FINAL

UTILITY WORKER EXPOSURE ASSESSMENT FOR THE NORTH COUNTY FUSRAP PROPERTIES

ST. LOUIS, MISSOURI

JULY 1999

U.S. Army Corps of Engineers
St. Louis District Office
Formerly Utilized Sites Remedial Action Program

FINAL

UTILITY WORKER EXPOSURE ASSESSMENT FOR THE NORTH COUNTY FUSRAP PROPERTIES

ST. LOUIS, MISSOURI

JULY 1999

prepared by
U.S. Army Corps of Engineers, St. Louis District Office, Formerly Utilized Sites Remedial Action Program

with technical assistance from
Science Applications International Corporation ESC-FUSRAP
under Contract No. DACW45-98-D-0029

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The United States Army Corps of Engineers (USACE) Formerly Utilized Sites Remedial Action Program (FUSRAP) administers cleanup or control of sites used or impacted by the Manhattan Engineer District (MED) and the Atomic Energy Commission's (AEC) radiological operations. One goal of FUSRAP is to minimize potential hazards to human health and the environment from residual radioactivity related to former MED/AEC activities. The Mallinckrodt Chemical Company in St. Louis was one such location of MED/AEC activities in the early years of the nation's atomic energy program. This site and associated properties are now being addressed under the FUSRAP program.

The St. Louis FUSRAP site consists of four main sets of properties: the St. Louis Downtown Site (SLDS), where Mallinckrodt Chemical Company continues to operate, and associated vicinity properties; the St. Louis Airport Site (SLAPS), a former residue storage area now owned by the St. Louis Airport Authority; the Hazelwood Interim Storage Site (HISS), where residues from SLAPS were transported for later offsite shipment; and the SLAPS vicinity properties, which were impacted by the transport of residue materials from SLAPS to HISS. SLAPS, HISS, and their associated vicinity properties are also referred to as the St. Louis site's North County properties.

Given the extent of residual radioactivity located in and along utility corridors at the St. Louis site, a likely scenario for human exposure to this residual radioactivity is a utility worker digging in these soils in order to work on gas, telephone, water, sewer or electric lines. This report evaluates a utility worker's potential exposure to residual radioactive materials in the North County areas including SLAPS and HISS, plus their vicinity properties and haul routes (see Figure 1 for the location of these properties). A separate report addresses similar concerns for SLDS and its vicinity properties.

NORTH COUNTY BACKGROUND AND DESCRIPTION

SLAPS

SLAPS is an 8.8 ha (22 acre) parcel of land adjacent to the north side of Lambert-St. Louis International Airport, approximately 24 km (15 mi.) from downtown St. Louis. SLAPS is bound by the Norfolk & Western Railroad to the south, McDonnell Avenue to the north and east, and Coldwater Creek to the west. MED/AEC used the site from 1946 to 1966 to store radioactive residues from manufacturing operations at SLDS. Most residues were stored in bulk on the open ground while others were buried. In the middle 1960s most of these residues were transported from SLAPS to HISS. In 1969 the structures at SLAPS were razed, and the site was leveled with clean fill. In 1973 the property was signed over to the St. Louis Airport Authority, which currently controls the site. Although most residues were shipped to the HISS property, elevated radioactivity still remains in surface and subsurface soils at SLAPS. SLAPS is currently fenced to prevent unauthorized access, but some radioactive material extends beyond the fence line and into the ditch along McDonnell Avenue.

