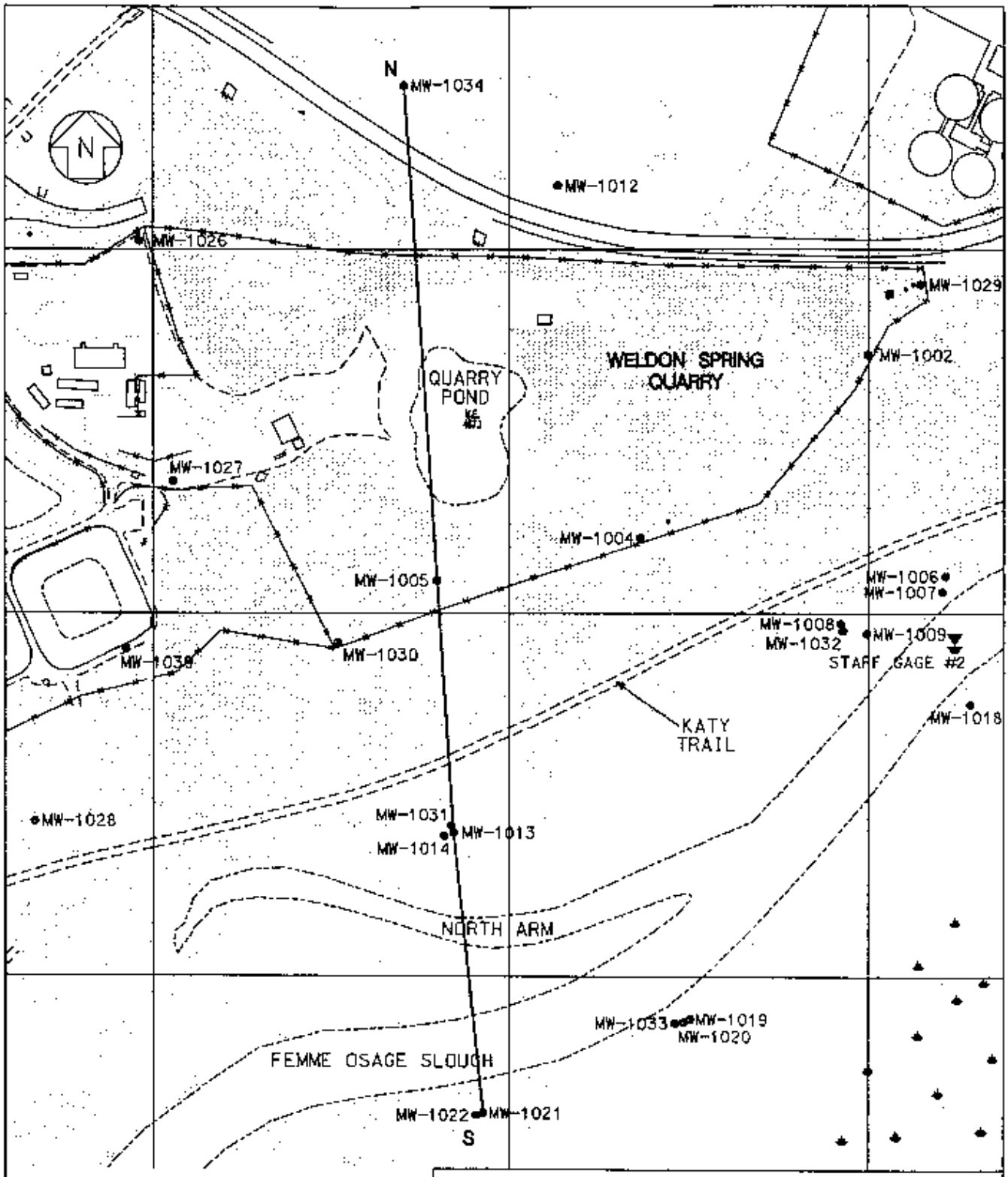


FIGURE 1-2



REFERENCE DRAWING: A/VP/044/1094
FIGURE 2-8

0 200 400
SCALE FEET

LOCATION OF QUARRY POND AND CROSS SECTION

FIGURE 1 - 3

REPORT NO.: DOE/OR/21548-484		EXHIBIT NO.: A/QY/053/1094	
ORIGINATOR: LMK	DRAWN BY: GLN	DATE: 10/24/94	

PRECIPITAION & SWL OF QY POND & WELLS

FILE:DOE/OR/21548-484; LML:QY-PRCP.E94

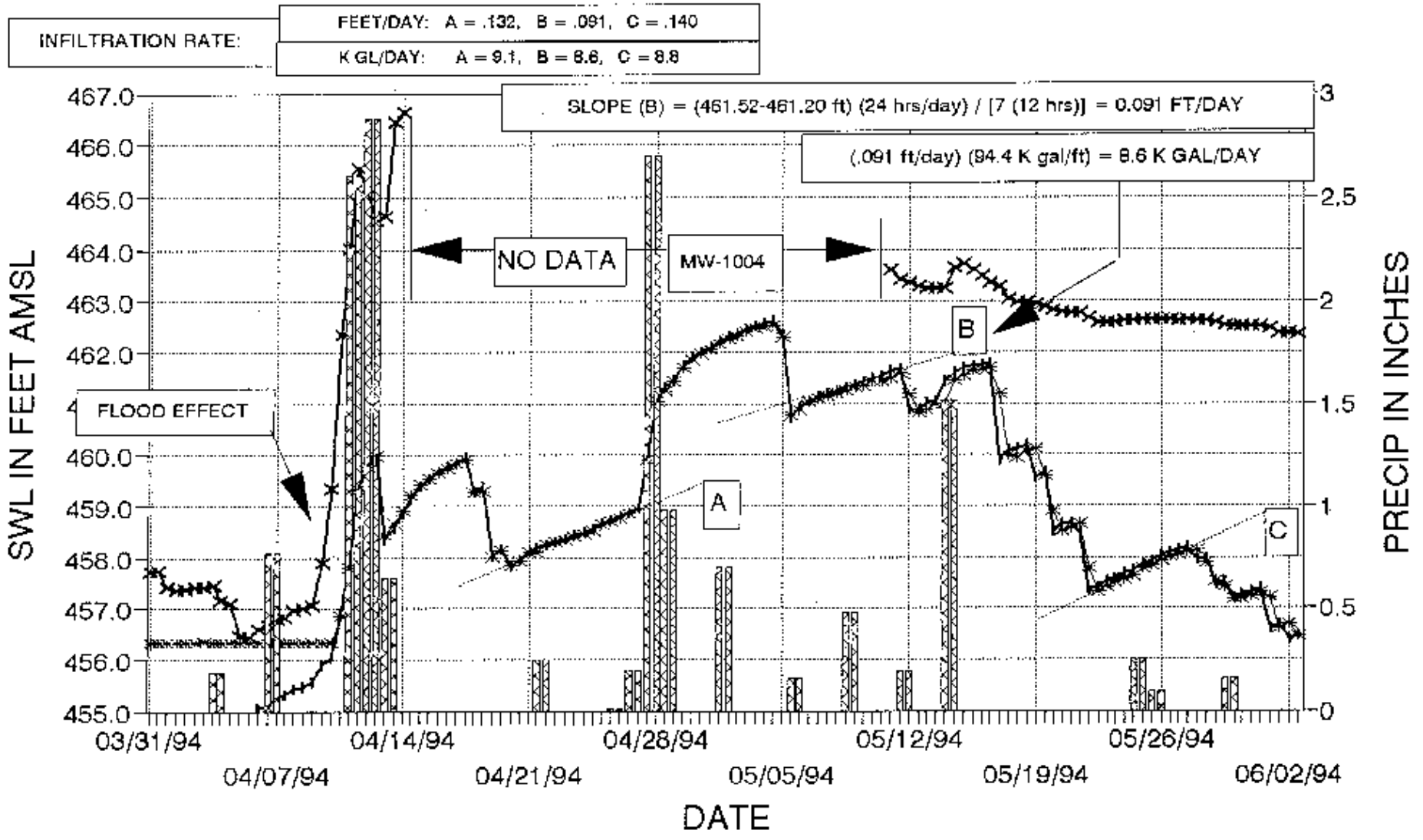


FIGURE 1-4

PUMPAGE AND SWL OF QUARRY POND, WELLS

FILE: DOE/OR/21548-484; LMLK QY-PUMP.E94

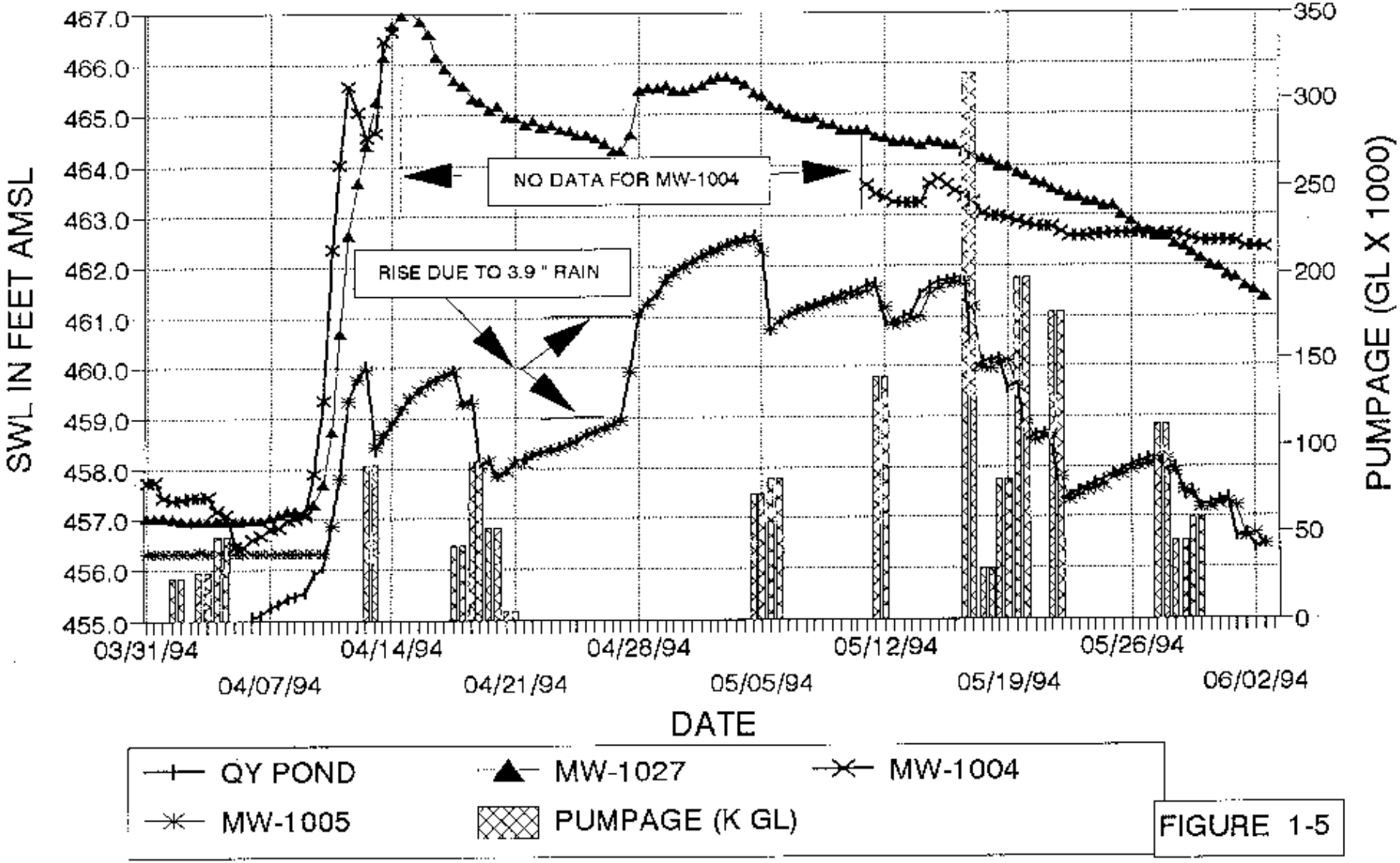


FIGURE 1-5

2 FINDINGS

2.1 Groundwater Flow Regime

Figures 2-1 through 2-4 are vertically exaggerated hydrogeologic cross sections of the quarry area using data from MW-1034, the quarry pond, MW-1005, MW-1013, and MW-1021. The following four flow scenarios are shown.

2.1.1 **Normal Conditions** (September 11, 1992, Figure 2-1)

A low gradient exists from the north toward the south, across the pond toward the Katy Trail cliff area. The lack of springs along the cliffs suggests that the water moves from the quarry through the limestone and some of the contaminated quarry water seeps out at multiple points in the alluvium/bedrock interface. This explains the contamination in alluvium wells north of the Femme Osage Slough. Monitoring wells MW-1013 and MW-1031 are screened in bedrock and have a slightly higher static water level (SWL) than the adjacent alluvium wells, suggesting a groundwater flow from the bedrock to the alluvium. Both bedrock wells contain uranium contamination.

