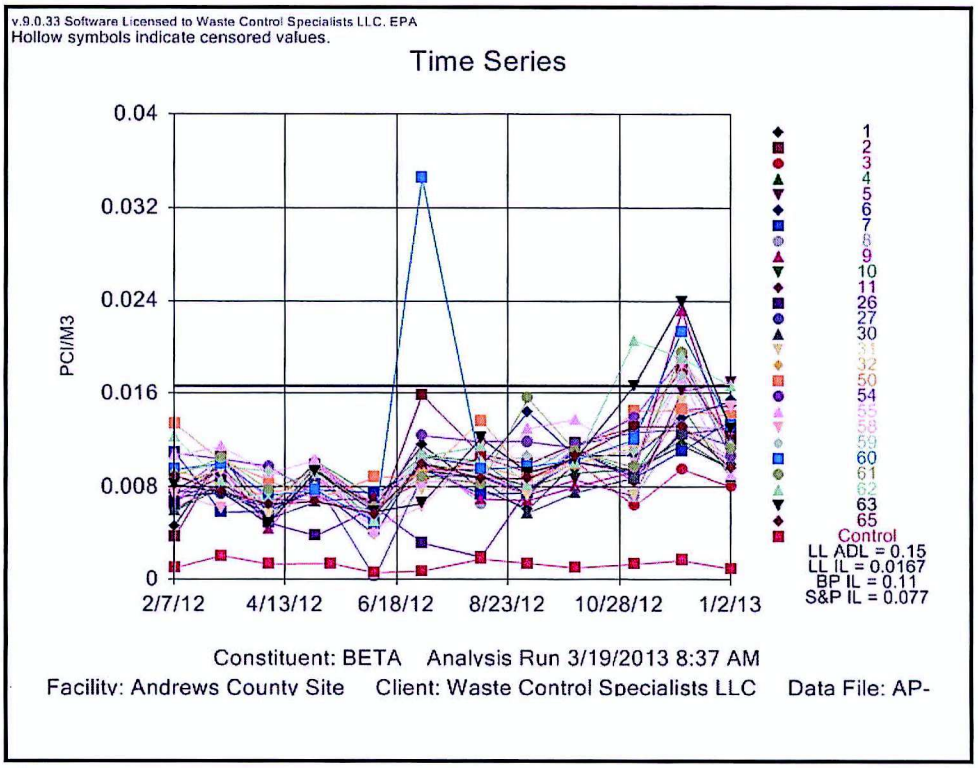

Figure 70 : Air Particulate Results for Gross Beta

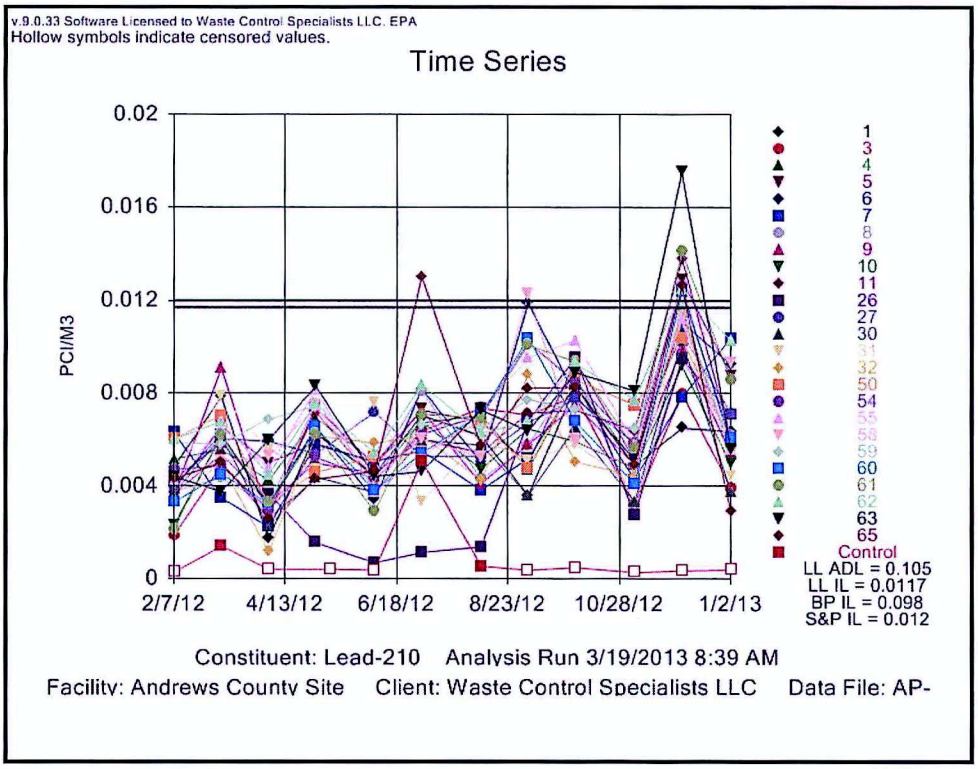

Figure 71 : Air Particulate Results for Lead-210

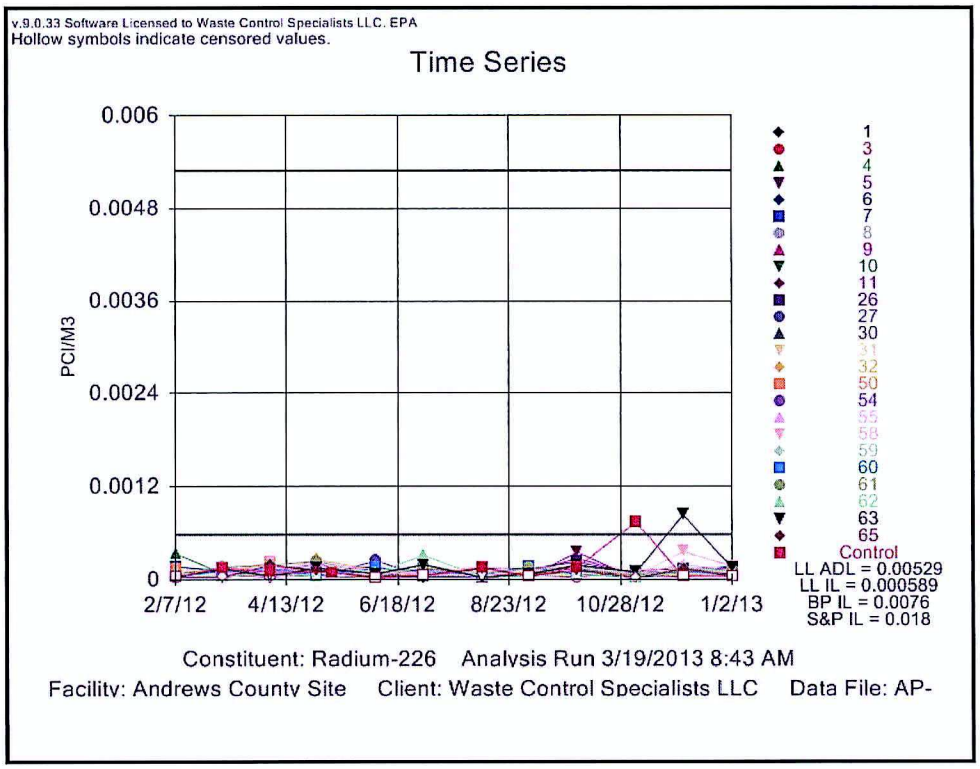

Figure 72 : Air Particulate Results for Radium-226

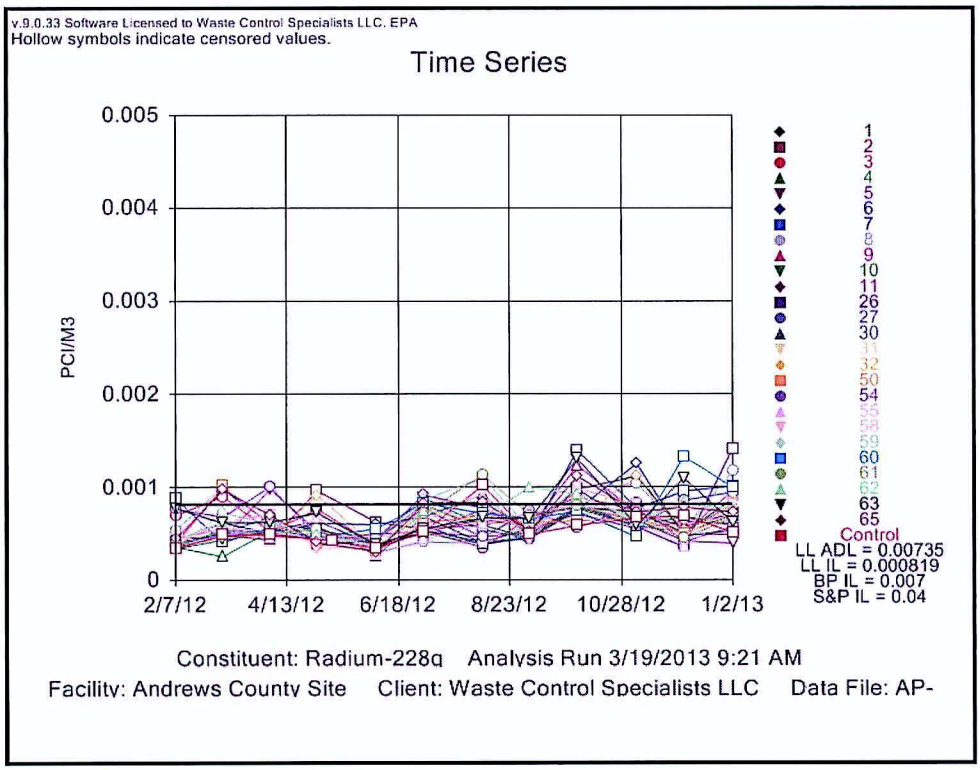

Figure 73 : Air Particulate Results for Radium-228

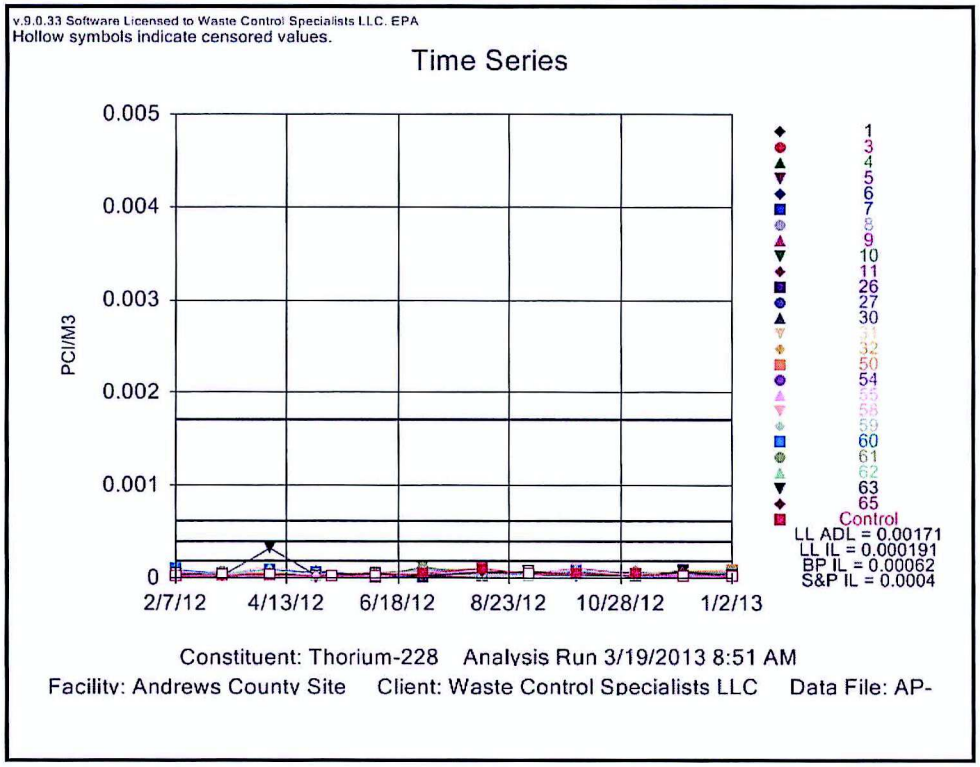

Figure 74 : Air Particulate Results for Thorium-228

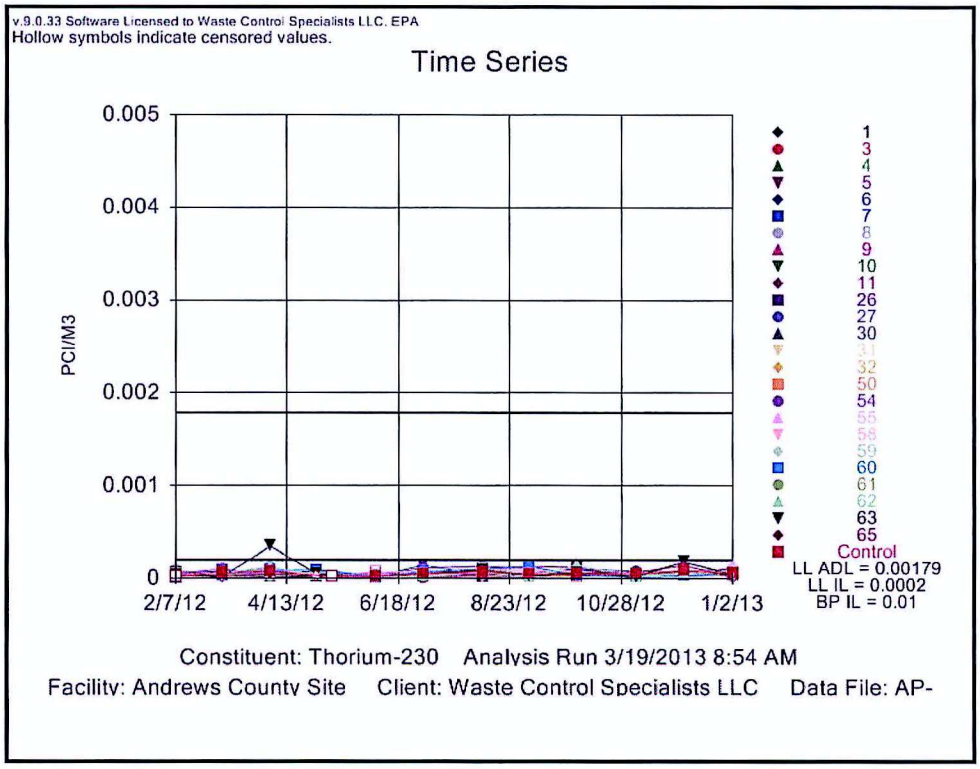

Figure 75 : Air Particulate Results for Thorium-230

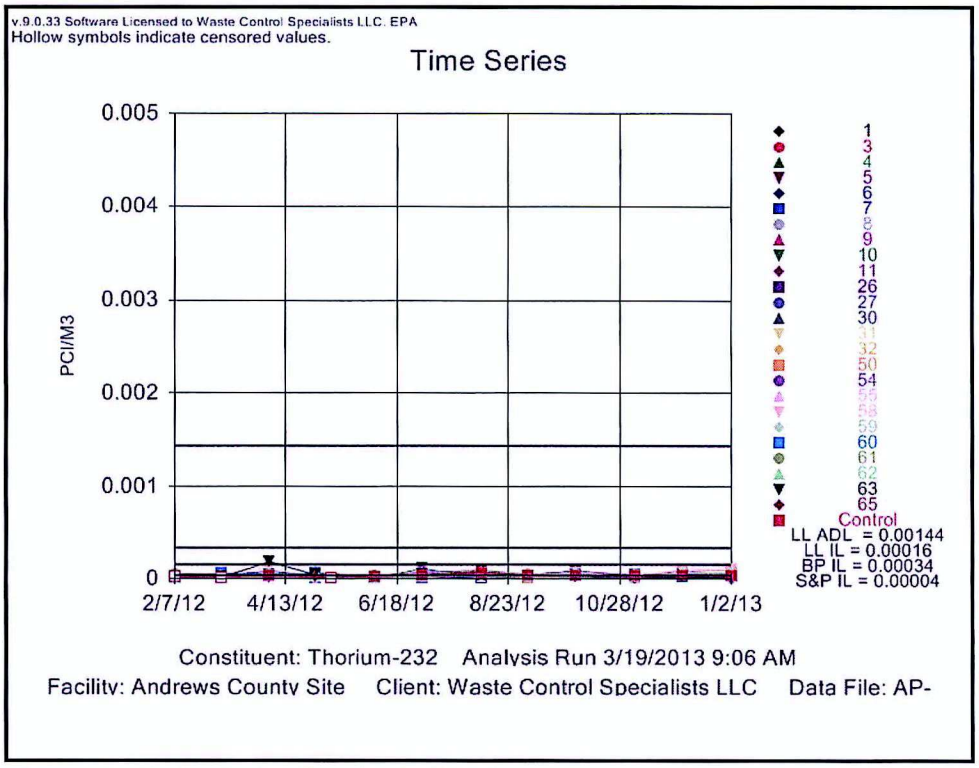

Figure 76 : Air Particulate Results for Thorium-232

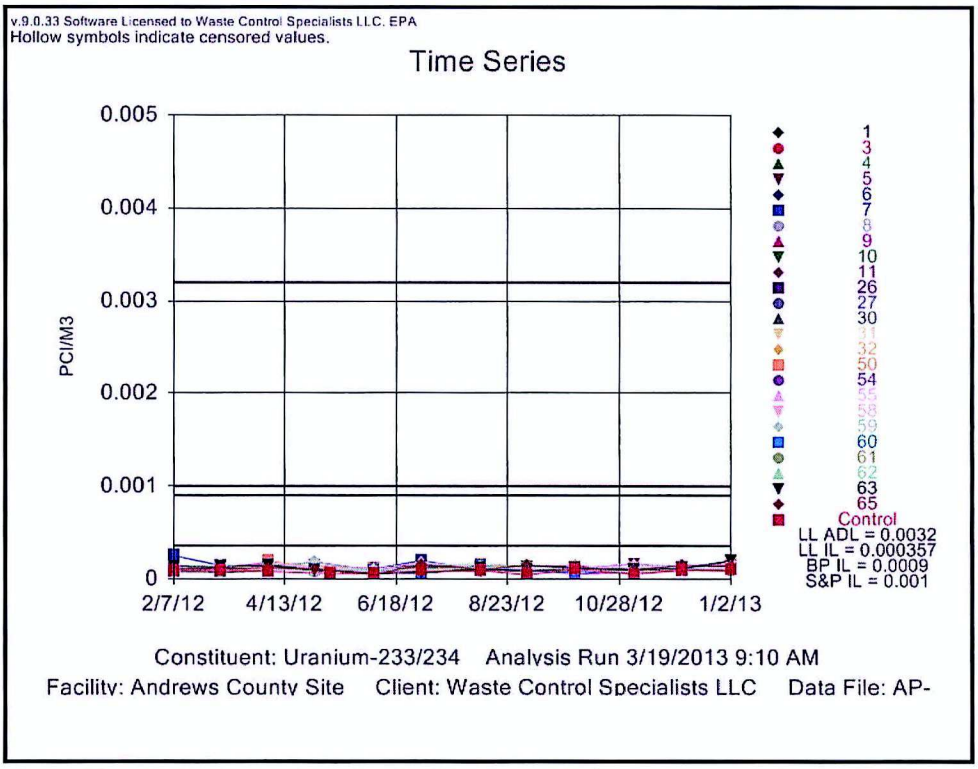

Figure 77 : Air Particulate Results for Uranium-233/234

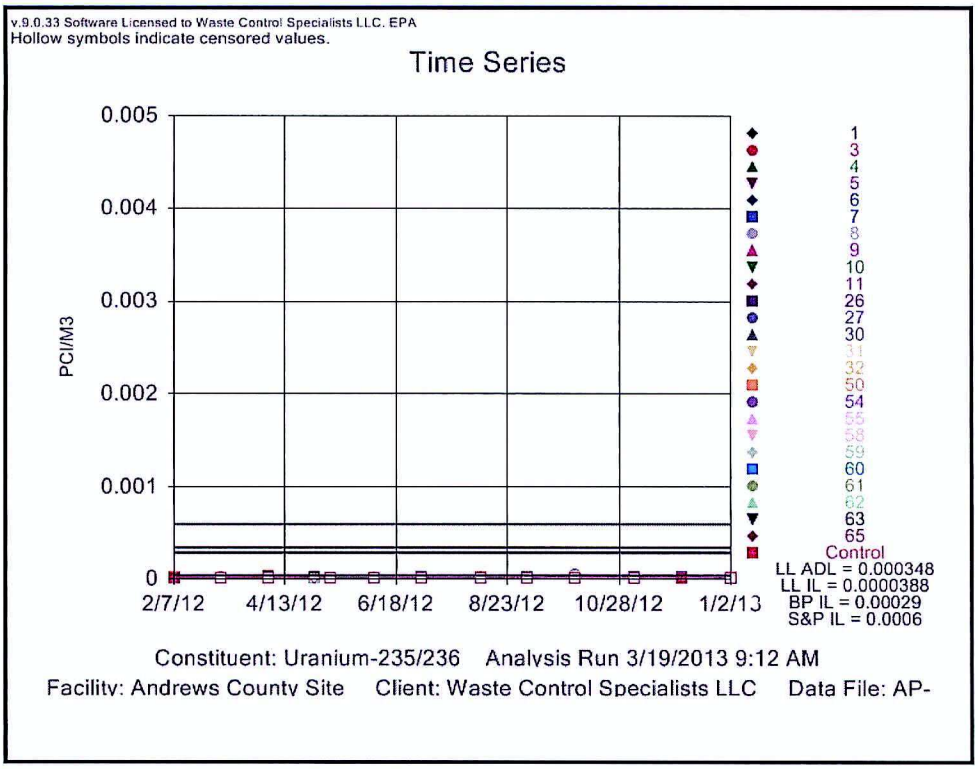

Figure 78 : Air Particulate Results for Uranium-235/236

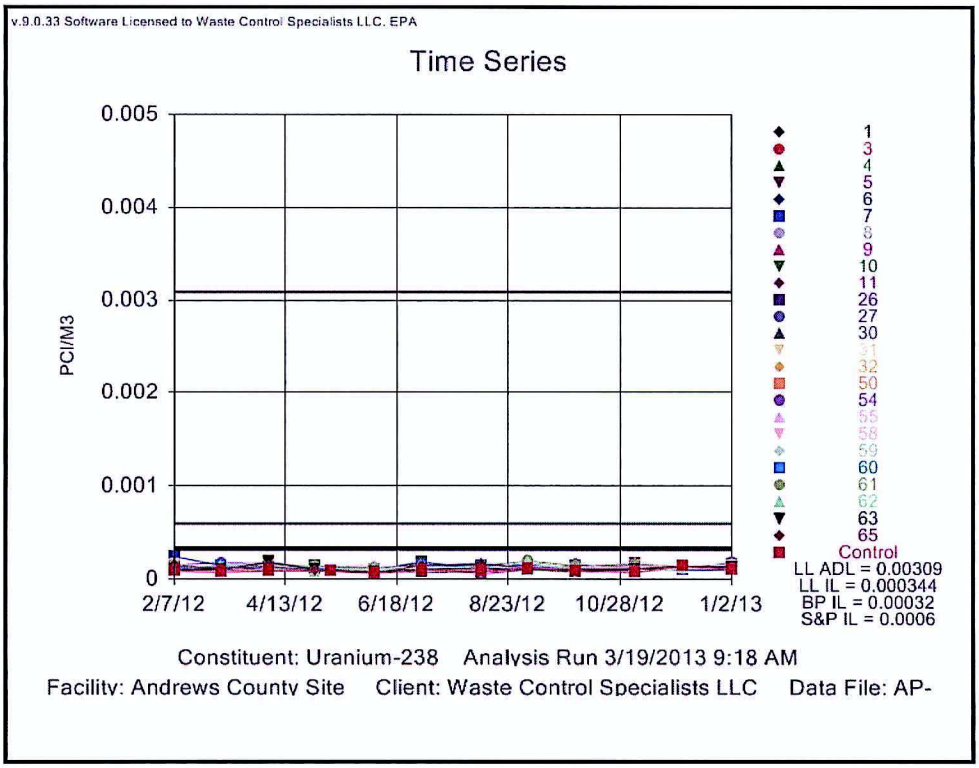

Figure 79 : Air Particulate Results for Uranium-238

3.7.2 Air Tritium

Air tritium samples were collected at 26 stations and sent to an offsite accredited laboratory for analysis in accordance with EV-7.1.2, *Low Volume Air Sampling*. Table 24 displays the air tritium sampling requirements. Table 25 contains summary statistics for the air tritium results. All air tritium results were less than their respective ILs. All tritium data are provided in Appendix F.

