FINAL

FINAL STATUS SURVEY EVALUATION FOR THE ST. LOUIS DOWNTOWN SITE CITY-OWNED PROPERTY NORTH (METROPOLITAN SEWER DISTRICT (MSD) SALISBURY LIFT STATION) VICINITY PROPERTY

ST. LOUIS, MISSOURI

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

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LIST OF ACRONYMS AND ABBREVIATIONS

BNI	Bechtel National, Inc.
CFR	Code of Federal Regulations
COC	contaminant of concern
cpm	counts per minute
DCGL	derived concentration guideline level
DOD	Department of Defense
DOE	Department of Energy
DQO	data quality objective
EMC	elevated measurement criterion
EPA	Environmental Protection Agency
FSSP	Final Status Survey Plan
FUSRAP	Formerly Utilized Sites Remedial Action Program
HISS	Hazelwood Interim Storage Site
IT	International Technology
m^2	square meter(s)
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mrem/yr	millirem per year
MSD	Metropolitan Sewer District
NAD	normalized absolute difference
NRC	Nuclear Regulatory Commission
pCi/g	picocurics per gram
Ra	radium
ROD	Record of Decision
RPD	relative percent difference
SAG	Sampling and Analysis Guide
SAIC	Science Applications International Corporation
SLDS	St. Louis Downtown Site
SOR	sum of ratio
Th	thorium
U	uranium
USACE	U.S. Army Corps of Engineers
VP	vicinity property
WRS	Wilcoxen Rank Sum

1.0 INTRODUCTION

The following is the evaluation of final status survey data collected from the City-Owned Metropolitan Sewer District (MSD) Salisbury Lift Station Vicinity Property (VP) DT-15 to determine whether the area represented by the data meets the current cleanup goals established in the *Final Status Survey Plan for Accessible Soil Within Plants 3, 6, 6E, 7N, 7W, 8, 9 and the Vicinity Properties* (FSSP) (USACE, 1999) and as specified in the *Record of Decision for the St. Louis Downtown Site* (ROD) (USACE, 1998).

The MSD Salisbury Lift Station property is bounded on the east by the Mississippi River, on the west by the Burlington Northern railroad tracks, on the south by the McKinley Bridge and on the north by Brenen Avenue. The area from which the final status survey data was collected is approximately 1.8 hectares (4.6 acres) and is shown on Figure 1. The MSD Salisbury Lift Station property was investigated from July 20, 2000 to August 3, 2000 and was revisited, to gather additional data (e.g., soil samples) on two occasions, September 6, 2000 and September 27, 2000.

The purpose of this evaluation is to determine whether the final status survey and associated data satisfies the current cleanup goals established in the FSSP. A final status survey was performed over the MSD Salisbury Lift Station property in accordance with the protocols established in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). MARSSIM was developed collaboratively by the Environmental Protection Agency (EPA), Department of Energy (DOE), Department of Defense (DOD), and Nuclear Regulatory Commission (NRC) for the release of real property contaminated with radioactivity. The U.S. Army Corps of Engineers (USACE) has detailed its plans for the design and implementation of the final status surveys at St. Louis Downtown Site (SLDS) City and VPs in the FSSP.

2.0 MARSSIM BACKGROUND

The MARSSIM provides a nationally consistent approach to conducting radiation surveys and investigations of contaminated sites and a standardized approach to demonstrating compliance with dose or risk based regulations known as "release criterion". Exposure pathway modeling is used to calculate radionuclide specific concentration in soil that could result in a dose equal to the release criterion. MARSSIM expresses such a concentration-based release criterion as the derived concentration guideline level (DCGL). Areas with multiple radionuclides that contribute to the total dose have an adjusted DCGL. The adjusted DCGL is referred to as the "unity rule". For the purpose of this report the "unity rule" is described as the sum of ratios (SORs) and is further discussed in Section 2.0 of this report. The DCGL is defined using SOR calculations and is one of the criterion that make up the cleanup goals discussed in Section 2.0 of this report.

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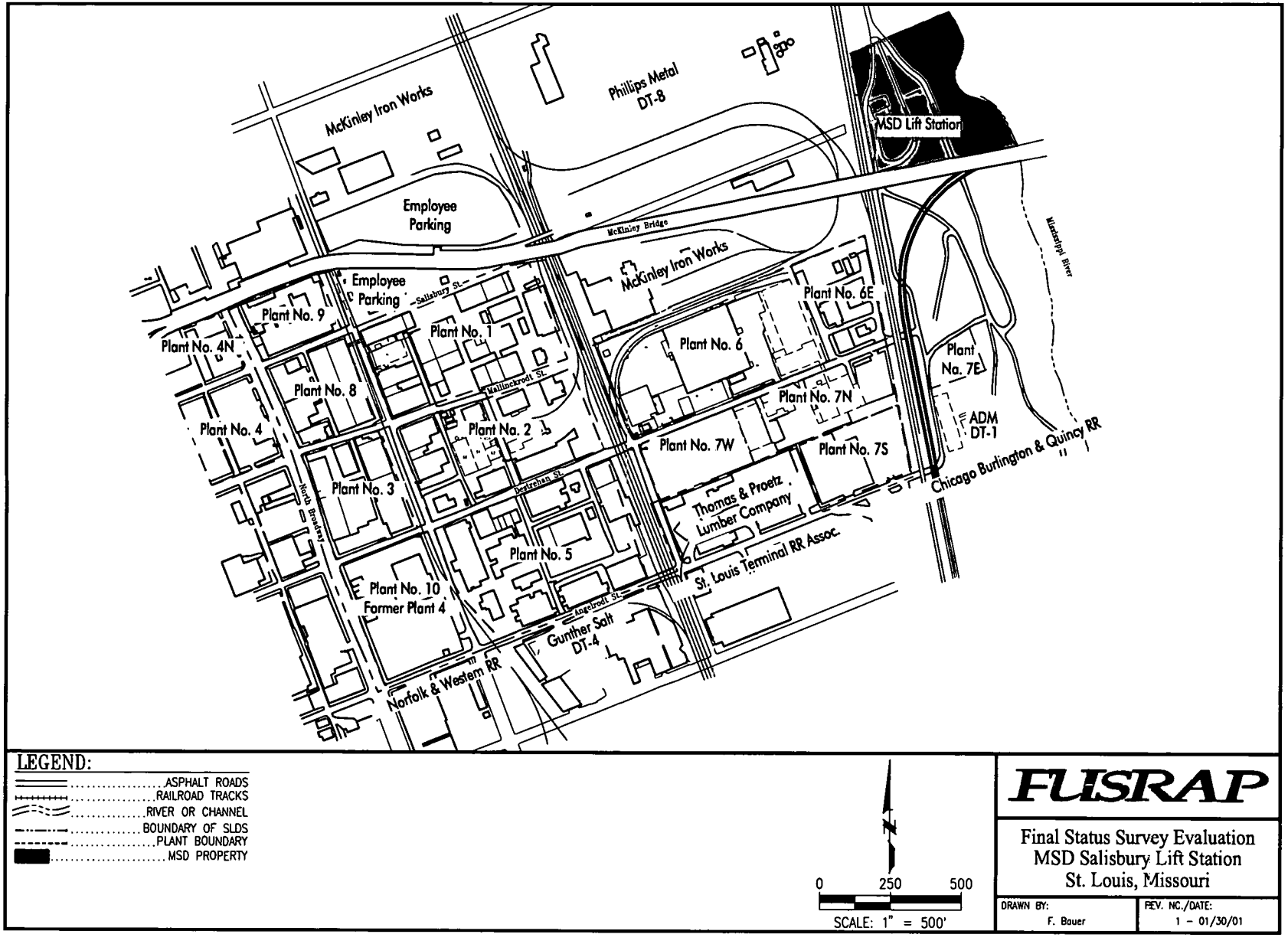

Figure 1. St. Louis Downtown Site - MSD Salisbury Lift Station Vicinity Property

The final status survey demonstrates to the responsible Federal or state agency that the cleanup effort was successful and that the release criterion was met. To make the best use of resources for the final status survey, MARSSIM places greater survey efforts on areas that have, or had, the highest potential for contamination. Classifications is the process by which an area is described according to radiological characteristics and this determines the final status survey design. Areas with a potential for residual contamination are classified as impacted areas. Impacted areas are divided into three classifications; Class 1 areas, Class 2 areas, and Class 3 areas. Class 1 areas have the greatest potential for contamination and therefore receive the highest degree of survey effort for the final status survey, followed by Class 2, and then Class 3.

The number of samples required for an area (i.e., survey unit) depends on many factors including but not limited to: the class designation, the DCGL, statistical testing, area, and minimum detectable concentration of the analytical methods. For Class 1 and Class 2 areas the required number of sample locations are placed over the survey unit using a uniform grid system. Samples collected from this grid system are referred to as "systematic samples" in this report.

3.0 CLEANUP GOALS

To determine if the MSD Salisbury Lift Station property meets the cleanup goals, the following criteria must be met:

1. Evaluate if enough samples were collected to perform the Wilcoxen Rank Sum (WRS) statistical test using actual survey unit data after remediation.

2. Calculate the SOR_N, for the contaminants of concern (COCs) as specified in the ROD, for each sample analyzed. The subscript "N" represents net (i.e., above background) concentrations. To satisfy the concentration-based cleanup goal the SOR_N must be less than 1.0. The SOR_N calculations for surface (top 0.5 feet) and subsurface (below 0.5 feet) soils are defined as follows:

   $SOR_{N\ top\ 0.5\ ft.}$ = (greater of $Th\text{-}230_N$ or $Ra\text{-}226_N$)/5 pCi/g + (greater of $Th\text{-}232_N$ or $Ra\text{-}228_N$)/5 pCi/g + ($U\text{-}238_N$)/50 pCi/g

   $SOR_{N\ below\ 0.5\ ft.}$=(greater of $Th\text{-}230_N$ or $Ra\text{-}226_N$)/15 pCi/g + (greater of $Th\text{-}232_N$ or $Ra\text{-}228_N$)/15 pCi/g + ($U\text{-}238_N$)/50 pCi/g

3. Evaluate areas of elevated activity against the elevated measurement criterion (EMC) established for the survey unit. No single area may have an $SOR_N \geq 1$ when averaged over 100 square meters (m^2) as defined in 40 Code of Federal Regulations (CFR) 192.

4. Perform the WRS statistical test for contaminants present in background, if required. The survey unit must pass the WRS statistical testing protocol specified in the MARSSIM demonstrating that the survey unit as a whole is below the cleanup criteria.

5. Calculate the dose and residual risk of the survey unit for comparison to the applicable guidelines established in the FSSP. The residual dose from the survey unit is limited to the NRC's dose limit of 25 mrem/yr, as defined in 10 CFR 20, Subpart E.

Average background values for calculating net radionuclide concentrations were developed by taking 32 soil samples consisting of 9 native soil samples, 16 common fill samples, and 7 samples that were a mix of native and fill soil from the SLDS reference area. *The Background Soil Characterization Report for the St. Louis Downtown Site* (USACE, 1999b) documents the reference area data development. A summary of the reference area data is presented in Table 1.

4.0 EVALUATION

The remedial action contractor, International Technology (IT) Corporation, reviewed previous data collected by Bechtel National Inc. (BNI) (BNI, 1990; BNI, 1994) on the MSD Salisbury Lift Station property. The review revealed that soil samples from two sample locations exceeded the DCGL established in the ROD. A gamma radiation walkover survey and near surface characterization borings were completed to confirm the horizontal and vertical extent of contamination previously identified by BNI. Near surface characterization boring locations were selected based on previous BNI analytical results and the contamination boundary interpreted by the Science Applications International Corporation (SAIC) three-dimensional model. A total of 10 surface (0 to 0.5 feet) and 10 subsurface (1.5 to 2.0 feet) near surface characterization samples were collected adjacent to two BNI boring locations that previously indicated radiological contamination exceeding DCGL. Near surface characterization samples include those identified as SLD05378 – SLD05397. Sample locations and corresponding identifications numbers are shown on Figure 2. Sample results and SOR_N calculations for the samples are provided in Table 2. No samples from the near surface characterization borings indicated SOR_N values greater than one nor did the gamma radiation walkover survey indicate any areas of elevated radioactivity.