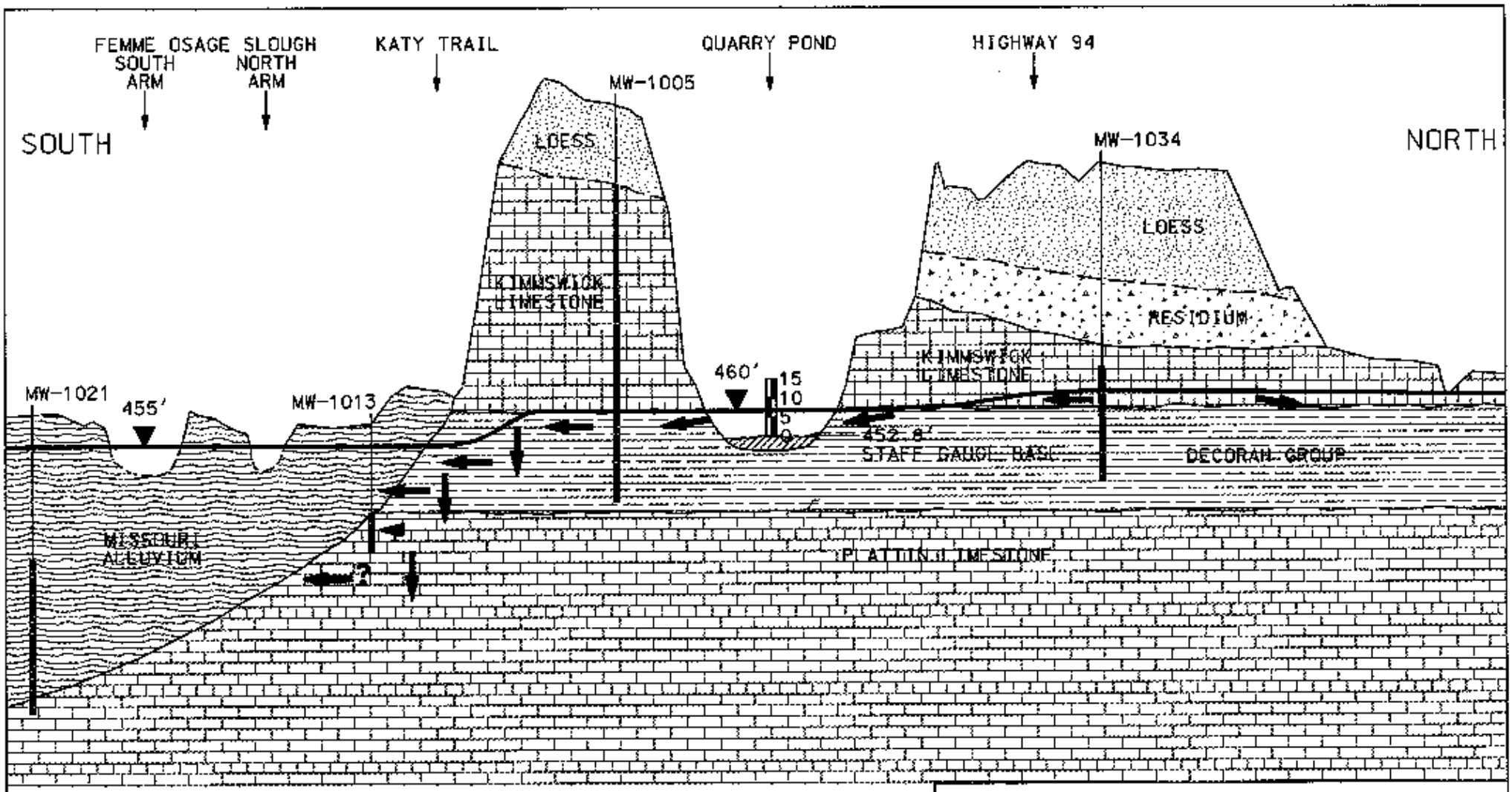
2.1.2 **Heavy Precipitation Event** (March 8, 1993, Figure 2-2)

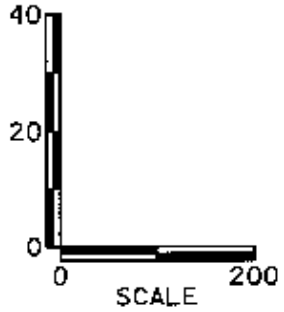
A significant rise in the SWL occurs in the quarry pond and MW-1005 due to a 1.85 in. rain event. A slight mounding is observed in MW-1005; and the flow direction is temporarily reversed from MW-1005 to the pond.

2.1.3 **Flood Stage** (July 23, 1993, Figure 2-3)

The Missouri River is at a record high (477.5 ft MSL). Little or no influence is observed at MW-1005 and the quarry pond as a result of the increased surface water levels.

MW-1004 and MW-1027 react to the flood condition with a time lag of approximately 12-24 hours.





LEGEND

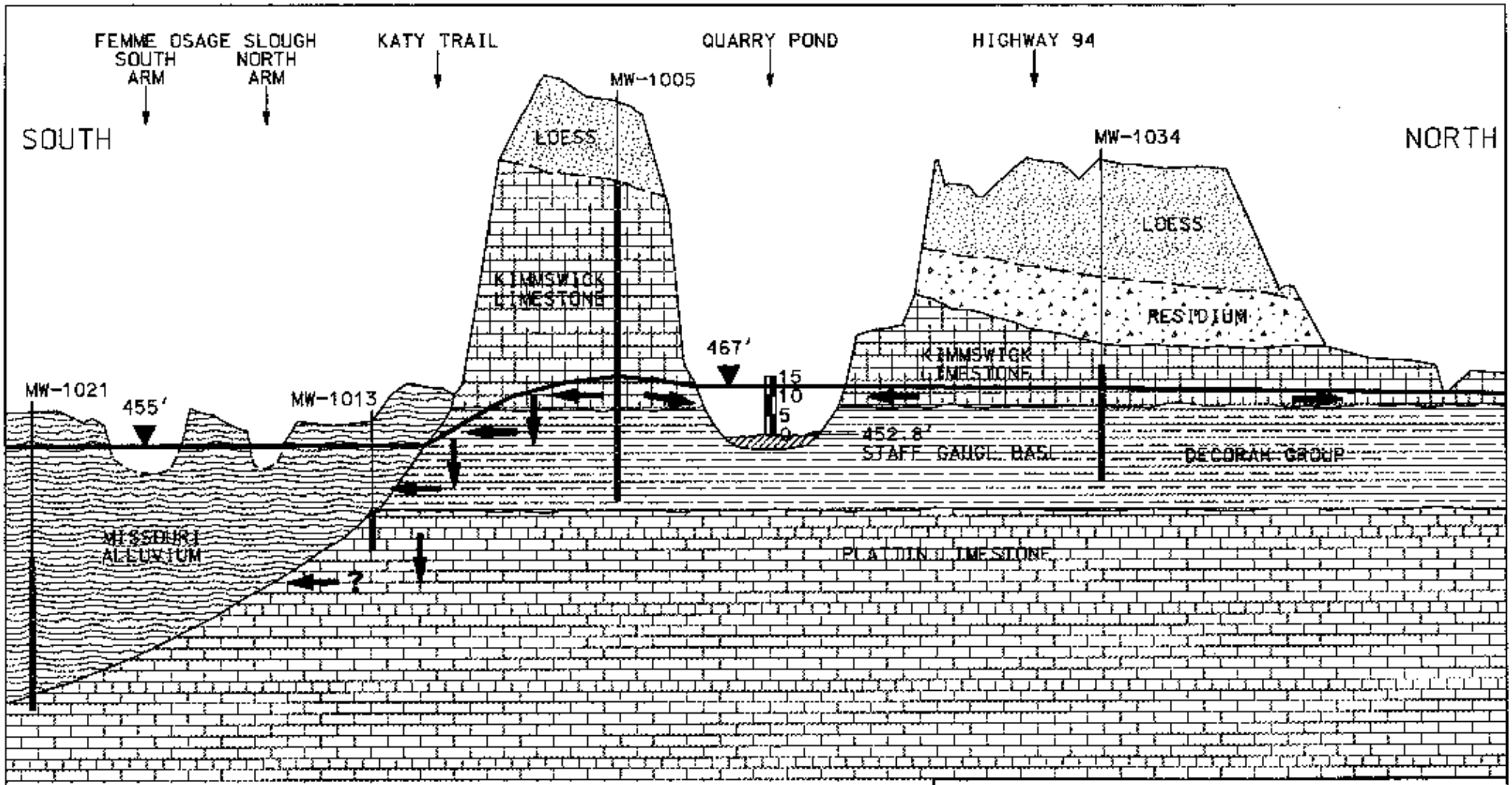
SAND PACK INTERVAL

PROJECTED GROUNDWATER FLOW DIRECTION

HYDROLOGICAL CROSS SECTION NORMAL CONDITIONS

FIGURE 2-1

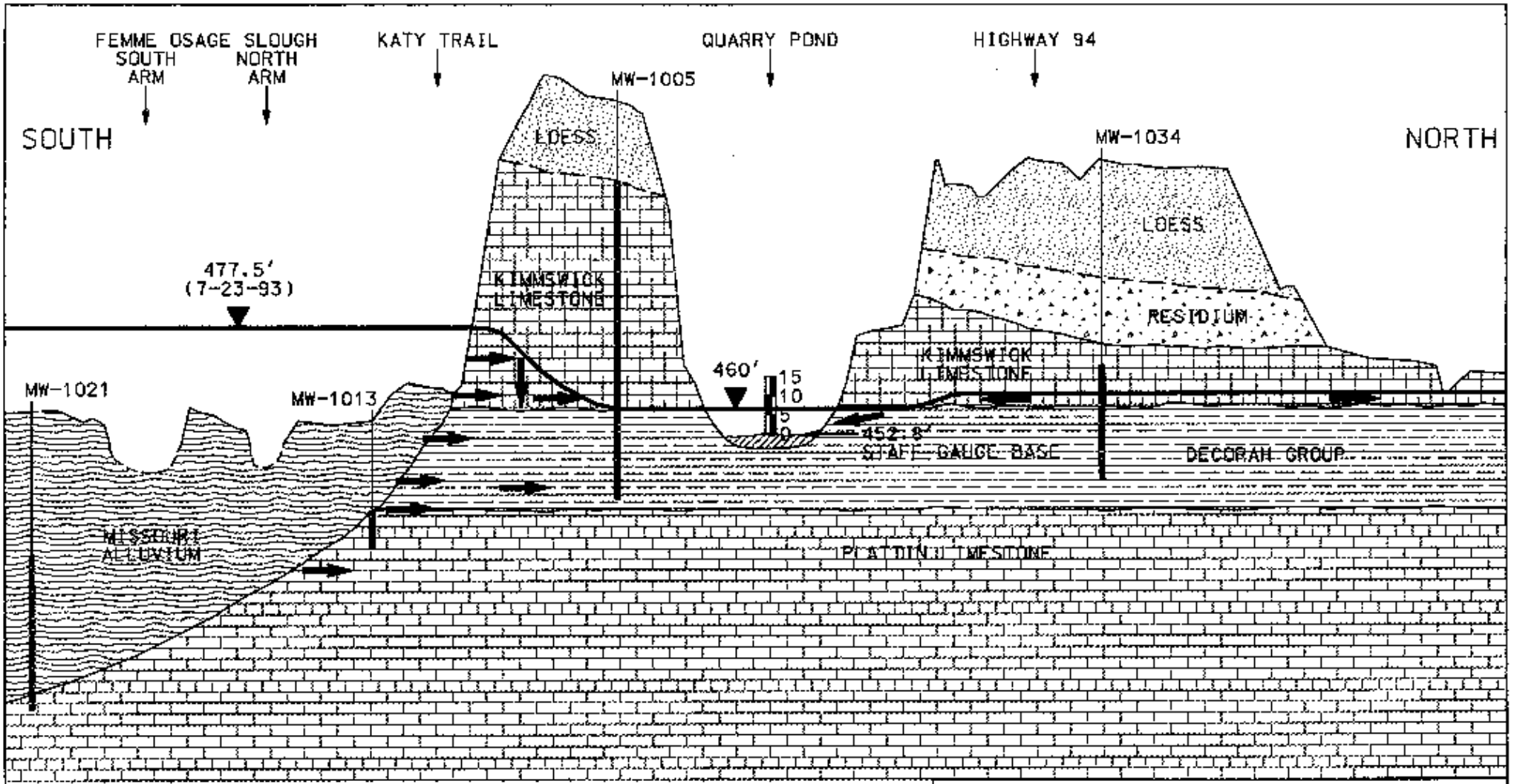
REPORT NO.: DOE/OR/21548-484	EXHIBIT NO.: A/QY/052/1094	
ORIGINATOR: LMK	DRAWN BY: GLN	DATE: 11/1/94



