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SOUTHEAST DRAINAGE SOILS SAMPLING REPORT

Weldon Spring Site Remedial Action Project
Weldon Spring, Missouri

JANUARY 1997 **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

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Project Manager — Date: 27 Jan 97

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Engineering Manager — Date: 1-28-97

Project Director (or Deputy Project Director) — Date: 01/31/97

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Weldon Spring Site Remedial Action Project

Southeast Drainage Soils Sampling Report

Revision 0

January 1997

Prepared by

MK-FERGUSON COMPANY
and
JACOBS ENGINEERING GROUP
7295 Highway 94 South
St. Charles, Missouri 63304

for the

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

PREFACE

This document is a revised and updated version of a previous report entitled *Soils Review Sampling Report - Southeast Drainage* (DOE/OR/21548-559).

ABSTRACT

The Southeast Drainage Soils Sampling Report summarizes all data collected in the drainage in 1995 in support of the *Engineering Evaluation/Cost Analysis for the Proposed Removal Action at the Southeast Drainage Near the Weldon Spring Site, Weldon Spring* (EE/CA), Missouri and for engineering design. This report identifies the locations within the drainage where soils are proposed for removal based on risk-based concentrations defined in the EE/CA. Additionally, this report provides estimates of the volume of soils to be excavated.

TABLE OF CONTENTS

NUMBER **PAGE**

1 INTRODUCTION 1
2 SOILS SAMPLING PROGRAM 5
3 SAMPLING RESULTS 7

3.1 ORAU Sample Identification System 8
3.2 Surface Soil Scans 9
3.3 Soil Sampling 19

3.3.1 Radiological Data Results 23
3.3.2 Chemical Analytical Results 25

4 VOLUME ESTIMATE OF CONTAMINATED SOILS 27
5 SUMMARY 35
6 REFERENCES 37

APPENDIXES

A Soil Data Results
B Unpublished Documents

LIST OF FIGURES

NUMBER		PAGE
1-1	Location of the Southeast Drainage and the Weldon Spring Chemical Plant Area	2
1-2	Vicinity Property DA4 and DOC7 Showing Segments A-D and Natural Spring Locations in the Southeast Drainage	3
3-1	Comprehensive Survey Area Southeast Drainage	11
3-2	Southeast Drainage Soil Characterization Sampling Locations	12
3-3	Engineering Addendum Sampling at Select Southeast Drainage Locations August 1996	21
4-1	Southeast Drainage Proposed Excavation Locations	28

LIST OF TABLES

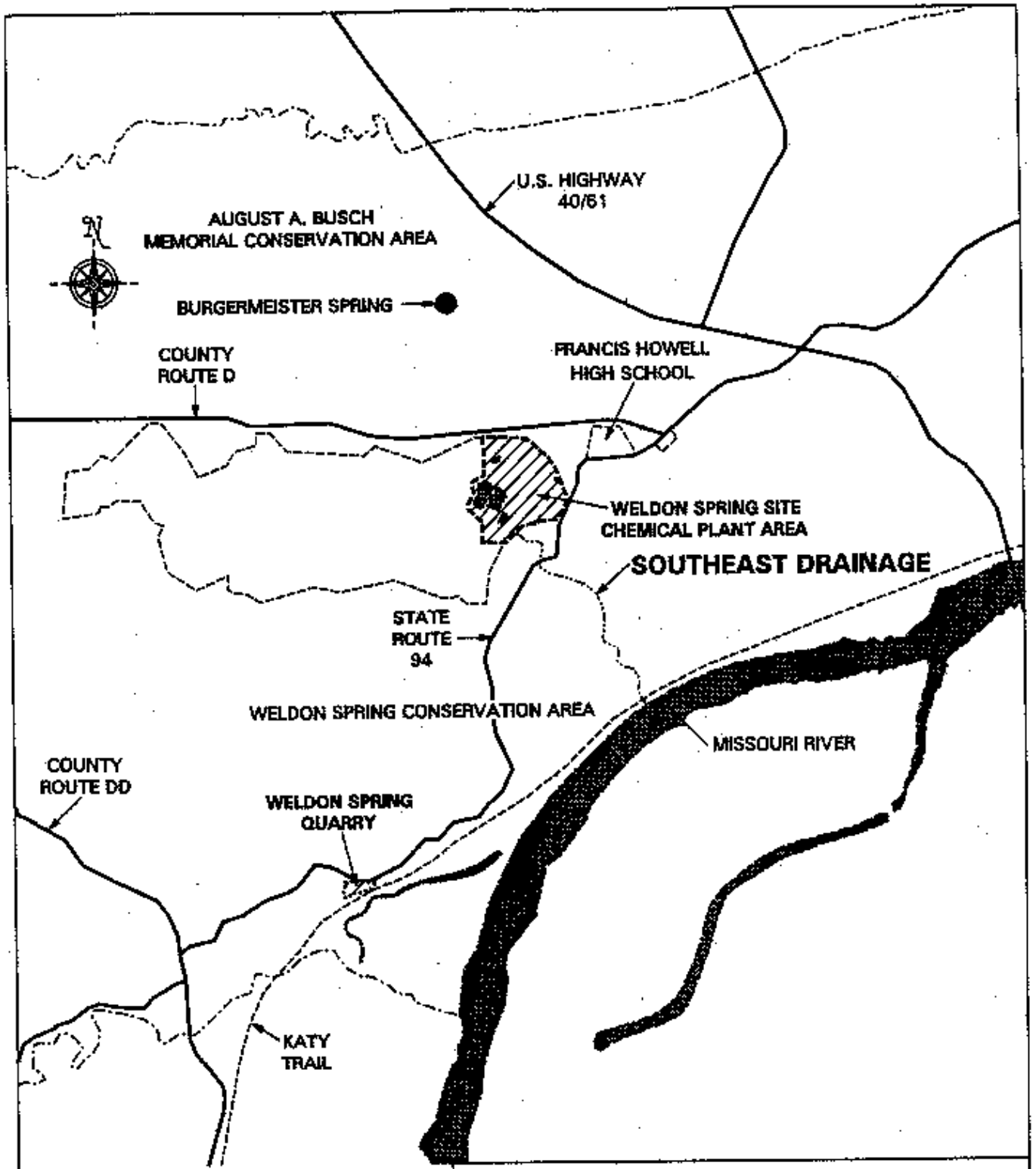
NUMBER		PAGE
3-1	Soil Sampling Locations, Sample Identification, and Location Coordinates	13
3-2	Range of Radiological Concentrations (pCi/g) in Soils from the Southeast Drainage	24
4-1	Southeast Drainage Risk-Based Cleanup Levels	27
4-2	Soil Locations Exceeding Risk-Based Standards	29
4-3	Dimensions and Excavation Volumes for Locations Exceeding Risk-Based Criteria	32

1 INTRODUCTION

The Southeast Drainage is a natural drainage with intermittent flow that traverses the Weldon Spring Conservation Area from the Weldon Spring Chemical Plant to the Missouri River (Figure 1-1). During past operations at the chemical plant, the Southeast Drainage received discharge from the sanitary and process sewers (Imhoff tank) and overflow from the raffinate pits. As a result, sediments and soils in the drainage are contaminated with uranium, thorium, and radium.

In 1985, the Oak Ridge Associated Universities (ORAU) conducted radiological surveys and sampling in the Southeast Drainage. A soil sampling was conducted at 100 meter intervals along the drainage, and surface and subsurface soil samples were collected. A radiological walkover scan was also conducted within the primary drainage channel using a sodium iodide meter. At locations where elevated meter readings were found, surface and subsurface soil samples were taken. The results of the survey indicated that sediment in the drainage was heterogeneously contaminated with radioactive contamination (Ref. 3 and Ref. 4). Analytical results for sediment samples indicated concentrations ranging from background to a maximum concentration of 210 pCi/g for Ra-226, 240 pCi/g for Ra-228, 1,000 pCi/g for U-238, and 10,000 pCi/g for Th-230. From this survey, the Southeast Drainage was identified as Vicinity Properties DA4 and DOC7 (Figure 1-2), additional areas outside the chemical plant boundary that contained elevated radionuclides.

In 1995, the DOE began the development of the *Engineering Evaluation/Cost Analysis for the Proposed Removal Action at the Southeast Drainage Near the Weldon Spring Site* (EE/CA) (Ref. 1). A soils review sampling (SRS) was conducted in April, July, and August of 1995 (Ref. 2). In December of 1995 and August 1996, additional sampling was conducted in the drainage to provide data for engineering design (Ref. 3). The first sampling (April 1995) was conducted to determine the radiological concentrations at several locations previously demarcated in 1985 by the ORAU and to obtain limited chemical data to determine if elevated chemical compounds are collocated in elevated radiological locations. The second phase of sampling (July 1995) was conducted to obtain additional soil samples at the lower portion of the drainage to adequately characterize radiological concentrations near the Katy Trail, a public hiking and biking trail. The third phase of sampling (August 1995) was conducted to obtain soil



LOCATION OF THE SOUTHEAST DRAINAGE AND THE WELDON SPRING CHEMICAL PLANT AREA

FIGURE 1-1

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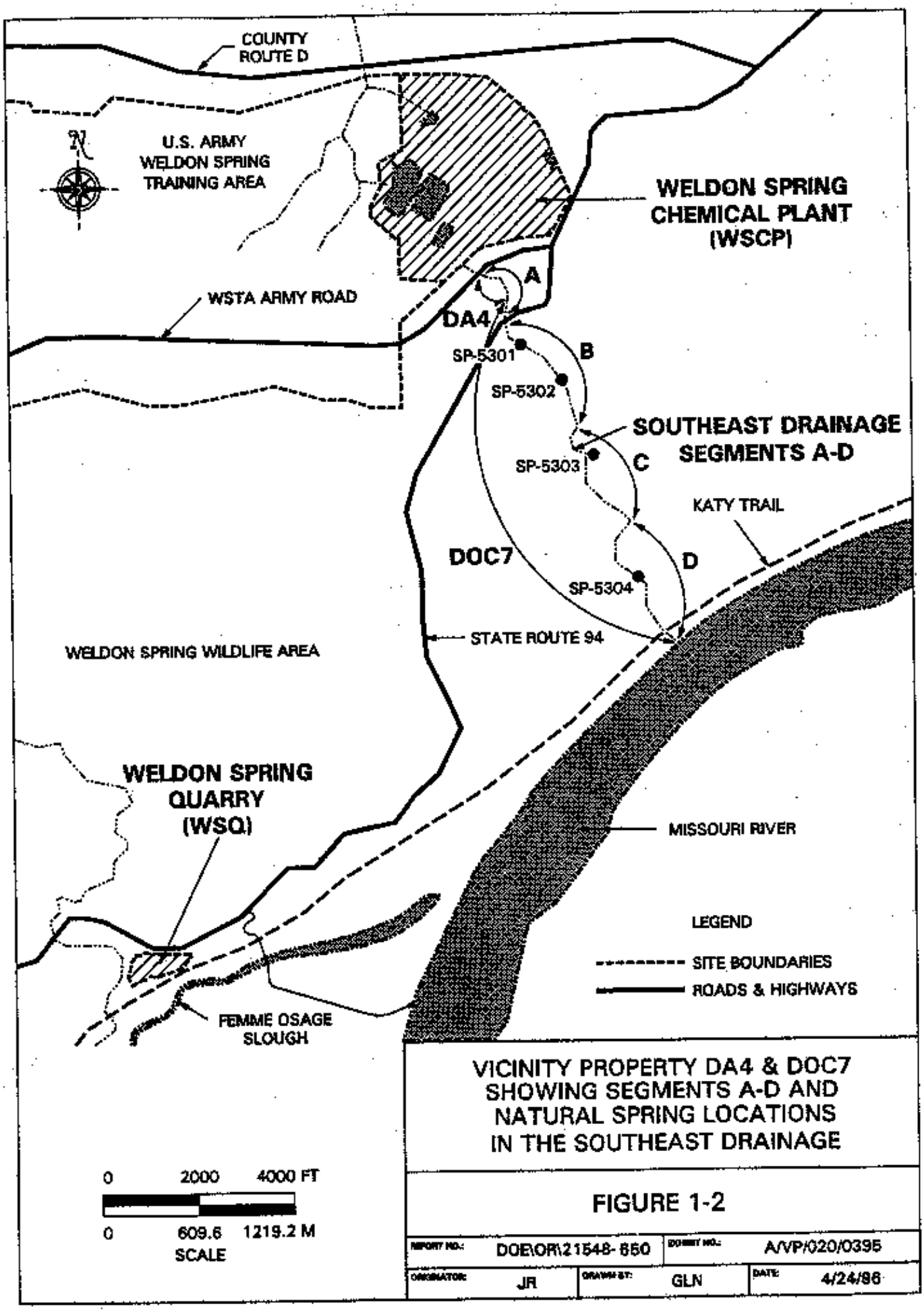
ORIGINATOR: JR	DRAWN BY: GLN	DATE: 7/10/95



VICINITY PROPERTY DA4 & DOC7
SHOWING SEGMENTS A-D AND
NATURAL SPRING LOCATIONS
IN THE SOUTHEAST DRAINAGE

FIGURE 1-2

REPORT NO.:	DOE\OR\21548-650	DOCUMENT NO.:	A/VP/020/0395
ORIGINATOR:	JR	DRAWN BY:	GLN
		DATE:	4/24/96

samples at depths to 30 in. at the lower portion of the drainage. The December 1995 engineering characterization included comprehensive radiological walkover surveys and collection of soil samples to more accurately delineate the lateral and vertical extent of radiological soil contamination, in support of the engineering design for remediation of this area. Soil samples were collected from locations greater than 1.5 times the background levels in order to identify potential areas for remediation. These data were used to estimate the volume of soil that will require removal, to prepare engineering designs, and to determine the affected land surface areas.

This report summarizes all data collected in the drainage in 1995 in support of the EE/CA (Ref. 1) and for engineering design. This report identifies the locations within the drainage where soils are proposed for removal based on risk-based concentrations defined in the EE/CA (Ref. 1). Additionally, this report provides estimates of the volume of soils to be excavated.

In August 1996, additional soil samples were taken at four locations where the volume of soils proposed for removal was greater than 50 cu yds, and sample data collected at the greatest depths exceeded the proposed remediation levels (Appendix B). Soil samples were also taken at one location for additional PCB analyses, to confirm December 1995 data results (Appendix B).

2 SOILS SAMPLING PROGRAM

The Soils Review Sampling (Ref. 2) included several field activities:

- Locating Oak Ridge Associated University (ORAU) locations within the drainage using the ORAU survey monuments and sample identification system.
- Sodium iodide scanning was conducted to relocate selected areas previously defined as radiologically elevated by ORAU.
- Collection of soil/sediment samples from elevated locations and several random locations and analysis for Uranium-238 (U-238), Radium-226 (Ra-226), Radium-228 (Ra228), and Thorium-230 (Th-230).
- Collection of composite soil/sediment samples from elevated radiological locations and random location and analysis for specific chemical compounds to determine whether chemical compounds are collocated with radiological compounds.
- Collection of soil/sediment samples from additional locations and depths at the lower portion of the drainage near the Katy Trail and analysis for U-238, Ra-226, Ra-228, and Th-230.

The Engineering Characterization (Ref. 3) included several field activities:

- Comprehensive radiological surveying (walkover surveys) conducted throughout the drainage using a sodium iodide (NaI) detector to locate/delineate areas that exceed 1.5 times background values.
- Collection of soil samples at locations identified as greater than 1.5 times background and analysis of samples for U-238, Ra-226, Ra-228, and Th-230.
- Collection of soil samples at seven specific locations in the drainage to confirm polychlorinated biphenyl (PCB) concentrations found in composite soil samples

taken in April 1995. Collection of soil samples at one location in August 1996 to confirm PCB data results from April 1995 sampling.

- Collection of sediment sampling at each of the four springs in the drainage and analysis for nitroaromatics, to determine if these compounds are accumulating in the sediments as a result of groundwater discharge.

- Collection of soil samples at depths to 6 ft at stream meander locations and analyze for U-238, Ra-226, Ra-228, and Th-230.

- Collection of soil samples at four locations in August 1996 to further delineate the lateral and vertical extent for remediation and to analyze for U-238, Ra-226, Ra-228, and Th-230.

3 SAMPLING RESULTS

The results of the soils sampling indicated that radiologically elevated sediments are still present in the Southeast Drainage. In addition, the results showed that the Oak Ridge Associated University (ORAU) sample identification locations could be found in the same areas at Vicinity Property DA4 since the length was relatively short and specific man-made features were used to bound the area. Most of the ORAU-defined locations at Vicinity Property DOC7 could not be found since the original markers could not be found, because of the overall length (greater than 2140 m), and because of meandering of the drainage channel. Several elevated locations were found by random scanning and sodium iodide (NaI) instrument readings ranged from 20,000 to 210,000 counts per minute (cpm) above instrument background. Soil samples were taken in these areas. In general, radiological concentrations at these locations were found to be similar to the concentration ranges previously reported by ORAU, except for Th-230, which was much lower.

Composite soil samples were also taken for chemical analysis at locations where elevated radiological readings were found and for comparison at random sampling locations. One random sampling location (not radiologically elevated) at DOC7 reported detectable concentrations of 2,4-dinitrotoluene (0.0023 μg/g). Two samples were reported to contain detectable concentrations of Aroclor-1254 and Aroclor-1260 ranging from 287 μg/kg to 3860 μg/kg. Elevated radiological compounds were also found at this location. Several metals were also detected in the soil samples, with higher concentrations of these elements reported at the upper (DA4) portions of the drainage.

Nineteen additional soil samples were taken during July from the lower portion of the drainage to increase the sample representative in the lower portion of the drainage. This sampling included both random sample locations and several samples taken from elevated locations identified by surface scans. Several of these samples were found to contain radiologically elevated soils within ranges found in the April sampling. In August 1995, additional soil samples were taken at six locations from the lower portion of the drainage to the depth of 30 in. Results show that only one location contained slightly elevated concentrations and only to 12 in. in depth.

The results of the engineering soils characterization sampling conducted in December 1995, identified 39 additional radiologically elevated areas in the drainage above 1.5 times background. Soil samples were collected from all locations where samples were not previously collected and were analyzed for U-238, Ra-226, Ra-228, and Th-230. Concentrations were found to be comparable to those collected in the April 1995 sampling. The resampling of four locations in August of 1996 provided additional data to define the lateral and vertical boundaries of these large soil volume areas and reduced the soil volume expected for removal.

3.1 ORAU Sample Identification System

The first objective of the SRS was to relocate elevated radiological soils by reestablishing the ORAU sample identification system. An example of a sampling location in this system is DA4 190 1L, which translates to the drainage location 190 m from the DA4 starting point (0 m). The second identifier is the transverse location, 1L, which is 1 m to the left (L) of the drainage centerline. Permanent topographical survey markers (monuments) were placed at three locations in the Southeast Drainage in 1985 (Ref. 3 and Ref. 4). ORAU used these survey markers as starting and ending points for their sampling interval system.