Since no areas exhibiting radiological contamination exceeding the DCGL were identified from the near surface characterization sampling the MSD Lift Station property was classified as a MARSSIM Class 2 survey unit. A Class 2 survey unit is defined by the MARSSIM as a survey unit expected to contain residual radioactivity above background but below the DCGL. The MSD Salisbury Lift Station property is approximately 15,873 m^2 in size. MARRSIM guidance recommends Class 2 areas be 2000 m^2 to 10,000 m^2 and therefore, the MSD Lift Station property was divided into two Class 2 survey units. Survey Unit 1 is approximately 8385 m^2 and Survey Unit 2 is approximately 7475 m^2. The final status survey of both Class 2 survey units included a gamma radiation walkover survey and collection of surface and subsurface systematic soil samples.

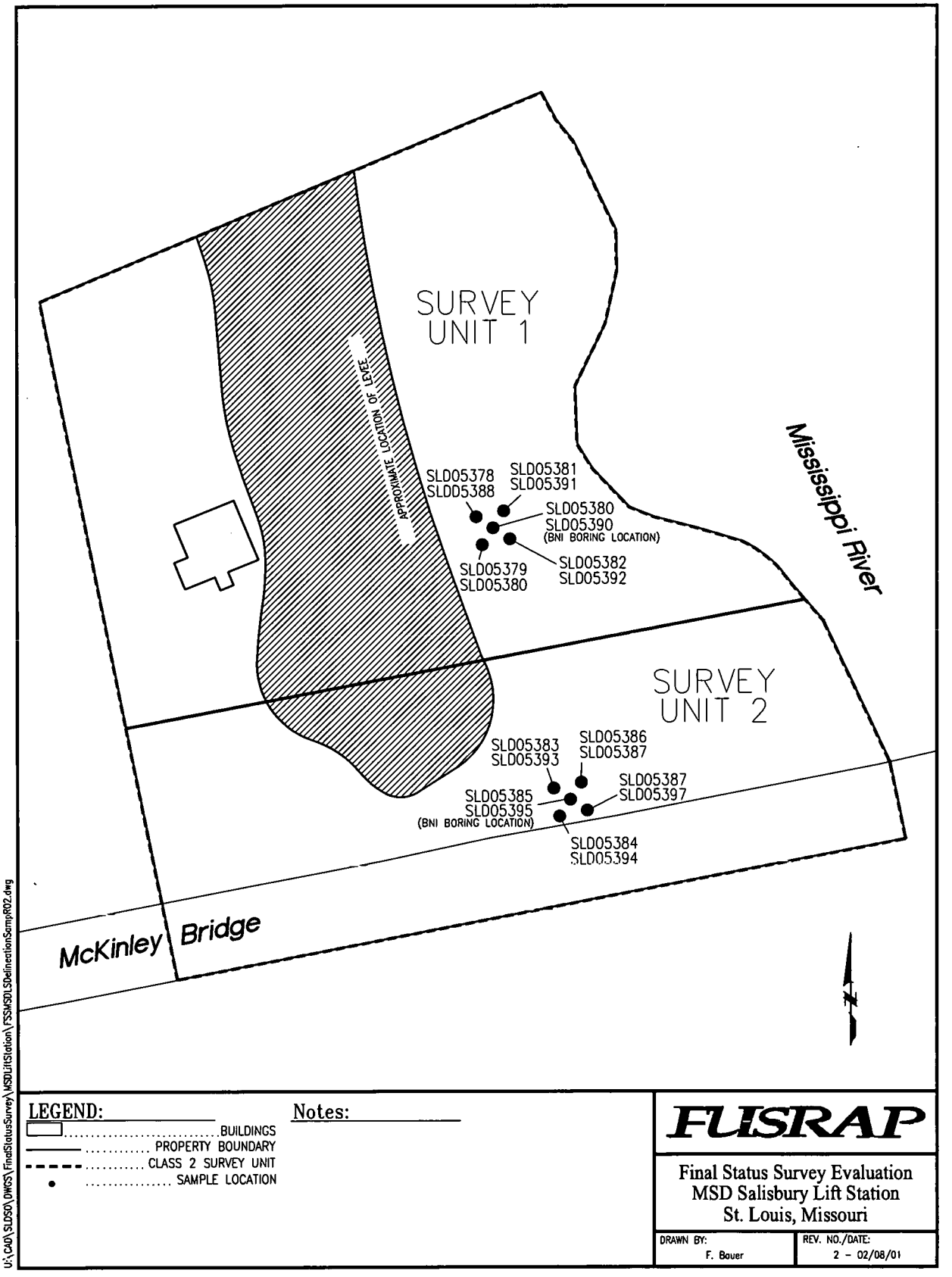

Figure 2. Near Surface Characterization Sample Locations

A gamma radiation walkover survey was performed on both Class 2 survey units as shown on Figure 3. One hundred percent of accessible area of this property was surveyed by gamma radiation walkover with global positioning system assistance. The gamma radiation walkover survey did not indicate any areas of elevated radioactivity above the predetermined investigation level established in the FSSP. The investigation level is set at approximately 2000 count per minute (cpm) above background. The gamma radiation walkover survey results are presented in Figure 3. Buildings and surrounding fenced areas, structures, piles of brick, and steep slopes did not receive a walkover survey and account for the gaps in the walkover survey as shown on Figure 3.

Fifty-two systematic sample boring locations were placed on both survey units that yielded 51 surface (0 to 0.5 feet) soil samples and 50 subsurface (0.5 to 2 feet below existing grade) soil samples. Soil boring locations and sample IDs are shown on Figure 4. Three samples were unable to be collected due to auger refusal. Twenty-seven sample locations were systematically placed across Survey Unit 1 and twenty-five sample locations were systematically placed across Survey Unit 2. Surface and subsurface soil samples were obtained to determine if the COCs concentrations met the DCGL. Subsurface sample cores were screened for radiological contamination using a Ludlum Model 2221 rate meter coupled with a Ludlum Model 44-10 (2x2 sodium iodine) detector. One discrete soil sample from each subsurface core was collected for confirmation analysis based on the highest gamma radiation field screening result from that interval.

The surface and subsurface areas of each survey unit will be evaluated independently. Samples were analyzed for the COCs, which are as follows: Ra-226, Ra-228, Th-230, Th-232, and U-238. Samples were also analyzed for other radionuclides in the natural uranium and thorium chains. Samples were collected in accordance with the FSSP and the *Sampling and Analysis Guide for the St. Louis Sites* (SAG) (USACE, 2000).

Survey Unit 1 had 27 surface and 26 subsurface samples collected. Subsurface sample SLD05373 was not obtained due to auger refusal. Survey Unit 1 surface samples include those identified as SLD05326 – SLD05351 and SLD06060. Survey Unit 1 subsurface samples include those identified as SLD05352 – SLD05377 and SLD06061. Sample locations and corresponding identification numbers are shown on Figure 4. Surface and subsurface sample results are presented in Table 3a and 3b, respectively.

Survey Unit 2 had 24 surface and 24 subsurface samples collected. Surface sample SLD05284 and subsurface sample SLD05308 were not obtained due to auger refusal. Survey Unit 2 surface samples include those identified as SLD05275 – SLD05298 and SLD06062. Survey Unit 2 subsurface samples include those identified as SLD05299 – SLD05322 and SLD06063. Sample locations and corresponding identification numbers are shown on Figure 4. Surface and subsurface sample results are presented in Table 3c and 3d, respectively.