Table 24 : Air Tritium Sampling Requirements

Sample Type	Byproduct Stations	TSDF Stations	LLRW Stations
Air Tritium	1, 3, 4, 6, 7, 8, 9, 11, 26, 27, 30, 31, and 32	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 26, and 27	1, 4, 6, 7, 9, 11, 26, 27, 31, 50, 54, 55, 58, 59, 60, 61, 62, 63, and 65

Table 25 : Summary of Air Tritium Results (pCi/m³), 2012

Analyte	Stations	Observations	Greater Than MDC	Mean	STDEV	Max	Min	TSDF IL	LLRW IL	LLRW ADL
Tritium	26	288	1	1.30E+00	5.70E+00	5.57E+01	-2.60E+01	2.00E+03	8.05E+01	7.22E+02

3.7.3 Air Cartridges

Air cartridge samples were collected weekly, composited monthly, and sent to an offsite accredited laboratory for analysis in accordance with procedure EV-7.1.2, *Low Volume Air Sampling*. Table 26 displays the air cartridge sampling requirements. Table 27 contains the results for air cartridge summary statistics for 2012. Graphical depictions of air cartridge data with respect to time are not provided because no ^{14}C, ^{129}I, or ^{85}Kr were detected above the MDC in any of the samples. All air cartridge results were representative of background levels. Please note that there are no Byproduct ILs for these constituents.

