APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: PSA 01 **Description:** Piping Survey Area Bld 230 NE (STM-3)

Survey Unit: 03 **Description:** Storm Water piping NE of Bld 230

Survey Type: FSS **Classification:** Class 1

Measurement or Sample ID	Surface or CSM	Type	Start * Elevation	End * Elevation	Feet NE from MH-03	Feet E from MH-03	Remarks / Notes
P01-03-01-S-O-S-00	O	S	NA	NA	4	N/A	STM-3 Int. Bottom
P01-03-02-S-O-S-00	O	S	NA	NA	12	N/A	STM-3 Int. Bottom
P01-03-03-S-O-S-00	O	S	NA	NA	20	N/A	STM-3 Int. Bottom
P01-03-04-S-O-S-00	O	S	NA	NA	N/A	2	STM-3 Int. Bottom
P01-03-05-S-O-S-00	O	S	NA	NA	N/A	10	STM-3 Int. Bottom
P01-03-06-S-O-S-00	O	S	NA	NA	N/A	18	STM-3 Int. Bottom
Measurement or Sample ID	Surface or CSM	Type	Start * Elevation	End * Elevation	Feet SW from MH-03	Feet SW from MH-24	Remarks / Notes
P01-03-07-S-O-S-00	O	S	NA	NA	4	N/A	STM-3 Int. Bottom
P01-03-08-S-O-S-00	O	S	NA	NA	12	N/A	STM-3 Int. Bottom
P01-03-09-S-O-S-00	O	S	NA	NA	20	N/A	STM-3 Int. Bottom
P01-03-10-S-O-S-00	O	S	NA	NA	N/A	3	STM-3 Int. Bottom
P01-03-11-S-O-S-00	O	S	NA	NA	N/A	11	STM-3 Int. Bottom
P01-03-12-S-O-S-00	O	S	NA	NA	N/A	19	STM-3 Int. Bottom
P01-03-13-S-O-S-00	O	S	NA	NA	N/A	27	STM-3 Int. Bottom
P01-03-14-S-O-S-00	O	S	NA	NA	N/A	35	STM-3 Int. Bottom
P01-03-15-S-O-S-00	O	S	NA	NA	N/A	43	STM-3 Int. Bottom
P01-03-16-S-O-B-00	O	B	NA	NA	0	N/A	Biased at 24" pipe opening
P01-03-17-S-O-B-00	O	B	NA	NA	N/A	N/A	MH23 Bottom
P01-03-18-S-O-B-00	O	B	NA	NA	0	N/A	MH03 Bottom
P01-03-19-S-O-B-00	O	B	NA	NA	N/A	14 (E of MH03)	Biased at pipe seam
P01-03-20-S-O-B-00	O	B	NA	NA	N/A	0	MH24 Bottom

*X and Y coordinates originate from lower left or southwest corner of structural surface. Each structural surface has it's own origin (0,0) point.

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Deep) or Uniform

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Ludlum 2360	Ludlum 43-68	Active Probe Area	α HDP Efficiency	α Cal. Efficiency	ß HDP Efficiency	ß Cal. Efficiency
248144	216857	125 cm^2	**29.2%**	N/A	**19.9%**	N/A

TOTAL WEIGHTED INSTRUMENT EFFICIENCY CALCULATION

Radionuclide	Radiation	Maximum Energy (MeV)	Instrument Efficiency (ε_i)	Surface Efficiency (ε_s)	Yield 100%	Activity Fraction	Weighted Efficiency
Am-241	Alpha	5.6	0.2920	0.25	1.00	2.682E-03	1.96E-04
Np-237	Alpha	5.0	0.2920	0.25	1.00	5.573E-05	4.07E-06
Pu-239	Alpha	5.2	0.2920	0.25	1.00	2.027E-06	1.48E-07
Tc-99	Beta	0.294	0.1990	0.25	1.00	2.829E-03	1.41E-04
Th-232	Alpha	4.1	0.2920	0.25	1.00	3.214E-03	2.35E-04
Ra-228	Beta	0.046	0.1990	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.1990	0.50	1.00	3.214E-03	3.20E-04
Th-228	Alpha	5.5	0.2920	0.25	1.00	3.214E-03	2.35E-04
Ra-224	Alpha	5.8	0.2920	0.25	1.00	3.214E-03	2.35E-04
U-234	Alpha	4.9	0.2920	0.25	1.00	8.270E-01	6.04E-02
U-235	Alpha	4.7	0.2920	0.25	1.00	3.720E-02	2.72E-03
Th-231	Beta	0.390	0.1990	0.25	1.00	3.720E-02	1.85E-03
U-238	Alpha	4.3	0.2920	0.25	1.00	1.270E-01	9.27E-03
Th-234	Beta	0.270	0.1990	0.25	1.00	1.270E-01	6.32E-03
Pa-234m	Beta	2.20	0.1990	0.50	1.00	1.270E-01	1.26E-02