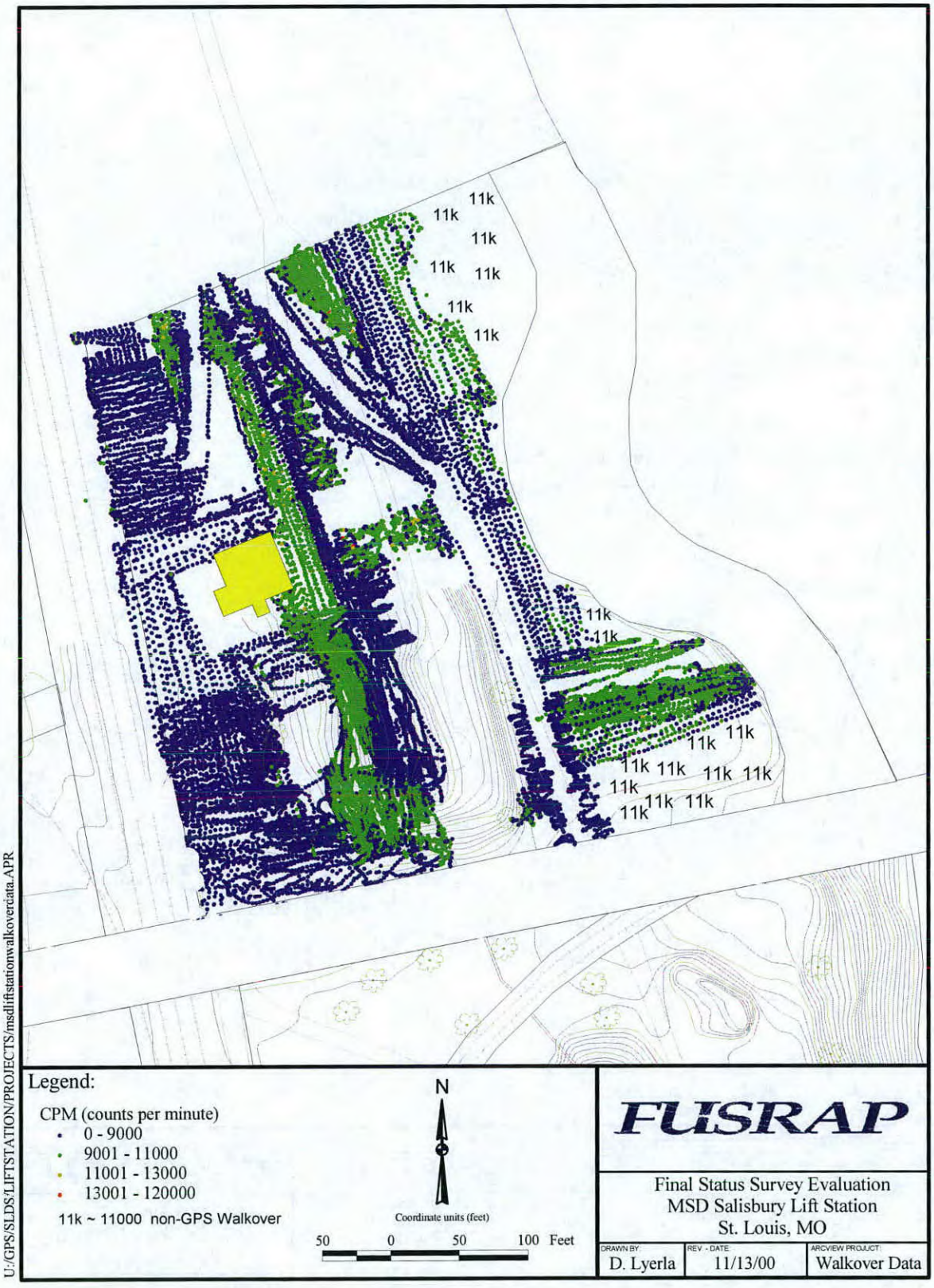

Figure 3. MSD Lift Station Walkover Survey Results

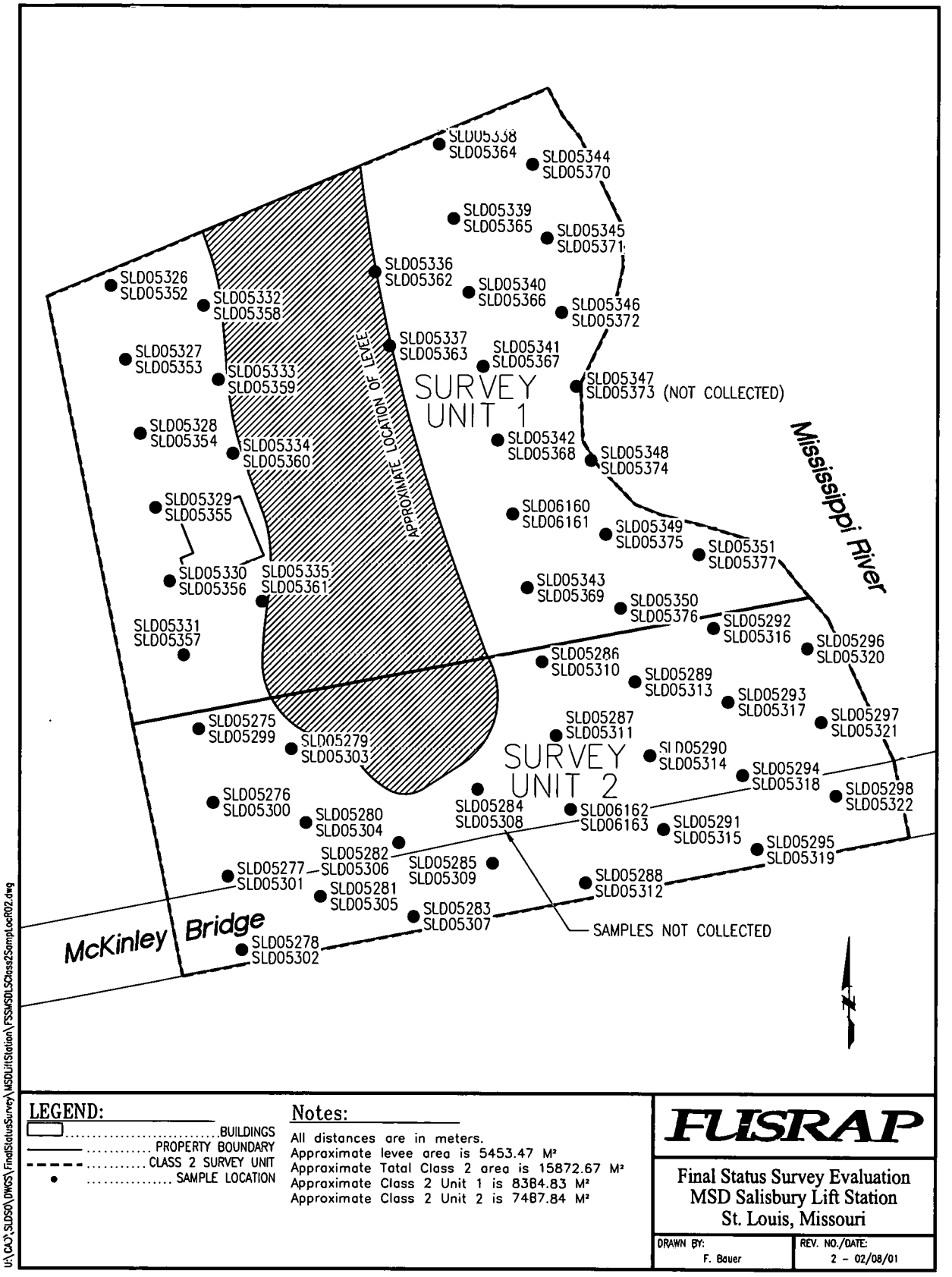

Figure 4. Class 2 Sample Locations

4.1 DETERMINATION OF STATISTICAL DATA POINT REQUIREMENTS

The following calculations are being performed following guidance presented in MARSSIM using the actual data collected from the MSD Lift Station to determine if an adequate number of samples from each survey unit were collected to perform the WRS statistical test:

$\Delta/\sigma_{overall}$ = Relative Shift

Δ = $DCGL_w$ – LBGR (lower bound of the gray region)

From the initial survey design specifications, $DCGL_w$ = 1.0 and the LBGR = 0.5.

$$\sigma_{overall} = [(\sigma_{Ra\text{-}226}/DCGL_{Ra\text{-}226})^2 + (\sigma_{Th\text{-}230}/DCGL_{Th\text{-}230})^2 + (\sigma_{U\text{-}238}/DCGL_{U\text{-}238})^2\ ]^{1/2}$$

The values used for σ_i (i.e., $\sigma_{Ra\text{-}226}$, $\sigma_{Th\text{-}230}$, and $\sigma_{U\text{-}238}$) were calculated from the population of systematic surface and subsurface samples for Survey Unit 1 and Survey Unit 2. A "normal" distribution of data was assumed for calculating statistical parameters. From Table 5.3 in MARSSIM, the required number of samples for the WRS test using the calculated relative shift, a Type I error set at 0.05, and a Type II error set at 0.2 are presented below:

Survey Unit	$\sigma_{Ra\text{-}226}$	$\sigma_{Th\text{-}230}$	$\sigma_{U\text{-}238}$	$\sigma_{overall}$	$\Delta/\sigma_{overall}$	Required # of Samples	Samples Collected
Area 1 surface	0.11	0.80	0.44	0.16	3.09	8	27
Area 1 subsurface	0.14	0.57	0.48	0.12	4.17	7	26
Area 2 surface	0.39	1.18	2.10	0.25	1.98	9	24
Area 2 subsurface	0.56	2.11	1.69	0.44	1.14	15	24

The actual number of samples collected from each survey area of the MSD Lift Station is greater than the required number to satisfy the WRS statistical test.

4.2 SOR CALCULATIONS

The equations used to calculate the sample SOR for the surface samples are as follows:

SOR_N = (greater of Th-230_N or Ra-226_N)/5 pCi/g + (greater of Th-232_N or Ra-228_N)/5 pCi/g + (U-238_N)/50 pCi/g

The equations used to calculate the sample SOR for the subsurface samples are as follows:

SOR_N = (greater of Th-230_N or Ra-226_N)/15 pCi/g + (higher of Th-232_N or Ra-228_N)/15 pCi/g + (U-238_N)/50 pCi/g

The SOR_N calculations for each systematic sample for Survey Unit 1 surface and subsurface, and Survey Unit 2 surface and subsurface are provided in Table 3a, Table 3b, Table 3c and Table 3d, respectively. The greatest SOR_N value was 0.84 calculated for Survey Unit 2 surface sample SLDO5295. The primary contaminants for sample SLD05295 were U-238 at 6.44 pCi/g and Th-230 at 5.64 pCi/g.

4.3 ELEVATED MEASUREMENT CRITERIA EVALUATION

All samples with an $SOR_N \geq 1$ must be evaluated against elevated measurement criteria derived using survey unit specific dose-based area factors. There were no samples with an $SOR_N \geq 1$, therefore the elevated measurement criteria evaluation is not required.

4.4 WILCOXEN RANK SUM (WRS) TEST

To evaluate a survey unit using the WRS test, a similar number of samples from a background reference area are required. However, as stated in Paragraph 8.2.5 of the MARSSIM, if the data clearly show that a survey unit meets or exceeds the release criterion, the formal statistical test may not be required.

Since the difference between the largest measurement in the MSD Lift Station and the smallest background reference area measurement is less than the DCGL ($SOR_N < 1.0$), the data meets the release criterion without performing the statistical test. Therefore, the WRS test is not required.

4.5 RESIDUAL DOSE

The residual dose from the survey unit was calculated for the potential maximum exposed individual. The residual dose resulting from the MSD Lift Station at Year 0 and Year 1000 was calculated using the 95% UCL from the population of all samples collected. The surface and subsurface of each survey unit were evaluated independently. The results of UCL_{95} calculations are in Table 3a and Table 3d for each respective survey unit. The residual industrial worker dose from Survey Unit 1 surface and subsurface is shown in Table 4a. The residual industrial worker dose from Survey Unit 2 surface and subsurface is shown in Table 4b. Base on the size of each survey unit the residual dose estimate for the entire property is <1 mrem. This meets the 10 CFR 20, Subpart E, criteria of 25 mrem/yr.

5.0 QUALITY ASSURANCE AND QUALITY CONTROL

Precision and accuracy are determined by the analysis of field duplicate samples and split samples. Precision is measured by comparing the analytical results of the field duplicates, which are samples taken at the same location as the sample they duplicate and analyzed in the same laboratory. Accuracy is measured by comparing the results of split samples, which are aliquots of samples analyzed by a separate laboratory. MSD Salisbury Lift Station Property split samples were analyzed by the onsite Formerly Utilized Sites Remedial Action Program (FUSRAP) laboratory at the Hazelwood Interim Storage Site (HISS).

The data quality objectives (DQOs) established in the (SAG) (USACE, 2000) require that 5% of the total number of samples be duplicated and split with another laboratory. A total of 3 splits and 3 duplicates were obtained from 101 samples collected during the final status survey. The objectives set by the FSSP were to achieve a relative percent difference (RPD) between duplicate samples of 30% or less at 50% of the DCGL value. Only three of the five field duplicate samples were taken; however, the RPD and normalized absolute difference (NAD) for these samples exhibited excellent precision therefore through proper implementation of the project data verification, validation, and assessment process, project information has been determined to be acceptable for use. The results of duplicate samples are shown in Appendix A. The objectives set by the FSSP were to achieve an accuracy of ±30% at 50% of the DCGL value. Of the 3 sets of quality assurance samples, 99% of the field duplicate comparisons indicated acceptable precision and 100% of the quality assurance split sample comparisons indicated acceptable accuracy. The detailed results of the quality control analysis for MSD Salisbury Lift Station Property data are provided in Appendix A, MSD Salisbury Lift Station Property Quality Control Summary Report.

6.0 CONCLUSIONS

The SLDS City Property MSD Salisbury Lift Station meets the COCs DCGL established in the ROD. No further action, institutional controls or land use restrictions will be implemented at this property. The MSD Salisbury Lift Station VP DT-15 is released without radiological restrictions.

7.0 REFERENCES

BNI, 1990. *Radiological, Chemical, and Hydrogeological Characterization Report for the St. Louis Downtown Site in St. Louis, Missouri*, Revision 1, DOE/OR/20722-258, Oak Ridge, Tennessee. September.

BNI, 1994. *Remedial Investigation Report for the St. Louis Site*, DOE/OR/21949-280, St. Louis Missouri. January.

USACE, 1998. *Record of Decision for the St. Louis Downtown Site, St. Louis, Missouri.* Final, July.

USACE, 1999. *Final Status Survey Plan for Accessible Soil Within Plants 3, 6, 6E, 7N, 7W, 8, 9 and the Vicinity Properties.* Final, September.

USACE, 1999b. *The Background Soil Characterization Report for the St. Louis Downtown Site, St. Louis, Missouri,* Final, March.

USACE, 2000. *Sampling and Analysis Guide for the St. Louis Sites.* Final, October.