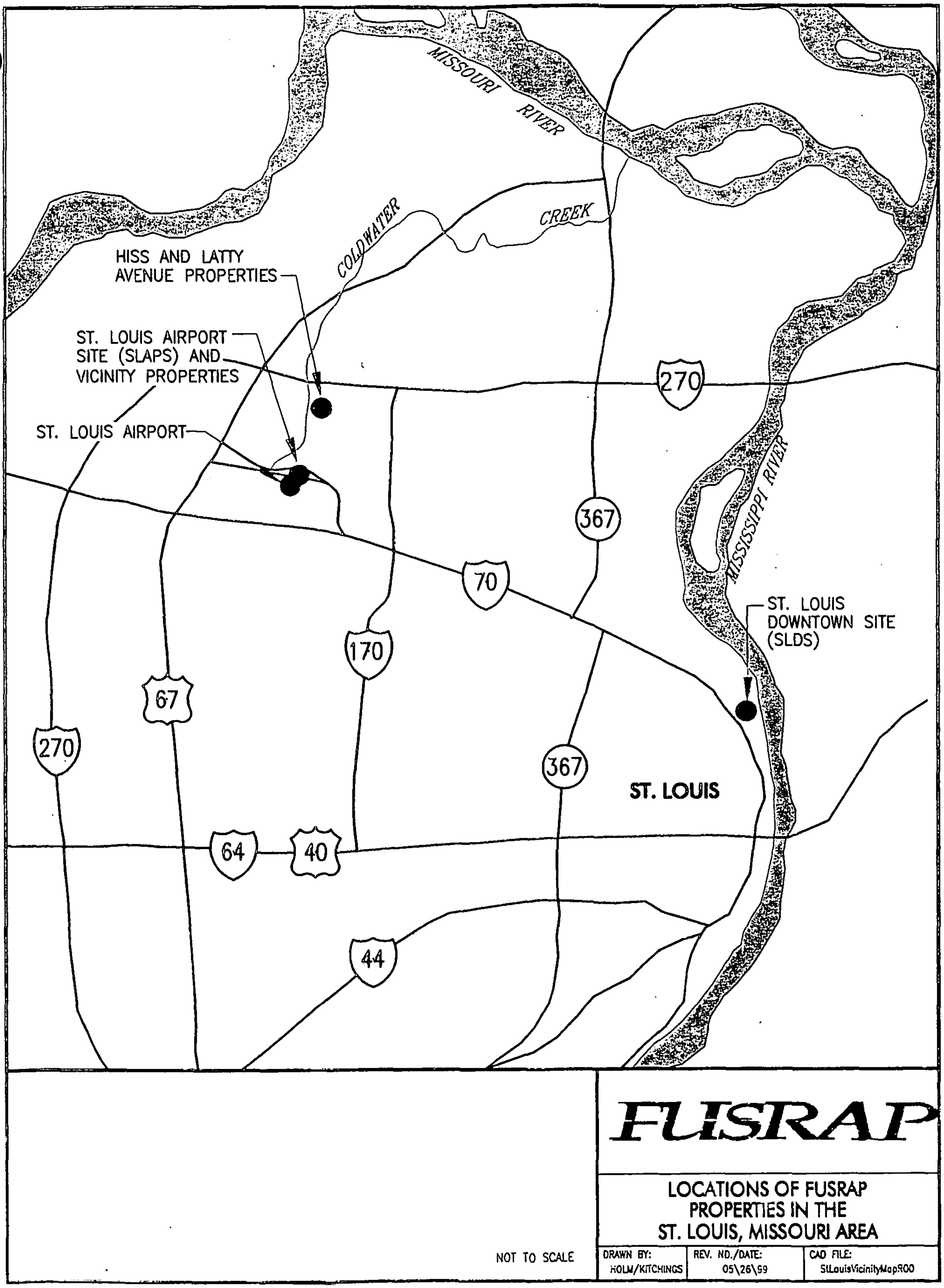

Figure 1. Location of FUSRAP Properties in the St. Louis, Missouri Area

HISS

The HISS property is located at 9200 Latty Avenue approximately 1.2 km (0.75 mi.) from the SLAPS property. The radioactive residues transferred from SLAPS were stored at HISS for a short period in the late 1960s and early 1970s. The residues were purchased by the Commercial Discount Corporation and Cotter Corporation and shipped to Canon City, Colorado between 1967 and 1970. As with SLAPS, elevated radioactivity remains on site due to the practice of storing residues on the open ground. In 1979 the western portion of HISS was sold to Jarboe Realty and Investment Company, which razed the existing buildings and constructed a new facility. This facility is currently leased to Futura Coatings for the production of plastic coatings. There are currently two large, capped piles stored at HISS. One pile contains debris from the 1979 demolition and excavation activities performed to construct the Futura Coatings production facility, and the second contains soils excavated from areas along Latty Avenue that contained elevated radioactivity. HISS is fenced to prevent unauthorized access.

VICINITY PROPERTIES

In addition to the former storage sites, several other areas contain elevated radioactivity either through spills during residue transport on haul routes, runoff and erosion from storage piles, or other transport mechanisms, such as dispersal by wind or re-location by human activities. Haul routes including Latty Avenue, Eva Avenue, Frost Avenue, Hazelwood Avenue, McDonnell Boulevard, and Pershall Road were used to transport the residues between SLAPS and HISS. Various other vicinity properties have been impacted through runoff and erosion of the original storage areas including Coldwater Creek, which flows adjacent to SLAPS for approximately 500 feet. Low levels of elevated radioactivity have been detected in Coldwater Creek sediments along its length from SLAPS until it joins the Missouri River.

EXPOSURE ASSESSMENT METHODS

There have been numerous investigations at the various North County properties beginning in 1982. The primary purpose of these investigations was to determine the nature and extent of the residual radioactive material in the environment, and provide sufficient information to allow the estimation of risks and determine the cost and consequences of remediation alternatives. It has been determined that the primary radiological constituents are thorium-230 (Th-230), radium-226 (Ra-226), and uranium-238 (U-238). This assessment addresses potential exposure of workers who come into contact with these radioisotopes and their associated decay products during routine utility maintenance-related activities.

Given the location and extent of MED/AEC materials in the North County, there is a reasonable probability for utility workers performing routine activities to come into contact with radioactive residues. Because the utility worker is likely to perform maintenance activities which require digging through or generally disturbing soils containing radioactive residues, potential doses to a utility worker are considered separately from average members of the general public. This report assesses potential radiological exposure to utility workers, qualitatively describes the risks associated with exposure, and makes recommendations to minimize exposures.

DOSE ASSESSMENT USING RESRAD

An average utility worker scenario was developed to model potential exposures using conservative yet realistic assumptions. Local utilities were asked to respond to a series of questions related to their maintenance practices. Their responses were used to develop a scenario that includes a worker digging in the top eight feet of soil for two forty-hour workweeks in one year. The worker is assumed to be wearing no special safety gear while undertaking construction activities. These activities are reflected in the modeled breathing rate (12,300 m^3/yr) and soil ingestion rate (175 gm/yr).

