Shaw® Shaw Environmental, Inc.

Shaw Environmental, Inc.
110 James S McDonnell Blvd
Hazelwood, Missouri 63042-3102
314-895-2100
314-895-2200 (fax)

845843-SEICPR-132

10/13/2005

U.S. Army Engineer District, St. Louis
Corps of Engineers SLDS Project Office
ATTN: Dr. Gregory Hempen
8945 Latty Avenue
Berkeley, MO. 63134

RE: Contract No. DACW41-98-D-0006
Task Order No. 0011

Subject: Summary of the Preferential Pathway Evaluation for Survey Unit 4 (SU-4), Survey Unit 5 (SU-5), and Survey Unit 7 (SU-7) at Mallinckrodt Inc.'s Plant 7 South, St. Louis Downtown Site.

Dear Dr. Hempen:

This letter provides a summary of the preferential pathway evaluation performed for Survey Unit-4 (SU-4), Survey Unit 5 (SU-5), and Survey Unit 7 (SU-7) at the Mallinckrodt Inc. Plant 7 South at the St. Louis Downtown Site (SLDS) by Shaw Environmental, Inc (Shaw). A preferential pathway is defined by the U.S. Army Corps of Engineers (USACE), St. Louis District, as a change in soil lithology, any partially buried structures, piping, or other subsurface debris that may allow transport of radiological contaminants along or to more permeable units. The purpose of a preferential pathway evaluation is to determine and document whether other surrounding areas are sources of, or have been contaminated by, SLDS contaminates of concern (COCs) at levels exceeding remedial goals.

The preferential pathway evaluation for SU-4 identified two preferential pathway features that were associated with the survey unit. The results of the preferential pathway evaluation of the survey unit indicated that the identified preferential pathway features do not appear to be migration pathways for radiological COCs. The preferential pathway evaluation for SU-5 identified four preferential pathway features that were associated with the survey unit. The results of the preferential pathway evaluation of the survey unit indicated that the identified preferential pathway features do not appear to be migration pathways for radiological COCs. The preferential pathway evaluation for SU-7 identified two preferential pathway features within the accessible portion of the survey unit and one preferential pathway

feature within the inaccessible portion of the survey unit. The results of the preferential pathway evaluation of the SU-7 indicated that the identified preferential pathway features within the accessible portion of the survey unit do not appear to be migration pathways for radiological COCs. The preferential pathway feature identified within the inaccessible portion of the survey unit appears to be a migration pathway for radiological COCs. Information regarding the identified preferential pathways for SU-4, SU-5, and SU-7 is included in the following paragraphs. Additional documentation and original data used for the evaluations are on file at the FUSRAP SLAPS Modular Trailer. The survey units included in the respective preferential pathway evaluations are indicated on Figure 1. The radiological analytical results utilized as part of the evaluations for the survey units are included in Table 1. The preferential pathway evaluations were limited to the remedial excavation areas including the sidewalls and the floor of the excavations. The depths of the remedial excavations ranged from approximately 3 feet below ground surface (ft bgs) to approximately 5 ft bgs. The following preferential pathways were identified within the remediated portions of SU-4, SU-5, and SU-7.

SU-4

Preferential Pathway -1 (PP-1) was located midway along the southern sidewall of SU-4, approximately 1.5 ft bgs (see Figure 1). This preferential pathway was the contact between the overlaying gravel cover material and a fill layer fill that consisted of fine sand with silt that was loose, poorly graded, and contained an urban fill component of cinders and slag. A preferential pathway sample (SLD86842) was collected from this contact and submitted for analysis at the St. Louis FUSRAP laboratory for radiological COCs (see Table 1). The results from this preferential pathway sample and the results from verification sample locations SLD86860, SLD86862, and SLD86864 (see Table 1) were used to evaluate whether the identified feature lead to areas that may contain concentrations of radiological COCs that exceed ROD remedial goals. Based on the results from these sample locations and observations made during the field reconnaissance activities for SU-4, the identified preferential pathway feature does not appear to lead to areas with concentrations of radiological COCs that would likely exceed remedial goals.

Preferential Pathway -2 (PP-2) was located midway along the southern sidewall of SU-4, approximately 2.0 ft bgs (see Figure 1). This preferential pathway feature was a fill layer consisting of coarse to fine gravel size cinder and slag fragments that were loose and poorly graded. A preferential pathway sample (SLD86843) was collected from this contact and submitted for analysis at the St. Louis FUSRAP laboratory for radiological COCs (see Table 1). The results from this preferential pathway sample and the results from verification sample locations SLD86861, SLD86863, and SLD86865 (from sample locations SLD86860, SLD86862, and SLD86864, respectively) (see Table 1) were used to evaluate whether the identified feature lead to areas that may contain concentrations of radiological COCs that exceed ROD remedial goals. Based on the results from these sample locations and observations made during the field reconnaissance activities for SU-4, the identified preferential pathway feature does not appear to lead to areas with concentrations of radiological COCs that would likely exceed remedial goals.