TABLES

Table 1. MARSSIM Reference Data Summary - SLDS

Statistic	Th-230 (pCi/g)	Ra-226 (pCi/g)	Th-232 (pCi/g)	Ra-228 (pCi/g)	U-238 (pCi/g)	Ac-227 (pCi/g)	Pa-231 (pCi/g)	SOR (5/5/50)
Mean	1.94	2.78	1.09	0.95	1.44	0.14	0.90	0.82
UCL-95	2.18	3.04	1.18	1.00	1.67	0.18	1.12	-
St. Dev	0.76	0.89	0.29	0.17	0.75	0.14	0.76	0.21
No. Samples	32	32	32	32	32	32	32	32
SLD00001	2.07	1.94	1.11	0.97	1.66	0.18	0.62	0.67
SLD00002	1.67	2.39	1.12	1.03	0.61	-0.03	2.34	0.71
SLD00022	1.83	2.56	1.49	1.17	1.38	0.36	1.33	0.84
SLD00023	2.80	2.26	1.23	0.76	1.17	0.29	0.95	0.83
SLD00041	1.98	2.48	1.13	0.84	1.57	0.16	-0.09	0.75
SLD00042	2.24	3.02	1.05	1.07	1.80	0.7	-0.02	0.85
SLD00043	2.69	2.59	1.68	0.99	1.15	0.28	2.07	0.90
SLD00044	1.16	3.46	1.33	1.03	0.90	0.13	1.65	0.98
SLD00061	2.67	3.11	1.43	1.08	1.47	0.1	1.23	0.94
SLD00062	1.91	2.59	1.59	1.28	0.94	0.12	1.36	0.85
SLD00063	1.61	2.11	0.70	1.03	0.74	0.15	2.12	0.64
SLD00081	1.47	2.44	1.30	0.96	1.05	0.24	0.98	0.77
SLD00082	1.97	2.89	1.17	1.28	1.28	0.06	1.19	0.86
SLD00083	1.94	2.33	0.69	0.88	0.59	0.2	0.98	0.65
SLD00101	3.05	4.24	0.90	0.79	3.12	0.15	1.01	1.09
SLD00102	3.11	3.53	1.41	0.86	2.53	0.06	1.42	1.04
SLD00103	1.46	3.08	0.92	0.81	1.69	0.08	1.3	0.83
SLD00121	2.25	3.31	1.34	0.87	1.84	0.17	-0.1	0.97
SLD00122	1.46	2.68	0.94	0.85	1.13	0.09	0.42	0.75
SLD00123	1.33	3.51	0.94	1.02	1.17	0.23	0.25	0.93
SLD00141	4.15	5.46	1.56	1.04	3.78	0.16	-0.21	1.48
SLD00142	3.61	5.30	1.04	1.12	3.15	0.08	0.33	1.35
SLD00143	1.45	2.33	1.02	0.96	0.93	0.19	0.02	0.69
SLD00144	1.48	2.04	1.25	1.10	1.61	0.1	0.01	0.69
SLD00161	1.56	1.53	1.01	0.86	1.11	0.1	0.11	0.54
SLD00162	1.35	2.07	0.86	1.04	1.00	0.04	2.01	0.64
SLD00181	1.34	2.24	0.78	0.73	0.91	0.03	1.13	0.62
SLD00201	1.64	2.40	1.08	0.86	1.15	0.06	1.74	0.72
SLD00202	1.62	2.67	0.78	0.97	1.11	-0.1	1.73	0.75
SLD00241	1.28	2.04	0.43	0.46	1.70	0.01	-0.04	0.53
SLD00242	1.05	2.50	0.80	0.89	0.92	0.07	0.42	0.70
SLD00243	0.96	1.97	0.90	0.65	0.86	0.03	0.37	0.59

Table 2. Delineation Samples

Reference Area Data Summary

Statistic	Ra-226 (pCi/g)	Th-230 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g)	Th-232 (pCi/g)	Ra-228 (pCi/g)	Th-228 (pCi/g)	Ac-227 (pCi/g)	Pa-231 (pCi/g)	SOR_B (5/5/50)	SOR_B (15/15/50)
Mean	2.78	1.94	1.44	0.09	1.09	0.95	1.16	0.14	0.89	0.82	0.29
Median	2.53	1.66	1.16	0.08	1.07	0.97	1.10	0.11	0.98	0.76	0.27
UCL-95	3.04	2.18	1.67	0.12	1.18	1.00	1.26	0.18	1.12	-	-
St. Dev	0.89	0.76	0.75	0.08	0.29	0.17	0.35	0.14	0.76	0.21	0.08
Range	3.93	3.19	3.19	0.33	1.25	0.82	1.59	0.80	2.55	0.95	0.35
Detects	32	32	32	0	32	32	32	7	13	-	-
No. Samples (m)	32	32	32	32	32	32	32	32	32	32	32

MSD Lift Station Delineation Samples

Statistic/Sample	Depth (in)	Ra-226 (pCi/g)	Th-230 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g	Th-232 (pCi/g)	Ra-228 (pCi/g)	Th-228 (pCi/g)	Ac-227 (pCi/g)	Pa-231 (pCi/g)	SOR_N (5/5/50)	SOR_N (15/15/50)
Mean	-	0.97	1.94	1.19	0.13	0.75	0.75	0.75	0.15	0.10	0.23	0.05
Median	-	0.86	2.32	1.08	0.13	0.80	0.80	0.80	0.17	0.17	0.13	0.02
St. Dev	-	0.29	2.30	0.47	0.05	0.21	0.21	0.21	0.06	0.22	0.27	0.07
Range	-	1.24	8.02	1.67	0.15	0.71	0.71	0.71	0.21	0.85	0.73	0.19
Maximum	-	1.86	5.62	2.33	0.20	1.02	1.02	1.02	0.26	0.35	0.73	0.19
No. Samples (n)	-	20	20	20	20	20	20	20	20	20		-
Student $t_{(n-1)}$ test		1.729	1.729	1.729	1.729	1.729	1.729	1.729	1.729	1.729		
UCL (normal)		1.08	2.83	1.37	0.14	0.83	0.83	0.83	0.17	0.19		
Sample ID												
SLD05378	0-6	0.83	3.97	0.86	0.06	0.45	0.45	0.45	0.10	0.32	0.406	
SLD05388	18-24	0.85	3.08	0.79	0.17	0.91	0.91	0.91	0.21	-0.18		0.076
SLD05379	0-6	0.85	1.73	1.25	0.19	0.42	0.42	0.42	0.06	0.22	0.000	
SLD05389	18-24	1.15	0.60	1.72	0.08	0.77	0.77	0.77	0.18	0.02		0.006
SLD05380	0-6	0.62	5.62	0.77	0.05	0.31	0.31	0.31	0.06	0.19	0.735	
SLD05390	18-24	0.78	1.19	0.92	0.13	0.94	0.94	0.94	0.16	0.33		0.000
SLD05381	0-6	0.74	2.74	0.94	0.14	0.69	0.69	0.69	0.08	0.15	0.159	
SLD05391	18-24	0.94	4.76	0.66	0.18	0.83	0.83	0.83	0.18	0.13		0.188
SLD05382	0-6	0.86	-1.57	0.80	0.15	0.62	0.62	0.62	0.14	0.21	0.000	
SLD05392	18-24	0.82	1.04	0.89	0.05	0.82	0.82	0.82	0.09	-0.23		0.000
SLD05383	0-6	0.80	-0.84	0.92	0.06	0.88	0.88	0.88	0.11	0.02	0.000	
SLD05393	18-24	1.49	-2.40	2.25	0.17	0.93	0.93	0.93	0.21	0.33		0.016
SLD05384	0-6	0.93	3.00	1.15	0.14	0.99	0.99	0.99	0.20	0.25	0.220	
SLD05394	18-24	1.26	-1.60	2.33	0.11	0.61	0.61	0.61	0.19	0.18		0.018
SLD05385	0-6	0.94	5.13	1.40	0.20	1.02	1.02	1.02	0.26	0.35	0.653	
SLD05395	18-24	1.86	3.01	1.72	0.17	0.95	0.95	0.95	0.18	-0.03		0.077
SLD05386	0-6	0.78	2.46	1.04	0.08	0.60	0.60	0.60	0.17	0.03	0.104	
SLD05396	18-24	0.90	0.72	1.15	0.13	0.93	0.93	0.93	0.22	-0.02		0.000
SLD05387	0-6	0.85	2.18	1.12	0.08	0.74	0.74	0.74	0.10	-0.50	0.048	
SLD05397	18-24	1.06	4.04	1.13	0.16	0.59	0.59	0.59	0.06	0.30		0.140

Table 3a. Survey Unit 1 Surface Samples

Reference Area Data Summary

Statistic	Ra-226 (pCi/g)	Th-230 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g)	Th-232 (pCi/g)	Ra-228 (pCi/g)	Th-228 (pCi/g)	Ac-227 (pCi/g)	Pa-231 (pCi/g)	SOR_B (5/5/50)	SOR_B (15/15/50)
Mean	2.78	1.94	1.44	0.09	1.09	0.95	1.16	0.14	0.89	0.82	0.29
Median	2.53	1.66	1.16	0.08	1.07	0.97	1.10	0.11	0.98	0.76	0.27
UCL-95	3.04	2.18	1.67	0.12	1.18	1.00	1.26	0.18	1.12	-	-
St. Dev	0.89	0.76	0.75	0.08	0.29	0.17	0.35	0.14	0.76	0.21	0.08
Range	3.93	3.19	3.19	0.33	1.25	0.82	1.59	0.80	2.55	0.95	0.35
Detects	32	32	32	0	32	32	32	7	13	-	-
No. Samples	32	32	32	32	32	32	32	32	32	-	-

MSD Lift Station Survey Unit 1 Surface Samples

Statistic/Sample	Ra-226 (pCi/g)	Th-230 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g	Th-232 (pCi/g)	Ra-228 (pCi/g)	Th-228 (pCi/g)	Ac-227 (pCi/g)	Pa-231 (pCi/g)	SOR_N (5/5/50)
Mean	0.77	1.68	1.03	0.06	0.87	0.64	0.98	0.09	0.17	0.05
Median	0.78	1.45	0.99	0.06	0.89	0.77	1.02	0.08	0.16	0.01
St. Dev	0.11	0.80	0.44	0.05	0.39	0.29	0.43	0.07	0.24	0.12
Range	0.42	4.02	1.73	0.20	1.29	0.91	1.70	0.27	0.91	0.61
Maximum	0.96	5.01	1.99	0.16	1.41	1.03	1.79	0.26	0.69	0.61
No. Samples (n)	27	27	27	27	27	27	27	27	27	-
Student $t_{(n-1)}$ test	1.706	1.706	1.706	1.706	1.706	1.706	1.706	1.706	1.706	-
UCL (normal)	0.81	1.94	1.18	0.08	0.99	0.74	1.12	0.11	0.25	-
Sample ID										
SLD05326	0.70	1.34	1.42	0.12	0.80	0.44	0.95	0.11	-0.04	0.00
SLD05327	0.78	1.97	0.91	0.07	0.89	0.41	1.37	0.01	0.48	0.01
SLD05328	0.83	0.99	1.17	0.01	0.57	0.57	0.73	0.07	0.55	0.00
SLD05329	0.53	1.03	0.45	0.10	0.33	0.25	0.24	0.05	-0.16	0.00
SLD05330	0.58	1.25	0.74	0.05	0.45	0.17	0.51	0.06	-0.09	0.00
SLD05331	0.66	1.27	0.68	0.00	0.58	0.25	0.72	0.05	0.30	0.00
SLD05332	0.79	2.25	1.83	0.08	0.97	1.03	1.55	0.13	0.49	0.09
SLD05333	0.74	1.61	0.26	0.05	0.70	0.75	1.33	-0.01	0.18	0.00
SLD05334	0.70	1.83	0.85	0.03	0.46	0.22	0.82	0.10	0.17	0.00
SLD05335	0.72	2.09	0.71	0.08	0.29	0.13	0.09	-0.01	-0.19	0.03
SLD05336	0.80	1.70	1.79	0.08	1.31	0.97	1.14	0.15	0.02	0.05
SLD05337	0.60	5.01	0.77	0.07	0.12	0.12	0.12	0.04	0.39	0.61
SLD05338	0.92	1.52	0.57	0.12	0.46	0.84	1.24	0.07	0.69	0.00
SLD05339	0.93	1.00	0.98	0.07	1.10	0.84	1.17	0.26	0.11	0.00
SLD05340	0.85	2.00	1.59	0.16	0.83	0.86	1.10	0.11	0.26	0.01
SLD05341	0.80	1.45	0.39	0.16	1.36	0.82	1.02	-0.01	0.10	0.05
SLD05342	0.78	2.72	1.99	-0.04	1.27	0.77	1.79	0.16	0.16	0.20
SLD05343	0.82	2.14	1.07	0.06	1.03	0.43	0.92	0.08	0.15	0.04
SLD05344	0.80	1.42	1.12	0.15	1.36	0.87	1.14	0.16	-0.05	0.05
SLD05345	0.77	1.64	1.28	0.02	1.40	0.88	1.48	0.12	0.14	0.06
SLD05346	0.96	1.85	1.17	0.03	1.17	1.01	1.52	0.06	0.39	0.02
SLD05347	0.95	1.41	1.53	0.05	0.55	0.90	1.41	0.17	0.26	0.00
SLD05348	0.82	1.39	1.04	0.06	1.41	0.86	0.74	0.15	0.17	0.06
SLD05349	0.87	0.99	1.00	0.04	1.13	0.77	0.85	0.18	-0.21	0.01
SLD05350	0.62	1.13	0.99	0.08	1.29	0.71	0.84	-0.01	-0.16	0.04
SLD05351	0.74	1.26	0.80	0.01	0.60	0.81	1.08	0.10	0.03	0.00
SLD06160	0.78	1.10	0.83	-0.01	0.96	0.64	0.67	0.00	0.41	0.00