Table 26 : Air Cartridge Sampling Requirements

Sample Type	Byproduct Stations	TSDF Stations	LLRW Stations
Air Cartridge	N/A	1, 4, 6, 7, 9, 10, 26, and 27	1, 4, 6, 7, 9, 11, 26, 27, 31, 50, 54, 55, 58, 59, 60, 61, 62, 63, and 65

Table 27 : Summary of Air Cartridge Results (pCi/m³), 2012

Analyte	Stations	Observations	Greater Than MDC	Mean	STDEV	Max	Min	TSDF IL	LLRW IL	LLRW ADL
Carbon-14	26	261	0	8.17E-03	8.49E-02	2.36E-01	-4.71E-01	60	1.05E-01	9.42E-01
Iodine-129	26	261	0	-1.87E-05	1.18E-03	2.78E-03	-4.86E-03	0.8	2.22E-03	2.00E-02
Krypton-85g	26	261	0	-3.40E-02	1.25E+00	2.60E+00	-3.26E+00	N/A	2.06E+00	1.76E+01

3.8 Precipitation

RML No. R04100 requires a monthly sampling and analysis by gamma spectroscopy at the ranch house draw weather station when quantity is sufficient for analysis. Precipitation water is collected in accordance with procedure EV-7.1.13, *Surface Water Sampling.* Figure 80 displays the location of the ranch house draw weather station. During this reporting period no precipitation was collected due to a lack of sufficient precipitation.

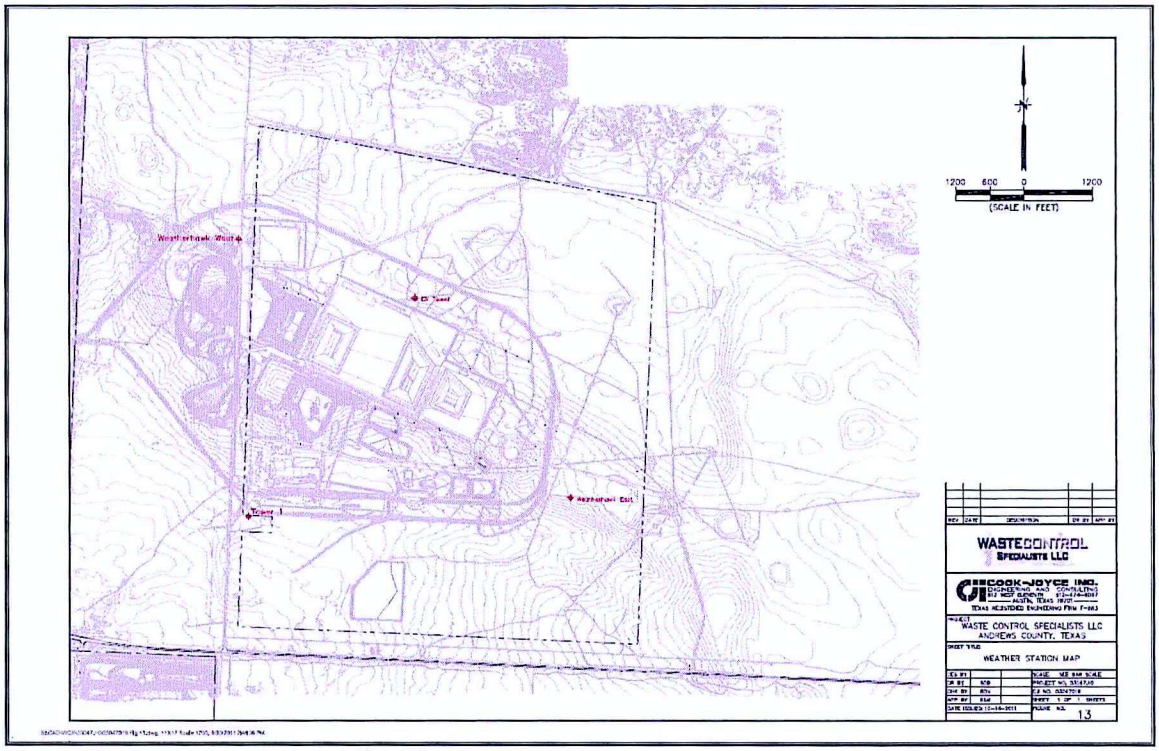

Figure 80 : Location of the Facility Weather Stations

3.9 Soil Moisture

RML No. R04100 requires quarterly soil moisture sampling at the twenty lysimeters locations when quantity is sufficient for analysis. Soil moisture samples are collected in accordance with procedure EV-7.1.19, *Lysimeter Sampling*. Figure 81 displays the location of lysimeters in relation to the LLRW Facility. During this reporting period no soil moisture samples were collected due to a lack of moisture.

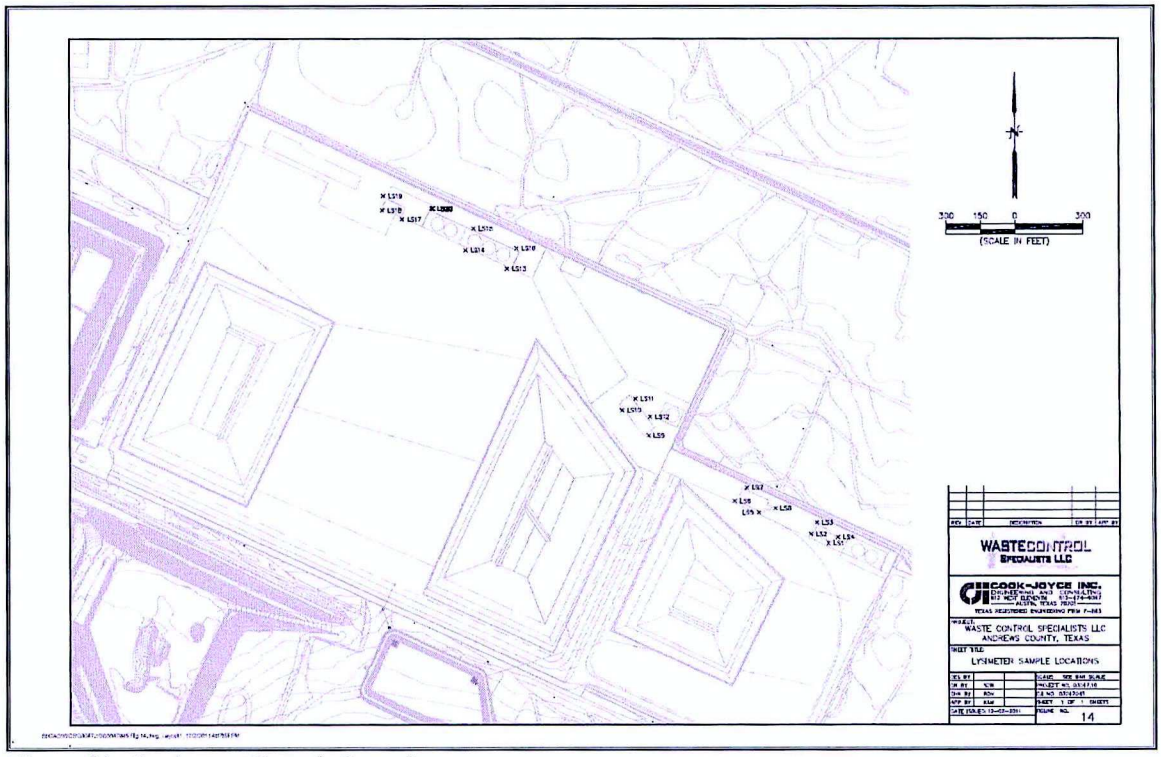

Figure 81 : Lysimeter Sample Locations

3.10 Water

In accordance with LC 92.A of RML No. R05807, water samples are collected from Baker Spring and groundwater wells. Surface water samples are collected semi-annually when surface water is available, and groundwater samples are collected quarterly/annually whenever there is sufficient water present.

For RML No. R04971, WCS collects surface and groundwater samples in accordance with the *Radiological Environmental Monitoring Program, Waste Processing and Storage Facility, EV-1.1.0*, dated July 2008.

WCS collects surface water and groundwater samples in accordance with Attachment B of RML No. R04100 when sufficient water is present. WCS samples Baker Spring (also variously known as station 18 and station GW-2), 4 playa locations (GW-3, GW-4, GW-5, and GW-6), and a former stock pond (GW-1) for radionuclides on a quarterly basis and chemicals on an annual basis. Groundwater samples are collected from the OAG unit and the 225-foot zone in the red bed clays of the Dockum Group. Dry wells are also completed in numerous locations in the 125-foot zone. All groundwater samples are collected on a quarterly basis.

WCS also collects groundwater samples from the 225-Foot Zone on a staggered semi-annual basis for HW-50358 and HW-50397.

Regardless of the license or permit water samples are collected for, all are shipped to an offsite laboratory for analysis. Sample results of environmental media are compared against their respective ILs (where applicable) to determine whether or not a change occurred significant enough to warrant an investigation.

3.10.1 Groundwater

Groundwater samples are collected in accordance with procedure EV-7.1.8, *Groundwater Sampling*. Groundwater sample results are compared against their respective ILs to determine whether or not a change significant enough to warrant investigation has occurred.

Groundwater is monitored in several different transmissive zones. The primary transmissive zones that are monitored for groundwater are described below.

- The undifferentiated Ogallala-Antlers-Gatuña (OAG) unit: This is the uppermost groundwater-bearing stratum that is sampled at the site. It is intermittently saturated at WCS. WCS sampled (or attempted to sample) 99 monitoring wells in the OAG for this reporting period. Eighty-two (82) of those 99 wells did not contain sufficient water for WCS to collect a sample. Of the remaining 14 OAG wells that were sampled, two did not yield a sufficient quantity of groundwater to allow analysis of all monitoring parameters during one or more monitoring events.
- The 125 foot (') zone: The 125'-zone is a discontinuous sand- and silt-stone stratum found in the Dockum Formation (the red beds), which underlies the OAG. It is unsaturated beneath the WCS site. WCS attempted to sample 35 monitoring wells completed in the 125'-zone for this reporting period. None of those wells contained sufficient groundwater to sample.
- The 225'-zone: This continuous sand- and siltstone stratum is found in the Dockum Formation. It is the uppermost continuously saturated stratum at WCS. WCS sampled 100 monitoring wells completed in the 225'-zone during this reporting period. WCS was able to collect full samples from all of the 225'-zone wells.

In addition to the primary transmissive zones identified above, WCS has monitored groundwater in a few wells completed in other transmissive zones, as part of the preoperational monitoring program, as follows:

- The 180'-zone: This discontinuous sand- and silt-stone stratum is found in the Dockum Formation. It is mostly unsaturated beneath WCS. Monitor well 6B1 is the only 180'-zone well in the pre-operational monitoring program.
- The Trujillo sandstone: This saturated stratum is located in the Dockum Formation at an approximate depth of 600 to 700 feet below the ground surface. The South Well (also known as Station 9) is completed in this formation.

Because each transmissive is discrete and hydrologically unconnected from one another, the data from each zone represent separate data populations, each of which are described separately below. Figure 82, Figure 83 and Figure 84 display the locations of wells completed in the OAG, 225'-zone, and other transmissive zones, respectively.