SU-5

Preferential Pathway -3 (PP-3) was located at the base of the excavation in the northeastern portion of SU-5 (see Figure 1). This preferential pathway was the contact between the overlaying fill material and a waterline that ran north-south along the eastern side of the excavation at approximately 4 ft bgs. The fill material consisted of fine to medium sand sized cinders and slag with some silt and fine to medium gravel sized cinders, slag, and brick fragments that were loose and poorly graded. A preferential pathway sample (SLD86844) was collected from this contact and submitted for analysis at the St. Louis FUSRAP Laboratory for radiological COCs (see Table 1). The results from this preferential pathway sample indicated the presence of radiological COCs at concentration levels that yielded an SOR value that was greater than 1.0 (SOR=1.4), with thorium-230 being the main contributor to this SOR value (Th-230 = 22 pCi/g). The location from which this preferential pathway sample was collected was subsequently remediated and then re-sampled by Science Applications International Corporation (SAIC), the verification contractor. Following the remedial activities along this preferential pathway feature, a verification sample (HTZ86517) was collected from the feature and analyzed for radiological COCs. The results from this sample also indicated the presence of radiological COCs at concentration levels that yielded an SOR value that was greater than 1.0 (SOR=1.04), with thorium-230 being the main contributor to this SOR value (Th-230=15 pCi/g). To determine if the samples collected from along the preferential pathway feature represented and area that exceeded ROD remedial goals, SAIC utilized the radiological results from HTZ86500, HTZ86501, HTZ86515, HTZ86516, HTZ86517, SLD87273, and SLD87275 (see Table 1) to calculate the areal average concentration of radiological COCs along and around this preferential pathway feature. According to SAIC, the areal average concentration of radiological COCs complies with the requirements of the ROD. Based on this information and observations made during the field reconnaissance activities for SU-5, the identified preferential pathway feature does not appear to lead to areas with concentrations of radiological COCs that would likely exceed ROD remedial goals.

Preferential Pathway -4 (PP-4) was located in the southeastern corner of SU-5 (see Figure 1). This preferential pathway was the contact between the fill material and a utility pole. The fill material that was in contact with the utility pole consisted of coarse to fine gravel with little silty clay and some coarse to fine gravel size cinder and slag fragments that were loose and poorly graded. A preferential pathway sample (SLD86845) was collected from this contact and submitted for analysis at the St. Louis FUSRAP Laboratory for radiological COCs (see Table 1). The results from this preferential pathway sample indicated the presence of radiological COCs, but not at concentration levels that would yield an SOR value that was greater than or equal to 1.0. Based on the radiological results and observations made during the field reconnaissance activities for SU-5, the identified preferential pathway feature does not appear to be a migration pathway for radiological COCs and does not appear to lead to areas with concentrations of radiological COCs that would likely exceed ROD remedial goals.

Preferential Pathway -5 (PP-5) was located in the southern portion of SU-5, near Angelrodt Street (see Figure 1). This preferential pathway feature consisted of the gravel bedding material that was surrounding a utility manhole that was located in this area. The gravel bedding material was fine to

medium size gravel that was loose and poorly graded. A preferential pathway sample (SLD86846) was collected from this contact and submitted for analysis at the St. Louis FUSRAP Laboratory for radiological COCs (see Table 1). The results from this preferential pathway sample indicated that radiological COCs were not present above the average mean background concentration levels. Based on the radiological results and observations made during the field reconnaissance activities for SU-5, the identified preferential pathway feature does not appear to be a migration pathway for radiological COCs and does not appear to lead to areas with concentrations of radiological COCs that would likely exceed ROD remedial goals.

Preferential Pathway -6 (PP-6) was located in the southern portion of SU-5, just west of PP-5 (see Figure 1). This preferential pathway was the contact between the fill material and a fire hydrant. The fill material that was in contact with the fire hydrant consisted of coarse to fine gravel size cinder and slag fragments that were loose and poorly graded. A preferential pathway sample (SLD86847) was collected from this contact and submitted for analysis at the St. Louis FUSRAP Laboratory for radiological COCs (see Table 1). The results from this preferential pathway sample indicated that radiological COCs were not present above the average mean background concentration levels. Based on the radiological results and observations made during the field reconnaissance activities for SU-5, the identified preferential pathway feature does not appear to be a migration pathway for radiological COCs and does not appear to lead to areas with concentrations of radiological COCs that would likely exceed ROD remedial goals.