Utility worker scenario exposures were modeled using RESRAD Version 5.61 (ANL 1993a-b and ANL 1995). The RESRAD model was designed to calculate exposures associated with residual radioactivity, such as at the North County sites. For this utility worker assessment, exposures were modeled for external gamma, inhalation, and soil ingestion. The model considers numerous human activity and radiological variables. The human activity parameters, such as the frequency and duration of exposure, were defined in the utility worker model scenario. Information obtained from site investigations regarding site-specific values of radiological conditions for the North County area was used in the model (DOE 1995). Where site-specific data were not available, RESRAD default values were used. These default parameters are generally conservative. Doses estimated by the model will generally be higher than actual doses. (Note: site specific geotechnical values are available, but these geotechnical values only affect the model's analysis of groundwater ingestion and ingestion of food grown in impacted soils. Because neither groundwater nor food consumption is evaluated in the utility worker scenario, these site-specific values were not used).

For the purpose of this assessment, the North County area was broken into 15 utility corridor subareas based on radioactivity levels and geographic location. Figure 2 illustrates the location of areas known to contain elevated radioactivity and the boundaries of each utility corridor subarea. The approximate area in square meters (m^2) and reasonable maximum radionuclide concentrations in pCi/g [ninety-five percent upper confidence limit (UCL) of the mean minus background, otherwise referred to as the "reasonable maximum exposure concentration" or RME] were calculated for each subarea.

The RME for each radionuclide for each subarea was used to represent the exposure concentrations for that radionuclide for that subarea. Radionuclide data and surface area estimates for each subarea are presented in Appendix A. It is important to note that cleanup along some areas with utility corridors in St. Louis is ongoing. The locations of elevated areas of radioactivity shown on Figure 2 are based on original data obtained prior to the vicinity property cleanups currently underway.

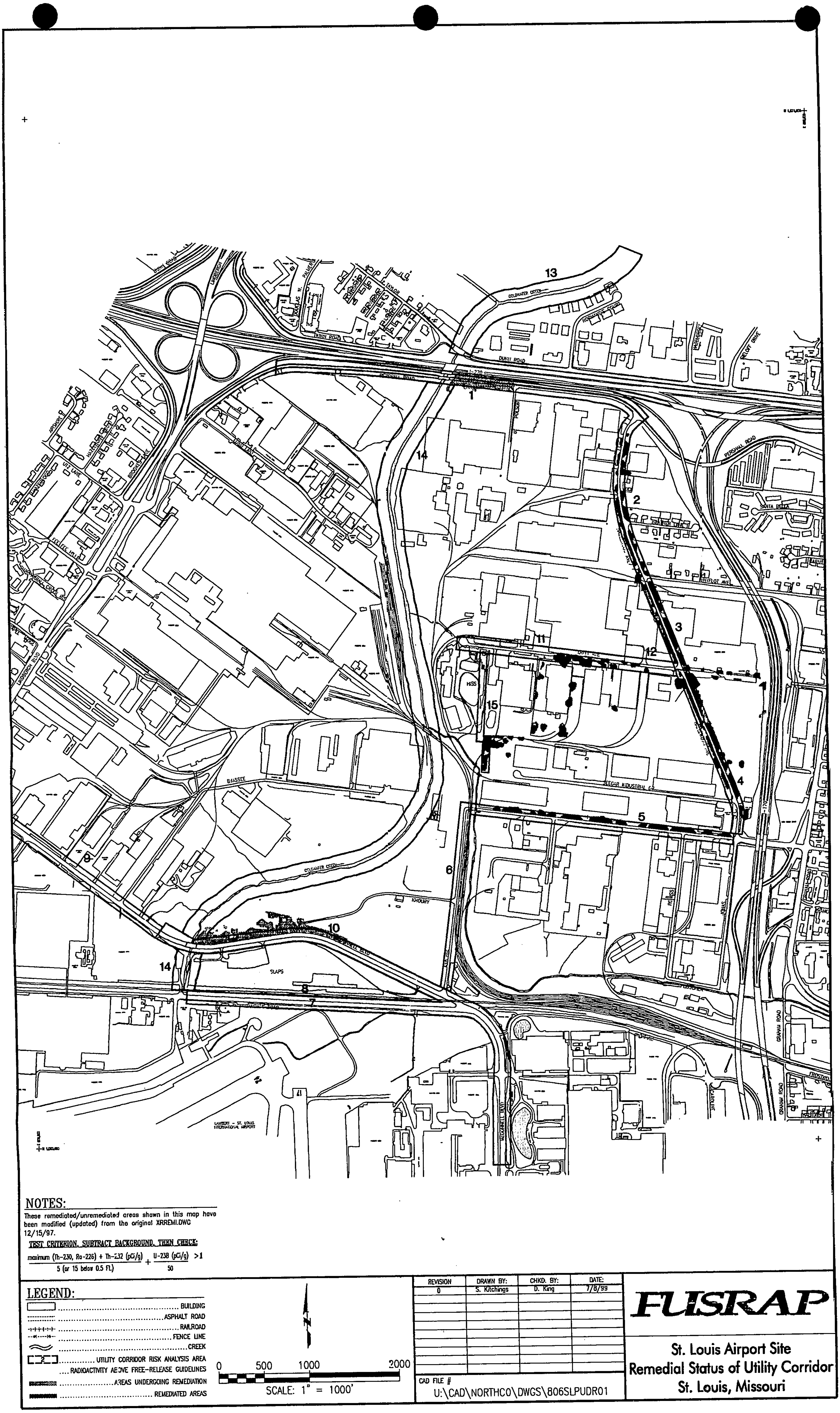

Figure 2. Areas of Known Elevated Radioactivity in the St. Louis North County

Some assumptions have been made to estimate site conditions and approximate a likely exposure scenario. A list of major assumptions is provided below. These conservative yet reasonable assumptions were used both to simplify the model and to assure that results tend to overestimate actual exposures.