Total Weighted Instrument Efficiency = Σ Weighted Instrument Efficiency for all Nuclides of Concern **Σ=** **9.45%**

Weighted Instrument Efficiency = ε_i * ε_s * Yield * Activity Fraction

ε_i = 2 Pi Instrument Efficiency for Nuclide of Concern

ε_s = Surface Efficiency for Nuclide of Concern

Meter
43-68

				Step 8.3.2					
MEASUREMENT ID	**MEASUREMENT LOCATION**	**DATE MEAS**	**MEASUREMENT**	**GROSS cpm (α+β)**	**BKG cpm (a+b)**	**Net cpm (α + β)**	**Combined Net dpm/100 cm^2 (α+β)**	**Corrected Net dpm/100cm^2**	**Fraction of DCGL Step 8.4.3**
P01-03-01-S-O-S-00	STM-3 Int. Bottom	01/28/2016	alpha + beta TSC	152	146	6	51	51	0%
P01-03-02-S-O-S-00	STM-3 Int. Bottom	01/28/2016	alpha + beta TSC	106	146	-40	-339	0	0%
P01-03-03-S-O-S-00	STM-3 Int. Bottom	01/29/2016	alpha + beta TSC	181	180	1	8	8	0%
P01-03-04-S-O-S-00	STM-3 Int. Bottom	01/28/2016	alpha + beta TSC	300	146	154	1304	1304	7%
P01-03-05-S-O-S-00	STM-3 Int. Bottom	01/28/2016	alpha + beta TSC	298	146	152	1287	1287	7%
P01-03-06-S-O-S-00	STM-3 Int. Bottom	01/28/2016	alpha + beta TSC	253	146	107	906	906	5%
P01-03-07-S-O-S-00	STM-3 Int. Bottom	01/28/2016	alpha + beta TSC	104	146	-42	-356	0	0%
P01-03-08-S-O-S-00	STM-3 Int. Bottom	01/28/2016	alpha + beta TSC	91	146	-55	-466	0	0%
P01-03-09-S-O-S-00	STM-3 Int. Bottom	01/28/2016	alpha + beta TSC	74	146	-72	-610	0	0%
P01-03-10-S-O-S-00	STM-3 Int. Bottom	01/28/2016	alpha + beta TSC	136	146	-10	-85	0	0%
P01-03-11-S-O-S-00	STM-3 Int. Bottom	01/28/2016	alpha + beta TSC	139	146	-7	-59	0	0%
P01-03-12-S-O-S-00	STM-3 Int. Bottom	01/28/2016	alpha + beta TSC	78	146	-68	-576	0	0%
P01-03-13-S-O-S-00	STM-3 Int. Bottom	01/28/2016	alpha + beta TSC	67	146	-79	-669	0	0%
P01-03-14-S-O-S-00	STM-3 Int. Bottom	01/28/2016	alpha + beta TSC	85	146	-61	-516	0	0%
P01-03-15-S-O-S-00	STM-3 Int. Bottom	01/28/2016	alpha + beta TSC	74	146	-72	-610	0	0%
P01-03-16-S-O-B-00	Biased at 24" pipe opening	01/29/2016	alpha + beta TSC	170	180	-10	-85	0	0%
P01-03-17-S-O-B-00	MH23 Bottom	01/28/2016	alpha + beta TSC	186	146	40	339	339	2%
P01-03-18-S-O-B-00	MH03 Bottom	01/28/2016	alpha + beta TSC	92	146	-54	-457	0	0%
P01-03-19-S-O-B-00	Biased at pipe seam	01/28/2016	alpha + beta TSC	131	146	-15	-127	0	0%
P01-03-20-S-O-B-00	MH24 Bottom	01/28/2016	alpha + beta TSC	74	146	-72	-610	0	0%
							Min	0	**1%** Average Fraction Step 8.4.5.g
							Max	1304	
							Mean	237	**DCGL$_{SO}$**
							Median	0	**0.3** mrem SU Dose Contribution Step 8.4.6
							Stdev	488.1	**mrem**