SU-7

Preferential Pathway -7 (PP-7) was located on the western sidewall of SU-7, approximately 2.5 ft bgs (see figure 1). This preferential pathway feature consisted of a layer of silt that was overlain by a layer of silty clay fill material. A preferential pathway sample (SLD87689) was collected from this silt layer and submitted for analysis at the St. Louis FUSRAP Laboratory for radiological COCs (see Table 1). The results from this preferential pathway sample indicated the presence of radiological COCs, but not at concentration levels that would yield an SOR value that was greater than or equal to 1.0. Based on the radiological results and observations made during the field reconnaissance activities for SU-7, the identified preferential pathway feature does not appear to be a migration pathway for radiological COCs and does not appear to lead to areas with concentrations of radiological COCs that would likely exceed ROD remedial goals.

Preferential Pathway -8 (PP-8) was located on the eastern sidewall of SU-7 at the base of the northern gravel ramp that was previously used for the load out area (see Figure 1). This preferential pathway feature was the contact between the overlaying gravel material for this ramp and a fill layer that consisted of coarse sand and coarse to fine gravel size cinders and slag with brick/brick fragments and ash that was loose, and poorly graded. A preferential pathway sample (SLD87688) was collected from this contact and submitted for analysis at the St. Louis FUSRAP laboratory for radiological COCs (see Table 1). The results from this preferential pathway sample indicated the presence of radiological COCs at concentration levels that yielded an SOR value that was greater than 1.0 (SOR=14), with thorium-230

being the main contributor to this SOR value (Th-230 = 200 pCi/g). On June 22nd, 2005, the preferential pathway feature was removed, by excavation, up to the inaccessible portion of the survey unit. [Note: The inaccessible portion of SU-7 was defined as the property line for the Burlington Northern Santa Fe Railroad Vicinity Property (DT- 12) (see Figure 1)]. Following the remedial excavation activities, the preferential pathway feature was again sampled (SLD87521) for the presence of radiological COCs (see Table 1). The results from this preferential pathway sample indicated that the radionuclide concentrations, and the resultant SOR value, were decreasing along this portion of the preferential pathway feature (SOR=0.5). Based on the radiological results and observations made during the field reconnaissance activities for SU-7, this identified preferential pathway feature does not appear to be a migration pathway for radiological COCs and does not appear to lead to areas with concentrations of radiological COCs that would likely exceed ROD remedial goals.

In addition to the preferential pathway that was identified within the accessible portion of SU-7, one preferential pathway was identified within the inaccessible portion of the survey unit. This preferential pathway, designated as Preferential Pathway -9 Inaccessible (PP-9IN), was located on the eastern sidewall of the survey unit and adjacent to DT- 12 (see Figure 1). This preferential pathway was the contact between the overlaying gravel cover material and a fill layer that consisted of coarse sand and coarse to fine gravel size cinders and slag with brick/brick fragments and ash that was loose, and poorly graded. A preferential pathway sample (SLD87687) was collected from this contact and submitted for analysis at the St. Louis FUSRAP laboratory for radiological COCs (see Table 1). The results from this preferential pathway sample indicated the presence of radiological COCs at concentration levels that yielded an SOR value that was greater than 1.0 (SOR=14), with thorium-230 being the main contributor to this SOR value (Th-230 = 200 pCi/g). Based on the radiological results from this sample location and observations made during the field reconnaissance activities for SU-7, the identified preferential pathway feature appears to be a migration pathway for radiological COCs and may lead to areas on DT-12 with concentrations of radiological COCs that may exceed ROD remedial goals.

The preferential pathway evaluations of SU-4, SU-5, and SU-7 consisted of field reconnaissance, observations of preferential pathway features, documentation of preferential pathway characteristics, radiological field screening of the excavation areas and features, the collection of soil samples for radiological analysis, and an evaluation of collected data. The remedial excavations were assessed for preferential pathways on the following dates by Mark Cummings (Geologist, Shaw); SU-4 (April 13 and 25, 2005), SU-5 (May 5, 2005), and SU-7 (June 15 and June 22, 2005). The health physics (HP) technicians that provided radiological support during the preferential pathway evaluations were Bill Orr (HP technician, EDI), Beau Gregory (HP Technician, EDI) and John Michele (HP technician, EDI). Geological data and field observations were evaluated by Mark Cummings, and the evaluations and this letter were reviewed by Don Jones, a Missouri registered professional geologist.