HYDROLOGICAL CROSS SECTION HEAVY PRECIPITATION EVENT

FIGURE 2-2

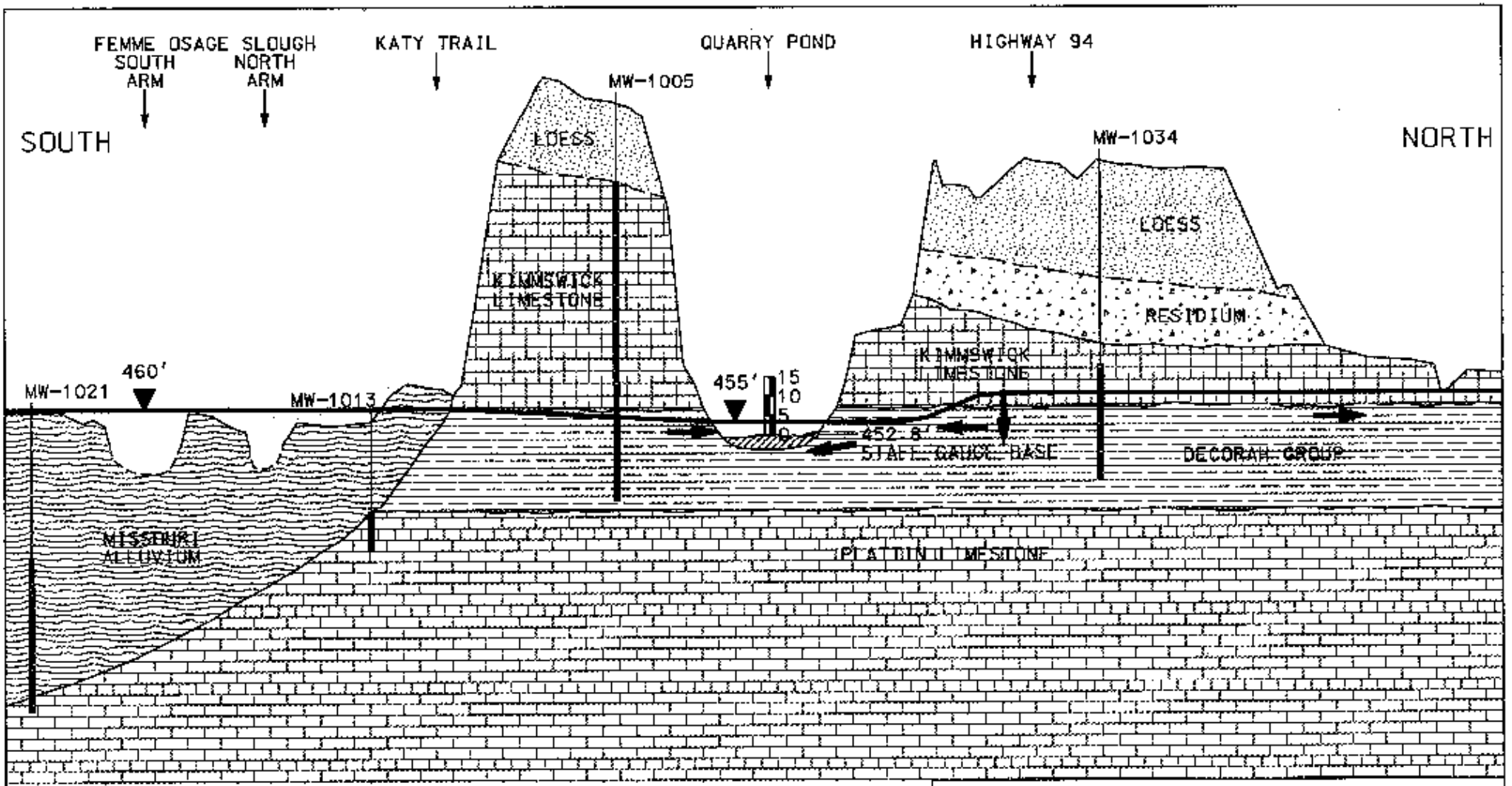
REPORT NO.:	DOE/OR/21548-484	EXHIBIT NO.:	A/QY/054/1094		
ORIGINATOR:	LMK	DRAWN BY:	GLN	DATE:	11/1/94



HYDROLOGICAL CROSS SECTION FLOOD STAGE

FIGURE 2-3

REPORT NO.: DOE/OR/21548-484	EXHIBIT NO.: A/QY/055/1094	
ORIGINATOR: LMK	DRAWN BY: GLN	DATE: 11/1/94



HYDROLOGICAL CROSS SECTION POST-FLOOD CONDITION & PUMPAGE

FIGURE 2-4

REPORT NO.:	DOE/OR/21548-484	EXHIBIT NO.:	A/QY/056/1094		
ORIGINATOR:	LMK	DRAWN BY:	GLN	DATE:	11/1/94

Figure 2-5, taken from monthly SWL reports, shows the rise and fall of the SWL in the wells in relation to Missouri River elevations. This graph demonstrates a direct hydraulic connection between the pond and MW-1005 and a separate connection between MW-1004 and the well field area. The initial rise of the pond and wells is attributed to a 6.13 in. precipitation event from April 11 through April 14, 1994.

2.1.4 Post-flood Conditions (June 1994, Figure 2-4)

The SWL of the pond has been depressed by pumpage from the pond to the equalization basin. The cone of depression extends to MW-1005, but does not affect the SWL in MW-1004, MW-1034, and MW-1027. Seepage into the quarry is from the surrounding bedrock as indicated by a steady increase of the SWL of the pond. The seepage rate varies between 1.10 in. and 1.68 in. per day, and is equivalent to 8,600 to 9,100 gal/day, which is computed from pond SWL data when precipitation and pumpage are absent (see Figure 1-4 and Appendix B).

2.2 Temporal Variations in Uranium

The uranium concentrations in MW-1004 and MW-1005 over the period of monitoring by the WSSRAP are shown in Figure 2-6. These wells are 200 ft apart and are located on the south side of the quarry. This graph illustrates the relative fluctuation of uranium levels over time.

Before quarry activities became significant, the 1992 average values for uranium were 4,700 pCi/l for MW-1004 and 1,850 pCi/l for MW-1005. Although there is a significant difference in the uranium levels of the two wells, relative rises and falls in concentrations match within 1 -2 months. MW-1004 peaks and troughs lag behind MW-1005 peaks and troughs (P and T, Figure 2-6). The all-time high of MW-1004 was on October 25, 1993, at 8,600 pCi/l, and the corresponding peak of MW-1005 occurred 1 month later on November 23, 1993. Uranium data for the quarry pond are not available for these dates.

The actual uranium increase in the wells due to quarry activities cannot be determined, since historically, uranium values in the monitoring wells and the quarry pond fluctuated

SWL CHANGES DUE TO 1994 MO RIVER FLOOD

FILE:DOE\OR 21548-484;LMLK QY-PUMP.D94

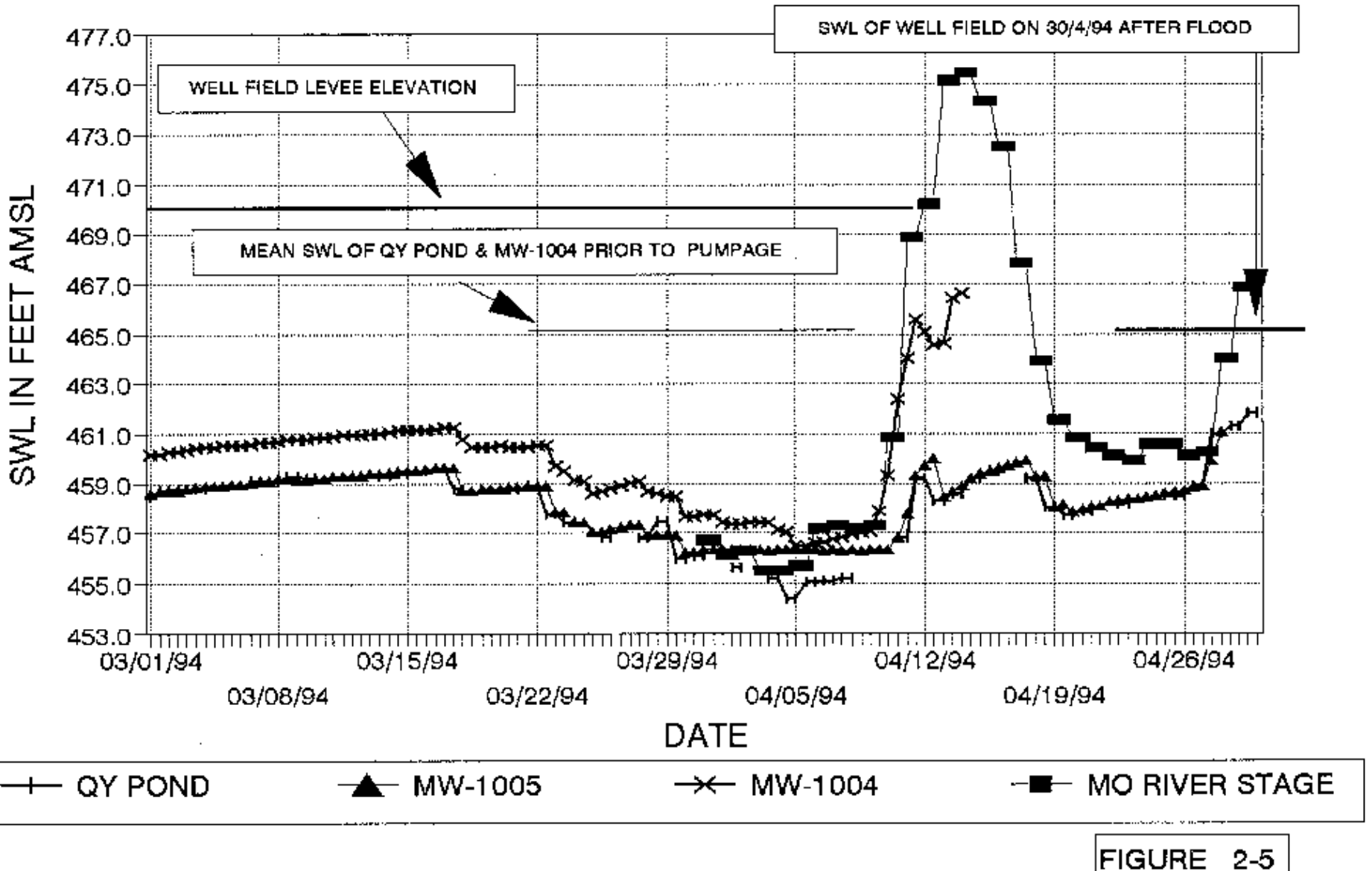


FIGURE 2-5

URANIUM FOR MW-1004 & MW-1005

FILE: DOE/OR/21548-484; LMLK:U04-05-X

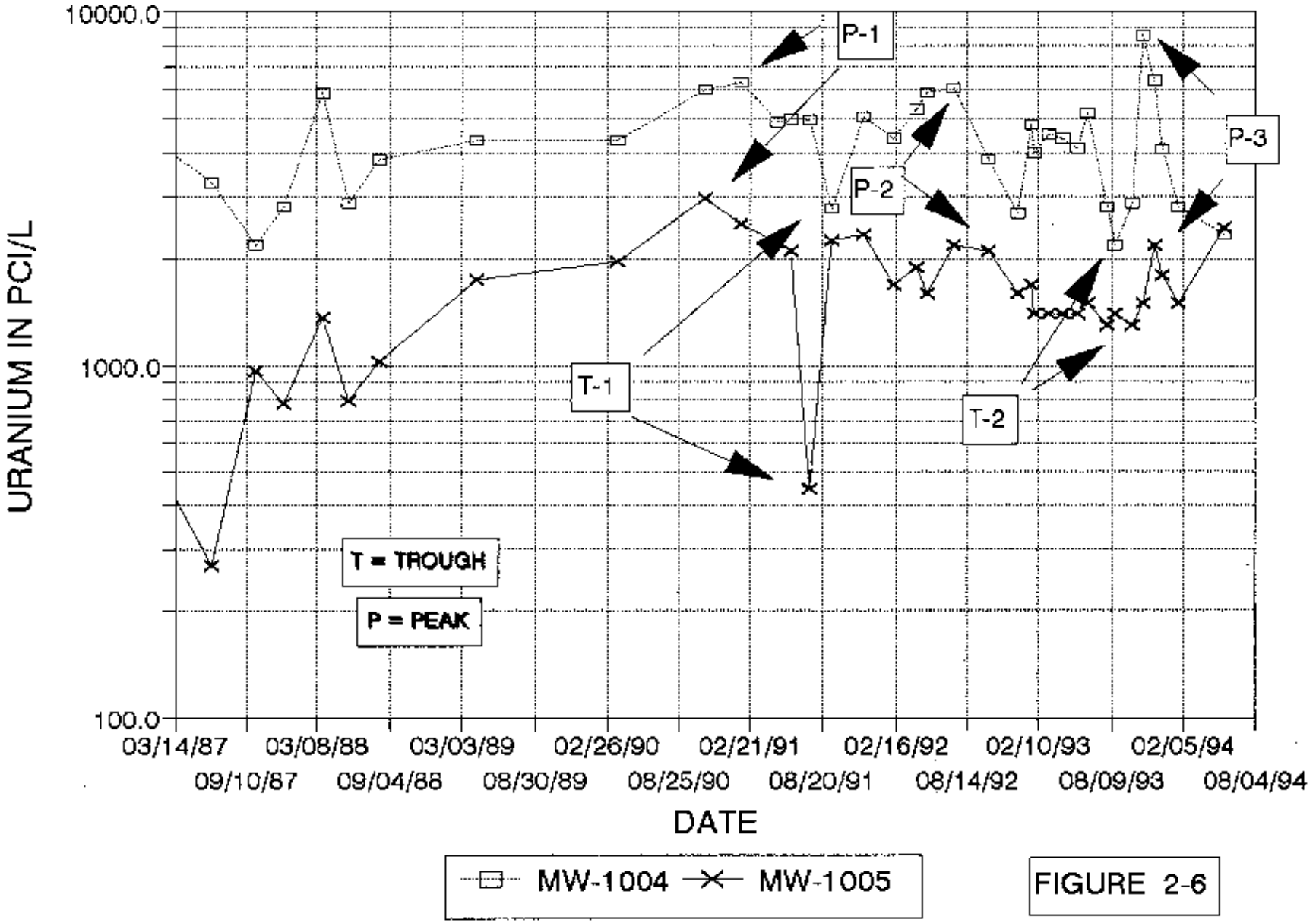


FIGURE 2-6

significantly prior to quarry activities. It is known that changes in dissolved oxygen, dissolved organics, organic activities (algae etc.) pH, and/or Eh can have a profound affect on the solubility of uranium. Groundwater quality data are being collected within the scope of the quarry residuals operable unit to determine the relative importance of these criteria.