1) The utility worker scenario (including duration of exposure, inhalation rate, etc.) is assumed to be a reasonable and conservative representation of the actual exposure conditions. Information was provided by North County utilities to support basic assumptions.

2) Only data results from areas with elevated levels of radionuclides were employed. A significant fraction of the data were collected from areas with radionuclides at levels below current cleanup guidelines. This data was not used in dose estimates so that exposure concentrations are conservative.

3) The RME concentration for each impacted subarea is assumed to be evenly distributed throughout the subarea, even though actual conditions are not uniform.

4) Exposure to radon was not considered given that all utility work is assumed to be outdoors and significant accumulation of radon decay products is unlikely.

5) Site-specific geotechnical data were not used, even though some values are available, because food and water ingestion pathways do not apply to the utility worker scenario.

6) The RESRAD model takes the changing nature of radionuclides and geologic conditions into account, and provides a projection of future doses based on these conditions (i.e., in-growth of radium, erosion of surface soils).

RESULTS

RESRAD RESULTS

The results of utility worker scenario RESRAD modeling for the North County sites are presented in Table 1. The model estimates doses from the combined external gamma, inhalation, and soil ingestion pathways for the three primary radionuclides and their decay products present at these properties. Doses are shown for both current exposures (time = 0) and the maximum doses projected to occur within a 1000-year timeframe. The current exposures are expected to be of most interest to the utility workers.

As shown in Table 1, current year (t = 0) doses estimated for the fifteen subareas range from a high of 22 mrem for Subarea 3 to a low of 1.2 mrem for Subareas 6, 12, and 13. (Subareas are shown on Figures 2). These values are significantly less than the guideline of 100 mrem/yr recommended by the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurement (NCRP) for additional exposure to the general public. These results also generally compare favorably to the NRC's promulgated dose criterion for license termination of 25 mrem/yr. These incremental doses are also within the statistical fluctuation of doses from natural and manmade sources of background radiation (such as cosmic radiation and medical x-rays), which are estimated to provide the average individual with 160 mrem/year of radiation dose (excluding the additional 200 mrem/yr from radon) (NCRP 1987). Table 2 provides a comparison of the length of exposure required in each subarea to approach the 25 mrem/yr and 100 mrem/yr limits.

Table 1. Modeling Results

Subarea	Subarea Description	Dose at Year 0.0 (mrem/yr)	Maximum Dose* (mrem/yr)
1	Pershall Road from Hazelwood Ave. west to boundary of properties 58 & 59	5.0	7.9
2	Hazelwood Ave. from Nyflet north to Pershall Rd.	1.4	1.8
3	Hazelwood Ave. from Nyflet south to Latty Ave.	9.3	22
4	Hazelwood Ave. from Latty Ave. south to Frost Ave.	2.7	4.6
5	Frost Ave.	0.9	3.3
6	Eva Ave.	0.9	1.2
7	South side of Banshee Rd., continuing south on McDonnell Blvd. after intersection	1.3	1.6
8	North side of Banshee Rd., from McDonnell Blvd. west to Coldwater Creek	1.2	1.8
9	McDonnell Blvd. west from the E. boundary of property 12	3.5	4.2
10	McDonnell Blvd. from Banshee intersection to eastern boundary of property 12	10.4	15
11	Latty Ave. west from the boundary between properties 2(L) & 3(L)	2.9	3.9
12	Latty Ave. from boundary between properties 2(L) & 3(L) to Hazelwood Ave.	1.2	1.2
13	Points along Coldwater Creek, north of I-270	0.8	1.2
14	Points along Coldwater Creek, south of I-270	14.1	14.1
15	HISS: sewer line running along eastern property boundary	13.9	13.9
* Combined dose rates from external gamma, inhalation and soil ingestion pathways over the next 1000 years.			

Table 2. Comparison of Dose to 25 mrem and 100 mrem Standards

Subarea	Dose after 2-wk exposure (Year 0.0)	Number of Work Days for 25 mrem Dose	Number of Work Days for 100 mrem Dose
1	5	50	200
2	1.4	179	714
3	9.3	27	108
4	2.7	93	370
5	0.9	278	1111
6	0.9	278	1111
7	1.3	192	769
8	1.2	208	833
9	3.5	71	286
10	10.4	24	96
11	2.9	86	345
12	1.2	208	833
13	0.8	313	1250
14	14.1	18	71
15	13.9	18	72

It is important to note that there is an ongoing effort to remediate vicinity properties in the North County. As material is removed, the average concentrations of radionuclides in those subareas will be reduced. Results in this report may, therefore, overestimate the potential exposures at certain subareas.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Results indicate that exposures to a utility worker in the North County will produce estimated doses below NRC, ICRP and NCRP limits and guidelines. Furthermore, remedial action is already underway for many of the vicinity properties. Remediation will only lower or eliminate the potential exposure to utility workers. For example, Subarea 5 (Frost Avenue) has been remediated along both sides of the road. The only remaining impacted soils in this subarea are beneath the road. Thus, any utility work in the ditches along Frost Avenue can proceed without regard to radiological impacts, unless excavation occurs beneath the road surface. An updated map of the cleanup progress is maintained by the USACE; this map will also be provided on a periodic basis to the utility companies for their continued use in conjunction with this report.

Although it is virtually impossible to predict with great certainty the true future doses to North County utility workers, this assessment demonstrates that under reasonable conservative conditions, the worker will likely not exceed or, in most cases, even approach suggested dose limits and guidelines.