Sincerely.

Bruce A. Fox
Project Manager

MC/km

cc:

Robin Parks - USACE	Gerry Rood - Shaw	Quality Control-Shaw
Gerald Allen- USACE	Dave Mueller - USACE	Jerry Cross-Shaw
Susan Adams- USACE	Don Jones- Shaw	Phil Statler-Shaw
Dennis Chambers - USACE	Project Files-Shaw	Engineering Library-Shaw
Bruce Fox-Shaw (Email)	Mark Peterson – SAIC (Email)	

Enclosure(s)

Ta

Plant 7 South
Preferential Pathway Evaluation Radiological Data Results

Sample Location	Sample Identification Number	Collection Date	Start Depth (ft[1] bgs)[2]	End Depth (ft bgs)	Thickness of Cover Material (ft)	Parameter	Result[3] (pCi/g)[4]	Error	Detection Limit (pCi/g)	Sum of[5] Ratios Value	Easting Coordinate (ft)	Northing Coordinate (ft)	Elevation[6] Coordinate (ft)
SU-04													
SLD86842	SLD86842PF	04/20/05	1.5	2.0		Radium-226	4.28	0.97	0.08	0.39	909371.6	1029924.1	421.2
						Radium-228	0.76	0.07	0.09				
						Thorium-228	1.05	0.47	0.27				
						Thorium-230	6.48	1.47	0.12				
						Thorium-232	0.43	0.29	0.22				
						Uranium-235	0.42	0.21	0.37				
						Uranium-238	5.90	0.71	0.58				
SLD86843	SLD86843PF	04/20/05	2	2.5		Radium-226	9.58	2.16	0.13	0.59	909371.7	1029924.1	420.2
						Radium-228	1.00	0.10	0.17				
						Thorium-228	0.96	0.48	0.31				
						Thorium-230	4.65	1.25	0.14				
						Thorium-232	0.94	0.47	0.14				
						Uranium-235	0.64	0.54	0.67				
						Uranium-238	7.96	1.03	0.97				
SLD86860	SLD86933VF	04/25/05	0	0.5		Radium-226	1.08	0.28	0.05	0.00	909347.7	1029910.9	422.3
						Radium-228	0.13	0.04	0.07				
						Thorium-228	0.22	0.25	0.37				
						Thorium-230	1.36	0.63	0.17				
						Thorium-232	0.06	0.12	0.17				
						Uranium-235	0.08	0.16	0.27				
						Uranium-238	0.91	0.54	0.64				
	SLD86860VF	04/25/05	1.8	2.3		Radium-226	8.70	1.95	0.12	0.66	909347.7	1029910.9	420.5
						Radium-228	0.95	0.10	0.15				
						Thorium-228	0.88	0.44	0.29				
						Thorium-230	9.64	2.04	0.13				
						Thorium-232	0.79	0.41	0.29				
						Uranium-235	-0.05	0.35	0.57				
						Uranium-238	8.58	1.04	0.83				
	SLD86861VF	04/25/05	2.5	3.0		Radium-226	1.48	0.37	0.06	0.00	909371.1	1029893.7	419.8
						Radium-228	0.70	0.07	0.09				
						Thorium-228	0.57	0.34	0.23				
						Thorium-230	1.27	0.52	0.30				
						Thorium-232	0.22	0.20	0.12				
						Uranium-235	0.13	0.19	0.31				
						Uranium-238	1.51	0.59	0.46				