2.3 Water Level Response to Precipitation

The quarry pond can be viewed as a large diameter well responding to precipitation, evaporation (minor), pumpage, and seepage from and to the surrounding rock mass. The initial pond level controls the rates of the latter two factors. The increase in volume due to precipitation was calculated from the measured rise in the SWL. Because the pond is roughly conical, as the SWL increases, the volume of water increases at a greater rate (see Figure 2-7). This nonlinear relationship of the quarry volume to the staff gauge elevation was determined from survey data (Figure 2-7). The survey points shown in Figure 2-7 are based on topographic survey data and volume computation. This graph was used to compute pond volume and rate increases.

TABLE 2-1 Quarry Pond SWL Increase Due to Precipitation

Datus	Rain (inches)	Pond Elv. Start (AMSL)	Pond Increases		Rate (K gal/1 in. rain)
			Feet	(K Gallons)	
3/2 to 3/5/93	1.85	464	1.9	243	131
8/11 to 8/12/93	3.1	463	2.4	289	93
11/13 to 11/18/93	5.3	465	1.8	248	47
4/26 to 4/29/94	3.9	459	2.1	257	66
5/15/94	1.5	461	.55	52	34

The rise in the SWL of the pond is determined by the antecedent soil moisture conditions, the type of precipitation event, and the total amount of precipitation. For example, an intense

QY POND VOLUMES VS STAFF GAUGE READING

FILE:DOE/OR/21548-484; LMK:QY-VOLUM.WQ1

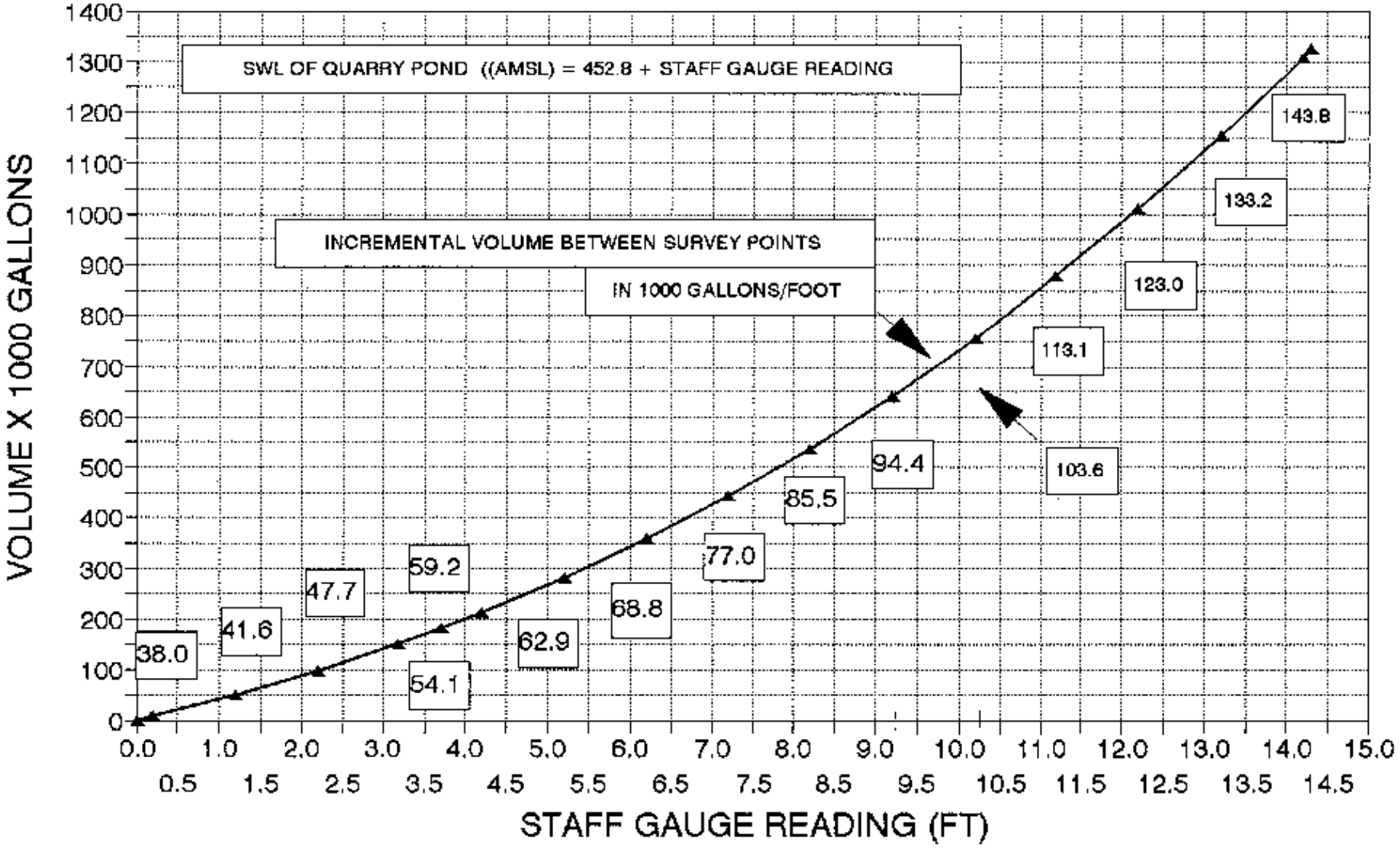


FIGURE 2-7

thunderstorm will foster maximum runoff while a slow, soaking rain will minimize runoff from the adjacent areas to the pond. The last column of Table 2-1 shows the affect of these two factors on the volume increase normalized for 1 in. of rain.

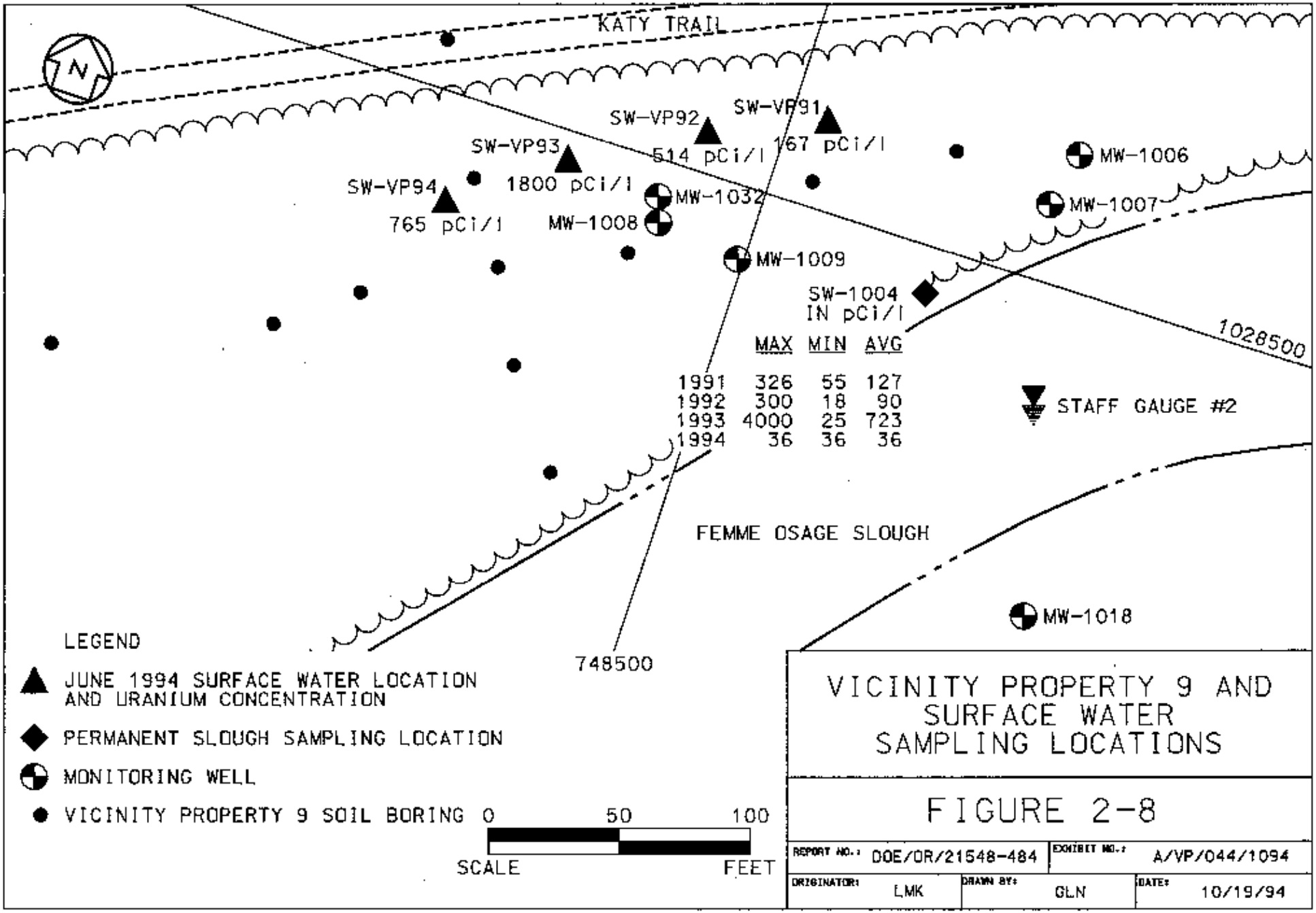
2.4 Vicinity Property 9 Surface Seepage

In early June 1994, four surface water samples were collected from around Vicinity Property 9 (VP 9) from an area normally not containing surface water (Figure 2-8). Elevated uranium values (167 pCi/l to 1800 pCi/l) were encountered in all samples. On April 10, 1994, just prior to the Missouri River flood, seepage water was observed to flow from the same general area within VP 9 area toward the slough just a few days after the quarry area received 6.13 in. of rain in 2-1/2 days. Surface samples were not collected at this time.

An unusual increase in uranium concentration (4,000 pCi/l) was recorded on January 11, 1993, from surface water sample site SW-1004 located on the slough bank (Figure 2-8). At that time, the water level of the slough was over the banks at the sample site at the $\pm$458 ft elevation due to abnormally high precipitation in November and December of 1992. From April 9 through April 16, 1993, when the slough was again above the banks covering most of VP 9, follow-up surface water sampling showed anomalous uranium values (up to 1,590 pCi/l). For further details see Appendix A.

A temporal graph of surface water samples from SW-1004 location shows anomalous uranium values during springtime in 1988 (122 pCi/l), 1989 (557 pCi/l), 1991 (326 pCi/l), 1992 (300 pCi/l), and in January 1993 (4,000 pCi/l) (Figure 2-9). This graph demonstrates that for five of the past 6 years, high uranium concentrations occurred in either spring or in January. In 1994, the well field was flooded from April 13 for 6 weeks, and bimonthly sampling was interrupted. Due to this flooding, the latest seasonal effect may have been obscured.

The seasonal high uranium values in surface waters at the SW-1004 location could be due to seasonal physical/chemical changes in the groundwater coupled with seepage pulses from the quarry pond. Sufficient data are lacking to decipher the precise causal mechanism. Further investigation of transport controls will be reviewed in the scope of the quarry residuals operable unit.