During surveillance activities in the drainage, no ORAU markers could be located within the Southeast Drainage. Three other markers were located within the upland areas of the Weldon Spring Conservation Area. These markers were used to develop a coordinate transformation equation from the ORAU coordinate system to the North American Datum 1983 (NAD83) topographic coordinates (Dwyer, Appendix B). This equation was used to attempt to convert the beginning and ending coordinates of DA4 and DOC7, as provided by the ORAU reports, to the NAD83 coordinates and to reestablish these locations. This transformation and relocation of starting and ending points for the ORAU interval system was unsuccessful.

An alternative method was used to try to find ORAU locations within the drainage. An outer fence in the Weldon Spring Conservation Area near the Weldon Spring Training Area entrance was present in 1985 and was used as the ORAU boundary line between DA4 and DOC7. The fence was used as an attempt to recreate the meter locations. Meter interval locations for DA4 were measured from the fence line upwards within the drainage to the approximate location of the Imhoff pipeline outfall. Meter locations for DOC7 were measured from the fence line and continued downstream within the drainage channel. A 100 m tape was

used to measure interval locations. Distance was measured from the centerline of the drainage following the meandering of the drainage.

The ORAU survey interval system could be recreated at DA4 since the length was relatively short and specific man-made features were used to bound the area. The total ORAU length of DA4 was 305 m starting at the Imhoff pipeline outfall location and ending at the outer Weldon Spring Training Area perimeter fence. As discussed in the following section, in general, the ORAU elevated locations were found at the same interval locations.

ORAU defined the total length of the DOC7 area as 2140 m from the outer fence to the Missouri River. The total length obtained from the SRS was 2550 m. In addition, the starting and ending intervals where the drainage passes under Highway 94 were identified by ORAU as 100 m and 113 m respectively (Figure 1-2). The SRS distance from the start of DOC7 to the Highway 94 culvert was 77 m. Since this was not the same as the ORAU distance of 100 m, the SRS assumed a length of 113 m on the southern side of Highway 94 to continue the remeasurement. Although several methods were used to try to identify ORAU demarcated locations at DOC7, the measurement method and interval system at DOC7 could not be regenerated. This was attributed to the overall length (greater than 2140 m) and the meandering of the drainage.

The results showed that walkover radiological surveys were needed to quantitatively identify the radiologically elevated soil locations. Each elevated location should also be surveyed using conventional surveying methods or using a portable global positioning system device so that exact locations can be established and relocated as necessary. These recommendations incorporated the characterization conducted for engineering design and reported in Sections 3.2 and 3.3.

3.2 Surface Soil Scans

Field scanning methods were used to initially identify locations in the Southeast Drainage where radiological compounds may have been deposited. Radiological gamma readings obtained from field instruments were used to define locations 1.5 times above background. Surface soil scans were conducted during each of the soil sampling activities. In April, 1995, predefined (ORAU) locations and several random locations were selected for soil sampling. In July and

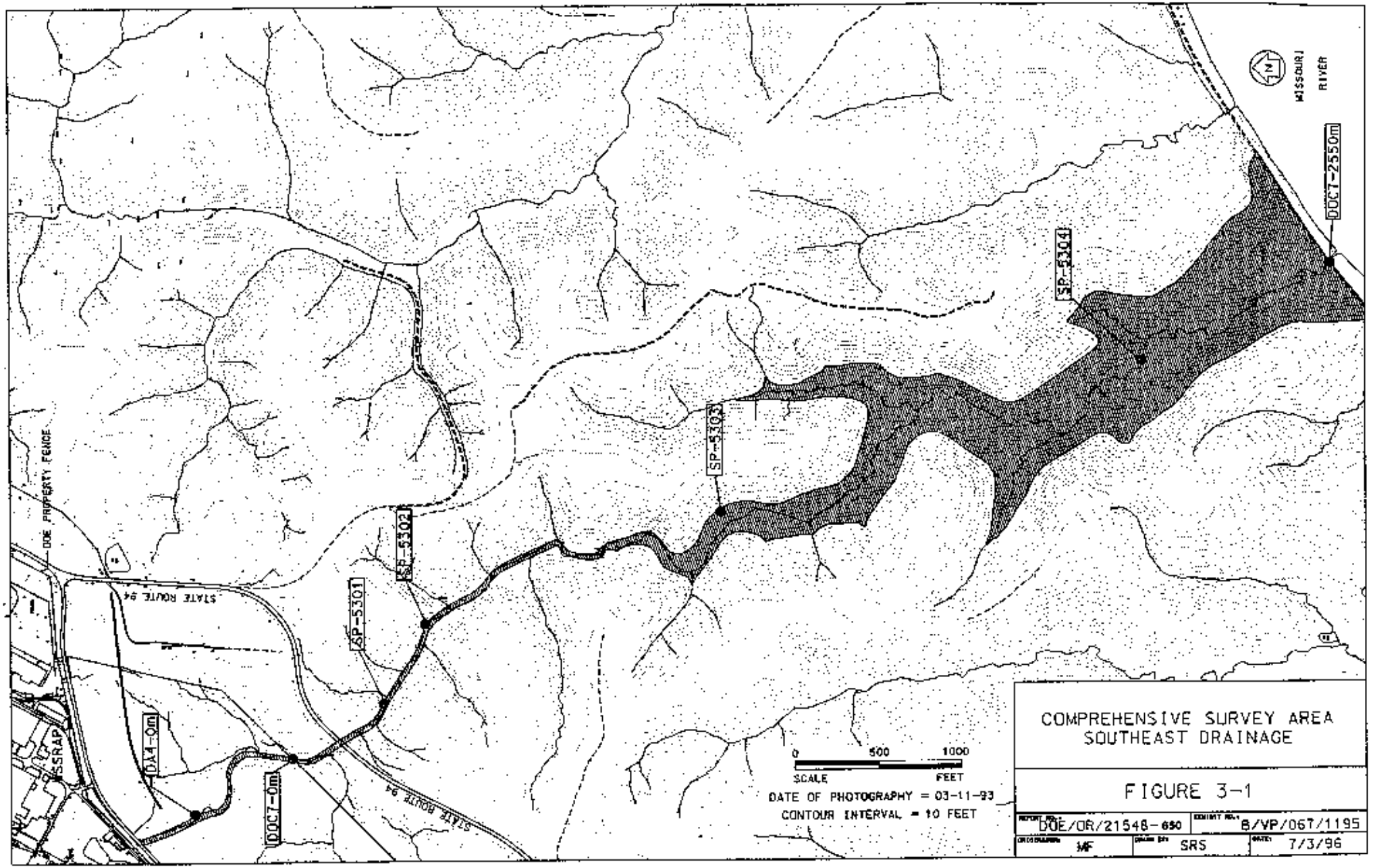
August 1995, surface scans were used to measure radioactivity at several additional soil locations in the lower portion of the drainage near the Katy Trail. In December, a comprehensive survey was performed within the entire Southeast Drainage to locate all radiologically elevated areas.

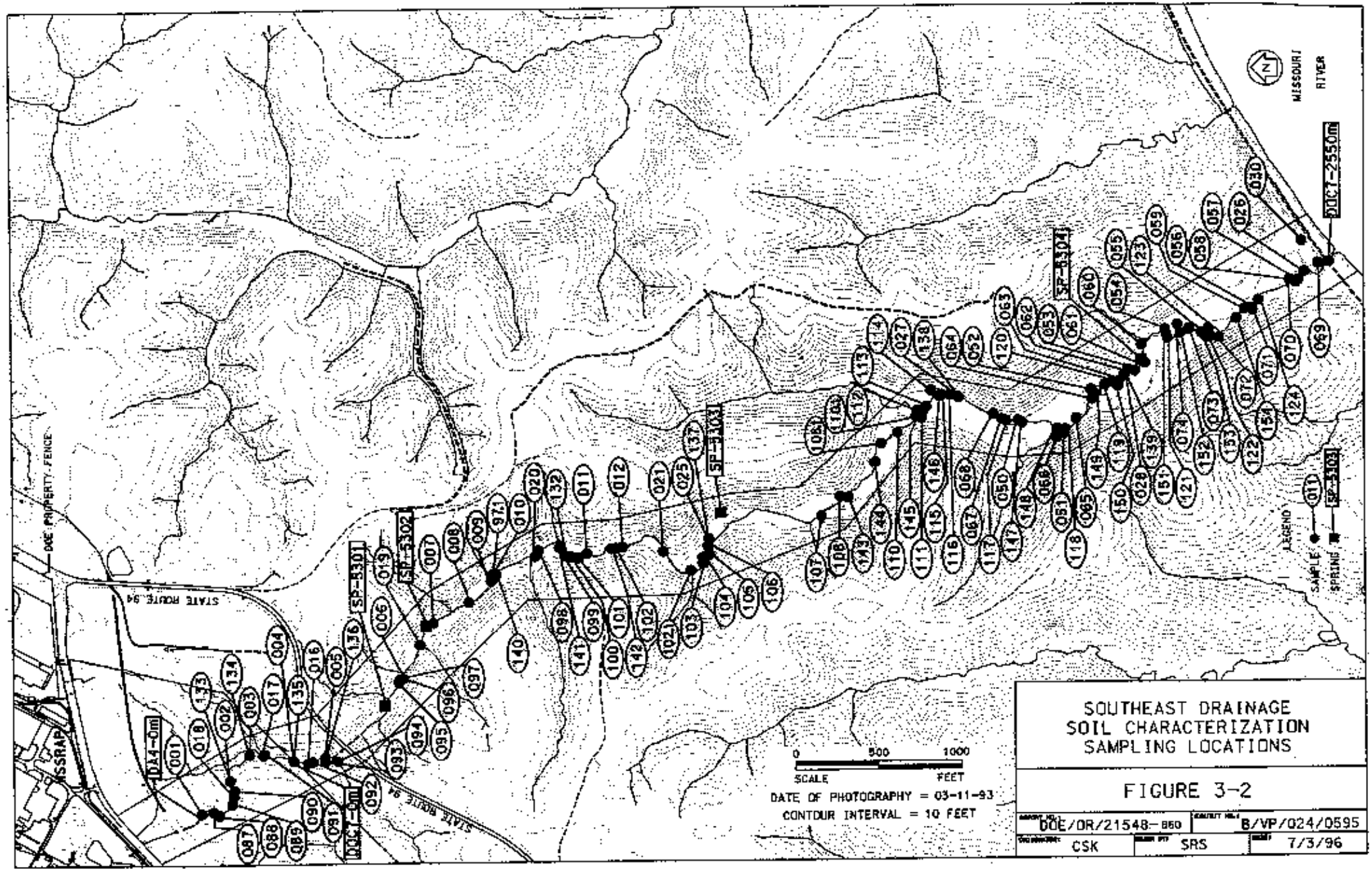
Soil surface scans were conducted at each location according to Procedure ES&H 2.6.2, *Calibration and Use of Ludlum Model 44-10 (2 x 2 Sodium Iodide) Detector*. Meters were calibrated and instrument background gamma readings were obtained at uncontaminated areas prior to the scans within the drainage. The instrument background ranges were determined to be 8,000 to 8,500 counts per minute (cpm) during the April 1995 sampling. The instrument background ranges were determined to be 9,000 cpm to 11,000 cpm during the July and August 1995 sampling. Background ranges obtained during December 1995 were 8,000 - 12,000 cpm. Surface scans were conducted at a walking rate of 1 ft/second at each predefined sampling location or while transversing the drainage.

In April, July, and August of 1995, each sampling location was scanned to a 10 ft x 10 ft area. If a greater-than-background meter reading was obtained at the location, the highest reading within the 10 ft by 10 ft area was located, and a meter reading was recorded in the logbook. If elevated readings were not detected by the surface scan at each sampling location, the general survey area was increased to a 25 ft x 25 ft area. If elevated readings were not obtained after the second surface scan, no additional scanning was conducted at the location, and this information was noted in the field logbook.

The comprehensive survey performed in December 1995 included a walkover of the drainage channel and the adjacent banks from the northern extent of DA4 (0 meters) to the Missouri River in DOC7 (2550 meters) (Figure 3-1). Any area exceeding 1.5 times background was demarcated, and designated for soil sampling. If an area was previously identified by the prior 1995 sampling, no soil sample was taken. Scanning results from December 1995 were used to define the extent of radiological contamination and were used to calculate soil volumes. In August 1996, several samples were collected from four locations to further define the lateral and vertical boundaries and better estimate soil volumes for remediation. PCB samples were also collected from one location to confirm results from December 1995 sampling.

Locations scanned and samples collected from these events are listed with topographical survey coordinates in Table 3-1. Sampling locations are also shown on Figure 3-2.


MISSOURI RIVER
DOC7-2550m
SP-5304
SP-5303
SB-5302
SP-5301
DOE PROPERTY FENCE
STATE ROUTE 94
STATE ROUTE 94
DA4-0m
DOC7-0m
SSRAP
0 500 1000
SCALE FEET
DATE OF PHOTOGRAPHY = 03-11-93
CONTOUR INTERVAL = 10 FEET
COMPREHENSIVE SURVEY AREA
SOUTHEAST DRAINAGE
FIGURE 3-1
DOE/OR/21548-650
B/VP/067/1195
MF
SRS
7/3/96



SOUTHEAST DRAINAGE
SOIL CHARACTERIZATION
SAMPLING LOCATIONS

FIGURE 3-2

DOE/OR/21548-860			B/VP/024/0595
CSK		SRS	7/3/96

TABLE 3-1 Soil Sampling Locations, Sample Identification, and Location Coordinates

VP	SAMPLE ID[a]	NORTHING	EASTING	SAMPLE TYPE	NAI SCANNING METER RESULTS (COUNTS PER MINUTE)
DOC7	SD-2531	1035518.90	757601.50	NITRO SOIL SAMPLE	na
DOC7	SD-2532	1039802.00	755922.00	NITRO SOIL SAMPLE	na
DOC7	SD-2533	1038037.00	756590.00	NITRO SOIL SAMPLE	na
DOC7	SD-2534	1034393.00	758087.00	NITRO SOIL SAMPLE	na
DA4	001	1041160.00	754807.00	RAD SOIL SAMPLE	131,000
DA4	002	1040980.00	755003.00	RAD SOIL SAMPLE	50,000
DA4	003	1040870.00	755158.00	RAD SOIL SAMPLE	75,000
DA4	004	1040609.00	755118.00	RAD SOIL SAMPLE	31,000
DOC7	005 (A,B,C,D)	1040418.00	755136.00	RAD SOIL SAMPLE	60,000
DOC7	005E	1040454	755119	Depth Rad Sample	ns
DOC7	005F	1040350	755112	Depth Rad Sample	ns
DOC7	005G	1040496	755123	Depth Rad Sample	ns
DOC7	005H	1040392	755156	Depth Rad Sample	ns
DOC7	006	1039943.00	755605.00	RAD SOIL SAMPLE	20,000
DOC7	007	1039763.00	755935.00	RAD SOIL SAMPLE	31,000
DOC7	008	1039544.00	756062.00	RAD SOIL SAMPLE	28,000
DOC7	009	1039412.00	756188.00	RAD SOIL SAMPLE	ns
DOC7	010	1039400.00	756229.00	RAD SOIL SAMPLE	8,500
DOC7	011	1038836.00	756348.00	RAD SOIL SAMPLE	ns
DOC7	012	1038621.00	756386.00	RAD SOIL SAMPLE	< 8,000
DA4	013	CHEM COMPOSITE OF 001			na
DA4	014	CHEM COMPOSITE OF 002,003,004,005			na
DOC7	015	CHEM COMPOSITE OF 009, 010, 011, 012			na
DOC7	016	1040523.00	755104.00	RAD SOIL SAMPLE	16,000
DA4	017	1040790.00	755153.00	RAD SOIL SAMPLE	16,000
DA4	018	1040965.00	754909.00	RAD SOIL SAMPLE	9,800
DOC7	019[b]	1039839.00	755809.00	RAD SOIL SAMPLE	< 8,000

TABLE 3-1 Soil Sampling Locations, Sample Identification, and Location Coordinates (Continued)

VP	SAMPLE ID[a]	NORTHING	EASTING	SAMPLE TYPE	NAI SCANNING METER RESULTS (COUNTS PER MINUTE)
DOC7	020	1039149.00	756335.00	RAD SOIL SAMPLE	8,000
DOC7	021	1038378.00	756358.00	RAD SOIL SAMPLE	ns
DA4	022	CHEM COMPOSITE OF 017, 018			na
DOC7	023	CHEM COMPOSITE OF 019b, 020, 021			na
DOC7	024	CHEM COMPOSITE OF 006, 007, 008			na
DOC7	025(A)	1038110.00	756434.00	RAD SOIL SAMPLE	210,000
DOC7	025B	1038107	756436	Depth Rad Sample	na
DOC7	025C	1038126	756380	Depth Rad Sample	na
DOC7	025D	1038132	756404	Depth Rad Sample	na
DOC7	025E	1038132	756438	Depth Rad Sample	na
DOC7	025F	1038089	756443	Depth Rad Sample	na
DOC7	026	1034457.00	758027.00	RAD SOIL SAMPLE	12,000
DOC7	027	1036613.00	757275.00	RAD SOIL SAMPLE	62,000
DOC7	028	1035625.00	757400.00	RAD SOIL SAMPLE	30,000
DOC7	029	CHEM COMPOSITE OF 025, 027, 028			na
DOC7	030[b]	1034563.00	758211.00	RAD SOIL SAMPLE	9,000
DOC7	031	CHEM COMPOSITE OF 030			na
DOC7	132	1038963.00	756336.00	RAD SOIL SAMPLE	62,000
DOC7	050	1036257.00	757136.00	RAD SOIL SAMPLE	13,000
DOC7	051	1035983.00	757051.00	RAD SOIL SAMPLE	26,000
DOC7	052	1035820.00	757318.00	RAD SOIL SAMPLE	13,000
DOC7	053	1035499.00	757428.00	RAD SOIL SAMPLE	14,000
DOC7	054	1035376.00	757678.00	RAD SOIL SAMPLE	12,000
DOC7	055	1035104.00	757630.00	RAD SOIL SAMPLE	28,000
DOC7	056	1034951.00	757806.00	RAD SOIL SAMPLE	16,000
DOC7	057	1034573.00	757978.00	RAD SOIL SAMPLE	17,000

TABLE 3-1 Soil Sampling Locations, Sample Identification, and Location Coordinates (Continued)