RECOMMENDATIONS

Despite modeling radiation doses below existing and proposed federal regulations, it is a practice of the radiation industry to keep all potential exposures "as low as reasonably achievable" (ALARA). Basic safety precautions are recommended when working in a radiologically impacted area. Training of utility worker safety personnel on radiological hazards and their mitigation (such as misting of dry soils to prevent excessive dusting and potential inhalation) should be conducted to ensure that safe work practices are incorporated into utility worker tasks. All workers should be informed of the nature of the radioactive residues, and given information on how to minimize exposure (such as refraining from eating, drinking, smoking, or partaking in any similar activities that may increase exposures via the inhalation or ingestion pathways).

Table 3 lists doses by pathway including direct gamma, dust inhalation, and soil ingestion. This table can be used to determine how best to minimize exposures. For example, inhalation exposure can be minimized by keeping the soils moist and eliminating dusting, or by wearing respiratory protection (a dust mask would be sufficient to significantly reduce dust inhalation). Soil ingestion can be minimized if workers wash their hands before eating, drinking, or smoking. Direct gamma is controlled only by time (reducing the amount of exposure), distance (operating further away from the source of exposure), or shielding (placing a barrier between the worker and the source of exposure).

Table 3. Major Contributors to Dose at Year 0.0

Subarea	Total Dose at Year 0.0 (mrem/yr)	Dose by Pathway (mrem/yr)		
		Gamma	Inhalation	Soil Ingestion
1	5	1	3.2	0.7
2	1.4	0.4	0.8	0.2
3	9.3	1	6.9	1.3
4	2.7	0.5	1.8	0.4
5	0.9	0.001	0.8	0.1
6	0.9	0.3	0.5	0.1
7	1.3	0.3	0.8	0.2
8	1.2	0.3	0.8	0.2
9	3.5	0.9	2.1	0.5
10	10.4	2	6.7	1.6
11	2.9	0.6	1.8	0.5
12	1.2	0.3	0.7	0.2
13	0.8	0.2	0.5	0.1
14	14.1	4.3	7.3	2.6
15	13.9	4	7.3	2.6

Work in these subareas has the potential to impact equipment used in excavation above the free-release criteria; thus all work in these subareas should be coordinated with the USACE. It is recognized that emergency response to utility breaks will sometimes result in work being performed outside of normal business hours; there is no reason that this work can not proceed prior to USACE involvement. Equipment used in an emergency should be tracked to allow a radiological survey to confirm that the equipment does not require decontamination. Information regarding utility coordination may be obtained from the USACE's FUSRAP Construction Management Office at (314) 524-6821. A radiological health specialist is generally available for consultation for more specific precautions related to a proposed utility project.

REFERENCES

ANL (Argonne National Laboratory) 1993a. *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0.* C. Yu, A.J. Zeilen, J.J. Cheng, Y.C. Yuan, L.G. Jones, D.J. LePoire, Y.Y. Wang, C.O. Loureiro, E. Gnanapragasam, E. Failace, A. Wallo III, W.A. Williams, and H. Peterson. ANL/EAD/LD-2, Argonne National Laboratory, Argonne, Illinois, September.

ANL 1993b. *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil.* C. Yu, C. Loureiro, J.J. Cheng, L.G. Jones, Y.Y. Wang, Y.B. Chia, and E. Faillace. ANL/EAIS-8, Argonne National Laboratory, Argonne, Illinois, April.

ANL 1995. *RESRAD Version 5.61* (Residual Radioactivity Computer Modeling software) C. Yu et al, Argonne National Laboratory, Environmental Assessment Division, Argonne, IL 60439. August.

DOE (Department of Energy) 1995. *Remedial Investigation Addendum for the St. Louis Site, St. Louis, Missouri.* DOE/OR/21950-132, September.

National Council on Radiation Protection and Measurements (NCRP) 1987. *Exposure of the Population in the United States and Canada from Natural Background Radiation.* NCRP Report No. 94, Bethesda, MD, December.

APPENDIX A

Appendix A

Subarea Specific Surface Area and Exposure Point Concentration (EPC) Calculations

Subarea 1: Pershall Road from Hazelwood Ave. west to boundary of properties 58 & 59

Analyte	UCL_{95}		Bkg		RME (pCi/g)	Multiplier[a]	Times What?		EPC[b] (pCi/g)
Ac-227						1.1	Ra-226 RME	=	6.9
Pa-231						1.3	Ra-226 RME	=	8.1
Pb-210						2.4	Ra-226 RME	=	15
Ra-226	7.14	-	0.9	=	6.24	1	Ra-226 RME	=	6.2
Ra-228						0.08	Th-232 RME	=	0.20
Th-228						1	Th-232 RME	=	2.5
Th-230	244	-	1.3	=	242.7	1	Th-230 RME	=	243
Th-232	3.52	-	1.0	=	2.52	1	Th-232 RME	=	2.5
U-234						1	U-238 RME	=	16
U-235						0.046	U-238 RME	=	0.73
U-238	17.0	-	1.1	=	15.9	1	U-238 RME	=	16

Area: 54634 m^2

Subarea 2: Hazelwood Ave. from Nyflet north to Pershall Rd.