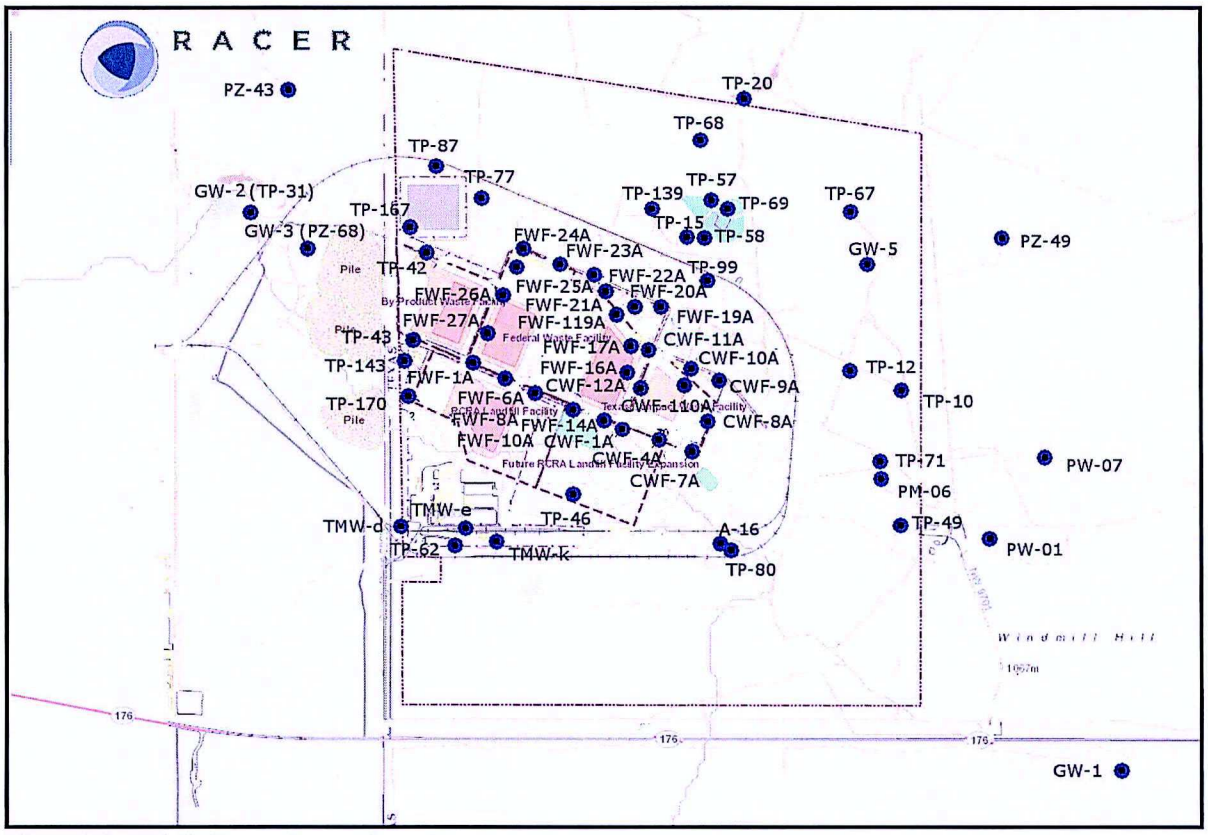

Figure 82 : OAG Groundwater Sampling Locations

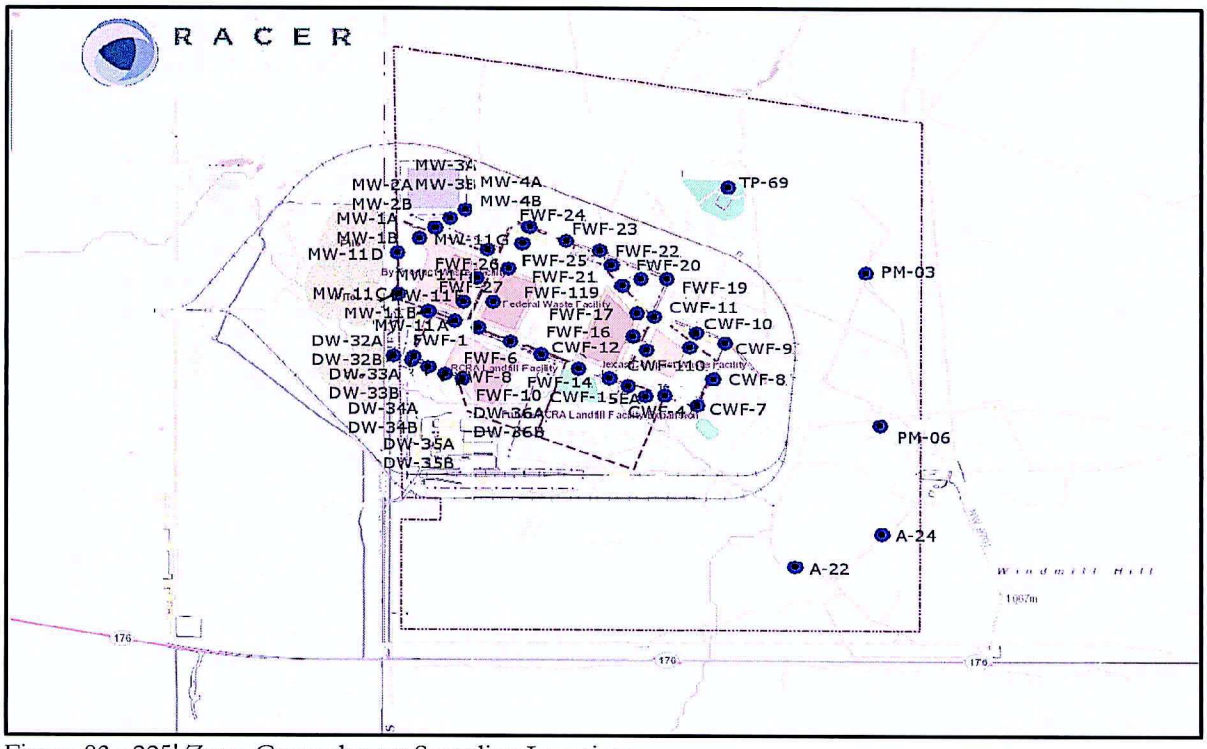

Figure 83 : 225' Zone Groundwater Sampling Locations

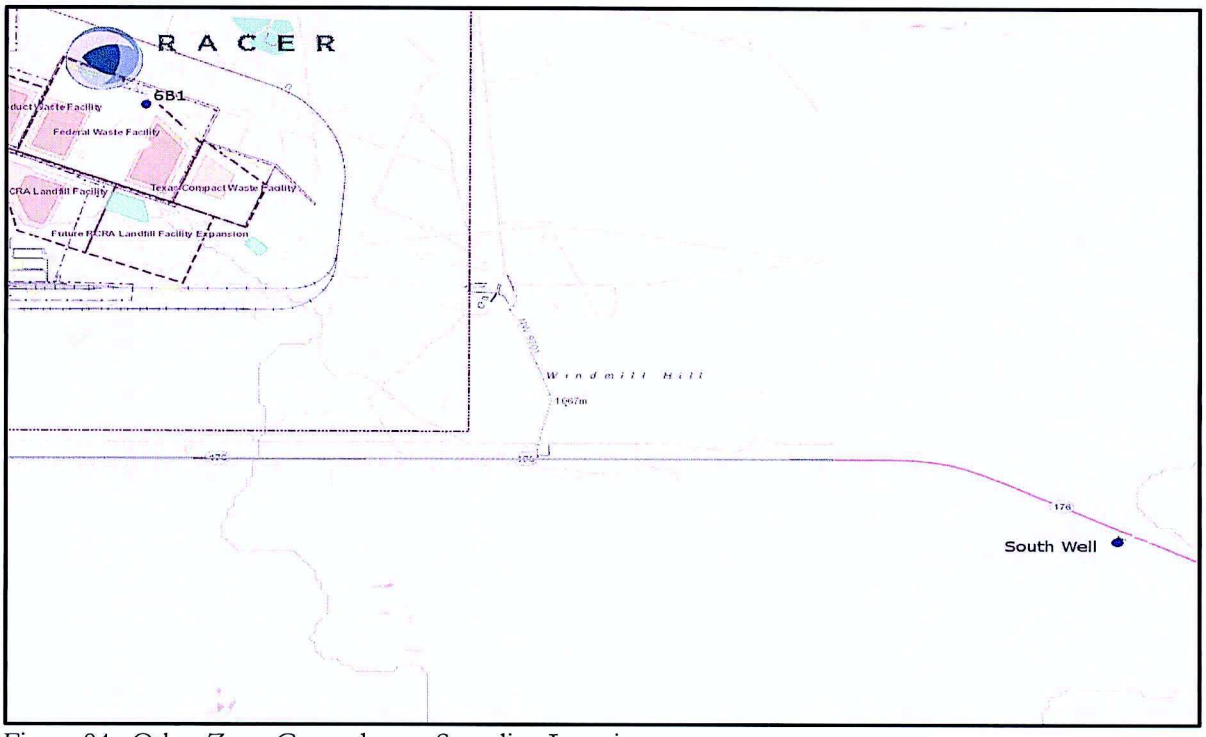

Figure 84 : Other Zone Groundwater Sampling Locations

3.10.1.1 OAG Groundwater

Table 28 below indicates whether the monitored OAG wells had sufficient water to sample as part of the radiological environmental monitoring program.

Table 28 : OAG Sample Availability

Well	Saturation	Well	Saturation	Well	Saturation	Well	Saturation
A-16	Dry	FWF-20A (OAG-44)	Dry	OAG-23	Dry	OAG-49	Dry
CWF-10A (OAG-33)	Dry	FWF-21A	Dry	OAG-24	Dry	OAG-5	Dry
CWF-110A	Dry	FWF-22A	Dry	OAG-25	Dry	OAG-50	Dry
CWF-11A	Dry	FWF-23A	Dry	OAG-26	Dry	OAG-51	Dry
CWF-12A	Dry	FWF-24A	Dry	OAG-27	Dry	OAG-52	Dry
CWF-13A	Dry	FWF-25A	Dry	OAG-28	Dry	OAG-56 (TP-102)	Dry
CWF-1A	Dry	FWF-26A	Dry	OAG-29	Dry	OAG-8	Dry
CWF-2A	Dry	FWF-27A	Partial	OAG-3	Dry	OAG-9	Dry
CWF-3A	Dry	FWF-6A	Sufficient	OAG-30 (TP-155)	Dry	PM-01	Sufficient
CWF-4A	Dry	FWF-8A	Dry	OAG-31 (TP-130)	Dry	PM-07	Sufficient
CWF-5A	Dry	FWF-9A	Dry	OAG-32 (TP-129)	Dry	TP-117 (GW-6)	Sufficient
CWF-6A	Dry	GW-1A	Sufficient	OAG-34	Dry	TP-14 (GW-4)	Sufficient
CWF-7A	Dry	GW-3 (PZ-68)	Dry	OAG-35	Dry	TP-18	Sufficient
CWF-8A	Dry	GW-5	Sufficient	OAG-36	Dry	TP-19	Sufficient
CWF-9A (TP-38)	Dry	OAG-1	Dry	OAG-37	Dry	TP-20	Dry
FWF-10A	Dry	OAG-10	Dry	OAG-38	Dry	TP-31 (GW-2)	Sufficient
FWF-11A	Dry	OAG-12R	Dry	OAG-39	Dry	TP-46	Sufficient
FWF-119A (OAG 7)	Dry	OAG-13	Dry	OAG-40	Dry	TP-69	Sufficient
FWF-12A	Dry	OAG-14	Dry	OAG-4	Dry		
FWF-13A	Dry	OAG-15	Dry	OAG-41	Dry		
FWF-14A	Dry	OAG-2	Dry	OAG-42	Dry		
FWF-15A	Dry	OAG-20	Dry	OAG-43	Dry		
FWF-16A	Dry	OAG-21	Sufficient	OAG-45	Dry		
FWF-17A	Dry	OAG-22	Sufficient	OAG-46 (TP-164)	Dry		
FWF-18A	Dry	OAG-23	Dry	OAG-47	Dry		
FWF-19A (TP-33)	Dry	OAG-24	Dry	OAG-48	Dry		
FWF-1A	Partial	OAG-22	Dry	OAG-49	Dry		

NOTES: Values in Saturation Columns are:
Sufficient = Sufficient Groundwater is present in the well to collect a full sample.
Partial = Enough Groundwater is present to collect a sample for some, but not all, of the required analyses.
Dry = Insufficient groundwater to collect a sample.

Summary statistics for the OAG groundwater results are presented in Table 29. Figure 85 through Figure 80 graphically depict the OAG groundwater results for analytes of note. All OAG groundwater sample results are given in Appendix G.

Organics constituents were detected at well TP-19, however, WCS believes that the water present in TP-19 is not groundwater. The use of chlorine to disinfect potable water produces various disinfection byproducts, which have been classified mainly as halogenated and non-halogenated byproducts. These primary byproducts are trihalomethanes (THMs) and haloacetic acids. THMs are the byproducts of chlorination of water that contains natural organic matter. During routine analyses of the water in TP-19, volatile organic analyses (VOA) were performed by an approved laboratory. Water in TP-19 showed quantifiable amounts of THMs in the August 17, 2012 sample. THM concentrations in TP-19 were as follows: dibromochloromethane (9.34 μg/L), bromoform (9.45 μg/L), chloroform (20.2 μg/L), and dichlorobromomethane (6.18 μg/L). The sum of these four compounds is referred to as total trihalomethanes (TTHMs). The certified chemical analysis of the THM fraction showed a combined total of about 45 μg/L. No other volatile organic compounds were identified by the laboratory in TP-19. The presence of THMs in TP-19 the water in TP-19 can only be from a clean potable water source and not a natural water source.