Table 1

Plant 7 South

Preferential Pathway Evaluation Radiological Data Results

Sample Location	Sample Identification Number	Collection Date	Start Depth (ft[1] bgs)[2]	End Depth (ft bgs)	Thickness of Cover Material (ft)	Parameter	Result[3] (pCi/g)[4]	Error	Detection Limit (pCi/g)	Sum of[5] Ratios Value	Easting Coordinate (ft)	Northing Coordinate (ft)	Elevation[6] Coordinate (ft)
SU-04													
SLD86862	SLD86935VF	04/25/05	0	0.5		Radium-226	1.07	0.28	0.05	0.00	909367.7	1029910.2	422.6
						Radium-228	0.11	0.08	0.12				
						Thorium-228	0.35	0.32	0.38				
						Thorium-230	0.75	0.46	0.17				
						Thorium-232	0.16	0.22	0.38				
						Uranium-235	0.24	0.15	0.24				
						Uranium-238	1.66	0.61	0.65				
	SLD86862VF	04/25/05	1.5	2.0		Radium-226	4.05	1.04	0.21	0.22	909367.7	1029910.2	421.1
						Radium-228	1.08	0.21	0.28				
						Thorium-228	1.22	0.51	0.23				
						Thorium-230	3.20	0.91	0.12				
						Thorium-232	1.17	0.50	0.23				
						Uranium-235	0.23	0.64	1.05				
						Uranium-238	7.85	1.85	1.55				
	SLD86863VF	04/25/05	2	2.5		Radium-226	5.49	1.40	0.24	0.26	909367.7	1029910.2	420.6
						Radium-228	1.44	0.20	0.33				
						Thorium-228	1.03	0.49	0.30				
						Thorium-230	3.87	1.08	0.14				
						Thorium-232	1.56	0.61	0.14				
						Uranium-235	-0.09	0.68	1.09				
						Uranium-238	3.89	2.17	1.69				
SLD86864	SLD86934VF	04/25/05	0	0.5		Radium-226	1.53	0.44	0.15	0.02	909382.6	1029910.6	422.9
						Radium-228	0.16	0.15	0.28				
						Thorium-228	0.42	0.39	0.23				
						Thorium-230	1.00	0.62	0.43				
						Thorium-232	0.06	0.17	0.43				
						Uranium-235	-0.16	0.39	0.61				
						Uranium-238	2.38	1.78	1.73				
	SLD86864VF	04/25/05	1.5	2.0		Radium-226	2.84	0.67	0.07	0.27	909382.6	1029910.6	421.4
						Radium-228	0.38	0.05	0.08				
						Thorium-228	0.44	0.35	0.33				
						Thorium-230	5.12	1.47	0.18				
						Thorium-232	0.32	0.29	0.18				
						Uranium-235	0.10	0.21	0.35				
						Uranium-238	4.45	0.69	0.54				

Tab

Plant 7 South
Preferential Pathway Evaluation Radiological Data Results

Sample Location	Sample Identification Number	Collection Date	Start Depth (ft[1] bgs)[2]	End Depth (ft bgs)	Thickness of Cover Material (ft)	Parameter	Result[3] (pCi/g)[4]	Error	Detection Limit (pCi/g)	Sum of[5] Ratios Value	Easting Coordinate (ft)	Northing Coordinate (ft)	Elevation[6] Coordinate (ft)
SU-04													
SLD86864	SLD86865VF	04/25/05	3	3.5		Radium-226	1.27	0.32	0.05	0.00	909382.6	1029910.6	419.9
						Radium-228	0.24	0.05	0.06				
						Thorium-228	0.36	0.32	0.19				
						Thorium-230	1.10	0.61	0.43				
						Thorium-232	0.27	0.29	0.36				
						Uranium-235	0.13	0.16	0.27				
						Uranium-238	1.28	0.45	0.36				
	SLD86866VF	04/25/05	4	4.5		Radium-226	2.94	0.68	0.07	0.06	909382.6	1029910.6	418.9
						Radium-228	0.54	0.05	0.09				
						Thorium-228	1.12	0.52	0.26				
						Thorium-230	2.67	0.86	0.14				
						Thorium-232	0.71	0.40	0.26				
						Uranium-235	0.28	0.19	0.34				
						Uranium-238	1.96	0.49	0.46				
	SLD86867VF	04/25/05	6.5	7.0		Radium-226	2.24	0.60	0.16	0.01	909382.6	1029910.6	416.4
						Radium-228	0.95	0.15	0.21				
						Thorium-228	0.74	0.45	0.35				
						Thorium-230	1.66	0.69	0.16				
						Thorium-232	0.83	0.46	0.16				
						Uranium-235	-0.11	0.45	0.75				
						Uranium-238	1.75	1.19	1.11				
SU-05													
HTZ86500	HTZ86500	05/16/05	4	4.5		Radium-226	3.77	0.90	0.11	0.16	909429.2	1030045.6	417.7
						Radium-228	1.37	0.11	0.12				
						Thorium-228	1.21	0.52	0.34				
						Thorium-230	3.20	0.92	0.13				
						Thorium-232	1.10	0.49	0.23				
						Uranium-235	0.38	0.40	0.56				
						Uranium-238	4.01	1.56	1.39				
HTZ86501	HTZ86501	05/16/05	4	4.5		Radium-226	8.31	1.95	0.16	0.52	909438.7	1030024.4	417.5
						Radium-228	1.20	0.12	0.21				
						Thorium-228	1.17	0.61	0.40				
						Thorium-230	7.82	2.03	0.40				
						Thorium-232	0.94	0.53	0.18				
						Uranium-235	0.86	0.63	0.89				
						Uranium-238	7.14	2.17	2.12				