*NOTE: Differences from documented survey results are due to rounding in Excel

Instrument used for FSS Static Measurements:

Ludlum 2360/43-68	S/N 248144	10/02/2016		Survey # 6932 C 160203	
Detector Area (A) =	125 cm^2	ave. ambient bkg = (α + β)	146 cpm (on 1/28/16)	weighted eff (ε_w)=	0.09450

TSC (dpm/100cm^2) = (gcpm-bkg) / (ε_w * (A_{det}/100 cm^2))

DCGL (structures) = 18,925 dpm/100 cm^2

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	Alpha Gross cpm	Alpha Net cpm	Alpha Net dpm/100cm^2	Corrected Alpha Net dpm/100cm^2	Beta Gross cpm	Beta Net cpm	Beta Net dpm/100cm^2
1	MH3 - S1	01/27/2016	0	-2	-6	0	30	-4	-18
2	MH3 - S2	01/27/2016	2	0	-1	0	44	11	53
3	MH3 - S3	01/27/2016	0	-2	-6	0	30	-4	-18
4	MH3 - S4	01/27/2016	2	0	-1	0	36	3	13
5	MH3 - B1	01/27/2016	2	0	-1	0	39	6	28
6	MH3 - B2	01/27/2016	0	-2	-6	0	29	-5	-23
7	MH3 - B3	01/27/2016	1	-1	-4	0	32	-2	-8
8	MH3 - B4	01/27/2016	2	0	-1	0	31	-3	-13
9	MH23a - S5	01/27/2016	3	1	2	2	35	2	8
10	MH23a - S6	01/27/2016	0	-2	-6	0	28	-6	-28
11	MH23a - S7	01/27/2016	1	-1	-4	0	30	-4	-18
12	MH23a - S8	01/27/2016	0	-2	-6	0	29	-5	-23
13	MH23a - B5	01/27/2016	2	0	-1	0	34	1	3
14	MH23a - B6	01/27/2016	0	-2	-6	0	20	-14	-68
15	MH23a - B7	01/27/2016	1	-1	-4	0	24	-10	-48
16	MH23a - B8	01/27/2016	0	-2	-6	0	30	-4	-18
17	MH23b - S9	01/27/2016	0	-2	-6	0	30	-4	-18
18	MH23b - S10	01/27/2016	1	-1	-4	0	28	-6	-28
19	MH23b - S11	01/27/2016	0	-2	-6	0	24	-10	-48
20	MH23b - S12	01/27/2016	1	-1	-4	0	35	2	8
21	MH23b - B9	01/27/2016	2	0	-1	0	40	7	33
22	MH23b - B10	01/27/2016	3	1	2	2	28	-6	-28
23	MH23b - B11	01/27/2016	1	-1	-4	0	31	-3	-13
24	MH23b - B12	01/27/2016	0	-2	-6	0	29	-5	-23
25	MH24 - S13	01/27/2016	1	-1	-4	0	30	-4	-18
26	MH24 - S14	01/27/2016	1	-1	-4	0	28	-6	-28
27	MH24 - S15	01/27/2016	0	-2	-6	0	30	-4	-18
28	MH24 - S16	01/27/2016	1	-1	-4	0	32	-2	-8
29	MH24 - B13	01/27/2016	1	-1	-4	0	36	3	13
30	MH24 - B14	01/27/2016	2	0	-1	0	30	-4	-18
31	MH24 - B15	01/27/2016	1	-1	-4	0	26	-8	-38
32	MH24 - B16	01/27/2016	0	-2	-6	0	31	-3	-13