Table 3b. Survey Unit 1 Subsurface Samples

Reference Area Data Summary

Statistic	Ra-226 (pCi/g)	Th-230 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g)	Th-232 (pCi/g)	Ra-228 (pCi/g)	Th-228 (pCi/g)	Ac-227 (pCi/g)	Pa-231 (pCi/g)	SOR_B (5/5/50)	SOR_B (15/15/50)
Mean	2.78	1.94	1.44	0.09	1.09	0.95	1.16	0.14	0.89	0.82	0.29
Median	2.53	1.66	1.16	0.08	1.07	0.97	1.10	0.11	0.98	0.76	0.27
UCL-95	3.04	2.18	1.67	0.12	1.18	1.00	1.26	0.18	1.12	-	-
St. Dev	0.89	0.76	0.75	0.08	0.29	0.17	0.35	0.14	0.76	0.21	0.08
Range	3.93	3.19	3.19	0.33	1.25	0.82	1.59	0.80	2.55	0.95	0.35
Detects	32	32	32	0	32	32	32	7	13	-	-
No. Samples	32	32	32	32	32	32	32	32	32	-	-

MSD Lift Station Survey Unit 1 Subsurface Samples

Statistic/Sample	Ra-226 (pCi/g)	Th-230 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g	Th-232 (pCi/g)	Ra-228 (pCi/g)	Th-228 (pCi/g)	Ac-227 (pCi/g)	Pa-231 (pCi/g)	SOR_N (15/15/50)
Mean	0.89	1.78	1.17	0.08	0.91	0.71	1.07	0.12	0.06	0.02
Median	0.91	1.64	1.07	0.07	0.97	0.84	1.15	0.11	0.01	0.01
St. Dev	0.14	0.57	0.48	0.09	0.40	0.33	0.47	0.08	0.23	0.03
Range	0.60	2.62	2.12	0.38	1.61	1.00	2.06	0.36	0.74	0.11
Maximum	1.24	3.64	2.34	0.33	1.67	1.09	2.10	0.36	0.42	0.11
No. Samples (n)	26	26	26	26	26	26	26	26	26	-
Student $t_{(n-1)}$ test	1.708	1.708	1.708	1.708	1.708	1.708	1.708	1.708	1.708	-
UCL (normal)	0.94	1.97	1.34	0.11	1.04	0.82	1.23	0.15	0.14	-
Sample ID										
SLD05352	0.83	1.68	1.70	0.03	0.72	0.50	1.05	0.08	-0.32	0.01
SLD05353	0.73	3.64	0.21	0.09	1.09	0.42	0.70	0.17	0.09	0.11
SLD05354	0.71	1.32	0.94	0.10	0.72	0.37	0.77	0.07	0.00	0.00
SLD05355	0.77	1.17	0.99	0.02	0.32	0.33	0.44	0.01	0.17	0.00
SLD05356	0.65	1.03	0.75	0.08	0.43	0.20	1.17	0.03	-0.12	0.00
SLD05357	0.75	1.63	1.27	0.14	0.85	0.31	1.07	0.10	-0.08	0.00
SLD05358	0.87	1.96	2.15	-0.03	1.31	1.02	1.37	0.13	-0.07	0.03
SLD05359	0.87	1.38	0.82	0.00	0.99	1.04	1.29	0.17	-0.02	0.01
SLD05360	0.83	1.29	0.64	-0.03	0.07	0.09	0.04	0.08	-0.32	0.00
SLD05361	0.92	1.53	1.04	0.07	1.18	0.94	1.32	0.22	0.30	0.01
SLD05362	0.89	2.61	0.87	-0.02	1.39	1.03	1.15	0.19	-0.03	0.06
SLD05363	0.65	1.60	1.49	0.05	0.06	0.12	0.23	0.05	-0.09	0.00
SLD05364	0.83	1.34	1.47	0.17	0.77	0.96	0.86	0.12	-0.18	0.00
SLD05365	0.83	1.65	1.08	-0.05	1.06	1.04	1.16	0.11	0.29	0.01
SLD05366	0.97	2.10	1.28	0.12	0.98	0.82	1.67	0.05	0.30	0.01
SLD05367	1.09	2.42	1.80	0.15	0.64	0.75	1.26	0.13	0.00	0.04
SLD05368	0.99	1.63	1.05	0.21	1.05	0.73	0.90	0.11	0.40	0.00
SLD05369	1.01	1.86	1.21	0.06	1.67	1.03	1.44	0.21	0.36	0.04
SLD05370	0.99	2.19	1.17	0.16	0.95	0.84	2.10	0.07	0.32	0.02
SLD05371	1.04	1.88	1.03	0.07	1.02	0.96	0.87	0.13	0.42	0.00
SLD05372	1.24	2.26	1.52	0.33	1.35	0.91	1.77	-0.01	-0.31	0.04
SLD05374	0.93	1.34	0.87	0.04	0.86	0.85	1.38	0.13	0.02	0.00
SLD05375	0.92	2.06	0.77	0.12	1.09	0.94	0.81	0.28	0.11	0.01
SLD05376	0.95	2.31	2.34	0.12	0.92	0.94	1.54	0.06	-0.13	0.04
SLD05377	0.92	1.21	0.61	0.04	1.55	1.09	1.17	0.36	0.19	0.03
SLD06161	1.06	1.24	1.47	0.02	0.57	0.32	0.43	0.04	0.34	0.00

Table 3c. Survey Unit 2 Surface Samples

Reference Area Data Summary

Statistic	Ra-226 (pCi/g)	Th-230 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g)	Th-232 (pCi/g)	Ra-228 (pCi/g)	Th-228 (pCi/g)	Ac-227 (pCi/g)	Pa-231 (pCi/g)	SOR_B (5/5/50)	SOR_B (15/15/50)
Mean	2.78	1.94	1.44	0.09	1.09	0.95	1.16	0.14	0.89	0.82	0.29
Median	2.53	1.66	1.16	0.08	1.07	0.97	1.10	0.11	0.98	0.76	0.27
UCL-95	3.04	2.18	1.67	0.12	1.18	1.00	1.26	0.18	1.12	-	-
St. Dev	0.89	0.76	0.75	0.08	0.29	0.17	0.35	0.14	0.76	0.21	0.08
Range	3.93	3.19	3.19	0.33	1.25	0.82	1.59	0.80	2.55	0.95	0.35
Detects	32	32	32	0	32	32	32	7	13	-	-
No. Samples	32	32	32	32	32	32	32	32	32	-	-

MSD Lift Station Survey Unit 2 Surface Samples

Statistic/Sample	Ra-226 (pCi/g)	Th-230 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g	Th-232 (pCi/g)	Ra-228 (pCi/g)	Th-228 (pCi/g)	Ac-227 (pCi/g)	Pa-231 (pCi/g)	SOR_N (5/5/50)
Mean	1.01	2.15	2.07	0.11	0.91	0.72	1.17	0.14	0.10	0.13
Median	0.85	1.74	1.47	0.09	1.03	0.79	1.20	0.14	0.14	0.04
St. Dev	0.39	1.18	2.10	0.12	0.38	0.27	0.46	0.10	0.32	0.21
Range	1.45	4.80	9.52	0.57	1.43	0.95	1.74	0.47	1.51	0.84
Maximum	2.03	5.64	10.10	0.39	1.42	1.07	2.01	0.44	0.50	0.84
No. Samples (n)	24	24	24	24	24	24	24	24	24	-
Student $t_{(n-1)}$ test	1.714	1.714	1.714	1.714	1.714	1.714	1.714	1.714	1.714	-
UCL (normal)	1.15	2.56	2.80	0.15	1.04	0.81	1.33	0.17	0.21	-
Sample ID										
SLD05275	0.68	1.25	0.77	0.05	-0.01	0.12	0.27	0.05	0.19	0.00
SLD05276	0.92	1.97	1.60	0.19	0.99	0.36	0.67	0.04	0.08	0.01
SLD05277	1.35	2.92	1.09	0.25	0.99	0.57	1.54	0.16	0.42	0.20
SLD05278	0.58	0.84	0.67	0.06	0.22	0.15	0.53	-0.03	0.18	0.00
SLD05279	0.85	1.30	1.11	0.13	0.79	0.67	1.45	0.14	0.33	0.00
SLD05280	0.65	1.39	0.58	0.10	0.46	0.57	1.07	0.21	-0.37	0.00
SLD05281	1.63	2.58	10.10	0.39	0.76	0.60	1.13	0.07	0.36	0.30
SLD05282	1.51	2.86	1.87	0.11	1.19	1.04	1.50	0.35	0.14	0.21
SLD05283	0.76	1.20	2.61	0.23	1.14	0.69	0.93	0.05	0.02	0.03
SLD05285	0.82	2.66	2.16	0.02	1.22	0.94	1.85	0.09	-0.05	0.18
SLD05286	0.78	1.64	1.87	0.15	0.94	0.82	0.92	0.11	0.21	0.01
SLD05287	0.63	1.16	2.38	0.01	0.88	0.65	0.82	0.08	-0.02	0.02
SLD05288	0.80	1.48	2.23	-0.05	1.07	1.07	1.26	0.09	0.37	0.04
SLD05289	1.14	1.28	1.36	0.02	0.59	0.91	0.81	0.13	0.38	0.00
SLD05290	0.87	1.64	1.75	0.06	1.12	0.79	1.60	0.16	-0.23	0.01
SLD05291	0.68	1.48	0.69	0.10	0.29	0.35	0.77	0.06	0.15	0.00
SLD05292	0.86	1.86	1.12	0.07	1.17	1.04	1.58	0.02	0.02	0.02
SLD05293	0.99	1.84	1.16	0.17	1.20	1.01	1.50	0.13	0.07	0.02
SLD05294	1.69	4.63	3.25	0.09	0.59	0.60	0.71	0.15	0.50	0.57
SLD05295	2.03	5.64	6.44	0.28	0.97	0.69	0.87	0.44	0.17	0.84
SLD05296	0.77	1.49	1.58	-0.18	1.42	0.85	1.49	0.16	-1.01	0.07
SLD05297	0.85	1.98	1.17	0.03	1.35	1.01	1.75	0.15	0.46	0.06
SLD05298	1.40	4.03	0.91	0.24	1.25	0.79	2.01	0.18	0.11	0.45
SLD06162	1.05	2.40	1.14	0.01	1.15	0.92	0.96	0.26	-0.02	0.10

Table 3d. Survey Unit 2 Subsurface Samples

Reference Area Data Summary

Statistic	Ra-226 (pCi/g)	Th-230 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g)	Th-232 (pCi/g)	Ra-228 (pCi/g)	Th-228 (pCi/g)	Ac-227 (pCi/g)	Pa-231 (pCi/g)	SOR_B (5/5/50)	SOR_B (15/15/50)
Mean	2.78	1.94	1.44	0.09	1.09	0.95	1.16	0.14	0.89	0.82	0.29
Median	2.53	1.66	1.16	0.08	1.07	0.97	1.10	0.11	0.98	0.76	0.27
UCL-95	3.04	2.18	1.67	0.12	1.18	1.00	1.26	0.18	1.12	-	-
St. Dev	0.89	0.76	0.75	0.08	0.29	0.17	0.35	0.14	0.76	0.21	0.08
Range	3.93	3.19	3.19	0.33	1.25	0.82	1.59	0.80	2.55	0.95	0.35
Detects	32	32	32	0	32	32	32	7	13	-	-
No. Samples	32	32	32	32	32	32	32	32	32	32	32