Table 1

Plant 7 South

Preferential Pathway Evaluation Radiological Data Results

Sample Location	Sample Identification Number	Collection Date	Start Depth (ft[1] bgs)[2]	End Depth (ft bgs)	Thickness of Cover Material (ft)	Parameter	Result[3] (pCi/g)[4]	Error	Detection Limit (pCi/g)	Sum of[5] Ratios Value	Easting Coordinate (ft)	Northing Coordinate (ft)	Elevation[6] Coordinate (ft)
SU-05													
HTZ86515	HTZ86515	05/16/05	4	4.5		Radium-226	3.50	0.81	0.07	0.44	909446.7	1030010.0	417.3
						Radium-228	0.85	0.07	0.09				
						Thorium-228	1.57	0.64	0.32				
						Thorium-230	7.07	1.70	0.14				
						Thorium-232	1.01	0.49	0.14				
						Uranium-235	0.42	0.23	0.38				
						Uranium-238	6.13	0.58	0.58				
HTZ86516	HTZ86516	05/16/05	4	4.5		Radium-226	3.66	0.84	0.08	0.55	909446.6	1030015.5	417.3
						Radium-228	0.88	0.07	0.10				
						Thorium-228	0.89	0.49	0.16				
						Thorium-230	8.50	2.06	0.30				
						Thorium-232	0.95	0.50	0.16				
						Uranium-235	0.50	0.24	0.39				
						Uranium-238	7.13	0.87	0.63				
HTZ86517	HTZ86517	05/16/05	4	4.5		Radium-226	3.99	1.05	0.21	1.04	909448.0	1030011.2	417.4
						Radium-228	1.00	0.16	0.32				
						Thorium-228	1.04	0.53	0.29				
						Thorium-230	15.13	3.22	0.16				
						Thorium-232	0.58	0.38	0.16				
						Uranium-235	0.83	0.84	1.10				
						Uranium-238	9.20	2.13	1.49				
SLD86844	SLD86844PF	05/11/05	4	4.5		Radium-226	3.44	0.83	0.09	1.43	909448.0	1030011.2	417.4
						Radium-228	0.75	0.09	0.13				
						Thorium-228	0.72	0.40	0.14				
						Thorium-230	22.04	4.17	0.14			Remediated	
						Thorium-232	0.87	0.44	0.14				
						Uranium-235	-0.03	0.34	0.55				
						Uranium-238	6.11	1.64	1.43				
SLD86845	SLD86845PF	05/11/05	3	3.5		Radium-226	2.45	0.58	0.06	0.41	909476.1	1029857.7	419.3
						Radium-228	0.57	0.05	0.09				
						Thorium-228	1.04	0.49	0.25				
						Thorium-230	7.46	1.72	0.14				
						Thorium-232	0.96	0.46	0.14				
						Uranium-235	0.15	0.20	0.35				
						Uranium-238	3.42	0.53	0.51				

Table

Plant 7 South
Preferential Pathway Evaluation Radiological Data Results

Sample Location	Sample Identification Number	Collection Date	Start Depth (ft[1] bgs)[2]	End Depth (ft bgs)	Thickness of Cover Material (ft)	Parameter	Result[3] (pCi/g)[4]	Error	Detection Limit (pCi/g)	Sum of[5] Ratios Value	Easting Coordinate (ft)	Northing Coordinate (ft)	Elevation[6] Coordinate (ft)
SU-05													
SLD86846	SLD86846PF	05/11/05	3	3.5		Radium-226	1.05	0.25	0.03	0.00	909466.3	1029846.1	418.5
						Radium-228	0.07	0.02	0.04				
						Thorium-228	0.07	0.14	0.28				
						Thorium-230	1.31	0.54	0.13				
						Thorium-232	0.14	0.16	0.13				
						Uranium-235	0.09	0.10	0.17				
						Uranium-238	0.83	0.27	0.24				
SLD86847	SLD86847PF	05/11/05	3	3.5		Radium-226	1.31	0.31	0.03	0.00	909457.7	1029842.9	418.5
						Radium-228	0.25	0.02	0.04				
						Thorium-228	0.48	0.33	0.14				
						Thorium-230	1.64	0.65	0.27				
						Thorium-232	0.62	0.38	0.27				
						Uranium-235	-0.06	0.11	0.18				
						Uranium-238	1.21	0.36	0.28				
SLD87273	SLD87273VF	05/16/05	4	4.5		Radium-226	4.96	1.13	0.07	0.22	909445.6	1029992.1	417.3
						Radium-228	0.84	0.06	0.09				
						Thorium-228	1.36	0.59	0.27				
						Thorium-230	4.51	1.23	0.14				
						Thorium-232	1.22	0.55	0.14				
						Uranium-235	0.23	0.24	0.40				
						Uranium-238	3.46	0.65	0.62				
	SLD87274VF	05/16/05	5.5	6.0		Radium-226	2.95	0.70	0.06	0.03	909445.6	1029992.1	415.8
						Radium-228	0.69	0.06	0.08				
						Thorium-228	0.63	0.35	0.12				
						Thorium-230	2.29	0.74	0.23				
						Thorium-232	0.54	0.32	0.12				
						Uranium-235	0.23	0.19	0.34				
						Uranium-238	1.67	0.42	0.55				
SLD87275	SLD87275VF	05/16/05	5	5.5		Radium-226	4.64	1.07	0.09	0.17	909433.4	1030036.4	412.7
						Radium-228	0.87	0.07	0.10				
						Thorium-228	0.99	0.49	0.31				
						Thorium-230	3.12	0.94	0.14				
						Thorium-232	0.90	0.46	0.26				
						Uranium-235	0.41	0.38	0.47				
						Uranium-238	3.84	0.82	0.73				