Table 29 : Summary of OAG Results, 2012

Analyte	No. of Stations	Obs	Above MDC or PQL	Mean	Standard Deviation	Max	Min	Units	BP IL	TSDF IL	LLRW IL	LLRW AL/ADL
Acetone	11	25	2	8.35E+0	3.61E+0	1.09E+1	5.80E+0	ug/L	N/A	N/A	3.07E+0	3.07E+1
ALPHA	16	60	44	6.15E+0	8.38E+0	5.79E+1	2.06E-1	pCi/L	1.80E+2	1.80E+2	**1.22E+1**	**2.20E+1**
Arsenic	14	30	24	1.32E+1	7.47E+0	3.31E+1	6.22E+0	ug/L	N/A	N/A	**2.58E+1**	**2.58E+1**
Barium	5	7	7	2.84E+2	2.77E+2	7.39E+2	1.67E+1	ug/L	N/A	N/A	**1.25E+2**	**1.25E+3**
Benzene	11	25	3	6.20E-1	4.16E-1	1.10E+0	3.70E-1	ug/L	N/A	N/A	5.00E+0	5.00E+0
Beryllium	5	7	3	1.52E+0	2.34E-1	1.79E+0	1.35E+0	ug/L	N/A	N/A	2.69E+0	4.00E+0
BETA	16	60	51	6.37E+0	4.97E+0	3.86E+1	3.78E-1	pCi/L	1.60E+2	1.60E+2	**1.02E+1**	**9.14E+1**
Bismuth-214g	16	60	6	5.04E+0	8.09E+0	3.75E+1	-7.93E+0	pCi/L	N/A	N/A	2.64E+1	2.37E+2
Bromodichloro methane	11	25	2	6.44E+0	3.61E-1	6.69E+0	6.18E+0	ug/L	N/A	N/A	5.00E+0	1.47E+1
Bromoform	11	25	2	6.88E+0	3.63E+0	9.45E+0	4.31E+0	ug/L	N/A	N/A	3.00E-1	3.00E+0
Cadmium	14	30	13	1.52E+0	3.61E-1	2.22E+0	1.02E+0	ug/L	N/A	N/A	4.72E+0	5.00E+0
Chloroform	11	25	2	1.66E+1	5.09E+0	2.02E+1	1.30E+1	ug/L	N/A	N/A	5.00E+0	5.00E+1
Chloromethane	11	25	3	5.03E-1	2.32E-1	7.60E-1	3.10E-1	ug/L	N/A	N/A	6.73E-1	6.73E+0
Chromium	5	7	7	5.95E+0	2.52E+0	9.73E+0	2.78E+0	ug/L	N/A	N/A	6.36E+2	6.36E+2
Cobalt	5	7	4	4.02E+0	1.62E+0	6.22E+0	2.44E+0	ug/L	N/A	N/A	1.35E+1	1.35E+1
Dibromochloro methane	11	25	2	9.44E+0	1.41E-1	9.54E+0	9.34E+0	ug/L	N/A	N/A	5.00E+0	1.09E+1
Lead	5	7	4	3.60E+1	1.71E+1	5.64E+1	1.56E+1	ug/L	N/A	N/A	1.96E+1	1.96E+1
Lead-210	10	29	1	2.01E+0	1.57E+0	4.41E+0	-7.93E-1	pCi/L	1.90E+1	2.00E-1	7.64E+0	1.19E+1
Lead-214g	16	60	1	1.93E+0	5.70E+0	3.05E+1	-8.07E+0	pCi/L	N/A	N/A	1.61E+1	1.45E+2
Nickel	14	30	24	1.30E+1	1.07E+1	3.99E+1	1.52E+0	ug/L	N/A	N/A	**1.38E+2**	**4.89E+2**
Radium-226	10	29	23	6.65E-1	5.22E-1	2.28E+0	1.13E-1	pCi/L	1.69E+0	2.40E+0	**9.10E-1**	**3.10E+0**
Radium-228	10	29	23	1.03E+0	7.57E-1	3.79E+0	1.43E-1	pCi/L	2.74E+0	2.40E+0	**7.36E-1**	**3.08E+0**
Selenium	14	30	14	2.40E+1	2.68E+1	8.90E+1	1.65E+0	ug/L	N/A	N/A	**7.58E+1**	**7.58E+1**
Silver	5	7	2	1.99E+1	8.77E+0	2.61E+1	1.37E+1	ug/L	N/A	N/A	5.00E+0	5.00E+1
Thallium-208g	16	60	1	-1.46E-1	2.47E+0	6.17E+0	-5.94E+0	pCi/L	N/A	N/A	6.97E+0	6.26E+1
Thorium-228	10	32	3	1.71E-2	2.95E-2	1.36E-1	-2.34E-2	pCi/L	3.20E+0	8.00E+0	4.53E-1	4.07E+0
Thorium-230	10	32	5	3.62E-2	4.43E-2	1.62E-1	-2.02E-2	pCi/L	2.60E-1	N/A	2.89E-1	2.59E+0
Toluene	11	25	4	6.78E-1	5.57E-1	1.51E+0	3.40E-1	ug/L	N/A	N/A	5.00E+0	5.00E+1
Uranium-233/234	10	32	32	3.17E+0	2.60E+0	1.24E+1	5.97E-1	pCi/L	7.30E+1	1.20E+1	**1.63E+0**	**1.46E+1**
Uranium-235/236	10	32	12	6.71E-2	7.06E-2	2.76E-1	-2.49E-2	pCi/L	4.40E+0	1.20E+1	**1.92E-1**	**1.72E+0**
Uranium-238	10	32	32	1.23E+0	1.26E+0	6.06E+0	3.26E-1	pCi/L	6.10E+1	1.20E+1	**1.46E+0**	**1.30E+1**
Zinc	5	7	6	2.59E+1	1.18E+1	4.20E+1	1.41E+1	ug/L	N/A	N/A	2.92E+2	2.92E+3

Please note that organic constituents detected in OAG groundwater, other than those detected in TP-19, are "J" flagged data, meaning that they are too low to quantify accurately. WCS does not consider "J" flagged data to be a concern. Non-radioactive metal concentrations appear to be natural. Radionuclide concentrations, including a radium-226 concentration reported in OAG-22, also appear to be natural. Byproduct groundwater results in exceedance of their associated ILs are discussed in Section 4, Investigations, of this report.

Several metal constituents OAG results were greater than the most conservative LL ALs. These included arsenic (TP-117), lead (TP-14, TP-19 and TP-46) and selenium (TP-19). As indicated in Figure 96, the maximum arsenic result for TP-14 was below the arsenic LLRW AL specific to TP-14 of 77 μg/kg. Sufficient data do not exist to create an arsenic LL ALs for well FWF-6A and TP-117. Similarly, sufficient data do not exit to create lead LLRW ALs for TP-19, TP-14 or selenium AL for TP-19. These metal are naturally present in the groundwater at the site and do not indicate a significant difference from background. Furthermore, the FWF facility is not open, and the CWF waste streams do not contain these metals.

Bromoform was detected at TP-19 is also greater than the IL, however, as previously stated, the water present in TP-19 is clean potable water, and the organics detected in it are a result of the disinfection process.