VP	SAMPLE ID[a]	NORTHING	EASTING	SAMPLE TYPE	NAI SCANNING METER RESULTS (COUNTS PER MINUTE)
DOC7	058	1034588.00	757962.00	RAD SOIL SAMPLE	40,000
DOC7	059	1034893.00	757800.00	RAD SOIL SAMPLE	38,000
DOC7	060	1035520.00	757585.00	RAD SOIL SAMPLE	70,000
DOC7	061	1035499.00	757475.00	RAD SOIL SAMPLE	49,000
DOC7	062	1035600.00	757437.00	RAD SOIL SAMPLE	40,000
DOC7	063	1035659.00	757365.00	RAD SOIL SAMPLE	35,000
DOC7	064	1035812.00	757260.00	RAD SOIL SAMPLE	40,000
DOC7	065	1035909.00	757145.00	RAD SOIL SAMPLE	90,000
DOC7	066	1036026.00	757027.00	RAD SOIL SAMPLE	55,000
DOC7	067	1036354.00	757143.00	RAD SOIL SAMPLE	38,000
DOC7	068	1036406.00	757174.00	RAD SOIL SAMPLE	114,000
DOC7	069	1035301.13	757657.33	DEPTH RAD SOIL SAMPLES	< 10,000
DOC7	070	1035230.92	757682.39	DEPTH RAD SOIL SAMPLES	< 10,000
DOC7	071	1035114.37	757680.88	DEPTH RAD SOIL SAMPLES	9,600
DOC7	072	1034845.03	757794.66	DEPTH RAD SOIL SAMPLES	20,000
DOC7	073	1034628.81	757977.97	DEPTH RAD SOIL SAMPLES	12,000
DOC7	074	1034457.06	758080.21	DEPTH RAD SOIL SAMPLES	11,400
DOC7	087	1041089.38	754818.80	RAD SOIL SAMPLE	18,000
DOC7	088	1041054.15	754797.26	RAD SOIL SAMPLE	18,000
DOC7	089	1040975.85	754861.57	RAD SOIL SAMPLE	30,000
DOC7	090	1040959.97	754943.71	RAD SOIL SAMPLE	60,000
DOC7	091	1040782.18	755161.92	RAD SOIL SAMPLE	30,000

TABLE 3-1 Soil Sampling Locations, Sample Identification, and Location Coordinates (Continued)

VP	SAMPLE ID[a]	NORTHING	EASTING	SAMPLE TYPE	NAI SCANNING METER RESULTS (COUNTS PER MINUTE)
DOC7	092	1040494.37	755112.35	RAD SOIL SAMPLE	98,000
DOC7	093	1040418.97	755137.43	RAD SOIL SAMPLE	530,000
DOC7	094	1040344.58	755114.62	RAD SOIL SAMPLE	60,000
DOC7	095	1039968.02	755582.56	RAD SOIL SAMPLE	32,000
DOC7	096	1039961.80	755600.26	RAD SOIL SAMPLE	30,000
DOC7	097	1039944.60	755605.43	Previously sampled (SO-495006)	ns
DOC7	097.1	1039401.29	756232.28	Previously sampled (SO-495010)	ns
DOC7	098	1039128.80	756370.82	RAD SOIL SAMPLE	148,000
DOC7	099	1038993.20	756386.78	RAD SOIL SAMPLE	40,000
DOC7	101	1038930.57	756329.84	Previously sampled (SO-495132)	ns
DOC7	101.1	1038890.00	756324.73	RAD SOIL SAMPLE	102,000
DOC7	102	1038662.05	756380.58	RAD SOIL SAMPLE	26,000
DOC7	102.1	1038214.90	756243.47	RAD SOIL SAMPLE	80,000
DOC7	103	1038142.50	756285.63	RAD SOIL SAMPLE	35,000
DOC7	104(A)[c]	1038143.81	756322.18	RAD SOIL SAMPLE	47,000
DOC7	104D	1038275	756275	Depth Rad Sample	ns
DOC7	104E	1038152	756307	Depth Rad Sample	ns
DOC7	104F	1038150	756326	Depth Rad Sample	ns
DOC7	104G	1038127	756373	Depth Rad Sample	ns
DOC7	105	1038103.49	756338.26	RAD SOIL SAMPLE	57,000
DOC7	106	1038113.03	756388.96	RAD SOIL SAMPLE	65,000
DOC7	107	1037438.35	756567.22	RAD SOIL SAMPLE	47,000
DOC7	108	1037326.75	756684.69	RAD SOIL SAMPLE	51,000
DOC7	108.1	1037075.61	756991.60	RAD SOIL SAMPLE	40,000

TABLE 3-1 Soil Sampling Locations, Sample Identification, and Location Coordinates (Continued)

VP	SAMPLE ID[a]	NORTHING	EASTING	SAMPLE TYPE	NAI SCANNING METER RESULTS (COUNTS PER MINUTE)
DOC7	110	1036978.57	757064.69	RAD SOIL SAMPLE	23,000
DOC7	110.1	1036867.08	757163.40	RAD SOIL SAMPLE	26,000
DOC7	111	1036837.77	757150.45	RAD SOIL SAMPLE	48,000
DOC7	112	1036859.83	757197.61	RAD SOIL SAMPLE	47,000
DOC7	113	1036809.34	757219.82	RAD SOIL SAMPLE	85,000
DOC7	114	1036782.10	757318.82	RAD SOIL SAMPLE	40,000
DOC7	115	1036712.74	757290.81	RAD SOIL SAMPLE	55,000
DOC7	116	1036667.65	757288.07	RAD SOIL SAMPLE	110,000
DOC7	117	1036629.22	757133.16	RAD SOIL SAMPLE	46,000
DOC7	118	1035974.72	757080.29	RAD SOIL SAMPLE	80,000
DOC7	119	1035740.00	757345.54	RAD SOIL SAMPLE	34,000
DOC7	120	1035696.44	757360.88	RAD SOIL SAMPLE	76,000
DOC7	121	1035861.04	757625.39	RAD SOIL SAMPLE	167,000
DOC7	122	1035129.57	757632.98	RAD SOIL SAMPLE	34,000
DOC7	123	1035049.05	757626.79	RAD SOIL SAMPLE	255,000
DOC7	124	1034810.67	757855.06	RAD SOIL SAMPLE	72,000
DA4	133	1040990.00	755003.00	PCB SOIL SAMPLE (Rad sample SO-495002)	na
DA4	134	1040870.00	755158.00	PCB SOIL SAMPLE (Rad sample SO-495003)	na
DA4	135	1040609.00	755118.00	PCB SOIL SAMPLE (Rad sample SO-495004)	na
DA4	136	1040419.00	755136.00	PCB SOIL SAMPLE (Rad sample SO-495006)	na
DOC7	137	1038110.00	756434.00	PCB SOIL SAMPLE (Rad sample SO-495025)	na
DOC7	138	1036613.00	757275.00	PCB SOIL SAMPLE (Rad sample SO-495027)	na

TABLE 3-1 Soil Sampling Locations, Sample Identification, and Location Coordinates (Continued)

VP	SAMPLE ID[a]	NORTHING	EASTING	SAMPLE TYPE	NAI SCANNING METER RESULTS (COUNTS PER MINUTE)
DOC7	139	1035625.00	757400.00	PCB SOIL SAMPLE (Rad sample SO-495028)	ns
DOC7	140	1039383.03	756224.29	TRENCH SOIL SAMPLE	ns
DOC7	141	1039003.15	756387.67	TRENCH SOIL SAMPLE	35,000
DOC7	142	1038689.26	756376.46	TRENCH SOIL SAMPLE	ns
DOC7	143	1037277.85	756678.96	TRENCH SOIL SAMPLE	< 10,000
DOC7	144	1037114.07	756868.24	TRENCH SOIL SAMPLE	< 10,000
DOC7	145	1036829.79	757192.70	TRENCH SOIL SAMPLE	< 10,000
DOC7	146	1036730.46	757284.24	TRENCH SOIL SAMPLE	ns
DOC7	147	1036233.94	767119.30	TRENCH SOIL SAMPLE	ns
DOC7	148	1036021.03	757081.80	TRENCH SOIL SAMPLE	ns
DOC7	149A	1035797.65	757293.24	TRENCH SOIL SAMPLE	ns
DOC7	149D	1035696	757358	Depth Rad Sample	ns
DOC7	149E	1035689	757349	Depth Rad Sample	ns
DOC7	150	1035663.27	757336.33	TRENCH SOIL SAMPLE	ns
DOC7	151	1035367.34	757642.81	TRENCH SOIL SAMPLE	ns
DOC7	152	1035284.33	757661.81	TRENCH SOIL SAMPLE	ns
DOC7	153	1035154.51	757664.63	TRENCH SOIL SAMPLE	26,000
DOC7	154	1034944.08	757742.89	TRENCH SOIL SAMPLE	< 10,000

(a) Sample identification number has prefix of SO-495; ex. SO-495001.
(b) Coordinate locations are estimated based on field notes.
(c) No 104-B or 104-C sample taken.

Random surface scans were conducted at a few locations where sampling personnel measured elevated readings. These locations are also listed in Table 3-1 but were not designated to be sampled according to the *Sampling Plan* (Ref. 2).

The results of surface radiological scans show that at Vicinity Property DA4, meter readings ranged from 8,000 cpm (background) to 131,000 cpm. At DOC7, meter readings ranged from 8,000 cpm (background) to 210,000 cpm. Instrument readings measure gamma flux; therefore, the geometry of the source as well as the type of radiological isotopes present directly influence the instrument response. As a result, while a gamma survey may indicate possible areas of radiological contamination, soil sampling is necessary to provide quantitative interpretation of the survey results. Additionally, thorium concentrations need to be confirmed by soil sampling as gamma/beta emitters.

3.3 Soil Sampling

Surface and subsurface soil samples were taken during each sampling event for radiological parameters U-238, Ra-226, Ra-228, and Th-230. Details of each sampling are provided in the sampling plans (Appendix B and Ref. 3). All soil sampling locations from all events are shown in Figure 3-2 and are listed with topographical coordinates in Table 3-1.

In April, sampling locations were selected from locations previously identified as elevated by ORAU. In addition, several locations where no elevated concentrations were found by ORAU were selected as random sampling locations. No random samples were collected at meter locations DOC7 100, R; 1300, 2L; or 1700, 1R, as designated in the sampling plan (Appendix B). A random sample was taken at the 2,550 m (Katy Trail) location during this April event. Soil samples were also taken from several locations and analyzed for PCBs and metals (Table 3-1). These samples will determine whether chemical compounds are collocated.

Soil samples taken in July 1995 were randomly selected based on the meter interval location of the drainage. These samples were taken from the lowermost portion of the drainage, within 870 m of the Katy trail. A walkover survey was also conducted that identified 11 additional locations that contained above-background meter readings. Surface and subsurface soil samples were collected in these areas. A random sample was not taken at 1,680 m, as proposed by the sampling plan (Appendix B). These sample locations are also shown in Figure 3-2 and Table 3-1.

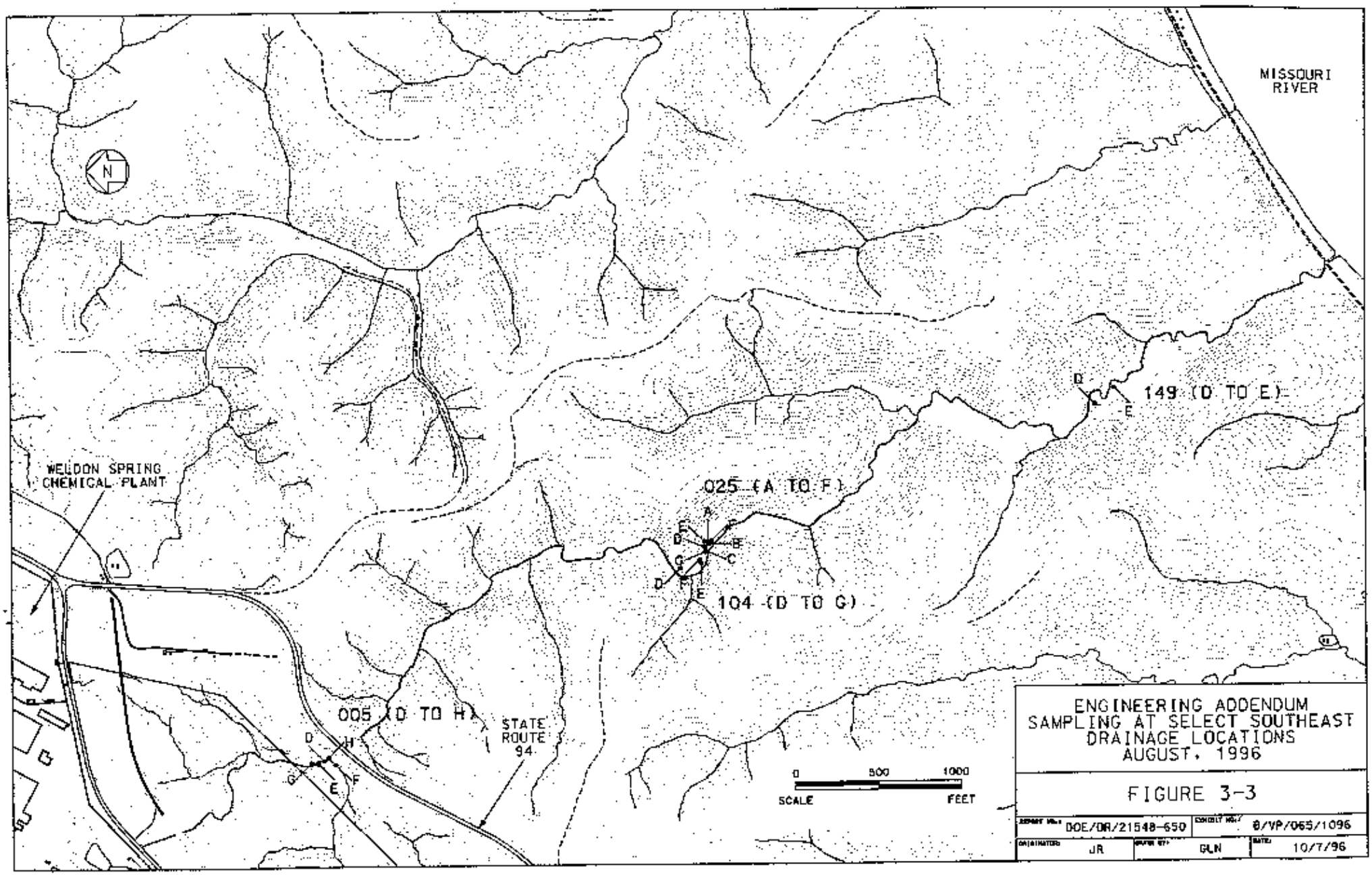
Soil samples taken in August 1995 were also randomly selected within the drainage and identified as SO-495149 to SO-495154. Six locations were selected, again from the lowermost

portion of the drainage within 870 m of the Katy Trail, and locations were selected from evenly spaced locations between Spring 5304 (Table 3-1 and Figure 3-2) and the Katy trail.

Soils were also sampled at seven locations in December 1995 to confirm polychlorinated biphenyl (PCB) concentrations found in composite soil samples taken in April 1995 and identified at Sample IDs SO-495133 to SO-495139. Location SO-495025 was resampled in August 1996 to confirm PCB data results from December 1995 sampling. The sample ID for PCB sampling for this location was SO-495137. Sediment samples from four spring locations and analyzed for nitroaromatics are identified as SD-2531 to SD-2534. Coordinates and sample IDs for these locations are recorded in Table 3-1.

The fifteen areas identified in photo search as potential stream meander locations were excavated, and soil was sampled at varying depths for radionuclides (Sites 140 through 154). In general, trench samples were collected every six inches up to three feet, after which samples were taken at one-foot intervals. Samples were collected until either: (1) groundwater was encountered, (2) bedrock was encountered, or (3) a significant gravel region (vertical) was encountered. Locations and coordinates of the trench sampling locations are shown in Table 3-1 and Figure 3-2. Results from the trench sampling are reported in Table A-1.

The August 1996 sampling was conducted to determine the lateral and vertical extent of radiological compounds at three locations where soil volume estimates were calculated to be greater than 50 cu yds. At each location, 005, 025, and 104, the immediate area was scanned to define an area above background levels. At the outer limits of the scanned areas, five soil samples were collected. These locations are shown in Figure 3-3 and are identified as Subsamples D,E,F, etc. At each subsample location, samples were taken at 6 in. intervals to define the vertical boundary. A drill rig was used to collect samples to depths of 52 in. Soil samples were also taken at one additional location, 149, due to the presence of elevated Ra-226 at a depth of 3 ft.



ENGINEERING ADDENDUM
SAMPLING AT SELECT SOUTHEAST DRAINAGE LOCATIONS
AUGUST, 1996

FIGURE 3-3

REPORT NO.:	DOE/OR/21548-650	CONTRACT NO.:	8/VP/065/1096
ORIGINATOR:	JR	REVIEW BY:	GLN
		DATE:	10/7/96

Each soil sampling location was identified by a 3-digit number that was assigned sequentially i.e., 001, 002, 003. Sample identification numbers were assigned as SO-495xxx-MMDDYY-zz (where SO-495 indicates a soil sample taken in a vicinity property in 1995; xxx indicates the sampling location number; MMDDYY is the sampling date; and zz indicates the sampling depth as 0 in. to 6 in. [01] or 6 in. to 12 in. [02] 12-18 in. [03], 18-24 in. [04], 24-30 in. [05]). Multiple samples taken at a location are identified using the suffix A, B, C, etc.

The following sample numbers correspond to specific sampling periods:

- April 1995 ORAU review: SO-495001 through SO-495031 and SO-495132 (013-015 and 022-024, and 029 and 031 are chemical sample IDs).
- July 1995 Segment D: SO-495049 through SO-495068.
- August 1995 Depth Samples by Drilling: SO-495069 through SO-495074.
- December 1995 Engineering Characterization: SO-495087 through SO-495108.1 and SO-495110 through SO-495124, SC-495133 through SO-495139 (PCB samples); and SO-495140 through SO-495154 (trench samples).
- August 1996 Engineering Characterization: Sampling at Locations SO-495005, SO-495025, SO-495104, and SO-495149 for radiological sampling at various adjacent locations. Identified as B, C, D, etc. Resampling for PCBs at SO-495137.

A minimum of one surface soil sample from a depth of 0 in. to 6 in. was taken at each location. Subsurface soil samples were taken from a depth of 6 in. to 12 in., if large gravel or bedrock were not encountered. Additional subsurface soil samples were also taken from several locations in August 1995, December 1995, and August 1996. In general, sample depths in the upper portions of the drainage did not exceed 12 in. due to auger refusal. In the lower portion of the drainage, soil samples taken specifically for depth analysis exceeded 30 inches in depth. If location scanned was larger than 25 ft x 25 ft, a minimum of three soil samples were taken for radiological analysis. This was the case at Meter Location 65 at DOC7, where multiple soil

samples are indicated in Table A-2 by the suffixes A, B, and C. In August 1996, five samples were taken at four locations and the Suffixes A, B, C, D, etc., were also used to identify adjacent sample locations. Soil samples were analyzed for U-238, Ra-226, and Ra-228 using gamma spectrometry and for Th-230 using alpha spectrometry. They are summarized in Section 3.3.1.