Table 1

Plant 7 South

Preferential Pathway Evaluation Radiological Data Results

Sample Location	Sample Identification Number	Collection Date	Start Depth (ft bgs)[2]	End Depth (ft bgs)	Thickness of Cover Material (ft)	Parameter	Result[3] (pCi/g)[4]	Error	Detection Limit (pCi/g)	Sum of[5] Ratios Value	Easting Coordinate (ft)	Northing Coordinate (ft)	Elevation[6] Coordinate (ft)
SU-05													
SLD87275	SLD87276VF	05/16/05	5.5	6.0		Radium-226	4.94	1.24	0.22	0.15	909433.4	1030036.4	412.2
						Radium-228	0.92	0.17	0.25				
						Thorium-228	0.88	0.53	0.42				
						Thorium-230	3.16	1.11	0.19				
						Thorium-232	0.63	0.44	0.19				
						Uranium-235	0.28	0.60	1.04				
						Uranium-238	2.00	1.54	1.67				
SU-07													
SLD87521	SLD87521PF	06/22/05	0.5	1.0		Radium-226	4.88	1.12	0.09	0.45	909434.8	1030081.3	419.6
						Radium-228	1.08	0.09	0.11				
						Thorium-228	1.03	0.52	0.16				
						Thorium-230	7.47	1.83	0.16				
						Thorium-232	0.69	0.41	0.16				
						Uranium-235	0.13	0.27	0.45				
						Uranium-238	4.87	0.90	0.67				
SLD87687	SLD87687PF	06/16/05	1	1.5		Radium-226	7.78	1.75	0.08	13.60	909441.1	1030059.9	419.9
						Radium-228	1.18	0.06	0.09				
						Thorium-228	1.18	0.06	0.09				
						Thorium-230	203.40	14.90	9.31				
						Thorium-232	1.18	0.06	0.09				
						Uranium-235	0.48	0.25	0.53				
						Uranium-238	9.29	0.84	0.95				
SLD87688	SLD87688PF	06/16/05	1	1.5		Radium-226	5.26	1.19	0.07	13.76	909428.4	1030076.3	420.0
						Radium-228	0.73	0.05	0.07				
						Thorium-228	0.73	0.05	0.07				
						Thorium-230	202.30	16.14	9.42			Remediated	
						Thorium-232	0.73	0.05	0.07				
						Uranium-235	1.48	0.32	0.47				
						Uranium-238	21.75	1.44	0.95				
SLD87689	SLD87689PF	06/16/05	2.5	3.0		Radium-226	0.93	0.23	0.04	0.23	909343.6	1030034.7	421.5
						Radium-228	0.78	0.05	0.06				
						Thorium-228	0.78	0.05	0.06				
						Thorium-230	0.53	3.69	5.29				
						Thorium-232	0.78	0.05	0.06				
						Uranium-235	0.68	0.15	0.25				
						Uranium-238	12.98	0.83	0.53				

Ta[redacted]

Plant 7 South
Preferential Pathway Evaluation Radiological Data Results

Sample Location	Sample Identification Number	Collection Date	Start Depth (ft[1] bgs)[2]	End Depth (ft bgs)	Thickness of Cover Material (ft)	Parameter	Result[3] (pCi/g)[4]	Error	Detection Limit (pCi/g)	Sum of[5] Ratios Value	Easting Coordinate (ft)	Northing Coordinate (ft)	Elevation[6] Coordinate (ft)