VICINITY PROPERTY 9 AND SURFACE WATER SAMPLING LOCATIONS

FIGURE 2-8

REPORT NO.:	DOE/OR/21548-484	EXHIBIT NO.:	A/VP/044/1094		
ORIGINATOR:	LMK	DRAWN BY:	GLN	DATE:	10/19/94

SEASONAL URANIUM HIGHS OF SW-1004

FILE: DOE/OR/21548-484; LMLK:U-SW1004

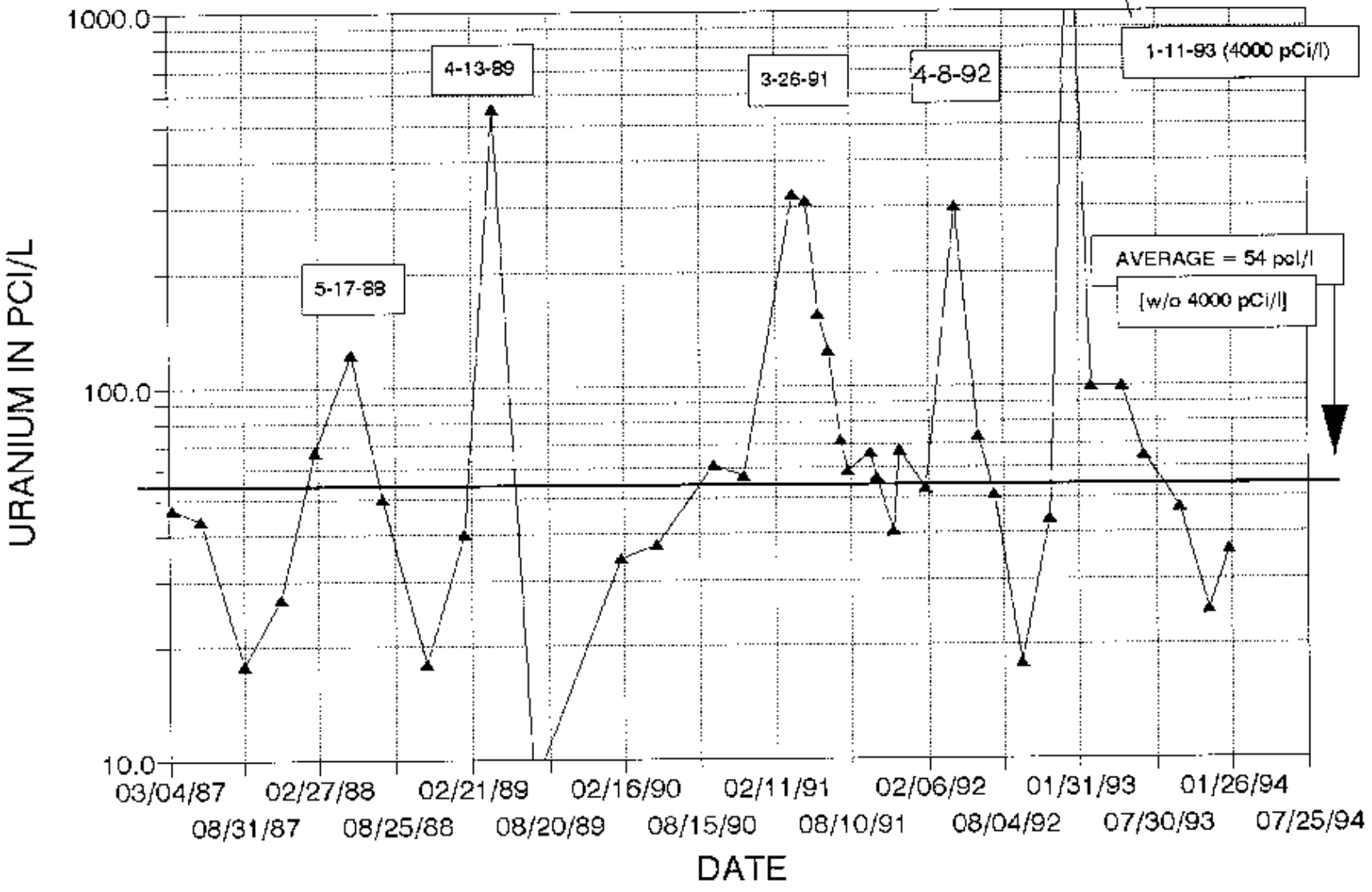


FIGURE 2-9

3 CONCLUSIONS

Observational data for the quarry, MW-1004, and MW-1005 are summarized in Table 3-1. In the Vicinity Property (VP)-9/Femme Osage Slough waters, seasonal above-normal uranium concentrations occurred in 5 out of 6 years of observation.

On the basis of these observations, several conclusions can be drawn about the flow mechanism from the quarry to the VP-9 area including the fringes of the alluvium groundwater.

3.1 Hydrological Considerations

- During normal[1] pond elevation conditions, head relationships between the quarry and alluvial groundwater would allow for contaminated groundwater of undetermined quantity to migrate from the quarry through the Decorah Group rocks. Based upon the groundwater monitoring results from within the alluvium, this water possibly discharges at various elevations at the rock/alluvium interface in the immediate vicinity of the quarry (north of the Femme Osage Slough in the VP-9 area).

- The Decorah/Kimmswick interface is about 460 ft elevation. When the SWL of the pond is above this interface, seepage from the quarry pond is approximately -5.75 k gal/day based upon the measurements of pond elevation decline. Without pumpage, the outflow seepage rate below the SWL of 460 ft appears to be lower and depends on the seasonal groundwater table elevation.

- Without pumpage, the pond SWL can temporarily increase above the normal 460 ft level because of major precipitation. It is speculated that during above-normal pond elevation conditions, quarry pond water egresses through fractures and solution cavities of the Kimmswick Limestone resulting in quarry pond water release "pulses."

- During pumpage from the quarry pond to the equalization basin, the quarry pond acts as a sump that triggers a reversal of the ground flow direction into the quarry. The

1 Normal groundwater conditions exist when major precipitation does not add water to the pond, and the pond static water level (SWL) is at, or below, 460 ft MSL elevation. At this stage, the pond is generally at equilibrium with bedrock groundwater.

infiltration rate depends on the regional groundwater level and the SWL of the pond. Infiltration rates are between 8.6 and 9.1 k gal/day (Figure 1-4).

- Although MW-1004 and MW-1005 monitor the same stratigraphic interval (Decorah), and both wells are similarly constructed, the wells are influenced differently by fracture-flow connections. Again, MW-1005 exhibits by its physical response to quarry pond water level variations a direct connection to the quarry pond, while MW-1004 is influenced by flood water of the Missouri River and has not demonstrated a similar "direct" hydrologic connection to the quarry.

3.2 Chemical Considerations

- Prior to bulk waste removal activities, uranium concentrations in the quarry varied; this is likely due to subtle chemical, organic/chemical, and/or microbiological changes in the water conditions. Supporting data does not exist to pinpoint the exact cause. However, organic matter (leaves, algae, etc.) or organic processes, dissolved oxygen, and temperature changes, could cause different pH and redox conditions.

TABLE 3-1 Summary of Findings

	MW-1004	MW-1005	QUARRY POND
SWL	0.6' +/- higher than MW-1005	Same elevation (direct connection)	
Reaction to flood	Reacts within 24 hrs (11' raise in April 1994)	No or minor reaction to flood	
Reaction to precipitation (in excess of 0.7 +/- in)	Within 36 to 48 hours, exceeds quarry pond and MW-1005	Within 12 hours - simultaneously and identical in magnitude	
Reaction to pumpage	a) Subdued if SWL ~ 460' ± b) Delayed and slightly subdued if SWL 460' ∓	Simultaneously all times	
Chemical character	Approximately one order of magnitude higher than quarry for U; nitroaromatics present	U similar magnitude; most nitroaromatics absent	
Recent changes in U, sulfate	Peaks and troughs lack 30 days from quarry; difference in order of magnitudes remain		Significant increase due to quarry activities
Drawdown for sampling	Small (1 to 4')	Big (10' +/-) intermittently well pumped dry	N.A.
Recovery after sampling	Fast	Slow	N.A.

4 FURTHER ACTIONS

Routine groundwater monitoring as prescribed in the *Environmental Monitoring Plan* (MK-Ferguson Company and Jacobs Engineering Group, Rev. 1, DOE/OR/21548-424, July 1994) will continue for the duration of the quarry remediation activity. In addition, a focused water level monitoring program and data review, will continue to assess the impact of cleanup activities to subjacent groundwater. The Weldon Spring Site Remedial Action Project (WSSRAP) has taken measures to protect the quality of the groundwater in contact with the quarry, including the lowering of quarry pond levels to reduce and flatten the groundwater gradient from the pond. The project will continue to control the quarry water levels through pumping and treatment of those waters at the water treatment plant.

Through in situ groundwater sampling activities, the WSSRAP is investigating the vertical and horizontal distribution of contaminants in the alluvial groundwater adjacent to the quarry, to identify the zones of preferential transport from the bedrock. Additionally, focused aquifer testing through the planned treatability study will be performed to evaluate the feasibility of implementing various control measures to impede the transport of contaminated groundwater from the quarry. Other groundwater control measures, such as using groundwater barriers and enhanced groundwater extraction methods, also remain viable options if water quality conditions within or around the quarry warrant further protection.

APPENDIX A
Unpublished Documents

MORRISON KNUDSEN CORPORATION

MK-FERGUSON GROUP

INTER-OFFICE CORRESPONDENCE

DATE: April 12, 1993

TO: Distribution

FROM: Lotar Klingmuller

SUBJECT: **MONTHLY PRECIPITATION AND SWL MONITORING OF QUARRY POND AND WELLS - MARCH, 1993**

Attached graph shows major precipitation events and SWL for the quarry pond and the three wells for the February 20 through March 31 period. Quantities of water withdrawn from the pond have been obtained from the quarry water treatment plant operations and are estinates based on the staff gauge readings. Withdrawal quantities and date are tabulated below. The summary for the March precipitation data is attached.

For additional detail refer to my TOC on this subject dated, March 9, 1993.

As previously pointed out, there are significant differences in the WSS site and quarry rain gauge readings for individual events and the monthly total (+33% for quarry for both March, 1993).

TABLE 1

WATER PUMPED FROM QUARRY POND* TO EQUALIZATION BASIN	
DATE	K GALLONS PUMPED
3-1	50
3-2	30
3-27	100
3-29	100
3-31	80
4-1	50