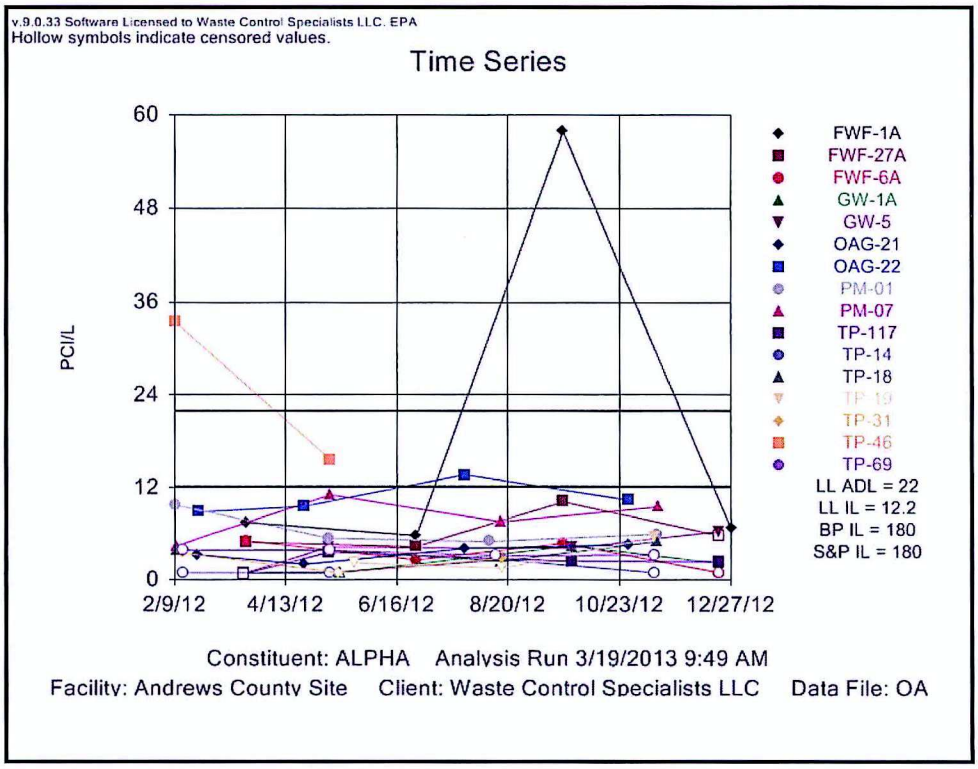

Figure 85 : Gross Alpha Activity Concentration in OAG Groundwater

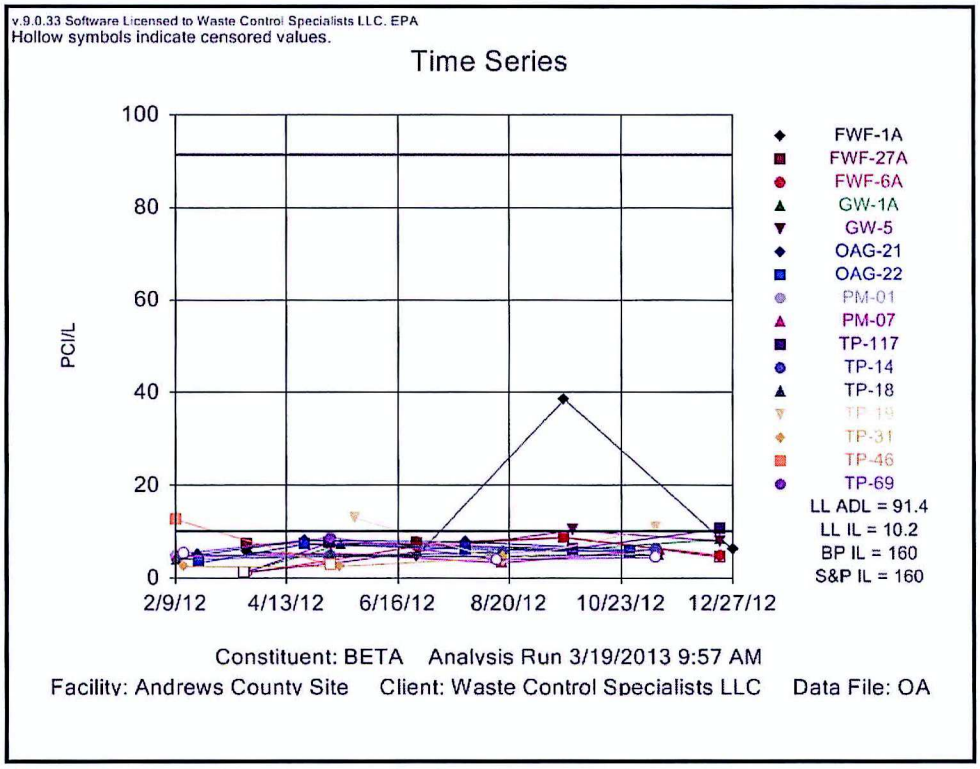

Figure 86 : Gross Beta Concentration in OAG Groundwater

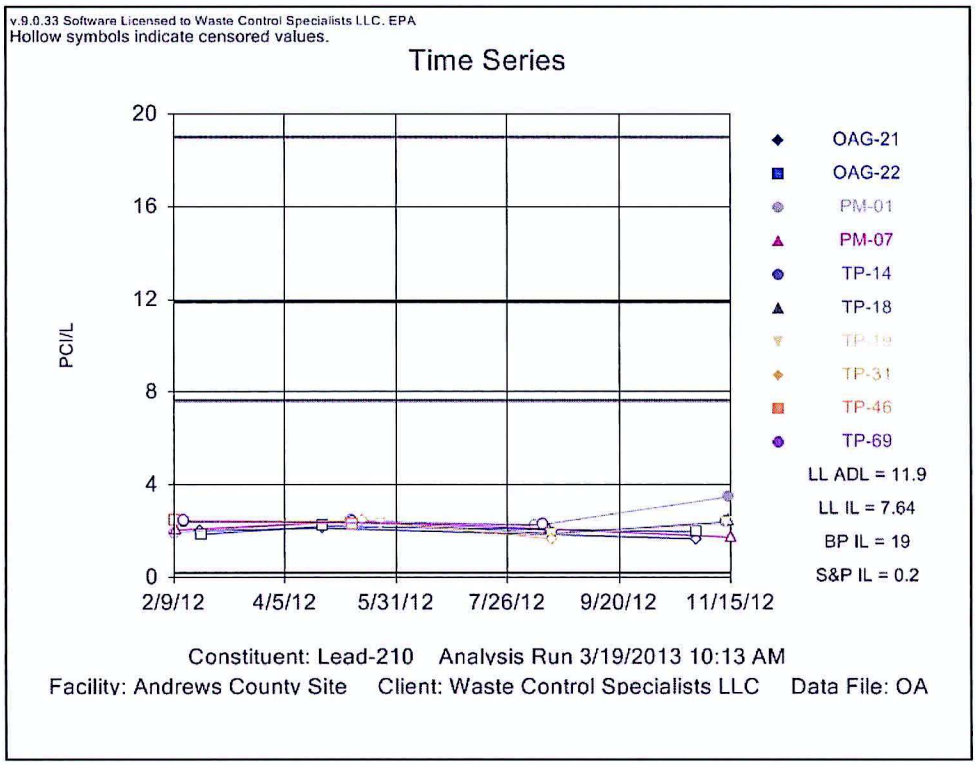

Figure 87 : Lead-210 Concentration in OAG Groundwater

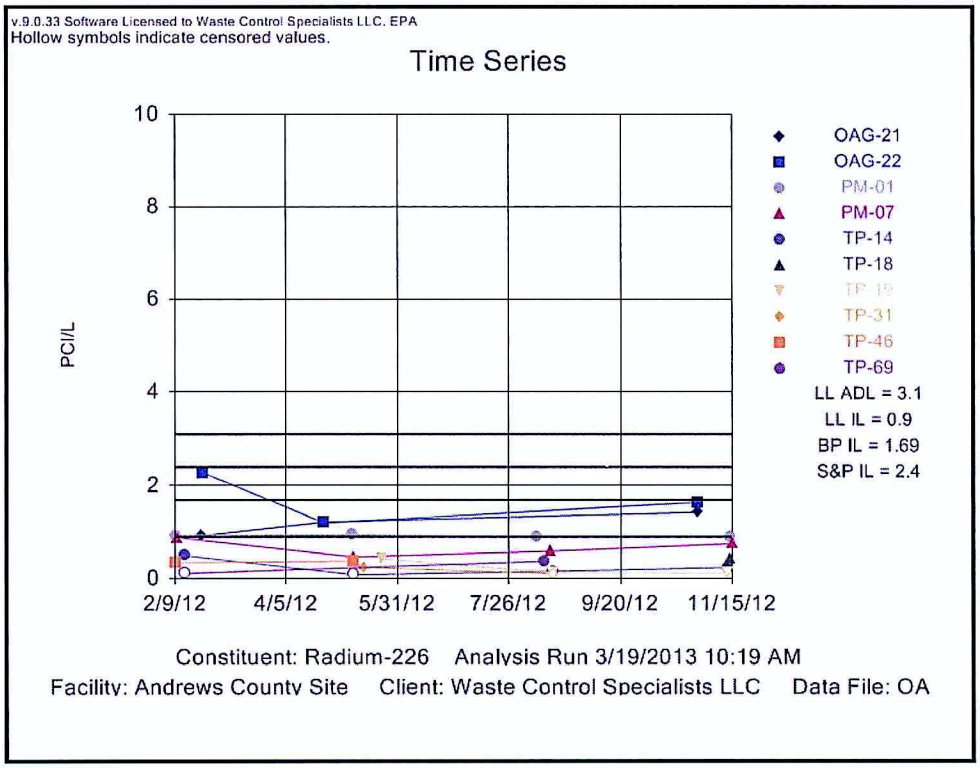

Figure 88 : Radium-226 Concentration in OAG Groundwater

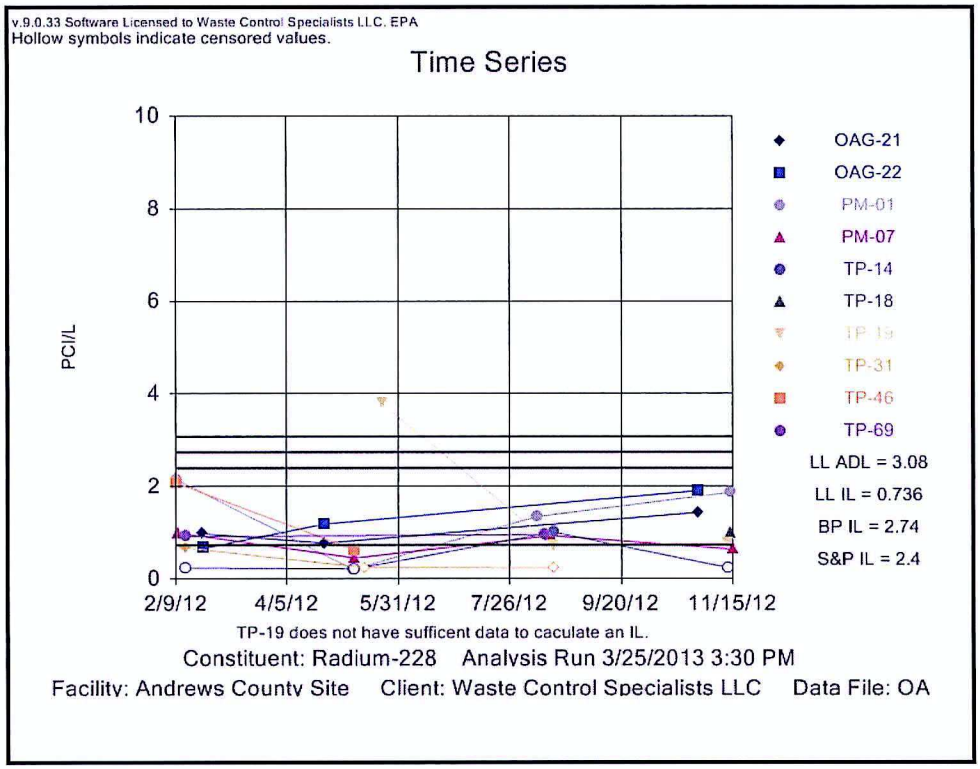

Figure 89 : Radium-228 Concentration in OAG Groundwater

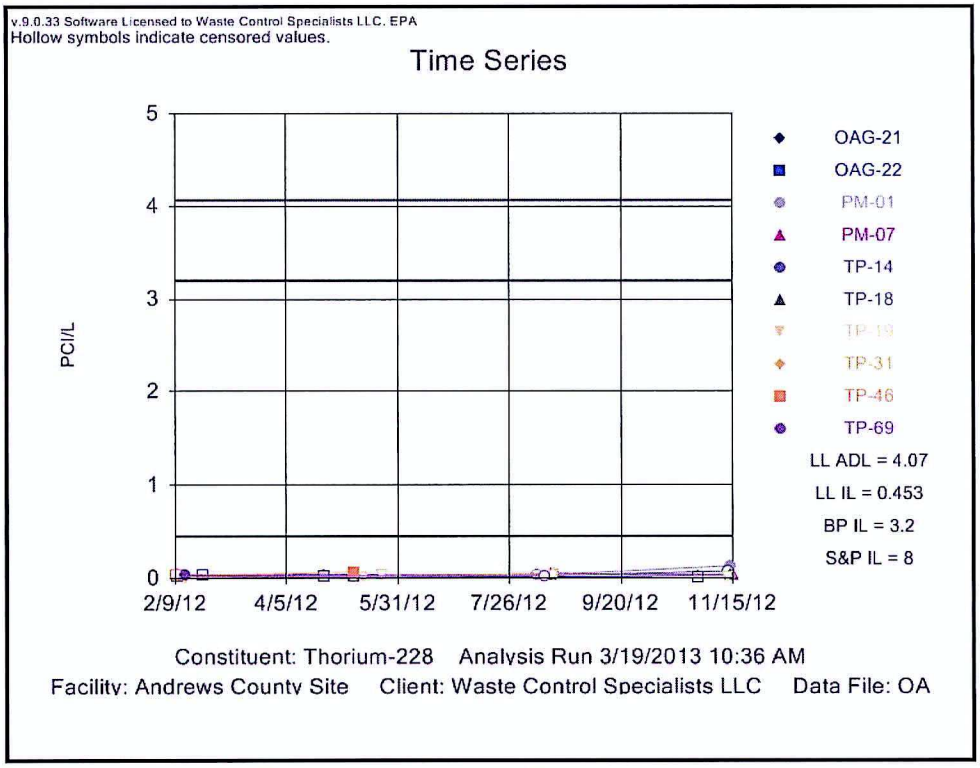

Figure 90 : Thorium-228 Concentration in OAG Groundwater