[1] ft - feet

[2] bgs - below ground surface

[3] Analytical data includes background values (i.e., concentrations reflect gross radionuclide values)

[4] pCi/g - Picocuries per gram

[5] Prior to calculating the SOR, background values for each radionuclide were subtracted from their respective gross radionuclide values

Background Values:
Radium-226 = 2.78 pCi/g
Radium-228 = 0.95 pCi/g
Thorium-230 = 1.94 pCi/g
Thorium-232 = 1.09 pCi/g
Uranium-238 = 1.44 pCi/g

[6] The reported elevation represents the top of the sample interval

OFFICE STL
Drawing File: 845843-E517

PLANT No. 7N

PLANT No. 7S

RAMP

GI

CONCRETE RETAINING WALL

MI 90 DAY HAZARDOUS WASTE STORAGE PAD

MAN DOOR

MATERIAL HANDLING BUILDING

DUMP AREA

LAYOUT AREA

BNSF RAILROAD VICINITY PROPERTY (DT-12)

SU-7

SU-4

SU-5

PP-1

PP-2

PP-3

PP-4

PP-5

PP-6

PP-7

PP-8

PP-9IN

SLD87521

SLD87688*

SLD87687

HTZ86500

SLD87275

HTZ86501

HTZ86516

HTZ86517

SLD86844*

HTZ86515

SLD87273

SLD86860

SLD86842

SLD86843

SLD86862

SLD86864

SLD87689

SLD86846

SLD86847

SLD86845

SLIDING GATE

GATE

ANGELRODT STREET

UMH

MH

WV

CITY WATER UTILITY MAP DISPLAYS VALVES AT THIS LOCATION

GENERAL LEGEND:

- PROPERTY LINE
- PLANT No.7S PROPERTY LINE
- BOUNDARY SURVEY UNIT
- SU-4 — BOUNDARY SURVEY UNIT NUMBER
- 421 — AS-BUILT EXCAVATION CONTOUR (1 FOOT)
- 420.5 — AS-BUILT EXCAVATION CONTOUR (HALF FOOT)
- CHAIN LINK FENCE
- UTILITY MANHOLE
- EXISTING BUILDING (INCLUDING TEMP. BUILDING)
- WV — WATER VALVE
- WV/MH — WATER VALVE IN MANHOLE
- WM — WATER METER
- UTILITY POLE
- MH — SEWER MANHOLE
- GI — GRATED INLET
- CHAIN LINK FENCE
- G — GAS LINE
- W — WATER LINE
- S — SEWER LINE
- OU — OVERHEAD UTILITY LINE
- RAILROAD TRACKS

SAMPLE LEGEND:

SYMBOL ID	DESCRIPTION
SLDxxxxx	= FSS CLASS 2 SAMPLE LOCATION
SLDxxxxx	= PP SAMPLE LOCATION
HTZxxxxx	= FSS HTZ SAMPLE LOCATION
SLDxxxxx*	= SAMPLE REMEDIATED
PP-8	= PERFERENTIAL PATHWAY LOCATION
PP-9IN	= PERFERENTIAL PATHWAY LOCATION INACCESSIBLE AREA

FSS = FINAL STATUS SURVEY
PP = PREFERENTIAL PATHWAY

STATE PLANE GRID (EAST ZONE NAD 83)

SCALE
0 15 30 45 FEET

Revisions

Symbol	Descriptions	Date	Approved
0	FOR PREFERENTIAL PATHWAY EVALUATION LETTER	9/15/05	K. Beach

Shaw Environmental, Inc.

FUSRAP
U.S. ARMY CORPS OF ENGINEERS
KANSAS CITY DISTRICT (CENWK)
ST. LOUIS DISTRICT (CEMVS)

Designed by: --
Drawn by: A. Smith
Checked by: M. Cummings
Approved by: B. FOX

PREFERENTIAL PATHWAY EVALUATION FOR SU-4, SU-5, AND SU-7

ST. LOUIS DOWNTOWN SITE, MALLINKRODT PLANT 7S
ST. LOUIS, MISSOURI

Scale: AS SHOWN
Date: 9/7/05
Drawing File: 845843-E517.dwg
Sheet Number: 1
Spec No. FIGURE
Contract No. DACW41-98-D-9006

File: O:\Shaw Documents - CAD Files\St. Louis\845843\845843E517.dwg
Plot Date/Time: 9/7/2005 - 10:44am
Plotted By: arthur_smith

AR-073