* Per M. Myers phone, April 5, 1993

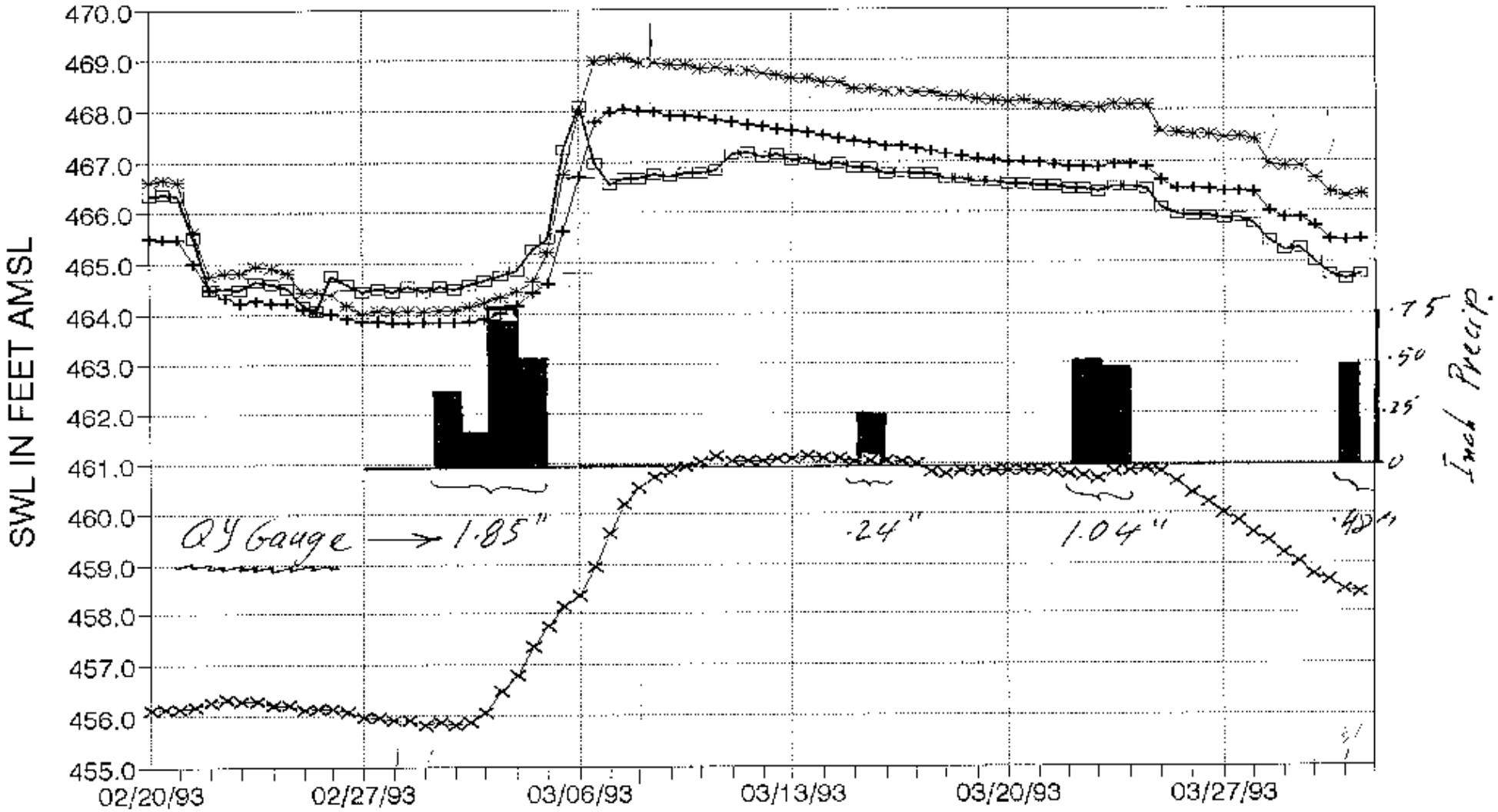
LMK/jn

Attachments

Distribution: J. Meier, K. Meyer, J. Carman, W. Goldkamp, B. Freeman, M. Myers

QY-POND,MW-1027,-04,-05 SWL

FILE: LMLK 1027-04.C93



040953

1993 consecutive day

WSSRAP PRECIPITATION SUMMARY: MONTH March '93

DATE	SITE	QUARRY	NOAA	Δ = QY-SITE	%
1 60	0				
2	.28	.36	.34		
3 62	.59	.12	.58		
4	.25 } 1.12	.76 } 1.85	.24 } 1.16	+ .73	65
5 64		.61			
6					
7 66					
8					
9 68					
10					
11 70					
12					
13 72					
14			.04		
15 74			.19		
16	.40	.14 } .24	0 } .23	- .16	40
17 76		.10			
18					
19 78	.30	.06	.47	-.24	80
20	0				
21 80			0		
22	.51	} 1.04	.94	+ .53	104
23 82		.56	tr		
24		.48	tr		
25 84					
26					
27 86					
28					
29 88					
30	.45	.02 } .50	.29 } .45	+ .05	11
31 90		.02 .48	.16		
TOTAL:>>	2.78	3.69	3.25	+ .91	33

NR = Gauge not read; QY gauge read ~7 AM; WSS and NOAA data for 24 hour period midnight to midnight.

MORRISON KNUDSEN CORPORATION

MK-FERGUSON GROUP

INTER-OFFICE CORRESPONDENCE

DATE: June 10, 1994

TO: Jim Meier

FROM: Lotar Klingmuller

SUBJECT: **MONTHLY STATIC WATER LEVEL RESULTS OF QUARRY POND AND WELLS, MAY 1994**

Attached are the monthly Static Water Level (SWL) graphs for the quarry pond, MW-1004, MW-1005, MW-1027, MW-1040, and MW-1041, including quarry precipitation and quarry pumpage data.

The defective transducer of MW-1004 was replaced on May 14. The transducer of MW-1005 was lowered from above to below the dedicated pump on June 3 in order to be able to record SWL readings below 456.4 ft.

The recorder and associated transducers of MW-1040 and MW-1041 were pulled at the beginning of June as the transducer monitoring program of these wells has been terminated. The mechanical problems of this recorder continued throughout May. A temperature-dependent component is suspected. Night readings of both transducers are lower starting April 14, 1994.

The resurvey data of well casing elevations for quarry rim monitoring wells were received in May. The old TOC elevations are for five out of eight wells about 0.15 ft higher than the May 1994 surveying results as shown in Table 1.

TABLE 1: DIFFERENCE IN TOC ELEVATION OF QUARRY RIM WELLS

WELL ID	ELEVATION NEW*	ELEVATION OLD	DIFFERENCE
MW-1002	557.94	558.12	0.18
MW-1004	538.05	538.20	0.15
MW-1005	540.82	540.97	0.15
MW-1026	483.68	483.81	0.13
MW-1027	488.06	488.20	0.14
MW-1029	564.07	564.45	0.38
MW-1030	542.44	542.46	0.02
MW-1034	526.58	526.69	0.11
MW-1039	479.63	479.63	0.00

* Work authorization #081 received May 23, 1994.

 MONTHLY STATIC WATER LEVEL RESULTS OF QUARRY POND AND WELLS, MAY 1994

NOTE: Vertical bars showing precipitation and pumpage are shown as double bars/double data points. This compensates for transducer readings which are obtained every 12 hours.

COMMENTS ABOUT MAY DATA

FIGURE 1

This graph show the static water levels of the transducers monitoring the quarry rim wells and the quarry pond plus the precipitation. Excellent correlation of the SWL exists again between the pond and the MW-1005. The correlation in the SWL is in many cases identical.

In May, water levels of MW-1027 and MW-1004 were still influenced by the April flood. For most of May, water was above the ground in the well field.

The May 1.5 in. precipitation event raised the SWL of the pond 6.0 in. This event occurred after 7 AM, May 13, 1994, (Friday) and before 7 AM, May 16, 1994 (Monday) when the gauge was read.

FIGURE 2

This is the same graph as in Figure 1 showing the computed quarry infiltration rates for three periods. The rates for the pond and the MW-1005 are shown in Table 2. Minor (<0.25 in.) or no precipitation occurred during these infiltration periods.

TABLE 2: INFILTRATION RATES FOR QUARRY POND AND MW-1005

PERIOD	AVERAGE POND LEVEL	QUARRY POND (INCHES/DAY)	MW-1005 (INCHES/DAY)
4/21 TO 4/27	458.5	1.58	1.51
4/08 TO 5/11	461.4	1.10	0.99
5/23 TO 5/28	457.5	1.68	1.55

FIGURE 3

Water levels and pumpage of the pond and wells are shown on this graph. As always, excellent correlation exists between SWL drops and water withdrawals for the pond and MW-1005.

PAGE 3: **MONTHLY STATIC WATER LEVEL RESULTS OF QUARRY POND AND WELLS, MAY 1994**

FIGURE 4

This graph shows the influence of the April 1994 Missouri River flood on MW-1040 and MW-1041. An early May resurgence of the river stage combined with heavy rains at the end of April caused a second peak in SWL. Steeper raises and slightly steeper falls for MW-1041 compared to MW-1040 were observed. MW-1041 is nearest to Little Femme Osage Creek. Similar curves have been obtained for the end of the last 1993 flood.

LMK/jn

Attachment

Distribution:

EP Tech File
Ken Meyer
Glen Schmidt (Distribute as needed)
Bill Goldkamp
Craig Branchfield