MSD Lift Station Survey Unit 2 Subsurface Samples

Statistic/Sample	Ra-226 (pCi/g)	Th-230 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g	Th-232 (pCi/g)	Ra-228 (pCi/g)	Th-228 (pCi/g)	Ac-227 (pCi/g)	Pa-231 (pCi/g)	SOR_N (15/15/50)
Mean	1.09	2.46	1.77	0.11	1.02	0.81	1.25	0.11	0.04	0.07
Median	1.02	1.85	1.44	0.07	1.10	0.86	1.24	0.10	0.12	0.02
St. Dev	0.56	2.11	1.69	0.11	0.34	0.25	0.37	0.07	0.43	0.14
Range	2.80	9.44	9.56	0.43	1.54	1.02	1.76	0.28	2.28	0.60
Maximum	3.34	10.32	7.72	0.36	1.75	1.09	1.95	0.27	0.64	0.60
No. Samples (n)	24	24	24	24	24	24	24	24	24	-
Student $t_{(n-1)}$ test	1.714	1.714	1.714	1.714	1.714	1.714	1.714	1.714	1.714	-
UCL (normal)	1.28	3.20	2.36	0.15	1.14	0.90	1.38	0.14	0.19	-
Sample ID										
SLD05299	0.63	1.51	0.69	0.04	0.21	0.07	0.19	0.03	-0.03	0.00
SLD05300	1.35	2.34	2.59	0.10	1.15	0.81	0.85	0.10	0.60	0.05
SLD05301	1.04	2.37	0.64	0.07	1.02	0.72	1.55	0.10	0.39	0.03
SLD05302	0.82	1.52	1.14	0.04	0.82	0.36	0.96	-0.01	0.12	0.00
SLD05303	1.25	1.87	1.40	0.15	0.36	0.92	1.13	0.16	0.31	0.00
SLD05304	1.13	1.70	-1.84	-0.07	1.35	1.09	1.54	0.16	-1.63	0.02
SLD05305	1.03	2.10	2.09	0.00	1.10	0.86	1.27	0.17	-0.36	0.02
SLD05306	1.16	1.83	1.49	0.07	1.29	0.82	0.93	0.24	0.20	0.01
SLD05307	0.80	0.88	1.37	-0.02	0.95	0.76	1.20	0.04	0.37	0.00
SLD05309	0.54	1.11	2.56	0.06	0.63	0.62	1.12	0.08	0.14	0.02
SLD05310	1.05	2.17	4.16	0.23	0.85	1.02	1.40	0.10	-0.13	0.07
SLD05311	1.01	1.79	1.71	0.19	1.09	1.09	1.18	0.06	0.13	0.01
SLD05312	0.71	1.89	0.91	0.12	0.58	0.36	1.05	0.03	0.17	0.00
SLD05313	1.07	2.67	1.93	0.05	1.09	0.95	1.53	0.17	0.08	0.06
SLD05314	0.80	2.22	1.24	0.09	1.43	0.93	1.49	0.02	-0.27	0.04
SLD05315	1.22	3.42	7.72	0.36	0.81	0.72	1.56	0.20	0.64	0.22
SLD05316	1.78	7.55	2.32	0.33	1.28	1.07	1.32	0.09	0.18	0.40
SLD05317	0.84	1.70	0.86	0.02	1.14	1.03	1.74	0.13	0.28	0.01
SLD05318	0.75	1.27	1.08	0.07	1.12	0.94	1.06	0.03	-0.04	0.00
SLD05319	0.63	1.35	0.87	0.08	1.75	0.88	0.95	0.14	0.07	0.04
SLD05320	0.81	1.39	0.72	0.19	1.24	1.03	1.61	0.15	-0.18	0.01
SLD05321	1.00	1.78	1.71	0.03	1.12	0.80	1.55	0.12	-0.20	0.01
SLD05322	3.34	10.32	3.31	0.29	1.14	0.86	1.95	0.27	-0.01	0.60
SLD06163	1.34	2.39	1.84	0.15	1.01	0.66	0.89	0.08	0.18	0.04

Table 4a. Survey Unit 1 Industrial Worker Dose Estimate

10,000 (m^2) Survey Unit 1 Surface

Year 0 SLDS Dose Estimate for 10,000 m^2 Area

Analyte	UCL_{95} (pCi/g)[a]	Background[b]	Estimated RME (pCi/g)[c]	Dose[d] (mrem/yr)
Ac-227	0.14	0.14	0.00	0.0
Pa-231	0.89	0.89	0.00	0.0
Pb-210	2.78	2.78	0.00	0.0
Ra-226	2.78	2.78	0.00	0.0
Ra-228	0.95	0.95	0.00	0.0
Th-228	1.59	1.16	0.43	0.8
Th-230	1.94	1.94	0.00	0.0
Th-232	1.15	1.09	0.06	0.0
U-234	1.46	1.46	0.00	0.0
U-235	0.09	0.09	0.00	0.0
U-238	1.44	1.44	0.00	0.0
			Total =	**0.84**

[a] Estimates of concentrations using site database
[b] Average of 32 samples or estimated assuming equilibrium conditions
[c] UCL_{95} - background
[d] RME times dose-to-source

10,000 (m^2) Survey Unit 1 Subsurface

Year 0 SLDS Dose Estimate for 10,000 m^2 Area

Analyte	UCL_{95} (pCi/g)[a]	Background[b]	Estimated RME (pCi/g)[c]	Dose[d] (mrem/yr)
Ac-227	0.14	0.14	0.01	0.0
Pa-231	0.89	0.89	0.00	0.0
Pb-210	2.78	2.78	0.00	0.0
Ra-226	2.78	2.78	0.00	0.0
Ra-228	0.95	0.95	0.00	0.0
Th-228	1.23	1.16	0.07	0.1
Th-230	1.97	1.94	0.03	0.0
Th-232	1.09	1.09	0.00	0.0
U-234	1.46	1.46	0.00	0.0
U-235	0.11	0.09	0.02	0.0
U-238	1.44	1.44	0.00	0.0
			Total =	**0.16**

[a] Estimates of concentrations using site database
[b] Average of 32 samples or estimated assuming equilibrium conditions
[c] UCL_{95} - background
[d] RME times dose-to-source

Year 1,000 SLDS Dose Estimate for 10,000 m^2 Area

Analyte	UCL_{95} (pCi/g)[a]	Background[b]	Estimated RME (pCi/g)[c]	Dose[d] (mrem/yr)
Ac-227	0.14	0.14	0.00	0.0
Pa-231	0.89	0.89	0.00	0.0
Pb-210	2.78	2.78	0.00	0.0
Ra-226	2.78	2.78	0.00	0.0
Ra-228	0.95	0.95	0.00	0.0
Th-228	1.59	1.16	0.43	0.0
Th-230	1.94	1.94	0.00	0.0
Th-232	1.15	1.09	0.06	0.2
U-234	1.46	1.46	0.00	0.0
U-235	0.09	0.09	0.00	0.0
U-238	1.44	1.44	0.00	0.0
			Total =	**0.20**

[a] Estimates of concentrations using site database
[b] Average of 32 samples or estimated assuming equilibrium conditions
[c] UCL_{95} - background
[d] RME times dose-to-source

Year 1,000 SLDS Dose Estimate for 10,000 m^2 Area

Analyte	UCL_{95} (pCi/g)[a]	Background[b]	Estimated RME (pCi/g)[c]	Dose[d] (mrem/yr)
Ac-227	0.15	0.14	0.01	0.0
Pa-231	0.89	0.89	0.00	0.0
Pb-210	2.78	2.78	0.00	0.0
Ra-226	2.78	2.78	0.00	0.0
Ra-228	0.95	0.95	0.00	0.0
Th-228	1.23	1.16	0.07	0.0
Th-230	1.97	1.94	0.03	0.0
Th-232	1.09	1.09	0.00	0.0
U-234	1.46	1.46	0.00	0.0
U-235	0.11	0.09	0.02	0.0
U-238	1.44	1.44	0.00	0.0
			Total =	**0.02**

[a] Estimates of concentrations using site database
[b] Average of 32 samples or estimated assuming equilibrium conditions
[c] UCL_{95} - background
[d] RME times dose-to-source

Table 4b. Survey Unit 2 Industrial Worker Dose Estimate

10,000 (m^2) Survey Unit 2 Surface

Year 0 SLDS Dose Estimate for 10,000 m^2 Area

Analyte	UCL_{95} (pCi/g)[a]	Background[b]	Estimated RME (pCi/g)[c]	Dose[d] (mrem/yr)
Ac-227	0.17	0.14	0.03	0.1
Pa-231	0.89	0.89	0.00	0.0
Pb-210	2.78	2.78	0.00	0.0
Ra-226	2.78	2.78	0.00	0.0
Ra-228	0.95	0.95	0.00	0.0
Th-228	1.33	1.16	0.17	0.3
Th-230	2.56	1.94	0.62	0.1
Th-232	1.09	1.09	0.00	0.0
U-234	2.84	1.46	1.38	0.1
U-235	0.15	0.09	0.06	0.0
U-238	2.80	1.44	1.36	0.1
			Total =	**0.61**

[a] Estimates of concentrations using site database
[b] Average of 32 samples or estimated assuming equilibrium conditions
[c] UCL_{95} - background
[d] RME times dose-to-source

10,000 (m^2) Survey Unit 2 Subsurface

Year 0 SLDS Dose Estimate for 10,000 m^2 Area

Analyte	UCL_{95} (pCi/g)[a]	Background[b]	Estimated RME (pCi/g)[c]	Dose[d] (mrem/yr)
Ac-227	0.14	0.14	0.00	0.0
Pa-231	0.89	0.89	0.00	0.0
Pb-210	2.78	2.78	0.00	0.0
Ra-226	2.78	2.78	0.00	0.0
Ra-228	0.95	0.95	0.00	0.0
Th-228	1.16	1.16	0.00	0.0
Th-230	3.20	1.94	1.26	0.1
Th-232	1.14	1.09	0.05	0.0
U-234	2.40	1.46	0.94	0.0
U-235	0.11	0.09	0.02	0.0
U-238	2.36	1.44	0.92	0.1
			Total =	**0.25**

[a] Estimates of concentrations using site database
[b] Average of 32 samples or estimated assuming equilibrium conditions
[c] UCL_{95} - background
[d] RME times dose-to-source

Year 1,000 SLDS Dose Estimate for 10,000 m^2 Area

Analyte	UCL_{95} (pCi/g)[a]	Background[b]	Estimated RME (pCi/g)[c]	Dose[d] (mrem/yr)
Ac-227	0.17	0.14	0.03	0.0
Pa-231	0.89	0.89	0.00	0.0
Pb-210	2.78	2.78	0.00	0.0
Ra-226	2.78	2.78	0.00	0.0
Ra-228	0.95	0.95	0.00	0.0
Th-228	1.33	1.16	0.17	0.0
Th-230	2.56	1.94	0.62	0.5
Th-232	1.09	1.09	0.00	0.0
U-234	2.84	1.46	1.38	0.0
U-235	0.15	0.09	0.06	0.0
U-238	2.80	1.44	1.36	0.0
			Total =	**0.50**

[a] Estimates of concentrations using site database
[b] Average of 32 samples or estimated assuming equilibrium conditions
[c] UCL_{95} - background
[d] RME times dose-to-source