Removable Data Evaluation

Instrument used for Removable Measurements:

Ludlum 3030/43-10-1 S/N 247399 Cal Due 3/12/16 Survey # 6893 C 160127

alpha bkg = 2.3 cpm alpha efficiency = 36.60% alpha MDA = 22.5
beta bkg = 33.5 cpm beta efficiency = 20.00% beta MDA = 115

Corrected Beta Net dpm/100cm^2	Combined Net dpm/100 cm^2 ($\alpha+\beta$)	Exceed 10% of Min. Sys. TSC Result?	Exceed MDA?	Exceed 10% of DCGL?
0	0	N	N	N
53	53	Y	N	N
0	0	N	N	N
13	13	Y	N	N
28	28	Y	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
8	9	Y	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
3	3	Y	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
8	8	Y	N	N
33	33	Y	N	N
0	2	Y	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
13	13	Y	N	N
0	0	N	N	N
0	0	N	N	N
0	0	N	N	N
Min	0			
Max	53			
Mean	5			
Median	0			
StDev	12.3			

DCGL = 18,925 dpm/100cm^2

Removable Activity (dpm/100cm^2) = (gcpm-bkg) / ε

Area "swiped" = 100 cm^2

Sign Test						
SAMPLE ID	SAMPLE ID	Gross TSC Step 8.5.4.a	Gross TSC / Adj. Gross DCGL (W_s) Step 8.5.4.b	Difference (1-W_s) Step 8.5.4.d	Corrected Difference Step 8.5.4.e	
P01-03-01-S-O-S-00	STM-3 Int. Bottom	51	0.003	0.997	0.997	α = 0.05
P01-03-02-S-O-S-00	STM-3 Int. Bottom	0	0.000	1.000	1.000	
P01-03-03-S-O-S-00	STM-3 Int. Bottom	8	0.000	1.000	1.000	
P01-03-04-S-O-S-00	STM-3 Int. Bottom	1304	0.069	0.931	0.931	
P01-03-05-S-O-S-00	STM-3 Int. Bottom	1287	0.068	0.932	0.932	
P01-03-06-S-O-S-00	STM-3 Int. Bottom	906	0.048	0.952	0.952	
P01-03-07-S-O-S-00	STM-3 Int. Bottom	0	0.000	1.000	1.000	
P01-03-08-S-O-S-00	STM-3 Int. Bottom	0	0.000	1.000	1.000	
P01-03-09-S-O-S-00	STM-3 Int. Bottom	0	0.000	1.000	1.000	
P01-03-10-S-O-S-00	STM-3 Int. Bottom	0	0.000	1.000	1.000	
P01-03-11-S-O-S-00	STM-3 Int. Bottom	0	0.000	1.000	1.000	
P01-03-12-S-O-S-00	STM-3 Int. Bottom	0	0.000	1.000	1.000	
P01-03-13-S-O-S-00	STM-3 Int. Bottom	0	0.000	1.000	1.000	
P01-03-14-S-O-S-00	STM-3 Int. Bottom	0	0.000	1.000	1.000	
P01-03-15-S-O-S-00	STM-3 Int. Bottom	0	0.000	1.000	1.000	
Number of Positive Differences (S+)					15	
Sign Test Critical Value (MARSSIM Table I-3)					**11**	

TEST: **PASS**

If every measurement in the systematic sample population is <= the DCGL, a statistical test is not required.

MARSSIM Table I-3 Critical Values for the Sign Test Statistic S+		MARSSIM Table I-3 Critical Values for the Sign Test Statistic S+	
N	Alpha = 0.05	N	0.05
4	4	28	18
5	4	29	19
6	5	30	19
7	6	31	20
8	6	32	21
9	7	33	21
10	8	34	22
11	8	35	22
12	9	36	23
13	9	37	23
14	10	38	24
15	11	39	25
16	11	40	25
17	12	41	26
18	12	42	26
19	13	43	27
20	14	44	27
21	14	45	28
22	15	46	29
23	15	47	29
24	16	48	30
25	17	49	30
26	17	50	31
27	18		