QY, MW-1027, -1004, -1005 SWL ADJUSTED

FILE: LMLK=QY-SWL\QY-PRCP.E94

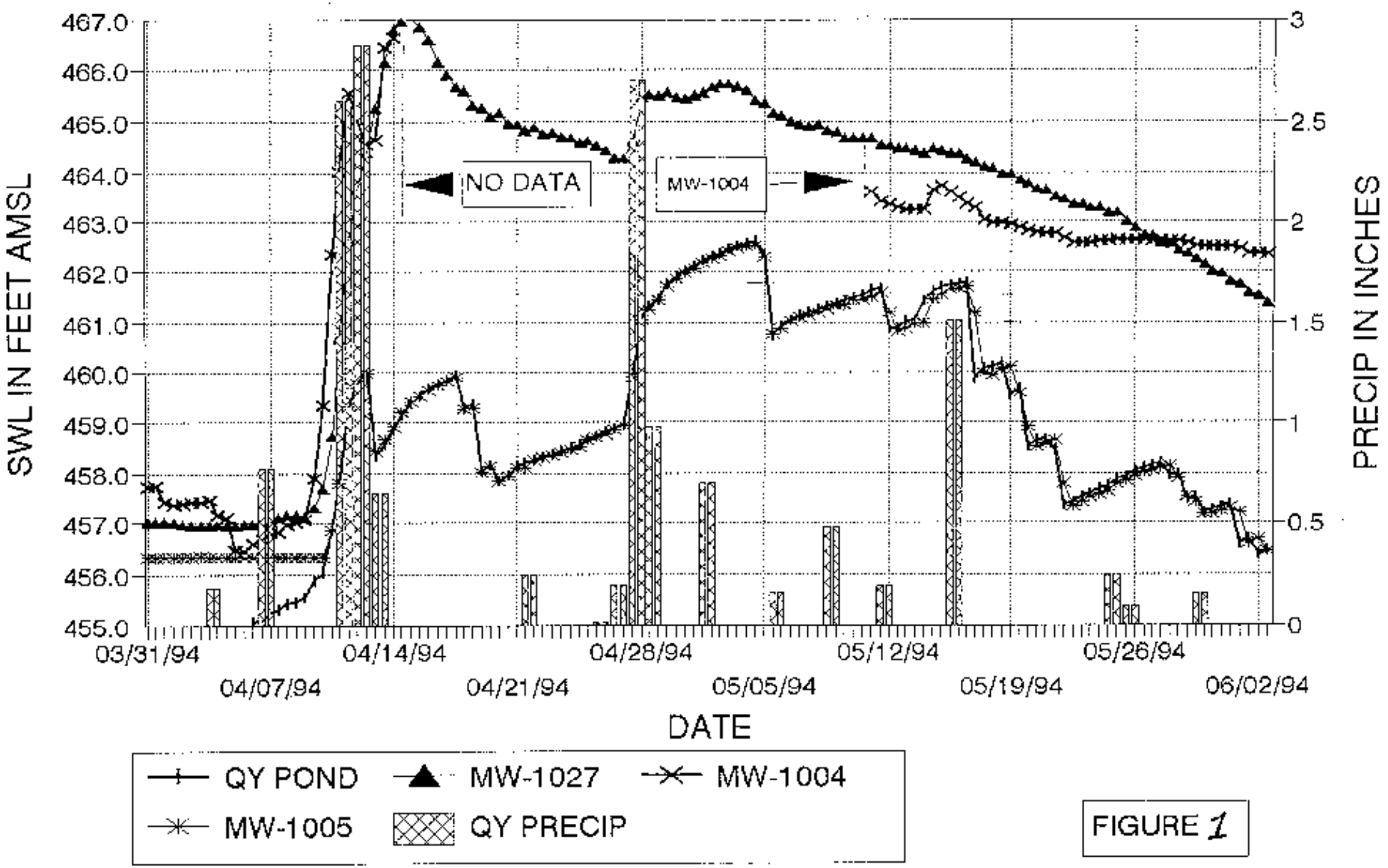


FIGURE 1

QY, MW-1027, -1004, -1005 SWL

FILE: LMLK=QY-SWL\QY-PRCP.E94

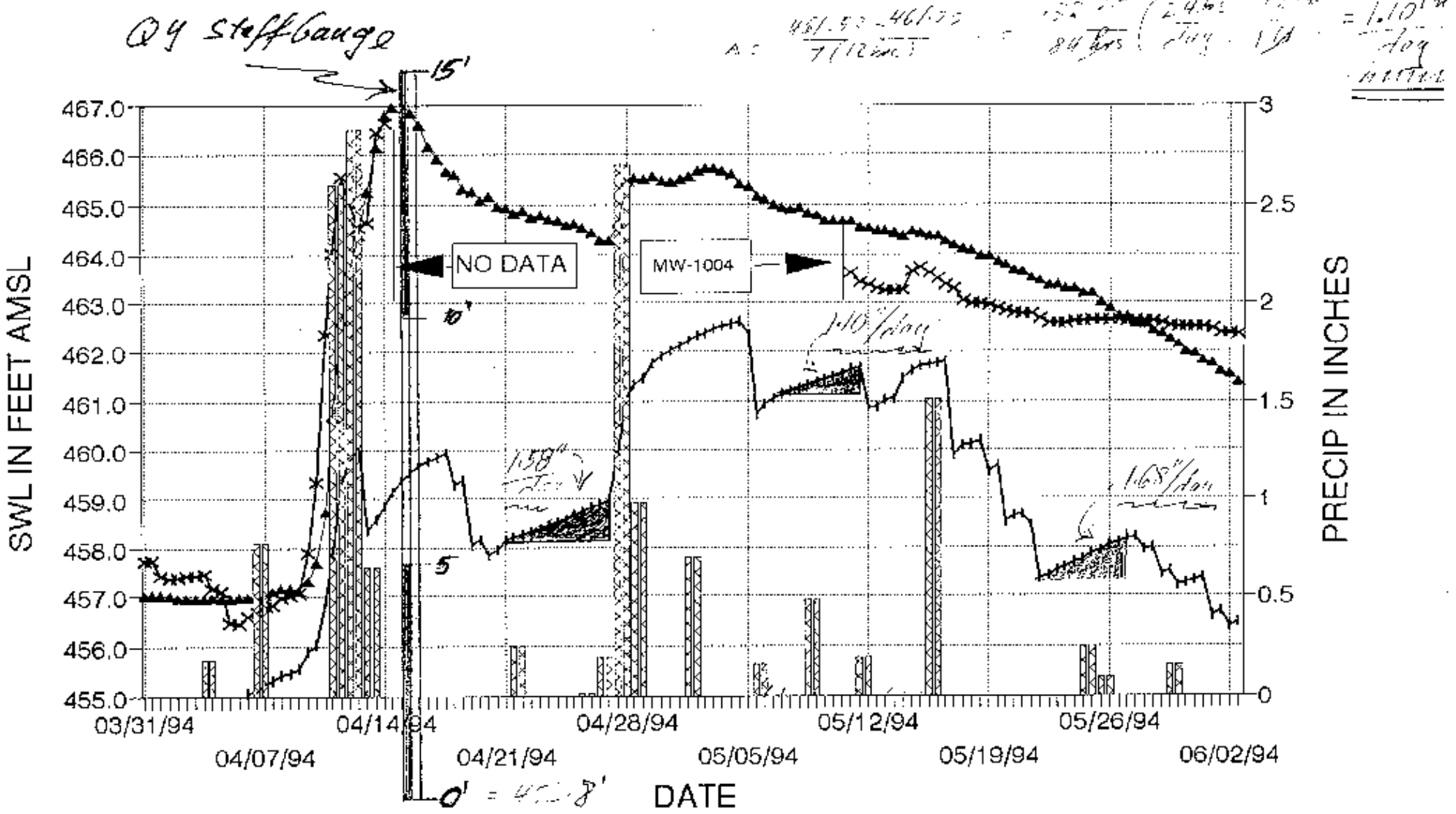


FIGURE 2

QY, MW-1027, -1004, -1005 SWL ADJUSTED

FILE: LMLK=QY-SWL\QY-PUMP.E94

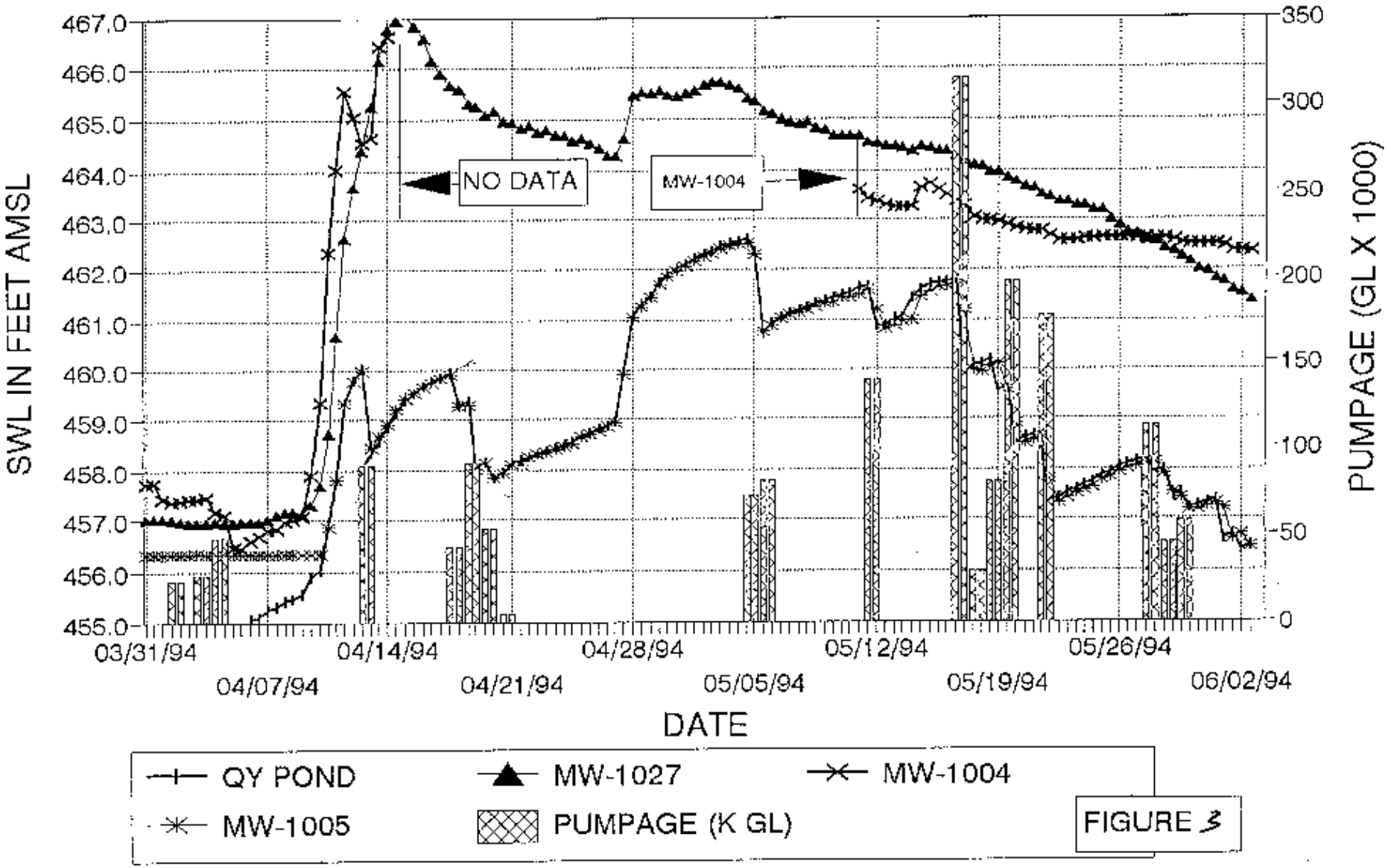


FIGURE 3

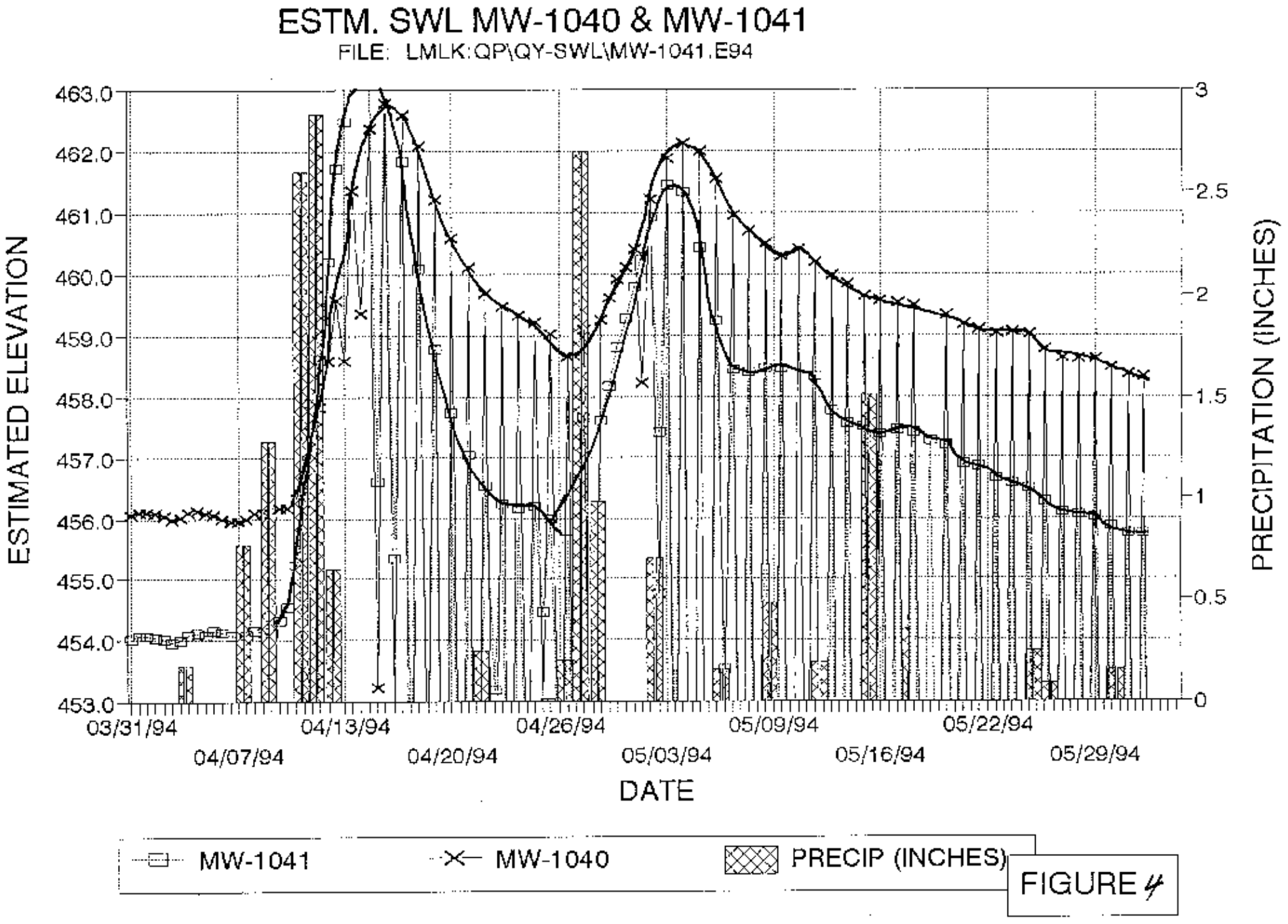

ESTM. SWL MW-1040 & MW-1041
FILE: LMLK:QP\QY-SWL\MW-1041.E94
ESTIMATED ELEVATION
463.0
462.0
461.0
460.0
459.0
458.0
457.0
456.0
455.0
454.0
453.0
PRECIPITATION (INCHES)
3
2.5
2
1.5
1
0.5
0
03/31/94
04/07/94
04/13/94
04/20/94
04/26/94
05/03/94
05/09/94
05/16/94
05/22/94
05/29/94
DATE
MW-1041
MW-1040
PRECIP (INCHES)

FIGURE 4

MORRISON KNUDSEN CORPORATION
MK-FERGUSON GROUP

INTER-OFFICE CORRESPONDENCE

DATE: April 30, 1993

TO: File

FROM: Rebecca Cato

SUBJECT: **ABOVE NORMAL URANIUM CONCENTRATION AT SW-1004 IN JANUARY 1993**

SUMMARY OF EVENTS

On January 11, 1993, the first bimonthly surface water sample was collected from the location SW-1004 in the Femme Osage Slough (Figure 1). This sample was submitted for total uranium and metals (arsenic and barium) analyses on a standard turn from the analytical laboratory. The sample was collected and preserved according to WSSRAP standard operating procedure. The field collection sheet indicated that the sample was "muddy" upon collection. It is standard procedure not to filter surface water samples for analytical sample collection.

Interviews with the sampling personnel indicated that the Femme Osage Slough was flooded (approximate water elevation: 454 ft to 456 ft MSL) and water was standing around the bases of the nearby monitoring wells (MW-1006 through MW-1009 and MW-1032). This flooded area is referred to as vicinity property #9 (VP #9) which exhibits uranium contamination at the ground surface ranging up to 100 pCi/g (Figure 2). Due to the flooded conditions the surface water grab sample was collected farther up on the bank and not at its typical location within the banks of the slough. This alternate sampling location was within the boundaries of VP #9. Groundwater levels measured during the sampling of monitoring wells MW-1006 and MW-1008 (shallow alluvial wells) indicated that the groundwater and slough elevations were similar during this time period.

The data package (Barringer #122) was review on February 27, 1993 and it was noted that the data value of 4012 pCi/L for total uranium at SW-1004 was two orders of magnitude greater that the historical average. On March 1, 1993, a verification discrepancy report was submitted for the re-analysis of the sample by the laboratory. A verbal request was made by the PMC on March 3, 1993, for the re-analysis of the SW-1004 samples. On March 17, 1993, the results for the re-analysis were received from the laboratory confirming the earlier analysis of 4012 pCi/L. The results were documented on April 6, 1993, and forwarded to myself. At this time, procedure ES&H 1.1.7 was initiated and notification was made to the appropriate personnel by April 7, 1993.

The adjacent slough surface water locations were sampled within a week of the January 11 sampling of SW-1004. The results indicated typical concentrations for SW-1003 (32 pCi/L) and SW-1005 (17.8 pCi/L). Groundwater results from the shallow alluvial wells MW-1006 and MW-1008 were 2400 pCi/L and 3300 pCi/l, respectively. These monitoring wells were sampled the previous week.

PAGE 2: **ABOVE NORMAL URANIUM CONCENTRATION AT SW-1004 IN JANUARY 1993**

On March 2, 1993, the surface water location SW-1004 was re-sampled for total uranium analysis. The result of 100 pCi/L for this sampling was received verbally on April 6, 1993 from the laboratory. The sampling conditions for this sampling event had changed from the previous event on January 11, 1993. The slough had since returned to its banks and therefore VP #9 was no longer flooded.