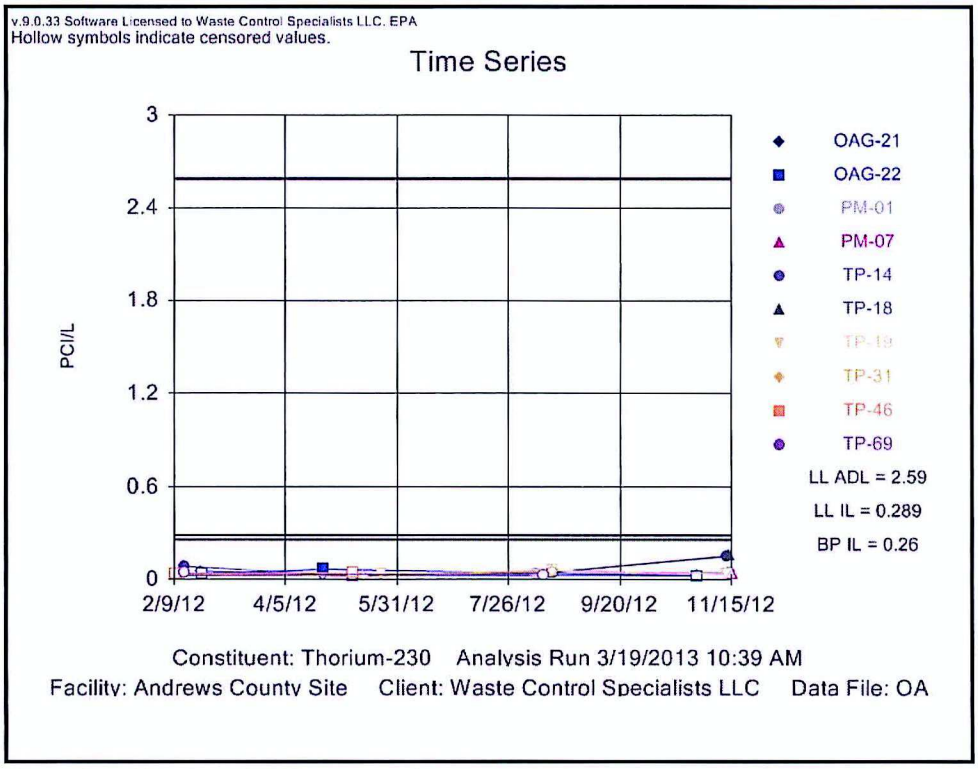

Figure 91 : Thorium-230 Concentration in OAG Groundwater

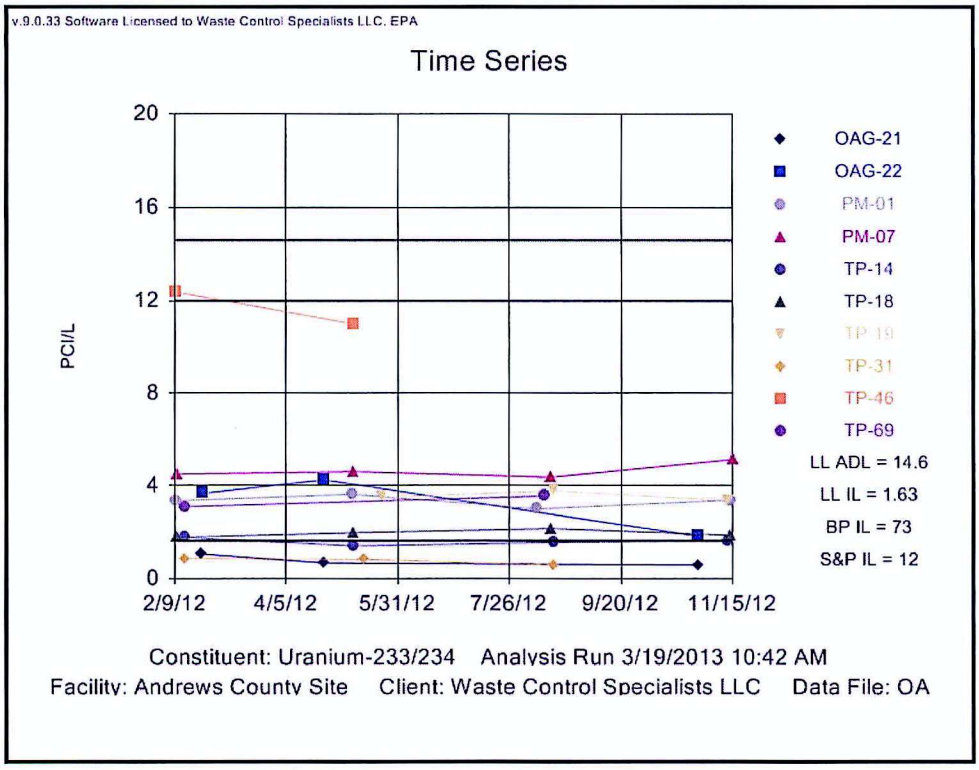

Figure 92 : Uranium-233/234 Concentration in OAG Groundwater

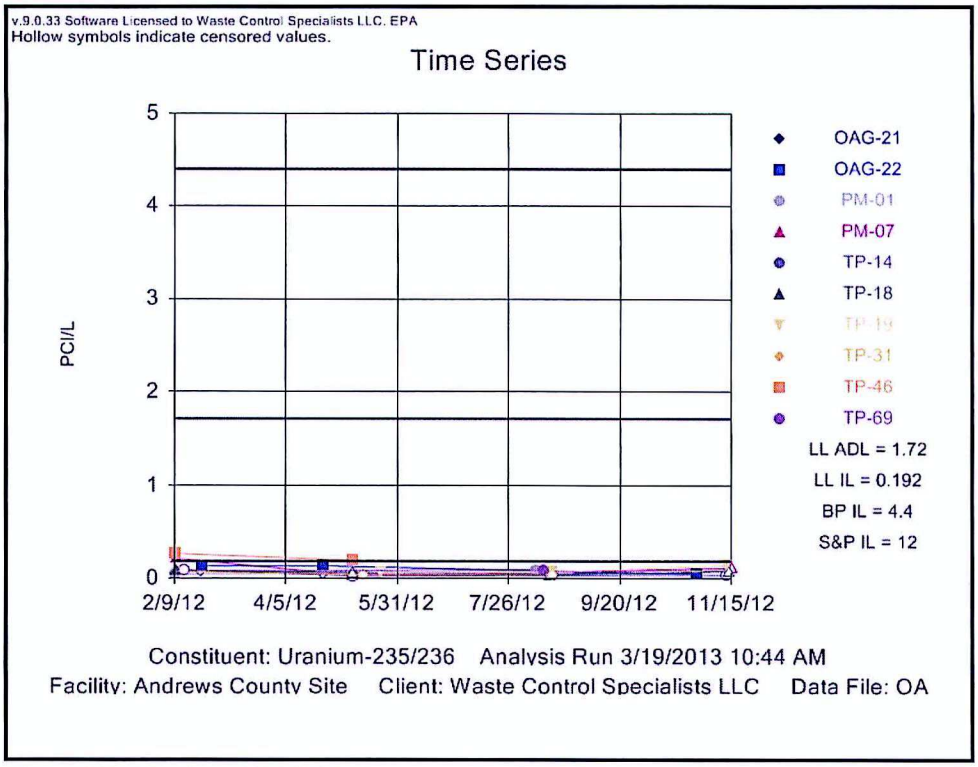

Figure 93 : Uranium-235/236 Concentration in OAG Groundwater

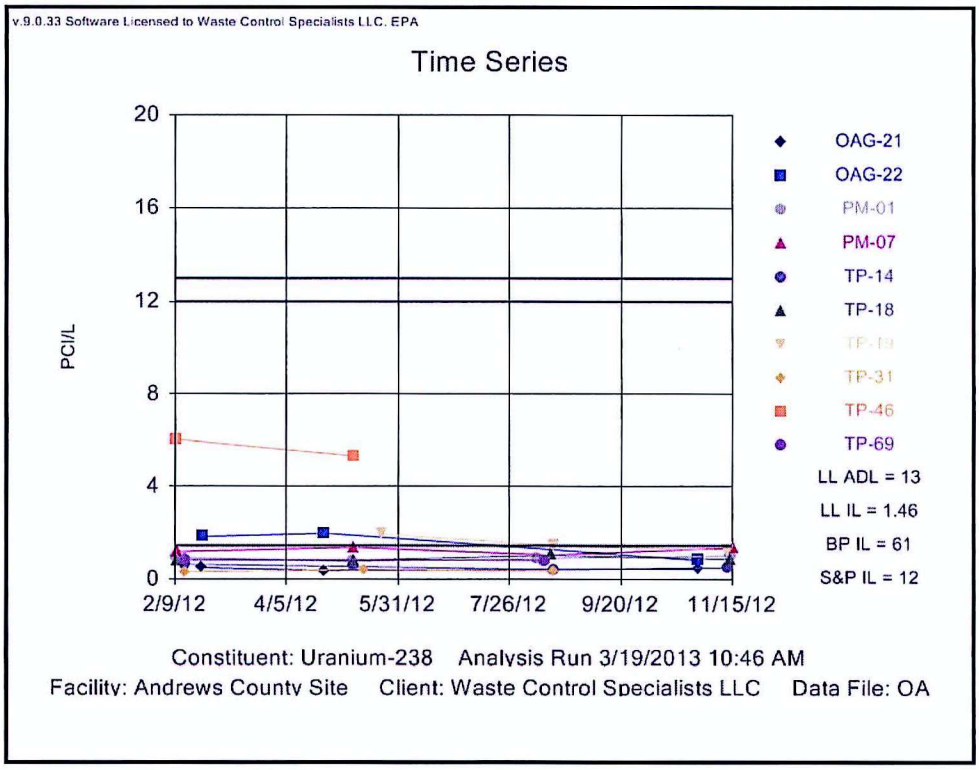

Figure 94 : Uranium-238 Concentration in OAG Groundwater

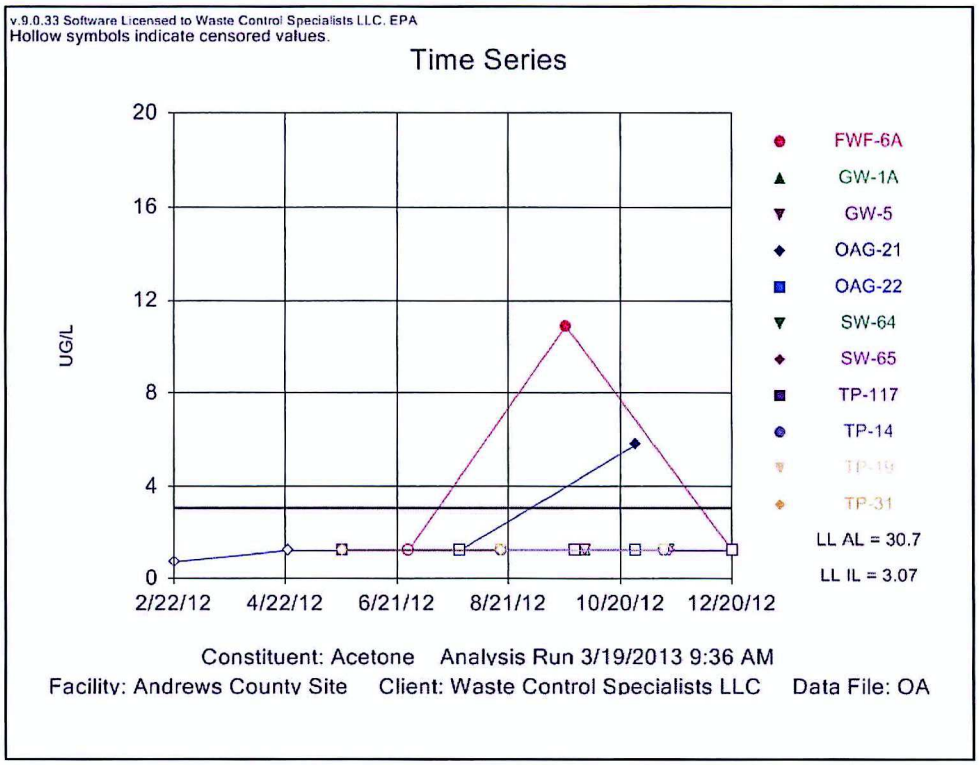

Figure 95 : Acetone Concentration in OAG Groundwater

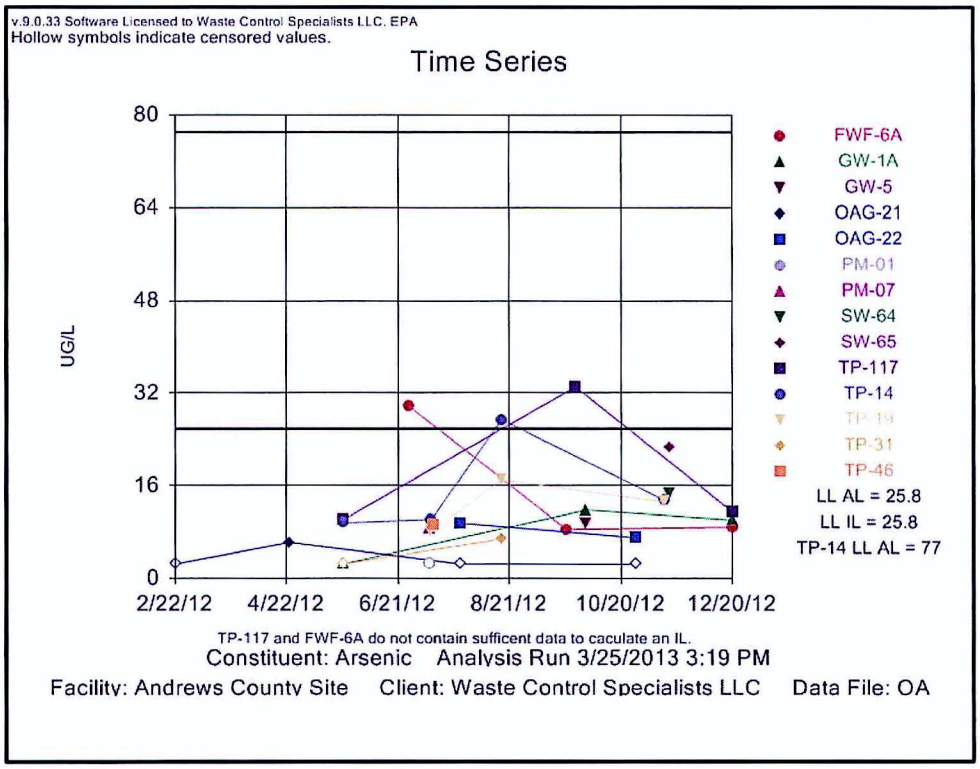

Figure 96 : Arsenic Concentration in OAG Groundwater