Analyte	UCL_{95}		Bkg		RME (pCi/g)	Multiplier[a]	Times What?		EPC[b] (pCi/g)
Ac-227						1.1	Ra-226 RME	=	1.8
Pa-231						1.3	Ra-226 RME	=	2.1
Pb-210						2.4	Ra-226 RME	=	4.0
Ra-226	2.55	-	0.9	=	1.65	1	Ra-226 RME	=	1.7
Ra-228						0.08	Th-232 RME	=	0.13
Th-228						1	Th-232 RME	=	1.7
Th-230	51.6	-	1.3	=	50.3	1	Th-230 RME	=	50
Th-232	2.68	-	1.0	=	1.68	1	Th-232 RME	=	1.7
U-234						1	U-238 RME	=	8.6
U-235						0.046	U-238 RME	=	0.40
U-238	9.69	-	1.1	=	8.59	1	U-238 RME	=	8.6

Area: 20984 m^2

Subarea 3: Hazelwood Ave. from Nyflet south to Latty Ave.

Analyte	UCL_{95}		Bkg		RME (pCi/g)	Multiplier[a]	Times What?		EPC[b] (pCi/g)
Ac-227						1.1	Ra-226 RME	=	8.6
Pa-231						1.3	Ra-226 RME	=	10
Pb-210						2.4	Ra-226 RME	=	19
Ra-226	8.74	-	0.9	=	7.84	1	Ra-226 RME	=	7.8
Ra-228						0.08	Th-232 RME	=	0.094
Th-228						1	Th-232 RME	=	1.2
Th-230	735	-	1.3	=	733.7	1	Th-230 RME	=	734
Th-232	2.17	-	1.0	=	1.17	1	Th-232 RME	=	1.2
U-234						1	U-238 RME	=	13
U-235						0.046	U-238 RME	=	0.59
U-238	14.0	-	1.1	=	12.9	1	U-238 RME	=	13

Area: 12253 m^2

Appendix A

Subarea 4: Hazelwood Ave. from Latty Ave. south to Frost Ave.

Analyte	UCL$_{95}$		Bkg		RME (pCi/g)	Multiplier[a]	Times What?		EPC[b] (pCi/g)
Ac-227						1.1	Ra-226 RME	=	3.4
Pa-231						1.3	Ra-226 RME	=	4.1
Pb-210						2.4	Ra-226 RME	=	7.5
Ra-226	4.03	-	0.9	=	3.13	1	Ra-226 RME	=	3.1
Ra-228						0.08	Th-232 RME	=	0.10
Th-228						1	Th-232 RME	=	1.3
Th-230	146	-	1.3	=	144.7	1	Th-230 RME	=	145
Th-232	2.31	-	1.0	=	1.31	1	Th-232 RME	=	1.3
U-234						1	U-238 RME	=	11
U-235						0.046	U-238 RME	=	0.51
U-238	12.20	-	1.1	=	11.1	1	U-238 RME	=	11

Area: 22246 m^2

Subarea 5: Frost Ave.

Analyte	UCL$_{95}$		Bkg		RME (pCi/g)	Multiplier[a]	Times What?		EPC[b] (pCi/g)
Ac-227						1.1	Ra-226 RME	=	0.0
Pa-231						1.3	Ra-226 RME	=	0.0
Pb-210						2.4	Ra-226 RME	=	0.0
Ra-226	No Data	-	0.9	=		1	Ra-226 RME	=	0.0
Ra-228						0.08	Th-232 RME	=	0.0
Th-228						1	Th-232 RME	=	0.0
Th-230	117	-	1.3	=	115.7	1	Th-230 RME	=	116
Th-232	No Data	-	1.0	=		1	Th-232 RME	=	0.0
U-234						1	U-238 RME	=	0.0
U-235						0.046	U-238 RME	=	0.0
U-238	No Data	-	1.1	=		1	U-238 RME	=	0.0

Area: 32325 m^2

Subarea 6: Eva Ave.

Analyte	UCL$_{95}$		Bkg		RME (pCi/g)	Multiplier[a]	Times What?		EPC[b] (pCi/g)
Ac-227						1.1	Ra-226 RME	=	1.1
Pa-231						1.3	Ra-226 RME	=	1.3
Pb-210						2.4	Ra-226 RME	=	2.4
Ra-226	1.92	-	0.9	=	1.02	1	Ra-226 RME	=	1.0
Ra-228						0.08	Th-232 RME	=	0.12
Th-228						1	Th-232 RME	=	1.4
Th-230	33.5	-	1.3	=	32.2	1	Th-230 RME	=	32
Th-232	2.44	-	1.0	=	1.44	1	Th-232 RME	=	1.4
U-234						1	U-238 RME	=	8.4
U-235						0.046	U-238 RME	=	0.39
U-238	9.54	-	1.1	=	8.44	1	U-238 RME	=	8.4

Area: 22832 m^2

Appendix A

Subarea 7: S. Side Banshee Rd, continuing south on McDonnell Blvd. after intersection

Analyte	UCL_{95}		Bkg		RME (pCi/g)	Multiplier[a]	Times What?		EPC[b] (pCi/g)
Ac-227						1.1	Ra-226 RME	=	1.8
Pa-231						1.3	Ra-226 RME	=	2.2
Pb-210						2.4	Ra-226 RME	=	4.0
Ra-226	2.57	-	0.9	=	1.67	1	Ra-226 RME	=	1.7
Ra-228						0.08	Th-232 RME	=	0.10
Th-228						1	Th-232 RME	=	1.3
Th-230	46.4	-	1.3	=	45.1	1	Th-230 RME	=	45
Th-232	2.26	-	1.0	=	1.26	1	Th-232 RME	=	1.3
U-234						1	U-238 RME	=	9.0
U-235						0.046	U-238 RME	=	0.41
U-238	10.1	-	1.1	=	9	1	U-238 RME	=	9.0