Year 1,000 SLDS Dose Estimate for 10,000 m^2 Area

Analyte	UCL_{95} (pCi/g)[a]	Background[b]	Estimated RME (pCi/g)[c]	Dose[d] (mrem/yr)
Ac-227	0.14	0.14	0.00	0.0
Pa-231	0.89	0.89	0.00	0.0
Pb-210	2.78	2.78	0.00	0.0
Ra-226	2.78	2.78	0.00	0.0
Ra-228	0.95	0.95	0.00	0.0
Th-228	1.16	1.16	0.00	0.0
Th-230	3.20	1.94	1.26	1.0
Th-232	1.14	1.09	0.05	0.2
U-234	2.40	1.46	0.94	0.0
U-235	0.11	0.09	0.02	0.0
U-238	2.36	1.44	0.92	0.0
			Total =	**1.13**

[a] Estimates of concentrations using site database
[b] Average of 32 samples or estimated assuming equilibrium conditions
[c] UCL_{95} - background
[d] RME times dose-to-source

APPENDIX A

MSD SALISBURY LIFT STATION PROPERTY
QUALITY CONTROL SUMMARY REPORT

TABLE OF CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS

DCGL	derived concentration guideline level
DQA	Data Quality Assessment
DQO	data quality objectives
FSSP	Final Status Survey Plan
FUSRAP	Formerly Utilized Sites Remedial Action Program
HISS	Hazelwood Interim Storage Site
LCS	laboratory control samples
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MS	matrix spike
MSD	Metropolitan Sewer District
NAD	normalized absolute difference
PCB	polychlorinated biphenyl
PE	performance evaluation
PRAR	Post-Remedial Action Report
QA/QC	quality assurance and quality control
QAPP	Quality Assurance Program Plan
QC	quality control
QCSR	Quality Control Summary Report
ROD	Record of Decision
RPD	relative percent differences
SAIC	Science Applications International Corporation
SDG	sample delivery group
SVOC	semivolatile organic compound
VOC	volatile organic compound
VP	vicinity property

A.1 INTRODUCTION

A.1.1 PROJECT DESCRIPTION

Class 2 final status survey sampling for the Metropolitan Sewer District (MSD) Salisbury Lift Station Vicinity Property (VP) DT-15 at the St. Louis Downtown Site (SLDS). Sampling was conducted in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) protocols and the *Final Status Survey Plan for Accessible Soil Within Plants 3, 6, 6E, 7N, 7W, 8, 9 and the Vicinity Properties* (FSSP) (USACE, 1999) and as specified in the *Record of Decision for the St. Louis Downtown Site* (ROD) (USACE, 1998).

A.1.2 PROJECT OBJECTIVES

The intent of the final status survey was to determine whether each survey unit satisfies concentration and dose-based criteria (DCGLs) as defined in the ROD. The results of this sampling provides the basis for proving that the after remediation conditions of the MSD Salisbury Lift Station VP meets the requirements of the ROD.

A.1.3 PROJECT IMPLEMENTATION

The scope of work for this sampling was submitted to the USACE in September 1999. The sampling was conducted from July 20 until September 27, 2000. Radiological analyses were conducted by the on-site Formerly Utilized Sites Remedial Action Program (FUSRAP) laboratory at the Hazelwood Interim Storage Site (HISS).

A.1.4 PURPOSE OF THIS REPORT

Environmental data must always be interpreted relative to its known limitations and its intended use. As can be expected in environmental media of this type, there are areas and data points where the user needs to be cautioned relative to the quality of the project information presented. The data validation process and this data quality assessment are intended to provide current and future data users assistance throughout the interpretation of this data.

The purpose of this Quality Control Summary Report (QCSR) is: to describe Quality Control (QC) procedures followed to ensure data generated by SAIC would meet project requirements; to describe the quality of the data collected; and to describe problems encountered during the course of the sampling.

The primary intent of this assessment is to illustrate that data generated for this sampling can withstand scientific scrutiny, are appropriate for their intended purpose, are technically defensible, and are of known and acceptable sensitivity, precision, and accuracy.

Multiple activities were performed to achieve the desired data quality in this project. As discussed in the text, decisions were made during the initial scoping to define the quality and quantity of data required. Data Quality Objectives (DQOs) were established to guide the implementation of the field sampling and laboratory analysis. A QA program was established to standardize procedures and to document activities. This program provided a means to detect and correct any deficiencies in the process. Upon receipt by the project team, data was subjected to verification and validation review, which identified and qualified problems related to the analysis. These review steps contribute to this final Data Quality Assessment (DQA) which defines that data used in the investigation met the criteria and are employed appropriately.

A.2 QUALITY ASSURANCE PROGRAM

A Quality Assurance Program Plan (QAPP) was developed for this project and is found as part of the *Sampling and Analysis Guide for the St. Louis Sites* (USACE, 2000). The purpose of this document was to enumerate the quantity and type of samples to be taken to inspect the various sites, and to define the quantity and type of Quality Assurance/Quality Control (QA/QC) samples to be used to evaluate the quality of the data obtained.

The QAPP established requirements for both field and laboratory QC procedures. In general, analytical laboratory QC duplicates, matrix spikes, laboratory control samples, method blanks were required for every 20 samples or less of each matrix and analyte. A primary goal of the QA program was to ensure that the quality of results for all environmental measurements was appropriate for their intended use. To this end, a QAPP and standardized field procedures were compiled to guide the investigation. Through the process of readiness review, training, equipment calibration, QC implementation, and detailed documentation, the project has successfully accomplished the goals set by the QA Program.

Laboratory "Definitive" Level Data Reporting

EPA "definitive" data has been reported including the following basic information:

a. laboratory case narratives
b. sample results
c. laboratory method blank results
d. laboratory control standard results
e. laboratory sample matrix spike recoveries
f. laboratory duplicate results
g. surrogate recoveries [volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), Pesticide/polychlorinated biphenyls (PCBs)]
h. sample extraction dates
i. sample analysis dates

This information from the laboratory along with field information provides the basis for subsequent data evaluation relative to sensitivity, precision, accuracy, representativeness and completeness. These have been presented in Section B.4.

A.3 DATA VALIDATION

The objective when evaluating the quality of the project data is to determine its usability. The evaluation is based on the interpretation of laboratory QC measures, field QC measures, and the project DQOs.

This project implemented the use of data validation checklists to facilitate laboratory data validation. These checklists were completed by the project designated validation staff and were reviewed by the project laboratory coordinator. Data validation checklists for each laboratory sample delivery group (SDG) have been retained with laboratory data deliverables by SAIC.

A.3.1 LABORATORY DATA VALIDATION

Analytical data generated for this project have been subjected to a process of data verification, validation, and review. The following describes this systematic process and the evaluation activities performed. Several criteria have been established against which the data are compared and from which a judgment is rendered regarding the acceptance and qualification of the data. Because it is beyond the scope of this report to cite those criteria, the reader is directed to the following documents for specific detail:

- SAIC Technical Support Contractor QA Technical Procedure (TP-DM-300-7) Data Verification and Validation;

Upon receipt of field and analytical data, verification staff performed a systematic examination of the reports, following standardized data package checklists to ensure the content, presentation, and administrative validity of the data. In conjunction with data package verification, laboratory electronic data diskettes were available. These diskette deliverables were subjected to review and verification against the hardcopy deliverable. Both a structural and technical assessment of the laboratory-delivered electronic reports was performed. The structural evaluation ensured that all required data had been reported and contract specified requirements were met (i.e., analytical holding times, contractual turnaround times, etc.).

During the validation phase of the review and evaluation process, data were subjected to a systematic technical review by examining all field and analytical QC results and laboratory documentation, following appropriate guidelines for laboratory data validation. These data validation guidelines define the technical review criteria, methods for evaluation of the criteria, and actions to be taken resulting from the review of these criteria. The primary objective of this phase was to assess and summarize the quality and reliability of the data for the intended use and to

document factors that may affect the usability of the data. Data verification/validation included but was not necessarily limited to the following parameters:

Method requirements

Requirements for all methods:

- Holding time information and methods requested
- Discussion of laboratory analysis, including any laboratory problems

Radiochemical Analysis

- Sample results
- Initial calibration
- Efficiency check
- Background determinations
- Spike recover results
- Internal standard results (tracers or carriers)
- Duplicate results
- Self-absorption factor (α,β)
- Cross-talk factor (α,β)
- LCS
- Run log

As an end result of this phase of the review, the data were qualified based on the technical assessment of the validation criteria. Qualifiers were applied to each field and analytical result to indicate the usability of the data for its intended purpose.

A.3.2 DEFINITION OF DATA QUALIFIERS (FLAGS)

During the data validation process, all laboratory data were assigned appropriate data validation flags and reason codes. Validation flags are defined as follows:

"U" When the material was analyzed for, but not detected above the level of the associated value.

"J" When the associated value is an estimated quantity. Indicating there is cause to question accuracy or precision of the reported value.

"UJ" When the analyte was analyzed for, but not detected, above the associated value, however, the reported value is an estimate and demonstrates an decreased knowledge of its accuracy or precision.

"R" When the analyte value reported is unusable. The integrity of the analyte's identification, accuracy, precision, or sensitivity have raised significant question as to the reality of the information presented.

SAIC validation flagging codes have been provided in Attachment 1, while copies of validation checklists and qualified data forms are on-file with the analytical laboratory deliverable.

A.3.4 DATA ACCEPTABILITY

A total of one hundred and one (101) soil samples were collected with approximately 1,515 discrete analyses (i.e., analytes) being obtained, reviewed, and integrated into the assessment. The project produced acceptable results for 99.9% of the sample analyses performed.

A.4 DATA EVALUATION

A.4.1 ACCURACY

Accuracy provides a gauge or measure of the agreement between an observed result and the true value for an analysis. Analytical accuracy is evaluated by measuring the agreement between an analytical result and its known or true value. This is generally determined through use of laboratory control samples (LCSs), matrix spike (MS) analysis, and performance evaluation (PE) samples. Accuracy, as measured through the use of LCSs, determines the methods implementation of accuracy independent of sample matrix, as well as document laboratory analytical process control. Accuracy determined by the MS is a function of both matrix and analytical process

Radiological Parameters

Individual sample chemical yields and LCS recoveries indicate that the analytical accuracy for all analytes were in control and the data is usable.

A.4.2 PRECISION

Laboratory Precision

As a measure of analytical precision, relative percent differences (RPD) for laboratory duplicate sample pairs for the two analytical groups (i.e., Alpha spectroscopy and gamma spectroscopy) were employed. As the RPD approaches zero, complete agreement is achieved between the duplicate sample pairs. Sample homogeneity, analytical method performance, and the quantity of analyte being measured all contribute to this measure of sample analytical precision.

RPD values for all analytes were well within a 30% window of acceptance for this sampling event.

Field Precision

Field duplicate samples were collected to ascertain the contribution to variability (i.e., precision) due to the combination of environmental media, sampling consistency, and analytical

precision. The field duplicates were collected from the same spatial and temporal conditions as the primary environmental sample. Soil samples were collected from the same sampling device, after homogenization for all analytes.

RPD was calculated only when both samples were greater than five (5) times the analyte reporting level. When one or both sample values were between the quantitation level and five (5) times the analyte reporting level the normalized absolute difference (NAD) was evaluated. If both samples were not detected for a given analyte, precision was considered acceptable.

For the three field duplicate samples taken, the NAD and RPD values indicated good precision for the data. Only a single Radium-226 comparison, sample SLD05352, had an RPD greater than 30% (See Table 1). This sample and its representative field duplicate have been qualified as estimated; however, they can still be used for their intended purpose and are considered usable.