3.3.1 Radiological Data Results

The results of the radiological analyses of soil samples collected from the Southeast Drainage in 1995 and 1996 are summarized in Table 3-2 and detailed in Table A-1 of Appendix A. The random samples taken from background areas of the drainage are shown to have lower concentrations of all radionuclides at the specific depth sampled. Random samples were taken at 0 - 6 in. and 6 - 12 in. samples. In general, most locations show higher radiological concentrations at 0 - 6 in. depth, although 25 % of the samples showed higher concentrations of radionuclides at the 6 - 12 in. depth interval. In general, radiological concentrations decreased as soil depth increased, and highly elevated radiological concentrations were limited to 12 in. in depth. At a few locations, samples from depths greater than 12 in. were found to have elevated radiological concentrations primarily for Radium-226.

The range of concentrations resulting from this sampling indicates that (1) elevated concentrations of radiological compounds exist in soils that are generally 12 in. in depth, with a few other locations up to 4 ft in depth, (2) concentrations do appear to be significantly higher than background (and random) concentrations, (3) concentrations are generally less than the concentrations reported by ORAU (Ref. 3 and Ref. 4), and (4) isolated pockets or locations of elevated soils exist throughout the drainage.

Data results from the soil sampling were also reviewed to compare Th-230 concentrations in the drainage to other radionuclide concentrations. Th-230 is an alpha emitting radionuclide and therefore, field survey techniques used for this sampling would not exclusively detect concentrations of Th-230. Based on the known operational processes conducted at the Weldon Spring Chemical Plant, it is quite unlikely that Th-230 would be found in the drainage without other radionuclides. Ra-226, which is an immediate daughter of Th-230 in the decay process, would also be present if Th-230 is present. Ra-226 is a gamma emitter and therefore would also

Table 3-2 Range of Radiological Concentrations (pCi/g) in Soils from the Southeast Drainage

SAMPLE TYPE[a]	DEPTH ID	DEPTH[b]	NUMBER OF SAMPLES	U-238	Ra-226	Ra-228	Th-230
Select	01	0 - 6 in.	122	<0.96 - 741	0.4 - 363	<1.0 - 135	0.27 -7890
Random	01	0 - 6 in.	12	2.89 - 44.2	1.25 - 13.8	0.8 - 4.59	0.18 - 18.2
Select	02	6 - 12 in.	79	0.49 - 536	0.62 - 200	<1.1 - 326	0.58 - 2220 [361[c]]
Random	02	6 - 12 in.	11	<0.9 - 22.6	0.93 - 35.4	0.68 - 1.80	0.47 - 11.2
Select	03	12 - 18 in.	38	0.62 - 153	0.5 - 110	< 0.87 - 14.2	0.62 - 492
Select	04	18 - 24 in.	28	0.94 - 63.9	0.46 - 43.6	0.88 - 57.8 [4.78[(c)]]	0.73 - 286 [34.9[(c)]]
Select	05	24 - 30 in.	24	0.98 - 55.5	0.49 - 53.1	<0.78 - 6.66	0.85 - 38.4
Select	06	30 - 36 in.	11	1.12 - 65.1	0.38 - 47.2	(1.06) - 5.72	0.89 - 13.1
Select	07	3 - 4 ft	6	0.79 - 16.7	0.90 - 66.3	(1.38) - 2.55	0.8 - 6.0
Select	08	4 - 5 ft	2	9.4 - 14.2	0.87 - 1.6	(0.98) - 1.85	0.8 - 1.59
Select	09	5 - 6 ft	1	1.8	1.21	1.58	1.42

Values in parentheses are estimated; values reported below the detection limit.

(a) Select sample types are those that were preselected for sampling or selected based upon elevated radiological scanning results.

(b) Depths are approximate and at lower depths more susceptible to compaction and hole collapse.

(c) Next highest concentration reported in brackets.

be detected by the field scanning techniques used. Ra-226 concentrations from both biased and random (unbiased) sample locations were compared to Th-230 concentrations to review the relationship between these two isotopes. The comparison showed that in no case was Th-230 present when Ra-226 was not also detected above background. Therefore, as a result of this data comparison, the field survey techniques are adequate for detecting elevated radiological soils. Consequently, Th-230 would be represented in these elevated soils and could be quantitatively measured from soil sampling.

Results from the August 1996 sampling to delineate the volume boundaries at four locations found that the radiological concentrations were similar to concentrations previously reported from 1995 sampling. There were five samples that resulted in the highest concentrations (6.66 pCi/g to 285 pCi/g) reported for samples taken at depths of 12 in. to 18 in.; 18 in. to 24 in.; and 24 in. to 30 in. Four of these samples were collected from Location 005 and one sample was collected from Location 104. No samples were previously collected at these locations at these depths. The concentrations found are within the ranges found for the radionuclides overall in soil samples collected at these locations.

3.3.2 Chemical Analytical Results

Soil samples were collected in April for metals, nitroaromatics, PCBs, sulfate, fluoride, and nitrate analyses from 0 in. to 6 in. in depth and composited from three or more meter. locations. No samples for chemical analysis were collected from depths greater than 6 in. In December sampling, individual soil samples at select locations were analyzed for PCBs and sampling for nitroaromatics was performed from four spring locations in December 1995. Results of the chemical sampling are shown in Tables A-2, A-3, and A-4 of Appendix A.

One composite soil sample for nitroaromatics was found with detectable nitroaromatic compounds. Data results were from the composite soil sample taken at three locations within the drainage: (1) at 300 m, (2) 600 m, and (3) 900 m. 2,4-dinitrotoluene was detected just above the detection limit at 0.0023 μg/g, and 1,3-dinitrobenzene was reported as an uncensored data value (below the detection limit) at 0.00036 μg/g. All other samples were below the detection limit. No nitroaromatics were detected in sediments from the four spring locations (Table A-3).

Composite soil samples from the April 1995 sampling showed that two PCB compounds, Aroclor-1254 and Aroclor-1260, were detected in soil samples where highly elevated radiological concentrations were also found (Table A-2). The PCB compounds were detected ranging from 287 μg/kg to 3,860 μg/kg. All other samples were below the detection limit. Resampling of the seven individual locations that made up the two composite samples was conducted in December 1995. Detectable concentrations of Aroclor-1254 ranging from 48 μg/kg to 150,000 μg/kg were found in all seven samples taken for PCBs. No other Aroclor compounds were found above detection limits. Sample results appear in Table A-4. Sample Location SO-495137 (radiological sample Location 025) was resampled in August of 1996 because of the 150,000 μg/g concentration for Aroclor-1254 reported for this location in December sampling. No other locations sampled for PCBs were of concern for resampling. The sample collected in December 1995 was also reanalyzed for PCBs, and a concentration of 130,000 μg/g was reported. Therefore, resampling of Location SO-495137 was proposed and completed in August of 1996. PCB concentrations for the samples re-collected in August of 1996 resulted in PCB concentrations of 3100 μg/kg for Aroclor-1254, which is significantly less than the previously reported concentration. The results of this resampling effort are presented in Table A-5.

Several metal compounds were detected at elevated concentrations in the drainage including barium, chromium, copper, lead, mercury, silver, and zinc (Table A-2). These concentrations were compared to concentrations found for soil taken from random sampling locations. In general, the chemical data results indicated that metals were found to be slightly elevated at the locations where elevated radiological compounds were found and that they decreased in concentration according to the distance from the chemical plant area.

Also, sample results indicated that chemical contaminants will be located in depositional areas of the drainage by becoming suspended with sediments. Radiological compounds are also shown to be located within the drainage in sediment depositional areas. Therefore, the assumption is made that the radiological and chemical compounds, if present in the drainage, will be collocated.

The risk assessment (Ref. 1) conducted for the chemical compounds indicated that the hazard index for chemical compounds is below the unacceptable value of 1.

4 VOLUME ESTIMATE OF CONTAMINATED SOILS

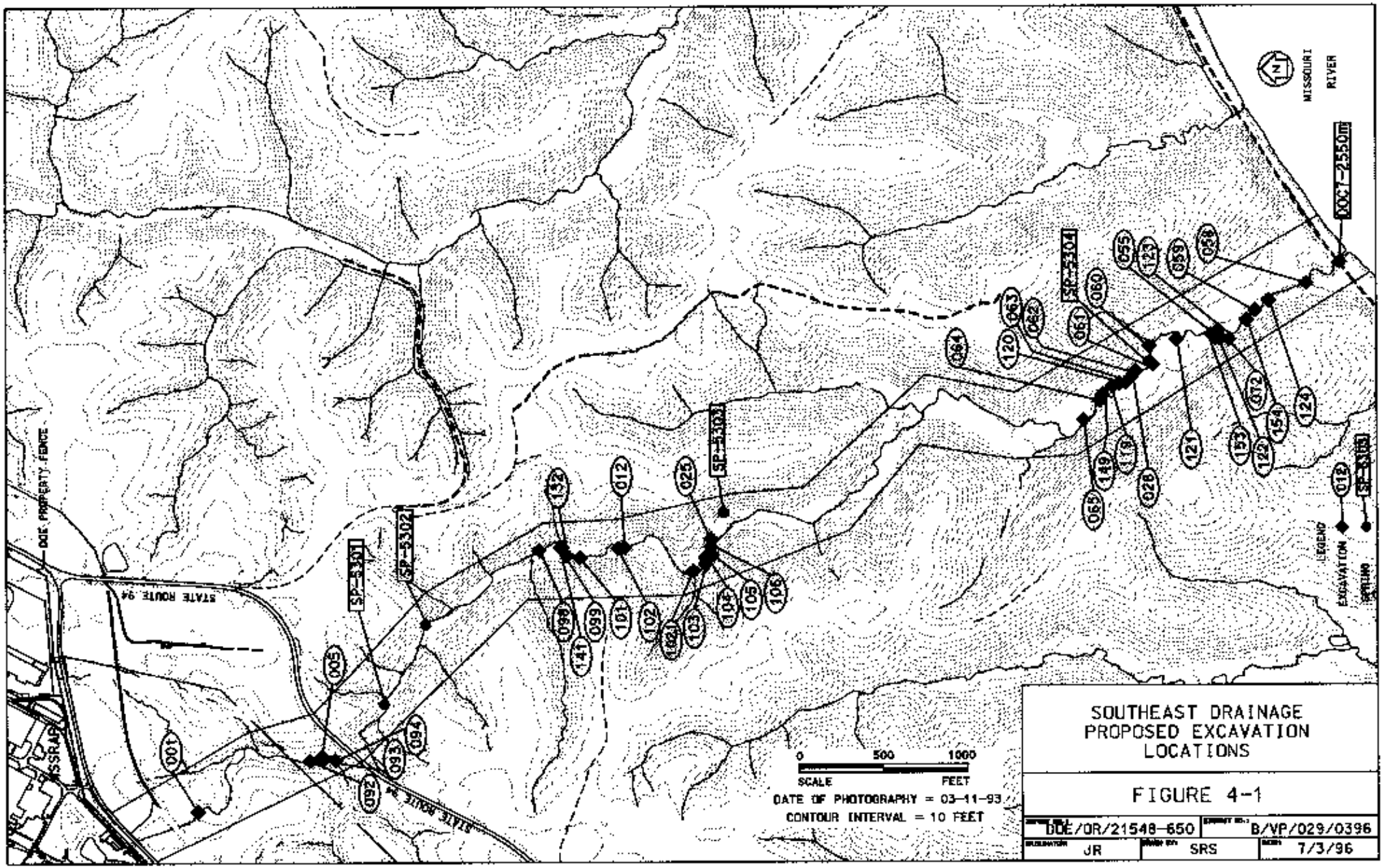
The proposed action for the Southeast Drainage would target selected areas of contamination in the drainage that exceed a risk of 1 x 10^{-4} for a child-use scenario (Ref. 1). These risk-based criteria are the radiological concentrations that relate to a 10^{-4} risk level for a child scenario. These radiological concentrations are presented in Table 4-1. Other contaminated sediments in the proximity of the targeted areas would also be removed to the extent possible and will be defined more specifically in engineering design specifications for remediation. The selected areas include those that are above a risk level of 10^{-5} for a child-use scenario (Ref. 1). Table 4-1 also designates the radiological concentrations that relate to a 10^{-5} risk level.

TABLE 4-1 Southeast Drainage Risk-Based Cleanup Levels

	CONCENTRATION (pCi/g)	
CONTAMINANT	10^{-4}	10^{-5}
U-238	2900	290
Ra-226	130	13
Ra-228	130	13
Th-230	3500	350

The concentrations shown in Table 4-1 were compared to the radiological data results from soil sampling (Table A-1). A list of the locations where concentrations on any radionuclide exceeded the risk-based criteria is shown in Table 4-2. A total of seven locations had one or more radionuclide that exceeded the 10^{-4} criteria. The primary radionuclide that was exceeded at the majority of the locations was Ra-226. Adjoining locations selected for proposed removal are above the 10^{-5} criteria shown in Table 4-2. A total of 31 additional locations are proposed for soil removal (Figure 4-1).

The estimated volume of each location designated in Table 4-2 was calculated based on an estimated horizontal and vertical extent as defined by walkover surveys. The lateral boundaries were established as exceeding 1.5 times background gamma activity and the vertical


MISSOURI RIVER
DOC7-2550m
SP-5304
SP-5303
SP-5302
SP-5301
DOE PROPERTY FENCE
STATE ROUTE 94
LEGEND
EXCAVATION
SPRING
0 500 1000
SCALE FEET
DATE OF PHOTOGRAPHY = 03-11-93
CONTOUR INTERVAL = 10 FEET
SOUTHEAST DRAINAGE
PROPOSED EXCAVATION
LOCATIONS
FIGURE 4-1
DOE/OR/21548-650
B/VP/029/0396
JR
SRS
7/3/96

boundary as the depth to either groundwater or bedrock. Since soil sampling was the only means used to determine actual depth to groundwater or bedrock, excavation depth was assumed to be 3 ft in cases where soil sampling did not reach groundwater or bedrock. Based on available data for depth to groundwater/bedrock in the SED, 3 ft is considered a conservative depth estimate.

The volume estimate for each area exceeding the risk-based concentrations is shown in Table 4-3. The sample number corresponding to each area can be located on Figure 4-1. Table 4-3 summarizes the volume estimates by drainage segment (Segments A through D). Segments A through D were defined through scoping activities and in the EE/CA (Ref. 1) to support remedial decisions based upon public use, equipment accessibility, environmental impacts, and cost.

Volume estimates are conservative since the assumption of 3 ft total excavation depth is conservative because observation and existing data indicate that the depth to bedrock or groundwater in much of the drainage is only 6 in. to 2 ft below the surface.

Table 4-2 Soil Locations Exceeding Risk-Based Standards[a] and Adjoining Soil Location Proposed for Additional Removal

SEGMENT	RATIONALE FOR CLEANUP	LOCATION ID	GAMMA RESULTS	DEPTH ID**	U-238	TH-230	RA-226	RA-228
A	10-4	001	131,000	01A			165.0	15.1
				01B			18.2	
				02A			21.1	
A	10-4	005	60,000	01A				96.6
				01B		431	23.3	28.8
				01C			17.3	135.0
				02A			19.3	288.0
				02B	291		18.8	326.0
				02C				94.5
				01D			22.9	59.7
				02D			20.5	26
				03D			23.6	
				03E		492	21.1	
				03F			17	
				03H			21.5	
				04F			37.3	
				04H			43.6	57.8

Table 4-2 Soil Locations Exceeding Risk-Based Standards[a] and Adjoining Soil Location Proposed for Additional Removal (Continued)

SEGMENT	RATIONALE FOR CLEANUP	LOCATION ID	GAMMA RESULTS	DEPTH ID**	U-238	TH-230	RA-226	RA-228
A	adjoining	092	98,000	01			27.6	
				02			16.9	
A	adjoining	093	530,000	01			19.1	
				02			15.5	
A	adjoining	094	60,000	02			15.2	
B/C	adjoining	012	20,000	01			42.2	
B/C	10-4	025	210,000	01A	741.0	384.0	363.0	
				02A	536.0		200.0	
				01D			46.2	
				01B			25.5	
				02D			15.3	
B/C	10-4	098	148,000	01		4940.0	177.0	
B/C	adjoining	099	40,000	01			51.1	
				02			59.6	
				03			47.3	
B/C	10-4	101	102,000	01		625.0	259.0	18.8
				02		2220.0	80.3	
B/C	adjoining	102		01	17.1	31.3	19.0	3.1
B/C	adjoining	102.1	80,000	01		384.0	106.0	
				02		358.0	58.6	
B/C	adjoining	103	35,000	01	331.0		32.9	
				02	326.0		18.1	
B/C	10-4	104	47,000	01			183.0	
				02			102.0	
				03			63.1	
				01D			46.2	
				02D			15.3	
B/C	adjoining	105	57,000	01			26.2	
B/C	adjoining	106	65,000	01			63.2	
B/C	adjoining	132	62,00	01			78.5	
				02		1640.0	125.0	
B/C	adjoining	141	na	01			63.8	
D	adjoining	028	30,000	01			36.9	
D	adjoining	055	28,000	01			17.9	
				02			15.7	
D	adjoining	058	40,000	01			78.3	
				02			31.1	
D	adjoining	059	38,000	01			54.2	
D	adjoining	060	70,000	02			123.0	
D	adjoining	061	49,000	01			75.7	
D	adjoining	062	40,000	01			14.0	
D	adjoining	063	35,000	01			48.2	
D	adjoining	064	40,000	01			20.5	
D	adjoining	065	90,000	01			17.5	16.1
				02			60.8	21.8
D	adjoining	072	20,000	01			32.9	

Table 4-2 Soil Locations Exceeding Risk-Based Standards[a] and Adjoining Soil Location Proposed for Additional Removal (Continued)

SEGMENT	RATIONALE FOR CLEANUP	LOCATION ID	GAMMA RESULTS	DEPTH ID**	U-238	TH-230	RA-226	RA-228
D	adjoining	119	34,000	01			18.9	
				02			21.6	
D	adjoining	120	76,000	01			77.2	
				02			124.0	
D	adjoining	121	167,000	01			16.5	
				02			19.6	
				03			13.0	
				04			25.3	
				05			53.1	
D	adjoining	122	34,000	01	15.1	42.8	35.0	3.1
D	adjoining	123	255,000	01			14.8	
				02			40.3	
				03			96.5	14.2
D	10-4	124	72,000	01		7890.0	163.0	
				02			51.2	
D	adjoining	149	na	01A			15.3	
				06A			47.2	
				07A			66.3	
				01D			16.4	
D	adjoining	153	NA	01			21.1	
				06			46.1	
D	adjoining	154	NA	01			14.8	