Area: 51776 m^2

Subarea 8: N. side Baschee Rd., from McDonnell Blvd. west to Coldwater Creek

Analyte	UCL_{95}		Bkg		RME (pCi/g)	Multiplier[a]	Times What?		EPC[b] (pCi/g)
Ac-227						1.1	Ra-226 RME	=	1.6
Pa-231						1.3	Ra-226 RME	=	1.8
Pb-210						2.4	Ra-226 RME	=	3.4
Ra-226	2.32	-	0.9	=	1.42	1	Ra-226 RME	=	1.4
Ra-228						0.08	Th-232 RME	=	0.095
Th-228						1	Th-232 RME	=	1.2
Th-230	52.1	-	1.3	=	50.8	1	Th-230 RME	=	51
Th-232	2.19	-	1.0	=	1.19	1	Th-232 RME	=	1.2
U-234						1	U-238 RME	=	11
U-235						0.046	U-238 RME	=	0.50
U-238	12.0	-	1.1	=	10.9	1	U-238 RME	=	11

Area: 18407 m^2

Subarea 9: McDonnell Blvd. west from the E. boundary of property 12

Analyte	UCL_{95}		Bkg		RME (pCi/g)	Multiplier[a]	Times What?		EPC[b] (pCi/g)
Ac-227						1.1	Ra-226 RME	=	5.2
Pa-231						1.3	Ra-226 RME	=	6.2
Pb-210						2.4	Ra-226 RME	=	11
Ra-226	5.67	-	0.9	=	4.77	1	Ra-226 RME	=	4.8
Ra-228						0.08	Th-232 RME	=	0.24
Th-228						1	Th-232 RME	=	3.0
Th-230	117	-	1.3	=	115.7	1	Th-230 RME	=	116
Th-232	4.00	-	1.0	=	3	1	Th-232 RME	=	3
U-234						1	U-238 RME	=	25
U-235						0.046	U-238 RME	=	1.1
U-238[c]	25.70	-	1.1	=	24.6	1	U-238 RME	=	25

Area: 29621 m^2

Appendix A

Subarea 10: McDonnell Blvd. from Banshee Rd. intersection to E. boundary of property 12

Analyte	UCL_{95}		Bkg		RME (pCi/g)	Multiplier[a]	Times What?		EPC[b] (pCi/g)
Ac-227						1.1	Ra-226 RME	=	17
Pa-231						1.3	Ra-226 RME	=	20
Pb-210						2.4	Ra-226 RME	=	37
Ra-226	16.3	-	0.9	=	15.4	1	Ra-226 RME	=	15
Ra-228						0.08	Th-232 RME	=	0.12
Th-228						1	Th-232 RME	=	1.5
Th-230	476	-	1.3	=	474.7	1	Th-230 RME	=	475
Th-232	2.45	-	1.0	=	1.45	1	Th-232 RME	=	1.5
U-234						1	U-238 RME	=	21
U-235						0.046	U-238 RME	=	0.97
U-238	22.10	-	1.1	=	21	1	U-238 RME	=	21

Area: 52464 m^2

Subarea 11: Latty Ave. west from the boundary between properties 2(L) & 3(L)

Analyte	UCL_{95}		Bkg		RME (pCi/g)	Multiplier[a]	Times What?		EPC[b] (pCi/g)
Ac-227						1.1	Ra-226 RME	=	4.7
Pa-231						1.3	Ra-226 RME	=	5.6
Pb-210						2.4	Ra-226 RME	=	10
Ra-226	5.18	-	0.9	=	4.28	1	Ra-226 RME	=	4.3
Ra-228						0.08	Th-232 RME	=	0.083
Th-228						1	Th-232 RME	=	1.0
Th-230	122	-	1.3	=	120.7	1	Th-230 RME	=	121
Th-232	2.04	-	1.0	=	1.04	1	Th-232 RME	=	1.0
U-234						1	U-238 RME	=	15
U-235						0.046	U-238 RME	=	0.69
U-238	16.0	-	1.1	=	14.9	1	U-238 RME	=	15

Area: 12424 m^2

Subarea 12: Latty Ave. from boundary between properties 2(L) & 3(L) to Hazelwood Ave.

Analyte	UCL_{95}		Bkg		RME (pCi/g)	Multiplier[a]	Times What?		EPC[b] (pCi/g)
Ac-227						1.1	Ra-226 RME	=	1.9
Pa-231						1.3	Ra-226 RME	=	2.3
Pb-210						2.4	Ra-226 RME	=	4.2
Ra-226	2.64	-	0.9	=	1.74	1	Ra-226 RME	=	1.7
Ra-228						0.08	Th-232 RME	=	0.080
Th-228						1	Th-232 RME	=	1.0
Th-230	33.1	-	1.3	=	31.8	1	Th-230 RME	=	32
Th-232	2.00	-	1.0	=	1	1	Th-232 RME	=	1.0
U-234						1	U-238 RME	=	11
U-235						0.046	U-238 RME	=	0.50
U-238	12.00	-	1.1	=	10.9	1	U-238 RME	=	11