Table 1. Grab Sample vs. Field Duplicate Summary

Alpha Spec.	TH-228		TH-230		TH-232	
Parent ID/Field Dup. ID	RPD	NAD	RPD	NAD	RPD	NAD
SLD05280/SLD05280-1	-	0.21	7.5	-	-	0.79
SLD05329/SLD05329-1	-	0.51	-	0.51	-	0.30
SLD05352/SLD05352-1	-	0.62	23.3	-	-	0.76

Gamma Spec.	AC-227		AM-241		CS-137		K-40		PA-231		RA-226	
Parent ID/Field Dup. ID	RPD	NAD	RPD	NAD	RPD	NAD	RPD	NAD	RPD	NAD	RPD	NAD
SLD05280/SLD05280-1	-	0.76	-	0.35	-	0.37	21.5%	-	-	0.21	-	0.3
SLD05329/SLD05329-1	-	0.18	-	0.51	-	0.00	17.5%	-	-	0.4	17.2%	-
SLD05352/SLD05352-1	-	0.12	-	0.94	-	0.35	9.2%	-	-	1.00	31.5%	-

	RA-228		TH-228		TH-230		TH-232		U-235		U-238	
Parent ID/Field Dup. ID	RPD	NAD	RPD	NAD	RPD	NAD	RPD	NAD	RPD	NAD	RPD	NAD
SLD05280/SLD05280-1	-	0.44	-	0.44	-	0.62	-	0.44	-	0.00	-	0.14
SLD05329/SLD05329-1	-	0.57	-	0.57	-	0.48	-	0.57	-	0.00	-	0.07
SLD05352/SLD05352-1	16.5%	-	16.5%	-	-	0.67	16.5%	-	-	0.18	-	0.06

A.4.3 SENSITIVITY

Determination of minimum detectable values allows the investigation to assess the relative confidence, which can be placed in a value in comparison to the magnitude or level of analyte concentration observed. The closer a measured value comes to the minimum detectable concentration, the less confidence and more variation the measurement will have. Project sensitivity goals were expressed as quantitation level goals in the Quality Assurance Project Plan. These levels were achieved or exceeded throughout the analytical process.

A.4.4 REPRESENTATIVENESS AND COMPARABILITY

Representativeness expresses the degree to which data accurately reflect the analyte or parameter of interest for the environmental site and is the qualitative term most concerned with the proper design of the sampling program. Factors that affect the representativeness of analytical data include proper preservation, holding times, use of standard sampling and analytical methods, and determination of matrix or analyte interferences. Sample preservation, analytical methodologies, and soil sampling methodologies were documented to be adequate and consistently applied.

Comparability, like representativeness, is a qualitative term relative to a project data set as an individual. These investigations employed appropriate sampling methodologies, site surveillance, use of standard sampling devices, uniform training, documentation of sampling, standard analytical protocols/procedures, QC checks with standard control limits, and universally accepted data reporting units to ensure comparability to other data sets. Through the proper implementation and documentation of these standard practices, the project has established the confidence that the data will be comparable to other project and programmatic information.

A.4.5 COMPLETENESS

Usable data are defined as those data which pass individual scrutiny during the verification and validation process and are accepted for unrestricted application to the human health risk assessment evaluation or equivalent type applications. It has been determined that estimated data are acceptable for project objectives.

Objectives for this investigation have been achieved. The project produced valid results for 99.9% of the sample analyses performed and successfully collected.

A.5 DATA QUALITY ASSESSMENT SUMMARY

The overall quality of the MSD Lift Station Port-Remedial Action Report (PRAR) information meets or exceeds the established project objectives, with the exception of the five percent field duplicate criteria. Only three of the five field duplicate samples were taken; however, the RPD and NAD for these samples exhibited excellent precision therefore through proper implementation of the project data verification, validation, and assessment process, project information has been determined to be acceptable for use.

Data, as presented, have been qualified as usable, but estimated when necessary. Data that have been estimated provide indications of either accuracy, precision, or sensitivity being less than desired but adequate for interpretation.

Data produced for this post-remedial action report demonstrates that it can withstand scientific scrutiny, is appropriate for its intended purpose, is technically defensible, and is of known and acceptable sensitivity, precision, and accuracy. Data integrity has been documented through

proper implementation of QA/QC measures. The environmental information presented has an established confidence, which allows utilization for the project objectives and provides data for future needs.

A.6 REFERENCES

USACE, 1998. *Record of Decision for the St. Louis Downtown Site, St. Louis, Missouri.* Final, July.

USACE, 1999. *Final Status Survey Plan for Accessible Soil Within Plants 3, 6, 6E, 7N, 7W, 8, 9 and the Vicinity Properties.* Final, September.

USACE, 2000. *Sampling and Analysis Guide for the St. Louis Sites.* Final, October.

ATTACHMENT 1

SAIC Validation Flagging Codes

MSD LIFT STATION PRAR
QUALITY CONTROL SUMMARY REPORT

February 2001

SAIC Validation Flagging Codes

Holding Times

A01 Extraction holding times were exceeded.
A02 Extraction holding times were grossly exceeded.
A03 Analysis holding times were exceeded.
A04 Analysis holding times were grossly exceeded.
A05 Samples were not preserved properly.
A06 Professional judgment was used to qualify the data.

GC/MS Tuning

B01 Mass calibration was in error, even after applying expanded criteria.
B02 Mass calibration was not performed every 12 hours.
B03 Mass calibration did not meet ion abundance criteria.
B04 Professional judgment was used to qualify the data.

Initial/Continuing Calibration - Organics

C01 Initial calibration RRF was <0.05.
C02 Initial calibration RSD was >30%.
C03 Initial calibration sequence was not followed as required.
C04 Continuing calibration RRF was <0.05.
C05 Continuing calibration %D was >25%.
C06 Continuing calibration was not performed at the required frequency.
C07 Resolution criteria were not met.
C08 RPD criteria were not met.
C09 RSD criteria were not met.
C10 Retention time of compounds was outside windows.
C11 Compounds were not adequately resolved.
C12 Breakdown of endrin or DDT was >20%.
C13 Combined breakdown of endrin/DDT was >30%.
C14 Professional judgment was used to qualify the data.

Initial/Continuing Calibration - Inorganics

D01 ICV or CCV were not performed for every analyte.
D02 ICV recovery was above the upper control limit.
D03 ICV recovery was below the lower control limit.
D04 CCV recovery was above the upper control limit.
D05 CCV recovery was below the lower control limit.
D06 Standard curve was not established with the minimum number of standards.
D07 Instrument was not calibrated daily or each time the instrument was set up.
D08 Correlation coefficient was <0.995.
D09 Mid range cyanide standard was not distilled.
D10 Professional judgment was used to qualify the data.

ICP and Furnace Requirements

E01 Interference check sample recovery was outside the control limit.
E02 Duplicate injections were outside the control limit.
E03 Post digestion spike recovery was outside the control limit.
E04 MSA was required but not performed.
E05 Correlation coefficient was <0.995.
E06 MSA spikes were not at the correct concentration.
E07 Serial dilution criteria were not met.
E08 Professional judgment was used to qualify the data.

Blanks

F01 Sample data were qualified as a result of the method blank.
F02 Sample data were qualified as a result of the field blank.
F03 Sample data were qualified as a result of the equipment rinsate.
F04 Sample data were qualified as a result of the trip blank.
F05 Gross contamination exists.
F06 Concentration of the contaminant was detected at a level below the CRQL.
F07 Concentration of the contaminant was detected at a level less than the action limit, but greater than the CRQL.
F08 Concentration of the contaminant was detected at a level that exceeds the action level.
F09 No laboratory blanks were analyzed.
F10 Blank had a negative value >2σ's the IDL.
F11 Blanks were not analyzed at required frequency.
F12 Professional judgment was used to qualify the data.

Surrogate/Radiological Chemical Recovery

G01 Surrogate/radiological chemical recovery was above the upper control limit.
G02 Surrogate/radiological chemical recovery was below the lower control limit.
G03 Surrogate recovery was <10%.
G04 Surrogate/radiological chemical recovery was zero.
G05 Surrogate/radiological chemical recovery was not present.
G06 Professional judgment was used to qualify the data.
G07 Radiological chemical recovery was <20%.
G08 Radiological chemical recovery was >150%.

Matrix Spike/Matrix Spike Duplicate

H01 MS/MSD recovery was above the upper control limit.
H02 MS/MSD recovery was below the lower control limit.
H03 MS/MSD recovery was <10%.
H04 MS/MSD pairs exceed the RPD limit.
H05 No action was taken on MS/MSD results.
H06 Professional judgment was used to qualify the data.
H07 Radiological MS/MSD recovery was <20%.
H08 Radiological MS/MSD recovery was >160%.
H09 Radiological MS/MSD samples were not analyzed at the required frequency.

Matrix Spike

I01 MS recovery was above the upper control limit.
I02 MS recovery was below the lower control limit.
I03 MS recovery was <30%.
I04 No action was taken on MS data.
I05 Professional judgment was used to qualify the data.

Laboratory Duplicate

J01 Duplicate RPD/radiological duplicate error ration (DER) was outside the control limit.
J02 Duplicate sample results were >5× the CRDL.
J03 Duplicate sample results were <5× the CRDL.
J04 Professional judgment was used to qualify the data.
J05 Duplicate was not analyzed at the required frequency.

Internal Area Summary

K01 Area counts were outside the control limits.
K02 Extremely low area counts or performance was exhibited by a major drop off.
K03 IS retention time varied by more than 30 seconds.
K04 Professional judgment was used to qualify the data.

Pesticide Cleanup Checks

L01 10% recovery was obtained during either check.
L02 Recoveries during either check were >120%.
L03 GPC Cleanup recoveries were outside the control limits.
L04 Florisil cartridge cleanup recoveries were outside the control limits.
L05 Professional judgment was used to qualify the data.

Target Compound Identification

M01 Incorrect identifications were made.
M02 Qualitative criteria were not met.
M03 Cross contamination occurred.
M04 Confirmatory analysis was not performed.
M05 No results were provided.
M06 Analysis occurred outside 12 hr GC/MS window.
M07 Professional judgment was used to qualify the data.
M08 The %D between the two pesticide/PCB column checks was >25%.

Compound Quantitation and Reported CRQLs

N01 Quantitation limits were affected by large off-scale peaks.
N02 MDLs reported by the laboratory exceeded corresponding CRQLs.
N03 Professional judgment was used to qualify the data.

Tentatively Identified Compounds (TICs)

O01 Compound was suspected laboratory contaminant and was not detected in the blank.
O02 TIC result was not above 10× the level found in the blank.
O03 Professional judgment was used to qualify analytical data.

Laboratory Control Samples (LCSs)

P01 LCS recovery was above upper control limit.
P02 LCS recovery was below lower control limit.
P03 LCS recovery was <50%.
P04 No action was taken on the LCS data.
P05 LCS was not analyzed at required frequency.
P06 Radiological LCS recovery was <50% for aqueous samples; <40% for solid samples.
P07 Radiological LCS recovery was >150% for aqueous samples; >160% for solid samples.
P08 Professional judgment was used to qualify the data.

Field Duplicate

Q01 No action was taken on the basis of field duplicate RPDs.
Q02 Radiological field duplicate error ratio (DER) was outside the control limit.
Q03 Duplicate sample results were >5× the CRDL.
Q04 Duplicate sample results were <5× the CRDL.

Radiological Calibration

R01 Efficiency calibration criteria were not met.
R02 Energy calibration criteria were not met.
R03 Resolution calibration criteria were not met
R04 Background determination criteria were not met.
R05 Quench curve criteria were not met.
R06 Absorption curve criteria were not met.
R07 Plateau curve criteria were not met.
R08 Professional judgment was used to qualify the data.

Radiological Calibration Verification

S01 Efficiency verification criteria were not met.
S02 Energy verification criteria were not met.
S03 Resolution verification criteria were not met
S04 Background verification criteria were not met.
S05 Cross-talk verification criteria were not met.
S06 Professional judgment was used to qualify the data.

Radionuclide Quantitation

T01 Detection limits were not met.
T02 Analytical uncertainties were not met and/or not reported.

T03 Inappropriate aliquot sizes were used.
T04 Professional judgment was used to qualify the data.

System Performance

V01 High background levels or a shift in the energy calibration were observed.
V02 Extraneous peaks were observed.
V03 Loss of resolution was observed.
V04 Peak-tailing or peak splitting that may result in inaccurate quantitation were observed.
V05 Professional judgment was used to qualify the data.

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