During the soil characterization activities of 1995, several samples were collected where areal extents overlapped with the lateral extent of another previously collected sample. As a result, the areal extent of elevated readings obtained during the December walkover (gamma) survey was used for volume estimation. The reason for this approach is that the 1.5 time background criteria of the engineering characterization survey is more restrictive than the 2 times background criteria of the SRS, and therefore larger areas were defined. Also, some sample data were eliminated from use in defining areas for remediation since they were co-located with other representative samples from the same area. Sample Number SO-495099 and Trench Sample Number SO-495141 were collected in the same vicinity (within 10 ft). Since the volume defined by SO-495141 is contained entirely within the volume defined by SO-495099, only the volume for SO-495099 is used to avoid duplication. Similarly, the volume defined by Sample SO-495122 is contained entirely within the contaminated area for SO-495072, so only the

Table 4-3 Dimensions and Excavation Volumes for Locations Exceeding Risk-Based Criteria

LOCATION ID	APPROX. DIMENSIONS (FEET BY FEET)		AREA (SQUARE FEET)	DEPTH (FEET)	VOLUME (CUBIC YARDS)	SEGMENT TOTAL VOLUME (cu yd)
001	5	20	100	2	7.4	
092	6	20	120	1	4.4	
005	41	104	2132[a]	2	157.9	
093	2	16	32	3	3.6	Segment A
094	5	25	125	3	13.9	187
098	3	80	240	3	26.7	
141	3	5	15	3	1.7	
099	16	16	256	3	28.4	
132	6	60	360	3	40.0	
101	2	2	4	3	0.4	
102	3	7	21	3	2.3	
012	2	2	4	3	0.4	
102.1	2	6	12	3	1.3	
103	8	20	160	2	11.9	
104	6.3	127	694[a]	1.5	44.2	
105	4	60	240	3	26.7	Segment B/C
106	25	65	1625	3	180.6	
025	23	60	1380	2	102.2	555
065	4	30	120	2	8.9	
064	30	30	900	2	66.7	
149	3	5	15	3	1.7	
063	15	40	600	0.5	11.1	
119	50	50	2500	3	277.8	
028	5	5	25	2	1.9	
120	20	30	600	3	66.7	
062	2	2	4	2	0.3	
061	6	45	270	3.5	35.0	

Table 4-3 Dimensions and Excavation Volumes for Locations Exceeding Risk-Based Criteria (Continued)

LOCATION ID	APPROX. DIMENSIONS (FEET BY FEET)		AREA (SQUARE FEET)	DEPTH (FEET)	VOLUME (CUBIC YARDS)	SEGMENT TOTAL VOLUME (cu yd)
060	10	50	500	1	18.5	
121	4	7	28	3	3.1	
153	3	5	15	3	1.7	
122	15	40	600	0.5	11.1	
055	2	2	4	2	0.3	
072	21	75	1575	0.5	29.2	
123	3	25	75	1.5	4.2	
154	3	5	15	3	1.7	
059	1	20	20	2	1.5	Segment D
124	6	20	120	3	13.3	466.6
058	2	2	4	2	0.3	
TOTALS FOR THE SOUTHEAST DRAINAGE					1209	

(a) Area of contamination is not square in shape.

volume for SO-495072 is used. Table 4-4 identifies sample locations that fall within another area above 1.5 times background gamma radiation levels.

Resampling at four locations (005, 025, 104, and 149) for defining the lateral and vertical extent resulted in a reestimate of soil volumes (Table 4-3) previously calculated for each location. Previously, a depth of 4 ft was used to calculate soil volumes at Location 005, but this has been modified to 2 ft based on the results of the resampling. The lateral boundaries increased from 18 ft by 80 ft to 41 ft by 104 ft, resulting in an overall reduction in volume estimate to 157.9 cu yd for Location 005. At Location 025, the depth of 2 ft for soil removal was confirmed, but the lateral extent was reduced to 23 ft by 60 ft for a total volume estimate of 102 cu yd. At Location 104, the depth was reestimated to be 1.5 ft for depth, and the lateral extent was modified from 30 ft by 70 ft to 6.3 ft x 127 ft, for a total soil volume reduction to 44.2 cu yd. No decrease in depth was found for Location 149, and therefore, volume estimates remain the same.

As reflected in Table 4-3, the total volume of soil to be excavated from areas in the Southeast Drainage that exceed the cleanup criteria is approximately 1,209 cu yds. Approximately 187 cu yds will come from Segment A, 555 cu yds from Segment B and Segment C, and about 467 cu yds from Segment D. Table 4-3 shows approximate lateral extent and volume estimates for areas to be excavated.

5 SUMMARY

- Radiologically elevated soils (greater than 1.5 times background levels) are found in small isolated areas throughout the Southeast Drainage. Primarily, these soils are found in depositional areas of the main drainage and are bound to fine sediments.

- Radiological concentrations are lower than those previously reported by QRAU in 1985. This is assumed to be a result of natural flushing of elevated sediments in the drainage.

- Elevated concentrations of radionuclides in soils are not confined to the first 6 in. of soil deposited within the Southeast Drainage. In general, the highest radiological concentrations occur at the 0 in. to 6 in. depth in soils, although 25% of samples actually have higher concentrations at the lower depths. A few locations have elevated levels to 4 ft in depth.

- Ra-226 and Th-230 have been detected in soil samples collected from the drainage. In no case was Th-230 present when Ra-226 was not also detected above background. Therefore, the field scanning techniques used were adequate to detect radiologically elevated locations and do include representative Th-230 soils.

- Chemical compounds, if present, are found to be collocated with radiological compounds in depositional areas of the drainage.

- Metals were not found to be highly elevated in the drainage.

- No nitroaromatics compounds were detected in sediments collected at spring locations.

- Aroclor-1254 was detected in several soil samples ranging from 48 μg/kg to 150,000 μg/kg. Resampling was conducted on the location that reported the highest concentration, and PCB concentrations reported were 3,100 μg/kg. This

location (025) will be remediated for radiological compounds. No elevated risk from PCB was calculated for this location.

- Seven locations were identified for soil removal based upon 10^{-4} risk-based criteria developed for the drainage (Ref. 1), and an additional 31 locations were recommended for removal to 10^{-5} risk levels

- An estimated volume of 1,209 cu yds of soil will require removal.

6 REFERENCES

1. Argonne National Laboratory. *Engineering Evaluation/Cost Analysis for the Proposed Removal Action at the Southeast Drainage Near the Weldon Spring Site, Weldon Spring, Missouri*. DOE/OR/21548-584. Prepared for the U. S. Department of Energy, Weldon Spring Site Remedial Action Project. Weldon Spring, MO. October 1995.

2. MK-Ferguson Company and Jacobs Engineering Group. *Engineering Sampling Plan to Identify Areas for Remediation in the Southeast Drainage (Vicinity Properties DA4 and DOC7)* Rev. 0. DOE/OR/21548-582. Prepared for the U. S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO. 1995.

3. Deming, E.J. *Radiological Survey U.S. Army Reserve Property Weldon Spring Site, St. Charles County, Missouri*, Final Report. Prepared for U.S. Department of Energy, Division of Remedial Action Projects, by Oak Ridge Associated Universities. January 1986.

4. Boerner, A.J. *Radiological Survey of the August A. Busch and Weldon Spring Wildlife Areas Weldon Spring Site, St. Charles County, Missouri*, Final Report. Prepared by Oak Ridge Associated Universities, for U.S. Department of Energy, Division of Remedial Action Projects. April 1986.

5. MK-Ferguson Company and Jacobs Engineering Group. *Engineering Sampling Plan to Identify Areas for Remediation in the Southeast Drainage (Vicinity Properties DA-4 and DOC-7)*. Rev. 0. DOE/OR/21548-582. Prepared for the U. S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO. November 1995.

PROCEDURES

ES&H 1.1.4, *Logbook Procedures*
ES&H 2.5.5, *Sample Preparation for Radiological Soil Samples*
ES&H 2.6.2, *Calibration and Use of Ludlum Model 44-10 (2x2 Sodium Iodide) Detector*
ES&H 2.6.9, *Instructions for Calibration and Operation of High Purity Germanium Detector*
ES&H 4.1.1, *Numbering System for Environmental Samples and Sampling Locations*
ES&H 4.1.2, *Initiation, Generation, and Transfer of Environmental Custody*
ES&H 4.4.5, *Soil/Sediment Sampling*
ES&H 4.9.2, *Environmental Monitoring Data Validation*
ES&H 4.9.3, *Data Review Procedure for Surface Water, Groundwater, and Soils*
SQP-7, *Quality Assurance Records*

APPENDIX A
Soil Data Results

TABLE A-1 Radiological Data Results from the Soil Sampling, Southeast Drainage, 1995

VICINITY PROPERTY	INTERVAL, TRAVERSE[a]	SAMPLE ID SO-495XXX	DEPTH	SPECTROSCOPY RESULTS (pCi/g)			
				U-238	R-226	R-228	TH-230
DA4	10,C	001	01A	241	165	15.1	58.6
			02A	167	21.1	3.4	40.7
			01B	78.7	18.2	3.9	4.2
DA4	100, R [b]	018	01	16.2	1.3	0.8	0.18
DA4	130,1L	002	01	143	39.7	8.1	23
			02	93.8	37.4	2.0	6.5
DA4	190,4R	003	01	328	60.5	1.4	30.4
			02	84.5	17.2	1.4	32.4
DA4	225, L [b]	017	01	14.7	13.8	1.4	2.4
			02	14.6	7.5	1.3	0.5
DA4	305,1R	004	01	35.5	8.5	1.8	4.0
			02	64.4	25.8	3.6	18.7
DOC7	13, C	016	01	17.6	5.1	1.3	4.42
			02	15.7	9.0	1.6	23.1
DOC7	65, C	005 (A,B,C)	01A	83.1	11.9	96.6	57.5
			02A	244	19.3	288	87.1
			01B	67.6	23.3	28.8	431
			02B	291	18.8	326	158
			01C	235	17.3	135	208
			02C	177	6.1	94.5	50.1
DOC7	65	005 D	01	59.8	22.9	59.7	46
			02	51.7	20.5	26	29.3
			03	25.8	23.6	4.32	3.4
			04	21.5	9.21	4.07	3.62
			05	12.5	1.58	1.93	2.13

TABLE A-1 Radiological Data Results from the Soil Sampling, Southeast Drainage (Continued)

VICINITY PROPERTY	INTERVAL, TRAVERSE[a]	SAMPLE ID SO-496XXX	DEPTH	SPECTROSCOPY RESULTS (pCi/g)			
				U-238	R-226	R-228	TH-230
			06	6.68	0.98	1.87	0.95
DOC7	65	005 E	01	28.8	5.26	2.22	18.6
			02	25.1	6.02	2.18	21.5
			03	60	21.1	7.99	492
			04	25.7	4.12	2.6	9.15
			05	49.6	4.23	2.55	32.5
			06	65.1	2.56	1.4	13.1
DOC7	65	005 F	01	26.1	5.8	2.96	16.5
			02	26.7	4.25	8.75	38.4
			03	37	17	4.51	337
			04	39.1	37.3	3.2	285
			05	52.8	1.56	(1.19)	6.6
DOC7	65	005 G	01	8.52	1.67	1.52	3.69
			02	6.44	1.49	(1.23)	4.06
			03	4.53	1.51	2.75	5.39
			04	1.12	0.81	(1.23)	1.11
			05	1.21	2.04	< 2.85	1.64
			06	1.42	1.02	5.72	1.71
			07	0.79	0.9	(0.70)	0.81
DOC7	65	005 H	01	5	3.13	(1.25)	5.12
			02	12.9	3.18	(4.35)	13.3
			03	33	21.5	11.2	104
			04	63.9	43.6	57.8	34.9
			05	23.6	9.97	6.66	6.11
DOC7	255, 2R	006	01	55.6	25.3	2.8	30.9

TABLE A-1 Radiological Data Results from the Soil Sampling, Southeast Drainage (Continued)

VICINITY PROPERTY	INTERVAL, TRAVERSE[a]	SAMPLE ID SO-495XXX	DEPTH	SPECTROSCOPY RESULTS (pCi/g)			
				U-238	R-226	R-228	TH-230
DOC7	300, 2R [b]	019	01	2.9	1.3	1.0	3.74
			02	12.7	35.4	1.2	11.2
DOC7	365, 3R	007	01	66.8	18.9	6.1	19.5
			02	31.2	5.6	1.8	2.7
DOC7	440, 1L	008	01	17	36	1.5	11.8
DOC7	485, 1L	009	01	58.6	111	1.7	12.7
DOC7	510, 2R	010	01	17.4	20.5	2.2	13.2
DOC7	600, R [b]	020	01	3.0	1.4	1.1	3.32
			02	2.1	0.9	0.7	2.63
DOC7	695, 2L	132	01	74.7	78.5	1.6	227
			02	39.7	125.1	4.5	1640
DOC7	730, 4L	011	01	2.6	1.3	0.7	0.3
DOC7	810, 2L	012	01	52.3	42.2	1.6	12.1
DOC7	900, R[b]	021	01	18.6	2.9	1.1	3.9
			02	9.1	1.4	1.0	1.7
DOC7	1050, 9L	025 A	01	741	363	1.8	384
			02	536	200	1.5	247
DOC7	1050,9L	025B (same location as 025A)	01	97.6	25.5	3.73	293
			02	27.9	2.02	(0. 64)	30.3
DOC7	1050	025 C	01	27.2	3.64	1.75	8.28
			02	12.1	2.02	(2.01)	2.73
			03	14.7	1.4	(0.55)	2.64
			04	2.58	0.46	0.47	1.06
DOC7	1050	025 D	01	31.6	46.2	2.68	72.2
			02	24.5	15.3	3.9	16.3

TABLE A-1 Radiological Data Results from the Soil Sampling, Southeast Drainage (Continued)

VICINITY PROPERTY	INTERVAL, TRAVERSE[a]	SAMPLE ID SO-495XXX	DEPTH	SPECTROSCOPY RESULTS (pCi/g)			
				U-238	R-226	R-228	TH-230
DOC7	1050	025 E	01	10.3	2.53	1.61	9.39
			02	1.07	0.62	1.39	1.29
DOC7	1050	025 F	01	9.3	0.91	(0.15)	1.6
			02	2.13	1.84	2.88	0.58
DOC7	1660, 3R	027	01	129	11.3	35.7	31
			02	27.9	3.0	5.6	6.1
DOC7	1680,3R[c]	049	01	25.7	6.5	1.7	15.1
			02	22.6	4.29	1.3	9.97
DOC7	1710	068	01	124	23.1	85.8	161
DOC7	1730	067	01	145	30.0	3.5	44
DOC7	1750[c]	050	01	5.8	7.8	0.9	7.2
			02	9.7	10.7	1.2	6.5
DOC7	1840	066	01	199	37.9	4.3	225
			02	79.4	19.7	2.4	361
DOC7	1850[c]	051	01	44.2	10.6	4.6	18.2
			02	21.6	5.8	1.8	218
DOC7	1915	065	01	116	17.5	16.1	48.1
			02	278	60.8	21.8	244
DOC7	1935	064	01	60.0	20.5	3.1	65
DOC7	1950[c]	052	01	7.5	2.3	1.6	4.8
			02	3.9	1.5	1.1	3.8
DOC7	2022	063	01	111	48.2	3.3	80.9
DOC7	2030, 4R	028	01	85.9	36.9	8.5	34.1
DOC7	2038	062	01	27.0	14.0	2.3	11.4

TABLE A-1 Radiological Data Results from the Soil Sampling, Southeast Drainage (Continued)

VICINITY PROPERTY	INTERVAL, TRAVERSE[a]	SAMPLE ID SO-495XXX	DEPTH	SPECTROSCOPY RESULTS (pCi/g)			
				U-238	R-226	R-228	TH-230
DOC7	2050[c]	053	01	36.5	9.2	1.4	14
			02	9.9	2.1	1.1	3.9
DOC7	2075	061	01	274	75.7	2.5	106
DOC7	2120	060	01	18.8	6.9	1.3	15.6
			02	30.8	123	1.0	41.1
DOC7	2150[c]	054	01	5.7	3.0	1.3	5.2
			02	<0.9	1.3	1.0	2.95
DOC7	2250[c]	055	01	47.9	17.9	1.6	56
			02	42.8	15.9	1.9	38.8
DOC7	2338	059	01	134.1	54.2	2.5	162
DOC7	2350[c]	056	01	17.4	5.3	1.3	11.5
			02	15.1	2.6	1.4	10.2
DOC7	2440	058	01	124	78.3	4.9	103
			02	38.0	31.1	2.4	25.5
DOC7	2450[c]	057	01	3.6	2.7	1.3	3.84
DOC7	2500, 2R	026	01	10.7	4.5	1.4	7.2
DOC7	Katy[b] TRAIL AREA (approx 2500 m)	030	01	1.6	1.5	1.4	3.6

TABLE A-1 Radiological Data Results from the Soil Sampling, Southeast Drainage (Continued)

VICINITY PROPERTY	INTERVAL, TRAVERSE[a]	SAMPLE ID SO-495XXX	DEPTH	SPECTROSCOPY RESULTS (pCi/g)			
				U-238	R-226	R-228	TH-230
DOC 7	NA	069	01	< 4.99	1.6	1.1	2.7
			02	< 2.94	1.2	1.3	2.8
			03	< 4.50	1.6	1.7	3.2
DOC 7	NA	070	01	9.1	6.0	1.7	19.2
			02	10.9	6.9	1.6	44.7
			03	< 3.37	1.8	1.1	6.1
			04	4.3	1.6	1.4	2.7
			05	4.2	1.5	1.0	3.2
DOC 7	NA	071	01	10.5	3.9	1.4	6.8
			02	< 4.89	1.4	< 1.24	3.4
			03	3.8	1.3	1.2	2.6
			04	5.7	1.0	< 1.11	2.8
			05	< 2.65	0.5	< 0.78	2.4
DOC 7	NA	072	01	72.1	32.9	4.7	52.4
			02	14.7	7.5	1.3	16.8
			03	< 3.85	1.5	1.3	2.8
			04	< 4.86	1.7	< 1.24	2.9
			05	4.4	1.6	0.9	2.9
DOC 7	NA	073	01	< 5.86	2.3	0.9	3.5
			02	2.0	1.3	1.3	2.8
			03	1.7	0.9	0.9	2.7
			04	< 3.12	1.6	0.9	4.0
			05	< 3.60	1.1	< 1.01	3.5

TABLE A-1 Radiological Data Results from the Soil Sampling, Southeast Drainage (Continued)