BACKGROUND INFORMATION FOR SURFACE AND GROUND WATER NEAR VP #9

The historic average for total uranium at SW-1004 is 95.2 pCi/L with a range of 557 pCi/L (Q289) to 8.3 pCi/L (Q389). For 1992, the average concentration was 89.8 pCi/L with a range of 18 pCi/L (B592) to 300 pCi/L (B292). No time dependent trend analysis has been previously performed due to the variability of the data. The 1992 annual averages for surface water locations SW-1003 and SW-1005 are 50.0 pCi/L and 24.5 pCi/L, respectively.

The shallow groundwater in the vicinity of SW-1004 has historically exhibited elevated concentrations of total uranium. The 1992 annual averages for MW-1006 and MW-1008 are 3260 pCi/L and 5023 pCi/L, respectively. These locations have been determined to have upward trends (407 pCi/L/yr and 910 pCi/L/yr, respectively) in total uranium concentrations over time.

INVESTIGATION OF FLOODED CONDITIONS AT VP #9

A mini-investigation was initiated on April 9, 1993, due to flood conditions in the slough area. It was believed that due to this flooding the sampling conditions occurring on January 11, 1993, could be recreated. This mini-investigation consisted of the sampling of SW-1004 location and several other locations both upstream and downstream of this location in VP #9 and standing water within VP #9 (Figure 3). These locations were sampled on April 9, April 13, April 15, and April 16. These results for this sampling are summarized in Table 1.

 ABOVE NORMAL URANIUM CONCENTRATION AT SW-1004 IN JANUARY 1993

TABLE 1 SUMMARY OF TOTAL URANIUM CONCENTRATIONS (pCi/L) IN SURFACE WATER DURING FLOODED CONDITIONS AT THE FEMME OSAGE SLOUGH (4/9/93 - 4/16/93)

LOCATION	TOTAL URANIUM (pCi/L)			
	04/09/93	04/13/93	04/15/93	04/16/93
SW-LF01	135.98	NS	103.3	125.1
SW-1003	146.22	NS	130.9	121.1
SW-FS01	137.84	NS	129.3	319.8
SW-1004	159.46	322.6	919.3	113.2
SW-FS02	128.06	309.4	183.9	124.4
SW-VP01	147.12	34.6	1530	486.7
SW-VP02	**	49.8	1290	758.4
SW-VP03	**	**	**	1590
SLOUGH ELEVATION	< 454'	454'	454.5'	455'

NS - Not sampled
** - Standing water not present
Note: Average groundwater elevation on 4/16/93 was 454.7'.

CONCLUSIONS

Although the elevated total uranium concentration of 4012 pCi/L was not duplicated during the mini-investigation, several conclusions regarding the re-occurrence of elevated total uranium concentrations can be drawn. These conclusions are as follows:

- During high surface water conditions, the groundwater in the alluvium north of the Femme Osage Slough behaves similarly to the surface water elevations.

- When the groundwater and surface water first mingles at the ground surface, the total uranium concentrations in the surface water are at their highest.

- As the water level becomes deeper over the ground surface, the total uranium concentrations begin to decrease due to the effects of mixing with the slough waters.

RC/jn

cc: Jim Meier, Sheryl Hodges, Jeff Carman, Ken Meyer, Lotar Klingmueller

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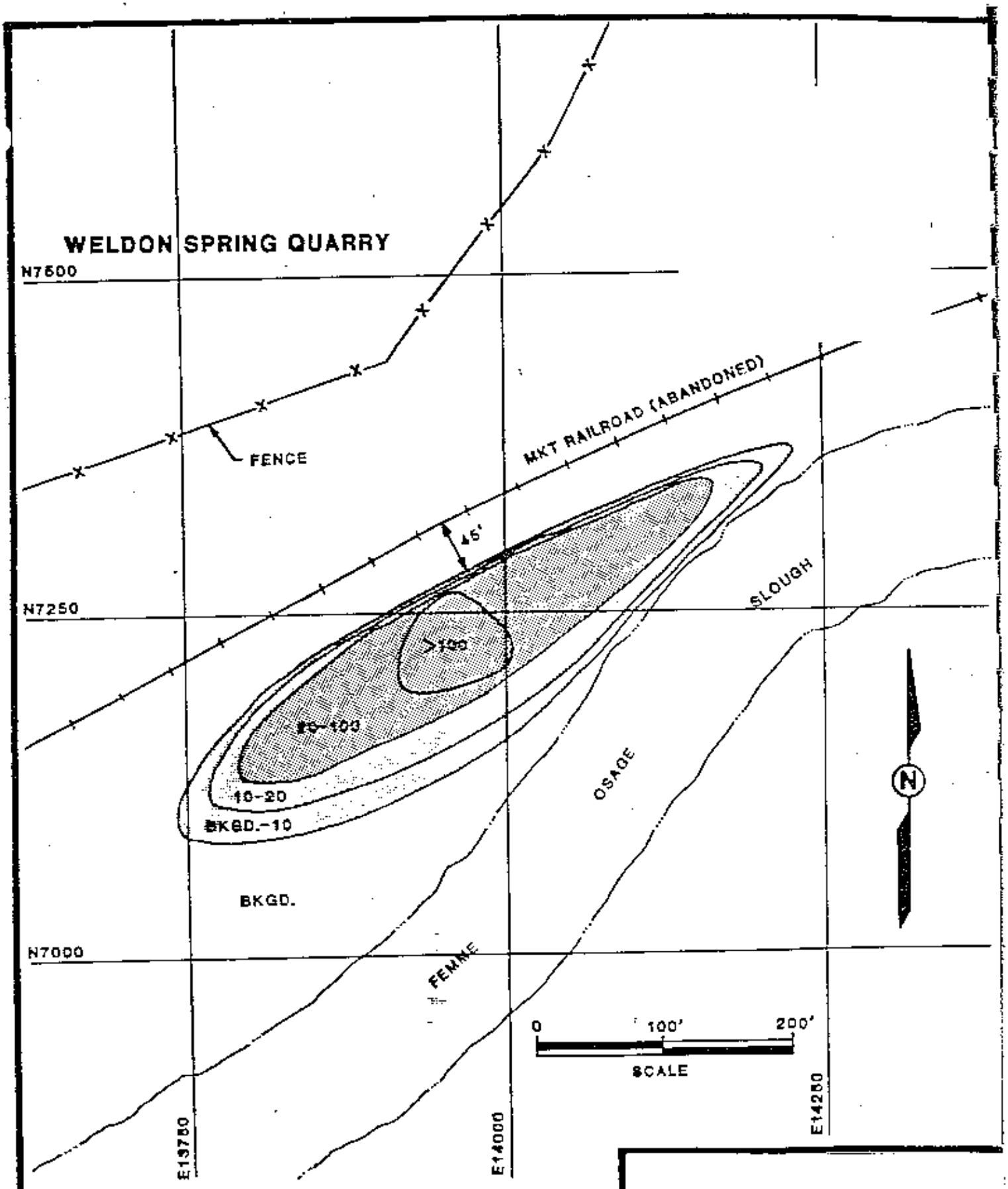
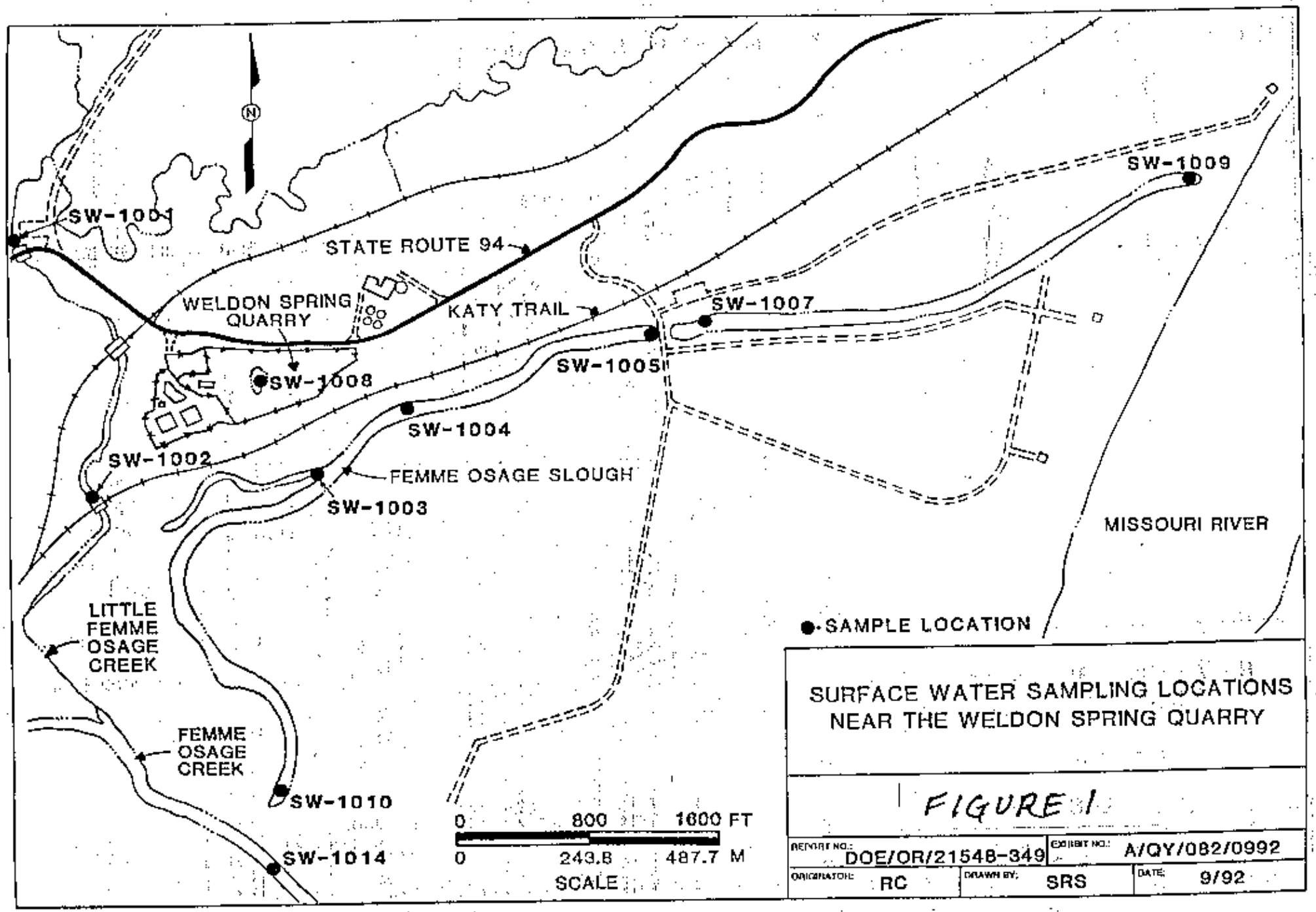


▨ – 15' DEPTH OF EXCAVATION (AVG.)

WELDON SPRING ORDNANCE WORKS GRID SYSTEM

FIGURE 2


N
SW-1001
STATE ROUTE 94
WELDON SPRING QUARRY
KATY TRAIL
SW-1009
SW-1007
SW-1005
SW-1008
SW-1004
SW-1002
FEMME OSAGE SLOUGH
SW-1003
MISSOURI RIVER
LITTLE FEMME OSAGE CREEK
FEMME OSAGE CREEK
SW-1010
SW-1014
SAMPLE LOCATION
0 800 1600 FT
0 243.8 487.7 M
SCALE
SURFACE WATER SAMPLING LOCATIONS NEAR THE WELDON SPRING QUARRY
FIGURE 1
REPORT NO.: DOE/OR/21548-349
EXHIBIT NO.: A/QY/082/0992
ORIGINATOR: RC
DRAWN BY: SRS
DATE: 9/92

APPENDIX B

Seepage Rate Into or From Quarry Pond Calculations

Seepage Rate Into or From Quarry Pond Calculations

Seepage rates are computed from the slope of the quarry pond water level data and the volumetric changes corresponding to that elevation. A positive slope indicates seepage into the pond. Three positive slopes are shown in Figure 1-4. Figure 1-2 shows a negative slope indicating seepage from the quarry pond. Slopes indicate elevation changes over time (ft/day). This rate needs to be translated to volume changes over time (K gal/day).

The quarry is roughly a funnel-shaped container. Therefor, the volumetric change depends on a specific elevation interval. These changes are shown in Figure 2-7, where each survey point of the staff gauge represents the total volume of the quarry pond. For example, the total volume of the pond at a staff gauge reading of 9.25 ft is 630 k gal and at 10.25 ft is 750 k gal. Between these elevations, the incremental volume of the pond is 103.6 K gal/ft. The incremental volume of the pond increases from 38.0 to 143.8 k gal per ft.

Computation for outflow seepage rate for the 12/19/1992 trough 1/1/1993 period (Figure 1-2):

Slope = (466.32-466.84 ft)/26 readings (12 hr/reading) X (24 hr/day)

= - 0.04 ft/day.

Volumetric conversion (Figure 2-7):

At 466.7 ft quarry pond elevation the staff gauge reading is (466.7 - 452.8 ft) 13.9 ft. The incremental quarry volume at this level is 143.8 K gal/ft.

Seepage rate = (-0.04 ft/day) (143.8 K gal/ft)

= 5.752 K gal/day.