Area: 20185 m^2

Appendix A

Subarea 13: Points along Coldwater Creek, north of I-270

Analyte	UCL95		Bkg		RME (pCi/g)	Multiplier[a]	Times What?		EPC[b] (pCi/g)
Ac-227						1.1	Ra-226 RME	=	1.1
Pa-231						1.3	Ra-226 RME	=	1.3
Pb-210						2.4	Ra-226 RME	=	2.5
Ra-226	1.93	-	0.9	=	1.03	1	Ra-226 RME	=	1.0
Ra-228						0.08	Th-232 RME	=	0.056
Th-228						1	Th-232 RME	=	0.70
Th-230	35.7	-	1.3	=	34.4	1	Th-230 RME	=	34
Th-232	1.70	-	1.0	=	0.7	1	Th-232 RME	=	0.70
U-234						1	U-238 RME	=	1.3
U-235						0.046	U-238 RME	=	0.060
U-238	2.40	-	1.1	=	1.3	1	U-238 RME	=	1.3

Area: 57458 m^2

Subarea 14: Points along Coldwater Creek, south of I-270

Analyte	UCL95		Bkg		RME (pCi/g)	Multiplier[a]	Times What?		EPC[b] (pCi/g)
Ac-227						1.1	Ra-226 RME	=	36
Pa-231						1.3	Ra-226 RME	=	42
Pb-210						2.4	Ra-226 RME	=	78
Ra-226	33.5	-	0.9	=	32.6	1	Ra-226 RME	=	33
Ra-228						0.08	Th-232 RME	=	0.13
Th-228						1	Th-232 RME	=	1.6
Th-230	64.7	-	1.3	=	63.4	1	Th-230 RME	=	63
Th-232	2.60	-	1.0	=	1.6	1	Th-232 RME	=	1.6
U-234						1	U-238 RME	=	23
U-235						0.046	U-238 RME	=	1.0
U-238	23.8	-	1.1	=	22.7	1	U-238 RME	=	23

Area: 14500773 m^2 (Area too large to model in RESRAD - set to 100,000 m^2)

Subarea 15: HISS: sewer line running along eastern property boundary

Analyte	UCL95		Bkg		RME (pCi/g)	Multiplier[a]	Times What?		EPC[b] (pCi/g)
Ac-227						1.1	Ra-226 RME	=	36
Pa-231						1.3	Ra-226 RME	=	42
Pb-210						2.4	Ra-226 RME	=	78
Ra-226	33.3	-	0.9	=	32.4	1	Ra-226 RME	=	32
Ra-228						0.08	Th-232 RME	=	0.12
Th-228						1	Th-232 RME	=	1.6
Th-230	56.4	-	1.3	=	55.1	1	Th-230 RME	=	55
Th-232	2.56	-	1.0	=	1.56	1	Th-232 RME	=	1.6
U-234						1	U-238 RME	=	56
U-235						0.046	U-238 RME	=	2.6
U-238	57.2	-	1.1	=	56.1	1	U-238 RME	=	56

Area: 9918 m^2

[a] Some progeny values are estimated by multiplying a known analyte value by the muliplier from the BRA Table 2.15 (e.g. multiply the Ac-227 multiplier by the Ra-226 RME value to get the Ac-227 RME value). The HISS/Futura multipliers were used because they are the most conservative.

[b] EPC = exposure point concentration.

[c] No measured values above detection limit. Detection is limit, therefore, used.

Cataloging Form
{Technical/Project Managers fill in C through G, K through Q. RM completes other fields}

A. Document ID Number: Assigned by database 712 | B. *Further Information Required?*: ☐

C. *Operable Unit (Choose One):*
- USACE ☐
- St. Louis Sites ☐
- Downtown ☐
- North County ☒
- Madison Sites ☐
- Inaccessible Areas ☐
- PRP ☐
- Oversight Committee ☐

D. *Site (Optional):*
- SLDS VPs ☐
- Mallinckrodt ☐
- SLAPS ☐
- SLAPS VPs ☐
- CWC ☐
- HISS ☐
- Madison ☐

E. *Area (Optional):* ____________

F. *Primary Document Type (Choose One):*

Site Management Records	☒	Remedial Action	☐
Removal Response	☐	Public Affairs/Community Relations	☐
Remedial Investigation	☐	Congressional Relations	☐
Feasibility Study	☐	Freedom of Information Act	☐
Record of Decision	☐	Real Estate	☐
Remedial Design	☐	Project Management	☐

G. *Secondary Document Type (see back of form):* Health + Endangerment Assessments

H. *Bechtel Number:* ____________ I. *SAIC Number:* ____________

J. *MARKS Number(Choose One):* FN: 1110-1-8100e ☐ FN: 1110-1-8100f ☐ FN: 1110-1-8100g ☐

K. *Subject:/Title:* Final Utility Worker Exposure Assessment for the North County FUSRAP Properties

L. *Author:* ____________ M. *Author's Company:* SAIC

N. *Recipient(s):* ____________ O. *Recipient(s) Company:* USACE

P. *Version (Choose One):* Draft ☐ Final ☒ Q. Date: 7/99

R. *Include in the ARF?* ☒ S. *Include in the AR?* ☐ T. *Filed as Confidential/Privileged?* ☐

U. *Document Format (Choose one):*

Paper	☒	Photographic	☐	Cartographic/Oversize	☐
Electronic	☐	Audio-visual	☐	Microform	☐

V. *Filed in AR Volume Number:* ____________

W. *Physical Location (Choose One):*

Central Files	☒	Microfilm Vendor	☐	In ARF	☐
Records Holding Area	☐	Department of Energy	☐	In AR	☐

X. *Associated with Document(s):* ____________