VICINITY PROPERTY	INTERVAL, TRAVERSE[a]	SAMPLE ID SO-495XXX	DEPTH	SPECTROSCOPY RESULTS (pCi/g)			
				U-238	R-226	R-228	TH-230
DOC 7	NA	074	01	5.5	3.1	1.4	2.7
			02	< 4.24	0.9	< 1.09	2.5
			03	3.7	1.0	< 0.87	2.4
			04	< 3.71	1.1	0.8	2.9
			05	< 3.83	1.6	1.2	2.8
DA 4	NA	087	01	47.3	15.2	0.6	1.3
DA 4	NA	088	01	33.3	14.4	1.3	13.2
			02	51.9	44.7	4.4	15.9
DA 4	NA	089	01	30.9	11.2	1.3	5.1
DA 4	NA	090	01	35.1	22.7	1.3	12.0
			02	61.5	43.1	1.2	16.2
DA 4	NA	091	01	28.4	27.6	2.1	15.2
			02	29.5	16.9	0.3	13.3
DOC 7	NA	092	01	38.0	14.1	1.3	49.4
			02	90.5	34.0	1.6	83.8
DOC 7	NA	093	01	72.4	19.1	10.4	77.0
			02	62.3	15.5	2.8	67.2
DOC 7	NA	094	01	2.4	1.1	0.6	2.4
			02	46.8	15.2	5.8	43.8
DOC 7	NA	095	01	15.6	4.6	1.5	6.8
DOC 7	NA	096	01	26.7	10.6	1.7	12.3
DOC 7	NA	097		PREVIOUSLY SAMPLED (SO-495006)			
DOC 7	NA	097.1		PREVIOUSLY SAMPLED (SO-495010)			

TABLE A-1 Radiological Data Results from the Soil Sampling, Southeast Drainage (Continued)

VICINITY PROPERTY	INTERVAL, TRAVERSE[a]	SAMPLE ID SO-495XXX	DEPTH	SPECTROSCOPY RESULTS (pCi/g)			
				U-238	R-226	R-228	TH-230
DOC 7	NA	098	01	122.0	177.0	3.4	4940.0
DOC 7	NA	099	01	43.5	51.1	6.5	101.0
			02	50.6	59.5	2.0	268.0
			03	23.0	41.4	2.6	150.0
DOC 7	NA	101	01	96.5	259.0	18.8	625.0
			02	32.2	80.3	7.2	2220.0
DOC 7	NA	102	01	17.1	19.0	3.1	31.3
DOC 7	NA	102.1	01	170.0	106.0	6.0	384.0
			02	105.0	58.8	3.6	358.0
DOC 7	NA	103	01	331.0	32.9	3.9	66.5
			02	326.0	18.1	1.8	22.4
DOC 7	NA	104A[d]	01	39.4	183.0	2.9	70.0
			02	30.9	102.0	2.5	60.3
			03	25.4	63.1	2.0	36.3
DOC7	NA	104 D	01	31.6	46.2	2.68	72.2
			02	24.5	15.3	3.9	16.3
			03	8.99	2.14	(1.56)	4.51
			04	1.99	0.58	1.59	1.35
			05	6.07	0.64	(1.37)	1.18
			06	11.6	0.38	(0.86)	0.89
DOC7	NA	104 E	01	10.3	2.53	(1.61)	9.39
			02	1.07	0.62	(1.39)	1.29
			03	1.68	0.47	(1.27)	0.62
			04	18.7	0.45	(0.94)	1.21
			05	35.6	0.94	(0.18)	1.

TABLE A-1 Radiological Data Results from the Soil Sampling, Southeast Drainage (Continued)

VICINITY PROPERTY	INTERVAL, TRAVERSE[a]	SAMPLE ID SO-496XXX	DEPTH	SPECTROSCOPY RESULTS (pCi/g)			
				U-238	R-226	R-228	TH-230
DOC7	NA	104 F	01	24.3	3.3	3.81	16
			02	3.09	1.99	(0.70)	2.76
			03	1.06	1.26	(1.39)	0.97
			04	1.14	0.75	(4.78)	0.73
			05	1.6	0.79	(2.56)	0.85
			06	22.2	1.33	(1.71)	0.9
			07	16.5	0.95	2.48	0.8
			08	14.2	0.87	(0.98)	0.8
DOC7	NA	104 G	01	9.8	3.19	1.13	15.1
			02	1.3	0.89	2.07	1.44
			03	0.	0.62	(0.87)	0.67
			04	7.96	0.57	(0.55)	1.54
			05	12.6	0.61	<1.57	1.21
DOC 7	NA	105	01	34.9	26.2	10.8	20.8
DOC 7	NA	106	01	61.5	63.2	6.0	54.3
DOC 7	NA	107	01	52.4	31.4	1.9	92.9
			02	63.6	39.5	2.4	148.0
DOC 7	NA	108	01	24.6	23.5	0.8	9.6
			02	30.1	22.3	5.7	14.4
			03	25.7	26.3	8.4	23.5
DOC 7	NA	108.1	01	29.1	46.8	2.1	27.4
			02	19.4	23.4	2.5	13.2
DOC 7	NA	110	01	98.0	34.4	2.7	32.1
DOC 7	NA	110.1	01	32.9	16.8	3.0	30.4
			02	43.4	6.2	2.4	13.4

TABLE A-1 Radiological Data Results from the Soil Sampling, Southeast Drainage (Continued)

VICINITY PROPERTY	INTERVAL, TRAVERSE[a]	SAMPLE ID SO-495XXX	DEPTH	SPECTROSCOPY RESULTS (pCi/g)			
				U-238	R-226	R-228	TH-230
DOC 7	NA	111	01	65.1	42.8	6.1	48.3
DOC 7	NA	112	01	55.2	70.4	2.5	1670.0
DOC 7	NA	113	01	35.6	18.4	2.4	29.4
			02	63.2	69.7	5.1	59.4
			03	106.0	10.0	1.3	78.0
DOC 7	NA	114	01	21.7	19.6	3.5	18.2
			02	23.3	24.7	4.3	22.9
DOC 7	NA	115	01	47.1	56.5	2.8	36.1
DOC 7	NA	116	01	26.3	14.4	6.0	20.0
			02	42.4	21.4	1.6	25.7
DOC 7	NA	117	01	117.0	98.8	5.8	54.2
DOC 7	NA	118	01	84.5	18.0	2.7	28.5
			02	68.8	19.7	3.1	66.4
DOC 7	NA	119	01	64.5	18.9	4.0	18.9
			02	65.6	21.6	3.3	17.2
DOC 7	NA	120	01	129.0	77.2	8.4	73.2
			02	229.0	124.0	7.7	95.1

TABLE A-1 Radiological Data Results from the Soil Sampling, Southeast Drainage (Continued)

VICINITY PROPERTY	INTERVAL, TRAVERSE[a]	SAMPLE ID SO-495XXX	DEPTH	SPECTROSCOPY RESULTS (pCi/g)			
				U-238	R-226	R-228	TH-230
DOC 7	NA	121	01	15.1	16.5	1.2	10.1
			02	17.9	19.6	2.8	16.5
			03	21.3	13.0	2.4	14.9
			04	40.6	25.3	2.8	33.7
			05	55.5	53.1	3.7	38.4
DOC 7	NA	122	01	15.1	35.0	3.1	42.8
DOC 7	NA	123	01	36.2	14.8	1.1	18.8
			02	68.1	40.3	6.0	60.7
			03	153.0	96.5	14.2	121.0
DOC 7	NA	124	01	130.0	163.0	5.5	7890.0
			02	68.7	51.2	3.0	230.0
			03	29.7	<0.9	2.1	30.9
DOC 7	N/A	140	01	1.1	0.9	2.2	1.3
			02	1.1	1.1	1.9	1.9
			03	1.1	0.7	2.0	2.0
			04	1.2	1.3	1.3	1.2
			05	1.0	1.2	1.1	1.4
DOC 7	N/A	141	01	22.4	63.8	1.2	28.6
			02	19.4	21.8	1.8	28.4
DOC 7	N/A	142	01	8.5	5.1	0.9	13.3
			02	2.7	1.9	0.1	4.0

TABLE A-1 Radiological Data Results from the Soil Sampling, Southeast Drainage (Continued)

VICINITY PROPERTY	INTERVAL, TRAVERSE[a]	SAMPLE ID SO-495XXX	DEPTH	SPECTROSCOPY RESULTS (pCi/g)			
				U-238	R-226	R-228	TH-230
DOC 7	N/A	143	01	14.5	5.6	2.3	18.7
			02	3.0	1.8	1.4	3.7
			03	1.3	0.7	1.9	1.2
			04	0.9	0.8	1.4	1.4
			05	1.2	1.2	1.2	1.3
			06	1.2	0.8	1.6	1.5
DOC 7	N/A	144	01	3.4	1.5	2.4	7.0
			02	0.8	0.8	1.1	1.7
			03	0.8	1.0	0.9	1.1
			04	0.9	1.0	1.7	1.2
			05	0.9	1.1	1.2	1.0
DOC 7	N/A	145	01	4.2	1.6	0.8	8.1
			02	1.6	1.3	0.9	3.8
			03	1.3	1.4	1.0	2.1
			04	2.3	1.1	0.8	4.5
DOC 7	N/A	146	01	1.6	1.2	1.3	1.4
			02	1.2	2.2	1.5	2.3
			03	1.0	1.1	3.9	1.5
			04	1.3	1.1	3.5	1.6
DOC 7	N/A	147	01	3.8	2.1	2.1	4.7
			02	2.7	1.3	6.5	4.0
			03	2.2	1.4	1.1	3.2

TABLE A-1 Radiological Data Results from the Soil Sampling, Southeast Drainage (Continued)

VICINITY PROPERTY	INTERVAL, TRAVERSE[a]	SAMPLE ID SO-495XXX	DEPTH	SPECTROSCOPY RESULTS (pCi/g)			
				U-238	R-226	R-228	TH-230
DOC 7	N/A	148	01	1.7	0.4	0.1	2.4
			02	1.2	1.0	2.7	1.7
			03	1.1	1.4	1.7	1.2
			04	1.0	1.0	1.8	1.5
			05	1.0	1.1	1.3	1.2
			06	1.1	1.0	1.2	1.3
			07	13.9	1.3	1.5	2.0
DOC 7	N/A	149(A)	01	55.4	15.3	2.1	31.8
			02	19.0	4.2	0.4	11.4
			03	2.3	1.3	0.7	2.2
			04	7.2	2.9	1.0	3.3
			05	19.5	6.8	1.6	5.9
			06	14.8	47.2	1.0	4.2
			07	16.7	66.3	2.6	6.0
DOC7	NA	149 D	01	38.6	16.4	2.71	31.8
			02	38.4	6.06	2.11	5.07
DOC7	NA	149 E	01	11.7	4.32	1.25	12.1
			02	2.69	1.6	(0.89)	2.29
			03	1.52	1.2	(0.34)	1.42
			04	19.1	1.04	(0.82)	1.7
DOC 7	N/A	150	01	16.4	6.4	1.7	23.8
			02	1.4	1.1	1.6	1.8
			03	15.5	2.3	2.5	1.8

TABLE A-1 Radiological Data Results from the Soil Sampling, Southeast Drainage (Continued)

VICINITY PROPERTY	INTERVAL, TRAVERSE[a]	SAMPLE ID SO-495XXX	DEPTH	SPECTROSCOPY RESULTS (pCi/g)			
				U-238	R-226	R-228	TH-230
DOC 7	N/A	151	01	14.6	0.9	2.0	13.7
			02	22.6	9.8	0.4	20.1
			03	19.2	9.7	2.7	18.5
			04	4.7	1.8	3.7	1.8
			05	9.0	4.2	3.9	3.2
DOC 7	N/A	152	01	10.9	8.4	4.6	9.5
			02	3.5	2.2	2.7	3.3
			03	3.1	1.4	2.3	2.0
			04	4.0	2.0	2.6	1.2
			05	5.4	1.1	2.1	1.2
			06	10.3	7.6	1.1	1.6
DOC 7	N/A	153	01	34.3	21.1	2.2	58.8
			02	11.4	3.6	2.3	8.2
			03	1.4	1.1	1.7	1.3
			04	0.9	1.2	0.9	1.3
			05	6.7	3.7	1.1	1.4
			06	8.9	46.1	1.7	3.3
			07	7.3	10.7	1.4	2.7
DOC 7	N/A	154	01	30.4	14.8	1.3	48.1
			02	24.4	9.8	1.2	39.6
			03	2.9	1.1	1.1	2.4
			04	2.4	1.5	1.3	2.8
			05	28.5	1.1	1.2	1.6
			06	5.7	3.4	3.9	8.1
			07	12.9	8.9	2.2	1.9

TABLE A-1 Radiological Data Results from the Soil Sampling, Southeast Drainage (Continued)

VICINITY PROPERTY	INTERVAL, TRAVERSE[a]	SAMPLE ID SO-495XXX	DEPTH	SPECTROSCOPY RESULTS (pCi/g)			
				U-238	R-226	R-228	TH-230
			08	9.4	1.7	1.9	1.6
			09	1.8	1.2	1.6	1.4

(a) Applicable to April 1995 sampling.
(b) Random samples or samples taken from areas that were not designated as ORAU elevated locations.
(c) Sample locations randomly selected for sampling soils at depths >12 in., July 1995.
(d) No sample 104-B or 104-C was taken.

TABLE A-2 Chemical Data Results from the Soils Sampling, Southeast Drainage, April 1995

LOCATION	DA 4 10 M	DA 130,190,305, 65 M	DA 4[a] 100,225 M	DOC 7 485,510,730 810 M	DOC 7 300,600, 900M[a]	DOC 7 255,365, 440 M	DOC 7 1050,1660, 2030 M	DOC 7 KATY TRAIL (~2500 M)[a]
SAMPLE ID	013	014	022	015	023	024	029	031
INORGANICS (µg/g)								
Nitrate	<1.27	<1.38	<1.40	5.20	3.90	4.50	4.30	4.10
Fluoride	29.80	133.00	17.60	15.90	13.40	60.70	54.10	30.90
Sulfate	39.50	78.50	<33.80	<31.50	<29.20	39.20	<27.10	<34.60
NITROAROMATICS (µg/g)								
1,3,5 TNB	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002
1,3-DNB	<.002	<.002	<.002	<.002	(0.000366)	<.002	<.002	<.002
2,4,6 TNT	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002
2,4 DNT	<.002	<.002	<.002	<.002	0.0023	<.002	<.002	<.002
2,6 DNT	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002
Nitrobenzene	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002
PCBs (µg/kg)								
Aroclor-1016	<209.	<46.1	<46.5	<43.7	<43.3	<43.5	<896.	<47.2
Aroclor-1221	<418.	<92.2	<93.0	<87.4	<86.6	<86.9	<1790.	<94.3
Aroclor-1232	<209.	<46.1	<46.5	<43.7	<43.3	<43.5	<896.	<47.2
Aroclor-1242	<209.	<46.1	<46.5	<43.7	<43.3	<43.5	<896.	<47.2
Aroclor-1248	<209.	<46.1	<46.5	<43.7	<43.3	<43.5	<896.	<47.2
Aroclor-1254	<1810.	320.	<46.5	<43.7	<43.3	<43.5	3860.	<47.2
Aroclor-1260	<1860.	287.	<46.5	<43.7	<43.3	<43.5	2960.	<47.2

TABLE A-2 Chemical Data Results from the Soils Sampling, Southeast Drainage, April, 1995 (Continued)

LOCATION	DA 4 10 M	DA 130,190,305, 65 M	DA 4[a] 100,225 M	DOC 7 485,510,730 810 M	DOC 7 300,600, 900M[a]	DOC 7 255,365, 440 M	DOC 7 1050,1660, 2030 M	DOC 7 KATY TRAIL (~2500 M)[a]
SAMPLE ID	013	014	022	015	023	024	029	031
METALS (µg/g)								
Al	12000.	16100.	8760.	7090.	7150.	9350.	13000.	13700.
Sb	<4.3	<4.75	<4.81	<4.6	<4.5	<4.7	<4.6	<5.1
As	26.1	11.3	13.1	14.4	4.7	9.4	8.8	4.9
Ba	533.	697.	154.	261.	117.	229.	207.	211.
Be	0.56	0.73	0.93	0.76	0.5	0.76	0.61	0.6
Cd	2.4	1.1	<0.8	0.78	<0.74	0.86	0.84	1.2
Ca	32800.	11400.	5390.	6200.	2290.	19700.	33000.	39900.
Cr	130.	64.1	38.5	22.8	9.8	32.3	49.4	52.8
Co	12.5	12.4	18.5	28.7	9.	22.7	11.	11.8
Cu	109.	52.3	12.4	13.4	6.6	15.5	34.8	36.2
Fe	21300.	8400.	27900.	21300.	10700.	19300.	14900.	15700.
Pb	121.	54.5	54.5	43.	21.	32.7	48.2	15.3
Li	8.4	11.4	5.3	5.	4.8	7.1	10.5	10.6
Mg	4470.	4810.	1640.	1190.	1140.	1640.	2250.	2420.
Mn	1200.	848.	1410.	2450.	877.	1890.	942.	988.
Hg	4.2	1.4	0.29	<0.13	<0.11	0.41	0.89	0.17
Mo	6.4	3.	1.9	2.6	<0.74	3.2	2.7	1.6
Ni	35.1	28.7	21.2	27.7	11.5	25.8	26.8	28.
K	859.	1180.	666.	745.	723.	711.	1140.	1210.

TABLE A-2 Chemical Data Results from the Soils Sampling, Southeast Drainage, April, 1995 (Continued)

LOCATION	DA 4 10 M	DA 130,190,305, 65 M	DA 4[a] 100,225 M	DOC 7 485,510,730 810 M	DOC 7 300,600, 900M[a]	DOC 7 255,365, 440 M	DOC 7 1050,1660, 2030 M	DOC 7 KATY TRAIL (~2500 M)[a]
SAMPLE ID	013	014	022	015	023	024	029	031
Se	0.61	0.69	<0.27	0.41	0.48	0.53	0.69	0.34
Ag	12.5	2.8	<0.54	<0.51	<0.5	1.1	3.4	5.1
Na	81.5	87.7	33.7	47.	30.4	34.3	134.	157.
Th	<0.24	<0.26	<0.27	<0.25	<0.26	<0.24	<0.26	<0.26
Va	44.7	47.6	55.2	47.1	21.	50.9	46.4	51.2
Zn	708.	236.	120.	75.9	33.1	87.5	86.2	97.8

(a) Random samples or samples taken from areas that were not designated as ORAU elevated locations.

TABLE A-3 Nitroaromatics Concentrations (ug/g) in Sediment Samples from Spring Locations, 1995

SPRING LOCATION[a]	1,3,5-TNB	1,3-DNB	2,4,6-TNT	2,4-DNT	2,6-DNT	NITROBENZENE
5301	< 0.2	< 0.02	< 0.02	< 0.33	< 0.33	< 0.20
5302	< 0.2	< 0.02	< 0.02	< 0.33	< 0.33	< 0.20
5303	< 0.2	< 0.02	< 0.02	< 0.33	< 0.33	< 0.20
5304	< 0.2	< 0.02	< 0.02	< 0.33	< 0.33	< 0.20

(a) All samples taken at a depth of 0 to 6 in.

TABLE A-4 PCBs Concentrations[a](ug/kg) in Soil from Southeast Drainage, 1995.

SAMPLE ID[b]	SOIL IDENTIFICATION FOR RADIOLOGICAL SAMPLING	AROCLOR-1016	AROCLOR-1221	AROCLOR-1232	AROCLOR-1242	AROCLOR-1248	AROCLOR-1254	AROCLOR-1260
SO-495133	002	< 780	< 1600	< 780	< 780	< 780	2200	< 780
SO-495134	003	< 48	< 98	< 48	< 48	< 48	380	< 48
SO-495135	004	< 51	< 100	< 51	< 51	< 51	350	< 51
SO-495136	005	< 900	< 1800	< 900	< 900	< 900	3000	< 900
SO-495137	025	< 9200	< 19000	< 9200	< 9200	< 9200	150000	< 9200
SO-495138	027	< 41	< 84	< 41	< 41	< 41	61	< 41
SO-495139	028	< 38	< 78	< 38	< 38	< 38	48	< 38

[a] Detection limits vary depending on percent solid calculation
[b] Samples taken at a depth of 0 to 6 in.

TABLE A-5 PCB Data Results (ug/kg) from Reanalysis and Resampling of Location 137[a], August, 1996.

SAMPLE ID[a]	Aroclor-1016	AROCLOR-1221	AROCLOR-1232	AROCLOR-1242	AROCLOR-1248	AROCLOR-1254	AROCLOR-1260
SO-495137-01-RE[b]	73.2	< 23,000	<46,000	<23,000	<23,000	130,000	<23,000
SO-495137-01B	< 16	< 16	< 16	< 16	< 16	3,100	3,300
SO-495137-02B	< 15	< 15	< 15	< 15	< 15	57	180
SO-495137-03B	< 14	< 14	< 14	< 14	< 14	< 14[c]	< 14[c]

(a) Location sampled was 025 but the sample identification number for the chemical samples taken at this location was 137 (SO-495137). Sample suffix of 01, 02 and 03 indicate the sample depth in six inch intervals; 01 is 0-6", 02 is 6 - 12" and 03 is 12-22" in depth. Bedrock was encountered at 22" in depth.

(b) Sample collected in December of 1995 was reanalyzed in August, 1996 although it was outside of the EPA-recommended holding time of 6 months. High detection limits are a result of dilution required for analysis of Aroclor-1254.

(c) Field duplicate for this sample resulted in detected values of 12 ug/kg for Aroclor-1254 and 25 ug/kg for Aroclor-1260.

APPENDIX B
Unpublished Documents

To: Julie Reitinger
MK-Ferguson, Weldon Spring Site
Fax: 447-0803

From: Todd Dwyer
St. Charles Engineering & Surveying

947-0607 FAX: 947-2448

Subject: Tranformation between ORAU and NAD83 coordinate systems

Let the ORAU coordinates be denoted N1 and E2. Let the Nad 83 coordinate be denoted N2 and E2.

N1	E1
23000.0000	21000.0000
20000.0000	19000.0000
19000.0000	21000.0000

N2	E2
1044212.1780	755438.9720
1041212.2859	753439.1508
1040212.3020	755439.1430

The transformations from ORAU to NAD83 coordinates, obtained by a least-squares criterion, are:

N2 = a*N1 - b*E1 + c
E2 = b*N1 + a*E1 + d

where

a = 0.99996444117645
b = -3.026470591438110e-05
c = 1.021212374799999e+06
d = 7.344404371000004e+05

The transformations from NAD 83 to ORAU coordinates are:

N1 = aa*N2 - bb*E2 + cc
E1 = bb*N2 + aa*E2 + dd

where

aa = 1.00003555874793
bb = 3.026685832401075e-05
cc = -1.021226458619994e+06
dd = -7.344974617640155e+05

The maximum observed error when these formulas were applied to the input data was 0.04725.

WSP60

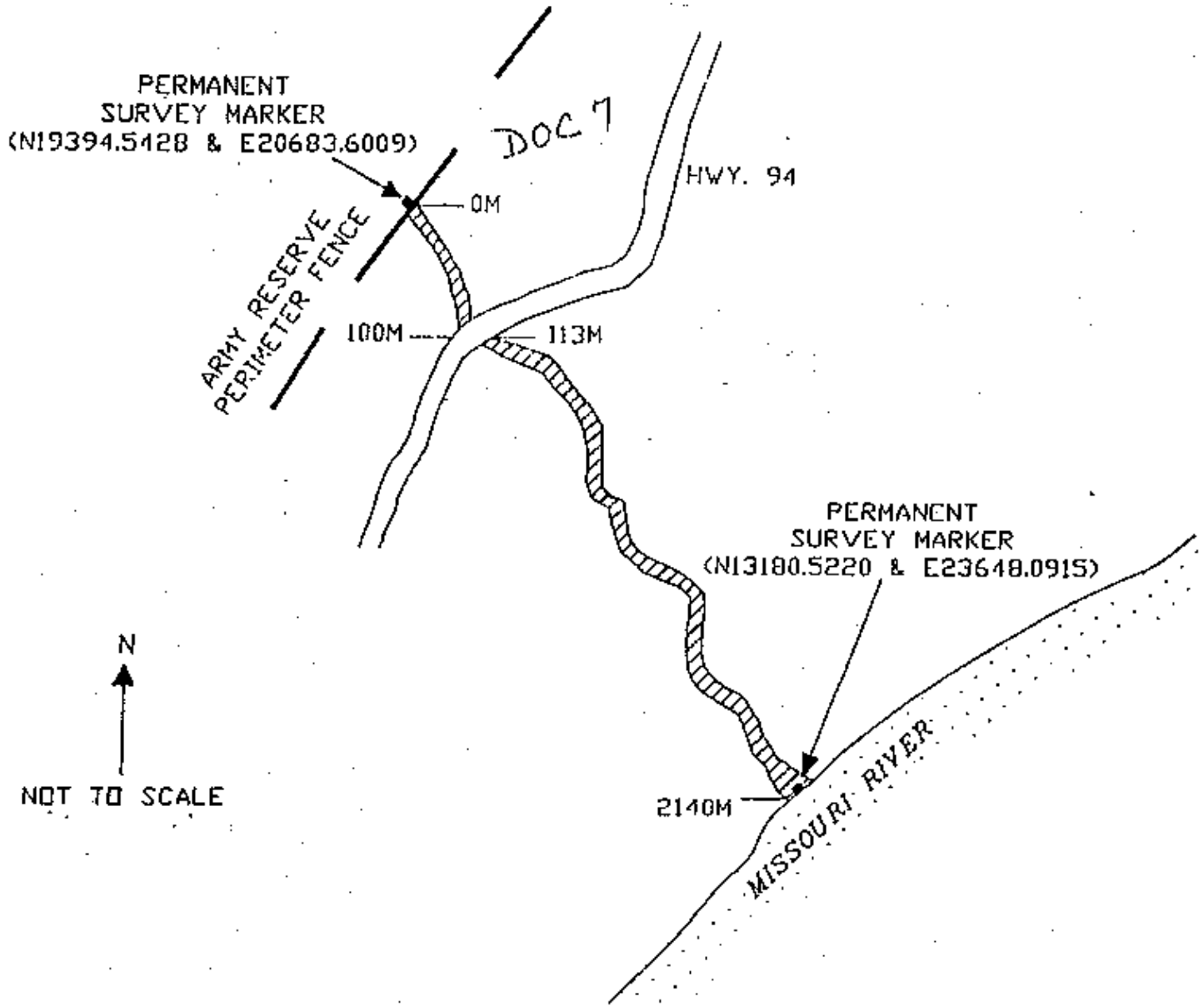


FIGURE 3:

under Highway 94 have been identified as 100 and 113 meters respectively (Figure 3).

Several locations for this survey and sampling were selected from the ORAU identified locations and are listed in Table 3-1. Locations were selected to include the upper range of medium to high concentrations of uranium-238, radium-226 and thorium-230. Starting at the location of the upper survey marker, a measuring tape with meter units shall be positioned in the center of the drainage. A wood stake will be placed within the drainage at the starting point. Progressing down the drainage, 100 meter intervals will be staked and marked in order to provide survey positions (coordinates) for the drainage. In addition, all locations listed in Table 3-1 will also be staked and marked.

In the case of identifying intervals within DA4, measuring will progress up the drainage from the survey marker with the 1st marker placed 5 meters from the survey marker and identified as 300 meters since the ending point of DA4 is 305 meters.

From the centerline interval location, the traverse location (perpendicular to the drainage) listed in Table 3-1 will also be located. This traverse location was measured from the centerline (C) to the left (L) or Right (R) at approximately 1-2 meter lengths. Therefore, the interval and traverse location listed as 510, 2R is 510 meters down the drainage and 2 meters to the right of the center of the drainage.

All locations will be staked and identified by location using this identification number system, D4-510,2R. D4 or D7 will indicate the vicinity property, 510 indicates the interval location down the drainage and 2R indicates the traverse location.

Table 3-1 Soil Review Sampling Locations and Identification Numbers

Vicinity Property	Interval, Traverse	Radiological Sample Id [a]	Chemical Composite Sample ID
DA4	10,C	SO-495001	SO-495013
DA4	130,L	SO-495002	
DA4	190,4R	SO-495003	
DA4	305,R	SO-495004	SO-495014
DOC7	65, C	SO-495005	
DOC7	230,2R	SO-495006	SO-495024
DOC7	320,1R	SO-495007	
DOC7	450,C	SO-495008	
DOC7	485,1L	SO-495009	SO-495015[b]
DOC7	510,2R	SO-495010	
DOC7	730,4L	SO-495011	
DOC7	810,11L	SO-495012	
DOC7	1450,4L	SO-495025	SO-495029
DOC7	1480,5L	SO-495026	
DOC7	1680,3R	SO-495027	
DOC7	2030,4R	SO-495028	

[a] The suffix -01 or -02 is also added to represent the sample depth as 0 to 6 inches or 6 to 12 inches, respectively.

[b] This sample has been selected for equipment blank (EB), duplicate (DU), field replicate (FR), and matrix spike (MS) and matrix spike duplicate (MSD) samples.

3.2 Soil Surveys

A portable sodium iodide detector will be used to conduct a walkover survey of each ORAU location listed in Table 3-1 and marked during the interval identification.

Surveys will be conducted according to Procedure ES&H 2.6.2, *Calibration and Use of Ludlum Model 44-10 (2 x 2 Sodium Iodide)*

Detector. The probe is suspended from a rope and is swung back and forth over the ground surface. The probe should stay within 12 in. of the ground during swinging action. Surveys shall be conducted at a walking rate of 1 ft/second. Surveys to locate the ORAU elevated soil areas utilizing the survey meter will be made be by scanning a 10 ft by 10 ft area around the staked location. Meter readings shall be made at 1 ft intervals at each 10 ft by 10 ft area and documented in the field logbook.

At each location where elevated meter readings are found, a scan will be made within the contiguous area to delineate the boundaries of the specific spot. These areas shall be measured using a meter tape, and a length, width, and depth estimate should be recorded in the field logbook.

If elevated locations are not detected by the surface scan within the initial staked area, the survey area shall increase to a 25 ft by 25 ft area. Meter readings shall be made at the additional 1 meter intervals and documented in the field logbook. If elevated locations are not detected after the second surface scan, no additional scanning will be conducted at the location.

3.3 Soil Sampling

Surface and subsurface soil samples will be taken for radiological and chemical analysis at each location designated in Table 3-1. Samples will be collected at locations where elevated meter readings were found and collection of random soil samples at those areas were elevated meter readings were not detected. A minimum of one surface and one subsurface sample will be taken near the center of each location. If the area has been delineated as greater than 25 ft by 25 ft, a minimum of three surface and subsurface samples shall be taken (one near center and one at the end of each boundary).

If locations are found where elevated readings are detected and the substrate is large rock or bedrock, no surface sample will be taken since this would be fixed radiation. At these locations, the rock layer shall be removed, and a subsurface soil sample taken. All rationale for no surface sample collection shall be recorded on the soil sampling form. All soil sampling and field information shall be recorded on the Soil/Sediment Sample Form in accordance with Procedure ES&H 4.4.5s, *Soil/Sediment Sampling*. Field logbooks will be maintained and completed in accordance with Procedure ES&H 1.1.4, *Logbook Procedure*.

Surface and subsurface soil samples will be collected using a stainless steel split spoon auger or trowel. Surface samples will be collected from ground surface to 6 in. in depth.

Subsurface samples will be collected from 6 in. to bedrock or 12 in. in depth. Each surface and subsurface sample will be prepared separately by mixing the sample in a decontaminated stainless steel pan. During sample compositing, any detritus (e.g., leaves and twigs) will be removed. A description of each sample (e.g., soil type, color, organic matter) will be recorded in field notes.

Soil samples will be identified according to ES&H Procedure 4.1.1 *Numbering System for Environmental Samples and Sampling Locations*. The assignment of sample identification numbers according to this procedure is listed in Table 3-1 and Table 3-2.

In addition to soil samples collected from elevated locations, six random sample locations will be selected from interval locations as listed in Table 3-2 and sampled as designated for surface and subsurface samples. These samples will be used as a control to provide readings and concentrations for non elevated locations.

Table 3-2 Random Sample Locations

Vicinity Property	Interval, Traverse [a]	Radiological Sample Id [b]	Chemical Composite Sample ID
DA4	100,C	SO-495016	SO-495022
DA4	225,L	SO-495017	
DOC7	100,R	SO-495018	
DOC7	300,L	SO-495019	SO-495023
DOC7	600,R	SO-495020	
DOC7	900,L	SO-495021	
DOC7	1300,2L	SO-495029	SO-495031
DOC7	1700,1R	SO-495030	

[a] Final traverse location will be selected in the field based upon location of depositional areas.

[b] The suffix -01 or -02 is also added to represent the sample depth as 0 to 6 inches or 6 to 12 inches, respectively.

Approximately 1000 grams of soil will be collected for radiological analyses. Large rocks, gravel and other debris (wood) will be removed from the sample prior to placing in sample container. The sample will be placed in a 1 gallon plastic bag

Appendix A: Data Quality Requirements for Soil Review Sampling

CATEGORY	PARAMETER	ANALYTICAL METHOD	MDC* SOIL (ug/g)	PRECISION	ACCURACY
Inorganics	Nitrate	300.3/353.1	50	50	50
	Fluoride	300.3/340.1,2,3	50		
	Sulfate	300.3/375.1,.2	200		
PCBs	PCBs - TCL	CLP	CRQL	As Required by CLP	
Nitroaromatics	TNT	HPLC or GC	0.006	50	50
	2,4-DNT		0.006		
	2,6-DNT		0.002		
	1,3,5-TNB		0.006		
	1,3-DNB		0.018		
	Nitrobenzene		0.006		
Metals	Antimony	CLP-ICP	6	As required by CLP	
	Arsenic	CLP-AA	1		
	Barium	CLP-ICP	20		
	Beryllium	CLP-ICP	0.5		
	Cadmium	CLP-ICP	0.5		
	Lead	CLP-AA	0.3		
	Lithium	EPA 200.7	5	50	50
	Molybdenum	EPA 200.7	0.4	50	50
	Nickel	CLP-ICP	4	As required by CLP	
	Selenium	CP-AA	0.5		
	Thallium	CLP-AA	1		
	Vanadium	CLP-ICP	5		

* MDC; minimum detected concentration

Table 1. Soil Sample Locations and Sample Identification Numbers

Meter Location	Sample Identification Number
1680	SO-495049
1750	SO-495050
1850	SO-495051
1950	SO-495052
2050	SO-495053
2150	SO-495054
2250	SO-495055
2350	SO-495056
2450	SO-495057
Elevated locations	As needed, assign sequential numbers starting at SO-495058.

ADDITIONAL SOUTHEAST DRAINAGE SOIL SAMPLING, AUGUST 1995

The purpose of this additional sampling is to determine if contaminates are present in deeper soil depth in section D of the Southeast Drainage. This information will also be evaluated to determine if further depth sampling would need to be performed in other areas of the drainage.

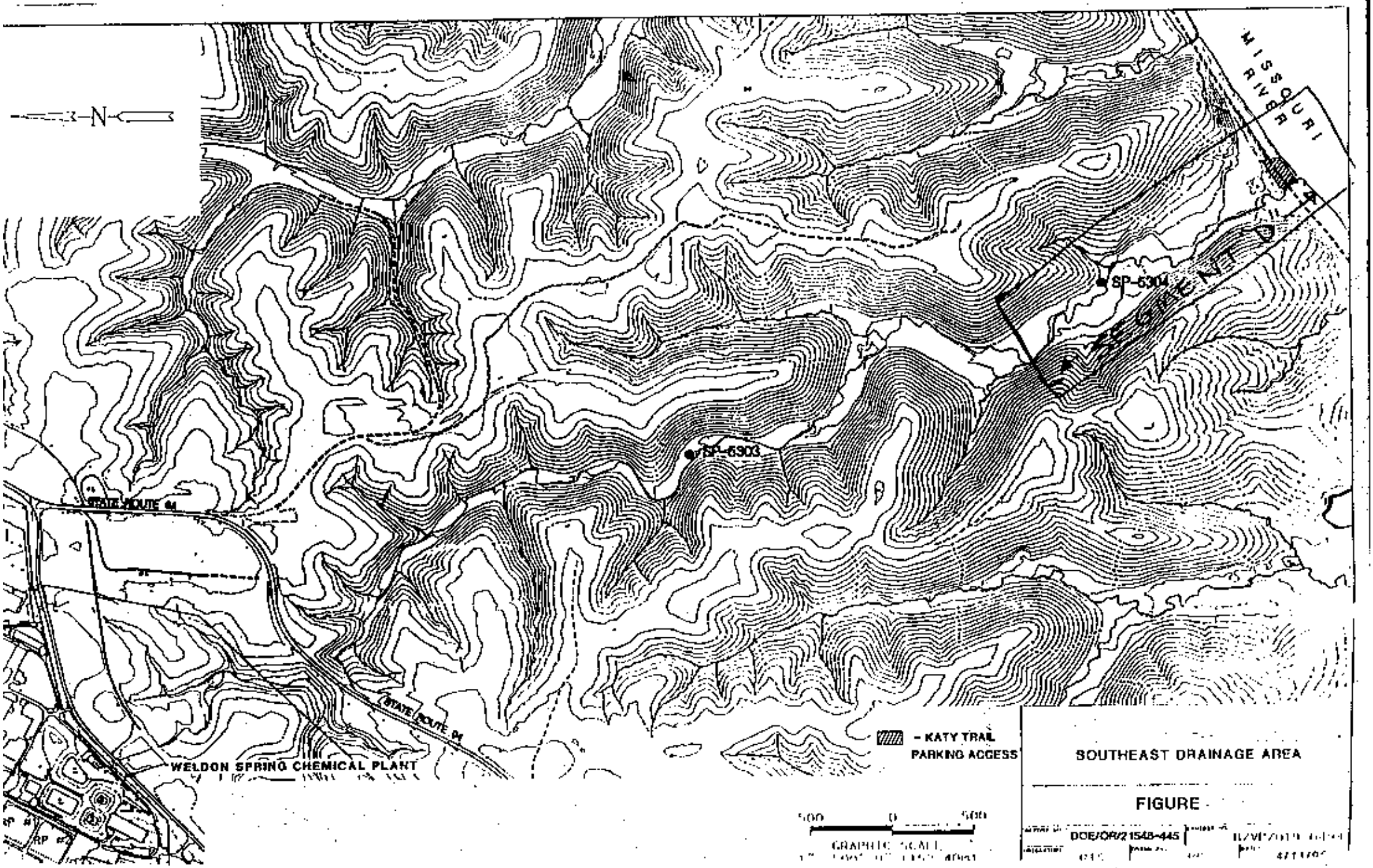
Soil sampling will be conducted in the lower portion of the Southeast Drainage, the portion shown as segment D (Figure 1). This the area that includes the KATY Trail and the spring identified as 5304. This segment is approximately 870 meters in length. Soils from random locations and radiologically elevated areas will be collected.

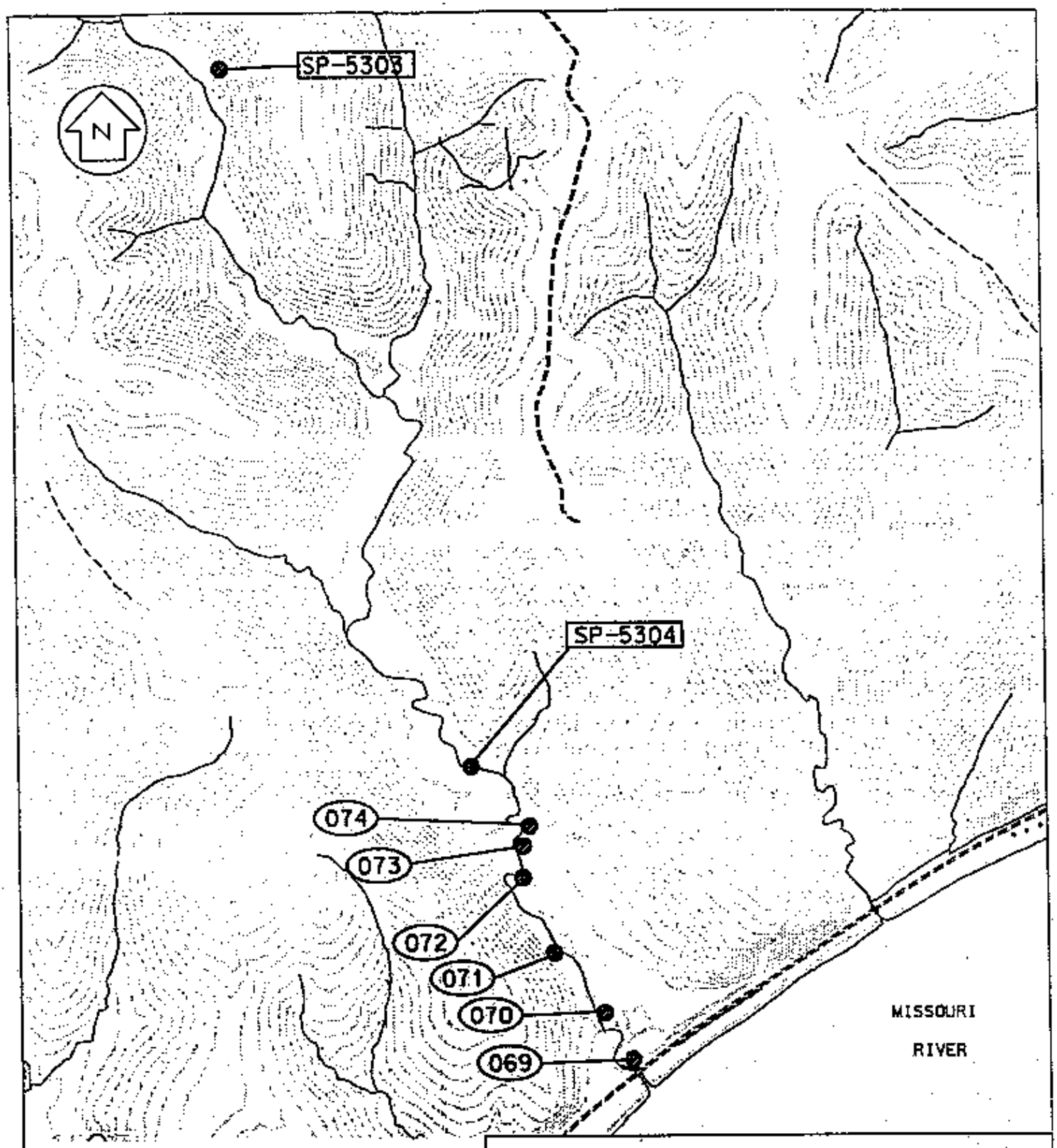
The drainage will be measured from the Missouri River (identified as 2550 meters) up the drainage from approximately 870 meters. Sampling personnel shall identify the meter location of spring 5304 and confirm that this segment contains this spring. From this segment, six sample locations were selected as shown in Fig1. Samples will be taken from each designated area.

A drill rig will be used to bore holes 15' in depth or until the bedrock surface is encountered at each sample location and samples will be taken every 6" laterial depth from each location. If adequate soil volume is not obtained from one 6" sample, then another 6" sample from the nextt depth will be added to the sample. All soil samples will be analyzed with an appropriate on-site or off-site lab for each of the following parameters: Radium 228, Radium 226, Thorium 230 and Uranium 238. Samples will be identified as SO-495069, SO-495070, SO-495071, SO-495072, SO-495073 and SO-495074. Suffixes will be added to each sample I.D. to identify depths of sample. A sequential 2-digit number will be used 01, 02, 03, etc. to represent 6" intervals with 01 being the first sample taken at 0" to 6".

A walkover surface soil scan will be conducted at each sample location and the results will be documented in the ES&H log book. Soil samles shall be placed in a ziploc plastic bag and labeled. Soil sampling forms and chain-of-custody forms shall be completed in accordance with ES&H procedures.

Sampling equipment and mechanical equipment will be deconned and surveyed in accordance with ES&H procedures.


N
MISSOURI RIVER
SP-6304
SP-6303
STATE ROUTE 94
STATE ROUTE 94
WELDON SPRING CHEMICAL PLANT
- KATY TRAIL PARKING ACCESS
SOUTHEAST DRAINAGE AREA
FIGURE
DOE/OR/21548-445



0 300 600

SCALE FEET

DATE OF PHOTOGRAPHY = 03-11-93

CONTOUR INTERVAL = 10 FEET

DISCRETE
SAMPLING LOCATIONS
SOUTHEAST DRAINAGE

FIGURE 1

REPORT NO.: DOE/OR/21548-582	EXHIBIT NO.: A/VP/018/0494	
ORIGINATOR: JXW	DRAWN BY: SRS	DATE: 11/6/95

MORRISON KNUDSEN CORPORATION
MK-FERGUSON GROUP

INTER-OFFICE CORRESPONDENCE

DATE: July 18, 1995

TO: Kenyon Warbritton

FROM: Julie Reitinger

SUBJECT: Additional Soil Sampling for Southeast Drainage

Argonne National Laboratory has requested additional soil sampling be conducted to support the baseline risk assessment for the Southeast Drainage. Specifically, additional sampling of soils from the lower portion of the drainage (segment D) for radionuclides will be conducted. The sampling plan for this effort is attached and is scheduled to begin on July 19, 1995. Please see me if you have any questions.

cc: Ken Lawver
Mary Picel
Jaime White
Bill Goldkamp
Randy Thompson
Walter Anderson
RC-24-06-03

Form 212-0692

MORRISON KNUDSEN CORPORATION
MK-FERGUSON GROUP

INTER-OFFICE CORRESPONDENCE

DATE: May 16, 1996

TO: Distribution

FROM: Julie Reitinger JMR

SUBJECT: **SAMPLING ADDENDUM TO THE ENGINEERING CHARACTERIZATION PLAN FOR THE SOUTHEAST DRAINAGE**

Attached is the sampling plan for the proposed collection of soil samples in the Southeast Drainage. This attachment is an addendum to the previously released document *Engineering Sampling Plan to Identify Areas for Remediation in the Southeast Drainage (Vicinity Properties DA-4 and DOC-7)*, DOE/OR/21548-582, November, 1995.

If you have any questions, please contact me at extension 3522.

Distribution: K. Warbritton
L. Koehmstedt
Y. Deyo
M. Picel
M. Donohue
R. Thompson
S. Warren
N. Boss
J. White
W. Anderson
RC-24-03

c:\addstaff\julie\ice\sampsdm.sed

Form 232-A 03/92

ADDENDUM TO ENGINEERING SAMPLING PLAN TO IDENTIFY AREAS FOR REMEDIAL ACTION IN THE SOUTHEAST DRAINAGE (VICINITY PROPERTIES DA-4 AND DOC-7)

The purpose of this additional sampling is to determine if contaminants are present in soil at depths greater than the vertical extent of previous sampling at eleven locations in the Southeast Drainage. These locations were selected because the volume of soil identified as contaminated by previous sampling was greater than 50 cubic yards and additionally, because the target cleanup concentrations were exceeded at the last depth sampled. A twelfth location (SO 495149) was added, even though the volume was less than 2 cubic yards, due to the presence of elevated Radium 226 at a depth of 3'.

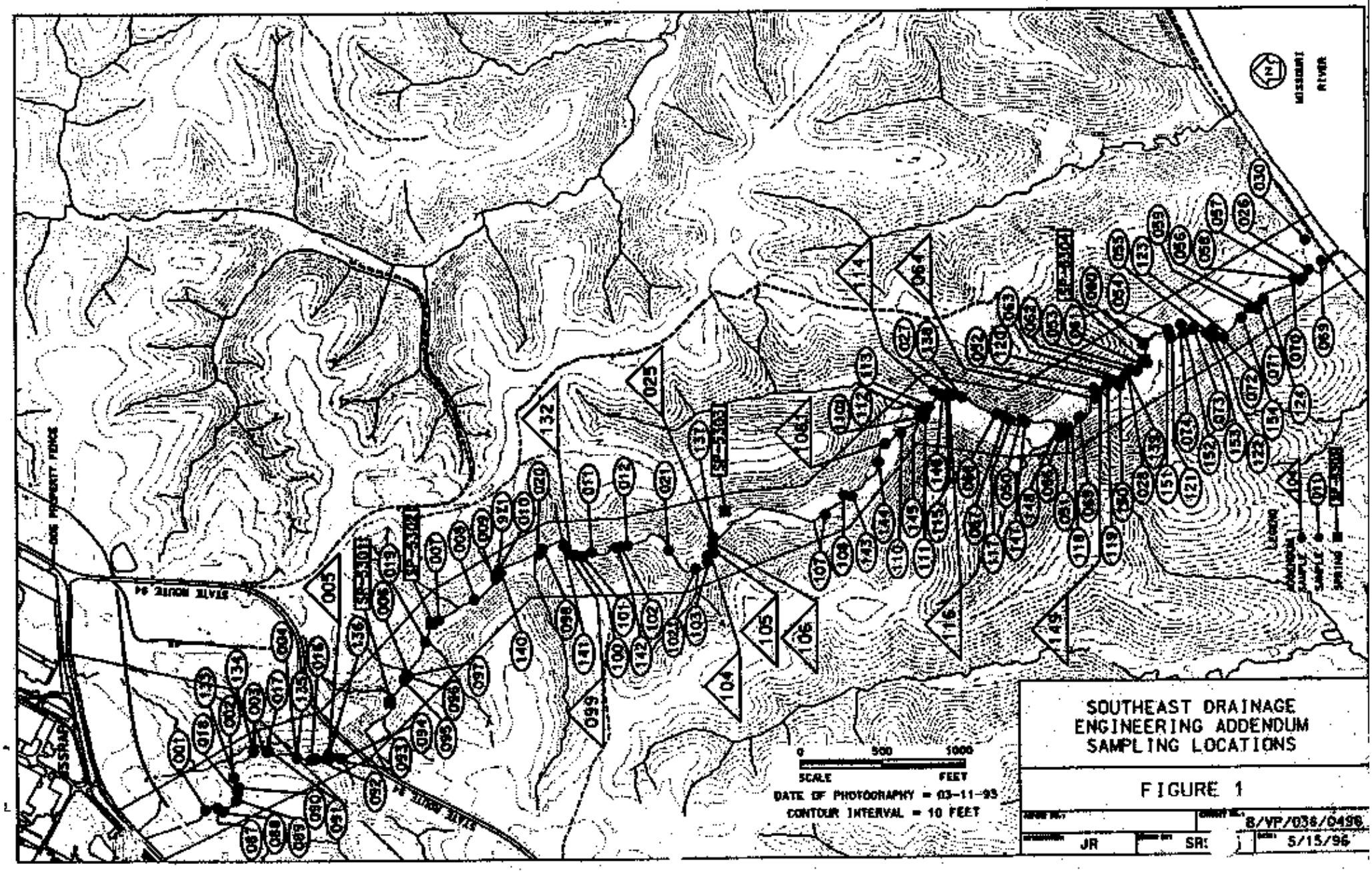
Soil sampling will be conducted at twelve sites at various intervals along the drainage (see Figure 1). The sample identification numbers for these locations are SO-495005, SO-495025, SO-495132, SO-495064, SO-495099, SO-495104, SO-495105, SO-495106, SO-495108.1, SO-495114, SO-495116, and SO-495149. Five samples will be collected at each location. Each location has been scanned to delineate the lateral boundaries where above background readings have been obtained. Four samples will be collected from each corner of area and the fifth will be collected directly adjacent to the original sample point. If the fifth sample point is strongly biased to one end of the area, a sixth sample will be collected to alleviate the bias. Only one sample will be collected from location SO-495149 since the boundaries of the contaminated area are small (< 2 yd^3).

Based upon field conditions, a drill rig using a continuous sampler or a backhoe will be utilized to collect samples at six inch (6") intervals to a depth of three feet (3') and at one foot intervals thereafter. Drilling or excavation will continue until one of the following occurs: surveys, using the Ludlum Model 44-9 and the Ludlum 44-10 (2x2 NaI) Detectors, indicate radiological levels consistent with established background readings; or groundwater is encountered; or bedrock is encountered. Radiological levels will be determined by scanning the sample after it is removed from the sampling tube and before it is containerized and labeled.

All soil samples will be analyzed for each of the following parameters: Radium 226, Radium 228, Thorium 230 and Uranium 238. A sequential 2-digit number will be used 01, 02, 03 etc. to represent each 6" sample interval through three feet and each 1' sample thereafter, as was used in previous sampling efforts in the Southeast Drainage.

Soil locations will be identified beginning with the original number associated with each site and adding the suffix B, C, D, E, or F after the numeric suffix to designate the location. SO-495005 will use suffixes D, E, F, G, and H since A, B, and C were previously used. Therefore the sample taken at the first location SO-495005 at a depth of 18" would be SO-495005-03D while the second location at SO-495025 at 18" would be SO-495025-03C.

A walkover surface soil survey will be conducted at each sample location and the delineated area will flagged and surveyed. The delineation will also be recorded in the ES&H logbook. Soil samples shall be placed ia a ziploc plastic bag and labeled. Soil sampling forms and chain-of-custody forms shall be completed in accordance with ES&H procedures, as will sampling and mechanical equipment surveys and decontamination.


SOUTHEAST DRAINAGE
ENGINEERING ADDENDUM
SAMPLING LOCATIONS
FIGURE 1
0 500 1000
SCALE FEET
DATE OF PHOTOGRAPHY = 03-11-95
CONTOUR INTERVAL = 10 FEET
JR
SR
8/VP/036/0498
5/15/96
MISSISSIPPI RIVER
STATE ROUTE 94
SSM-1
SP-5303
SP-5304
SP-5305
SP-5306
SP-5307
SP-5308
SP-5309
SP-5310
SP-5311
SP-5312
SP-5313
SP-5314
SP-5315
SP-5316
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SP-5318
SP-5319
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SP-5338
SP-5339
SP-5340
SP-5341
SP-5342

MORRISON KNUDSEN CORPORATION

MK-FERGUSON GROUP

INTER-OFFICE CORRESPONDENCE

DATE: July 31, 1996

TO: Randy Thompson

FROM: Julie Reitinger

SUBJECT: **PCB SAMPLING ADDENDUM FOR SOUTHEAST DRAINAGE**

Sampling of soils for PCB analysis will be conducted at one location in the Southeast Drainage in August, 1996. An addendum sampling plan for the soil sampling conducted in the drainage for engineering design was prepared in June of 1996 (DOE/OR/21548-582). Since then, data review of soils sampled in December, 1995 for PCB compounds has shown that one location (SO-495025) will require additional sampling because of an elevated Aroclor-1254 concentration.

The addendum sampling plan discusses the method for sampling soils for radiological compounds that will also be appropriate for PCB sampling. Six samples will be collected within location 025. Samples will be taken at a depth of 0 to 6 inches, and collected in clean, 250 ml glass amber wide mouth jars. Samples will be shipped to an off-site laboratory for analysis of PCB compounds.

cc: K. Warbritton
K. Reed
S. Warren
M. Donohue
Y. Deyo
M. Picel
L. Koehmstedt
D. Blunt
RC-24-06-04-01

[redacted]

Form 232-A 03/92

MK-Ferguson Company
Weldon Spring Site Remedial Action Project

TRANSMITTAL OF CONTRACT DELIVERABLE

Date: 03 Feb 97 **Transmittal No.:** CD-0107-00

Title of Document: Southeast Drainage Soils Sampling Report

Doc. Num.: 650 **Rev. No.:** 0 **Date of Document:** January 1997

Purpose of Transmittal: Request for Department of Energy acceptance of contract deliverable.

In compliance with the Project Management Contract, MK-Ferguson Company hereby delivers the attached document to the U.S. Department of Energy, Weldon Spring Site Office. The document has been reviewed and approved by Project Management Contractor management.

The document will be considered accepted unless we receive written notification to the contrary within 30 days of the date of this transmittal.

James R. Powers
Project Director