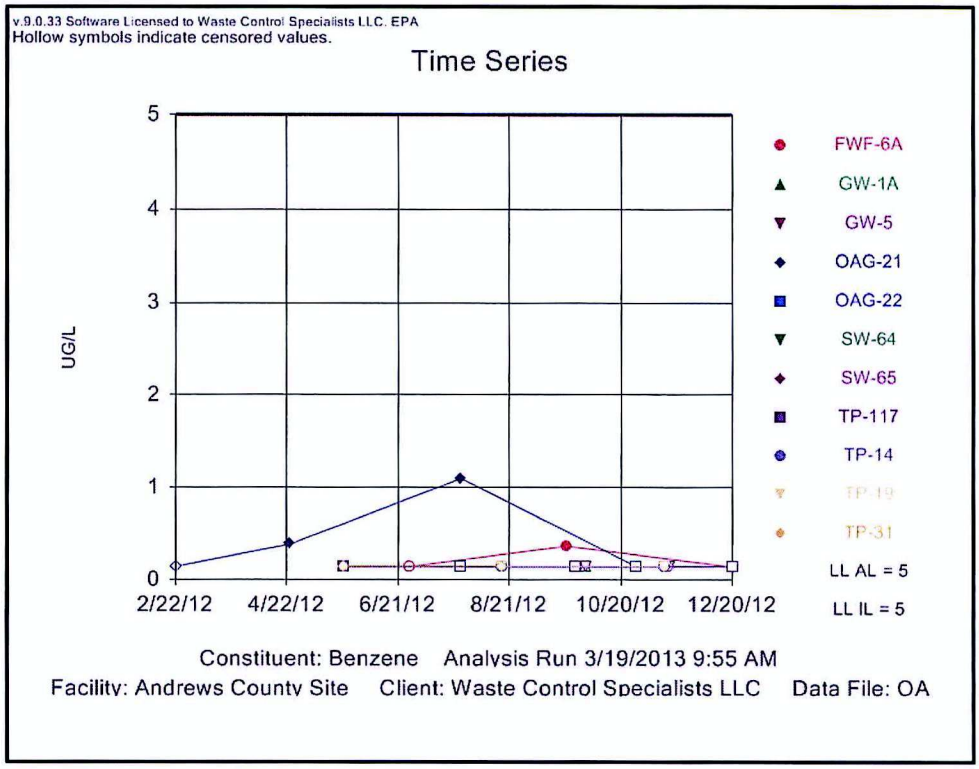

Figure 97 : Benzene Concentration in OAG Groundwater

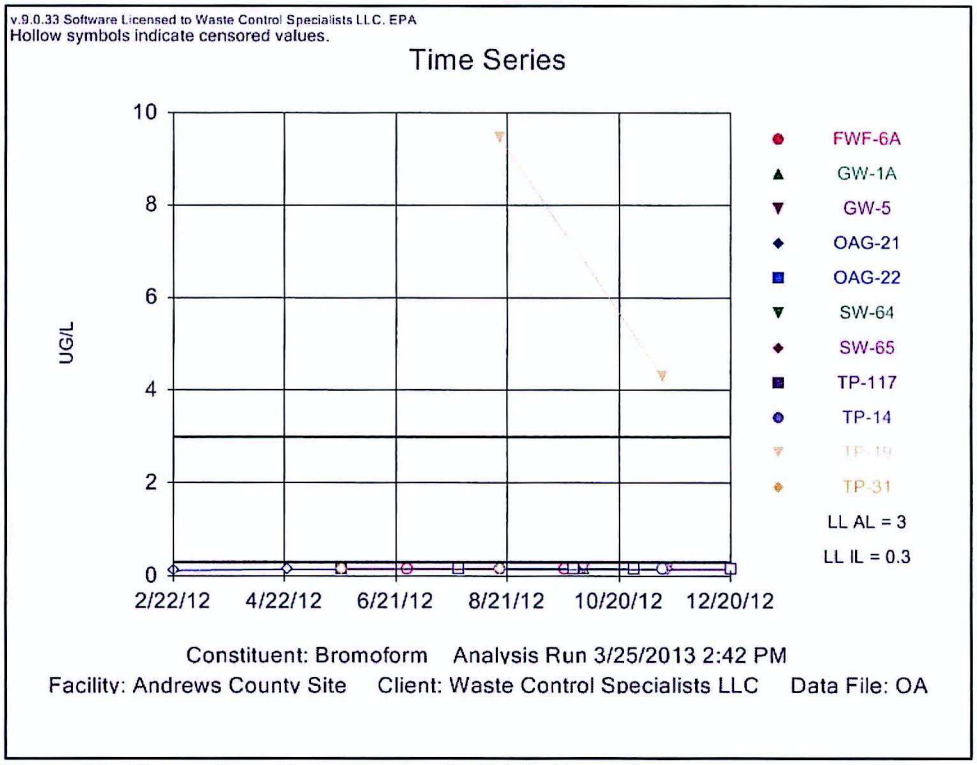

Figure 98 : Bromoform Concentration in OAG Groundwater

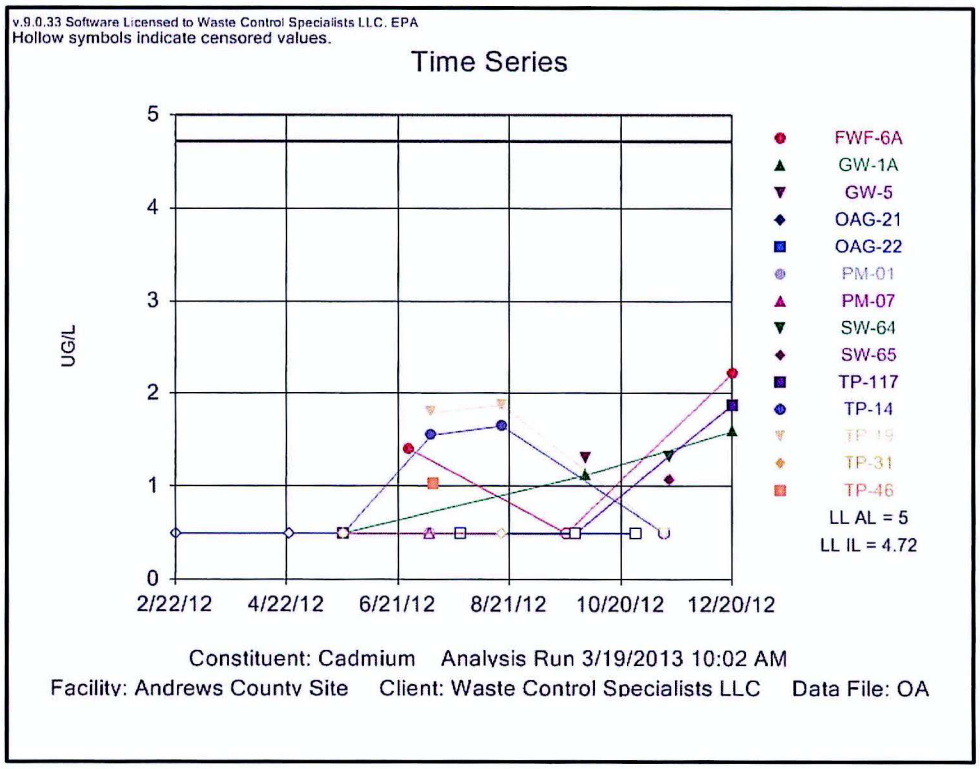

Figure 99 : Cadmium Concentration in OAG Groundwater

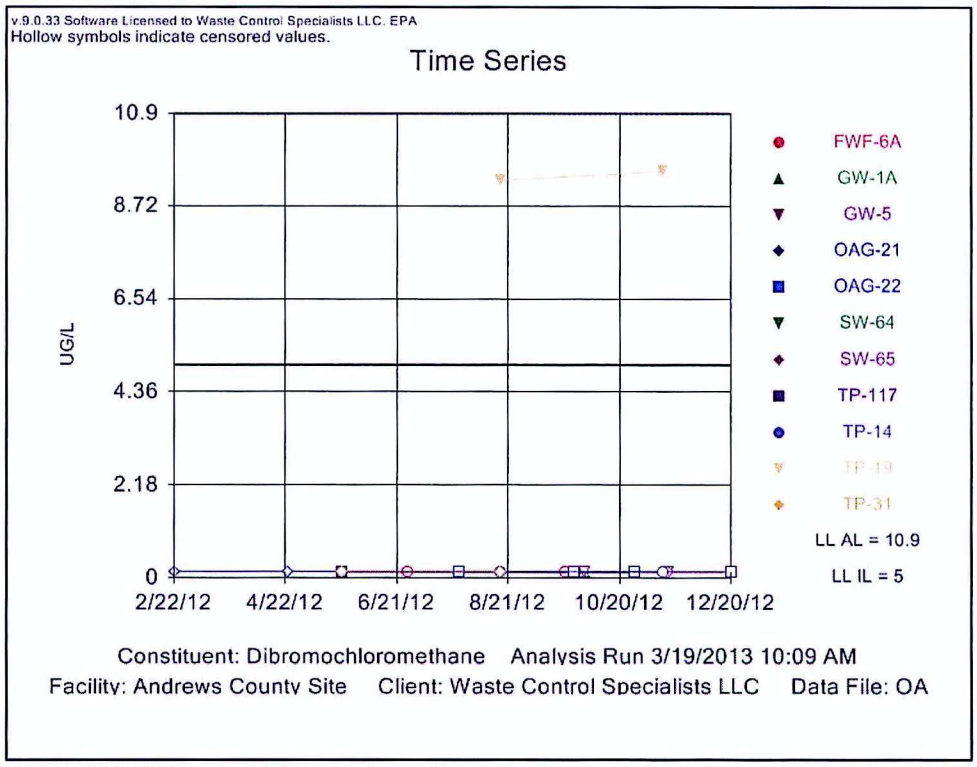

Figure 100 : Dibromochloromethane Concentration in OAG Groundwater

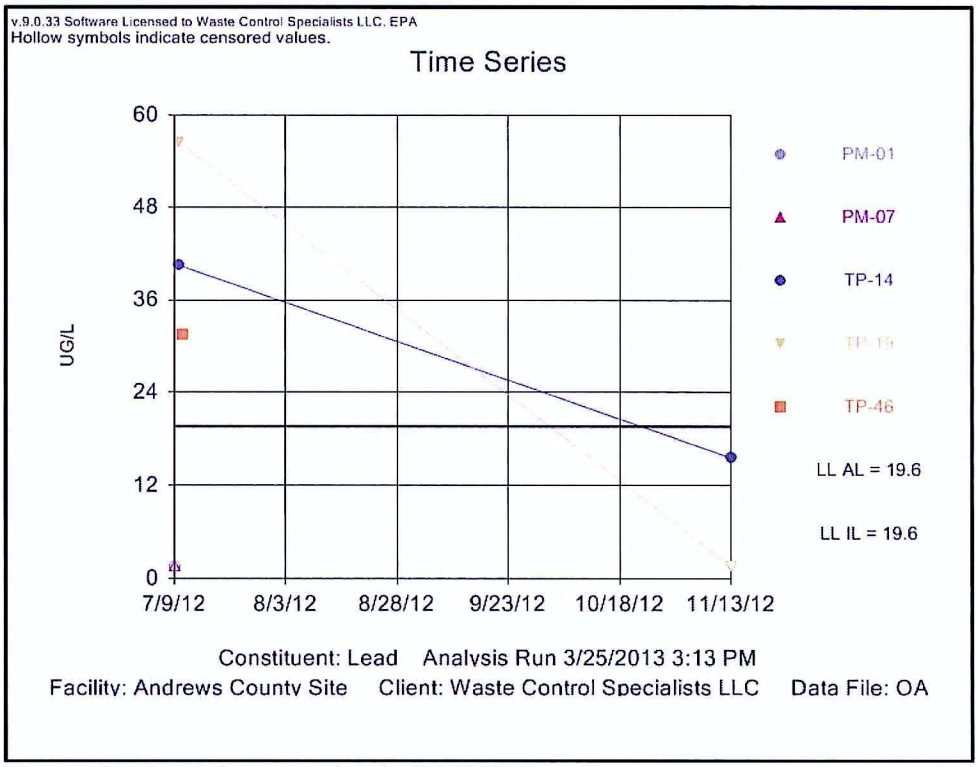

Figure 101 : Lead Concentration in OAG Groundwater

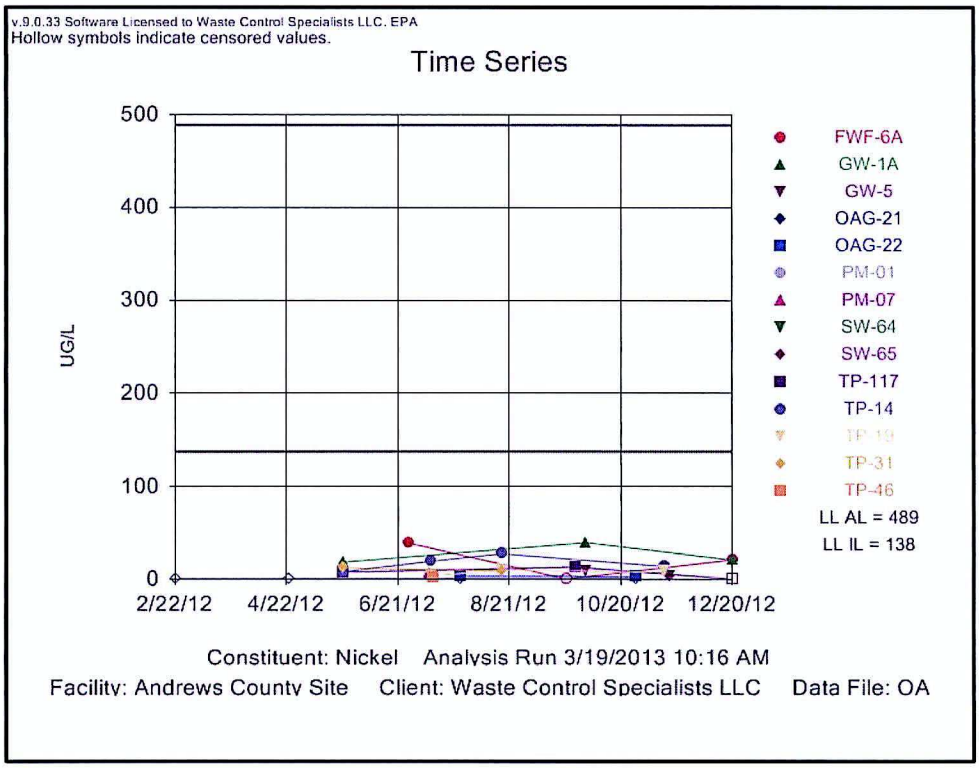

Figure 102 : Nickel Concentration in OAG Groundwater

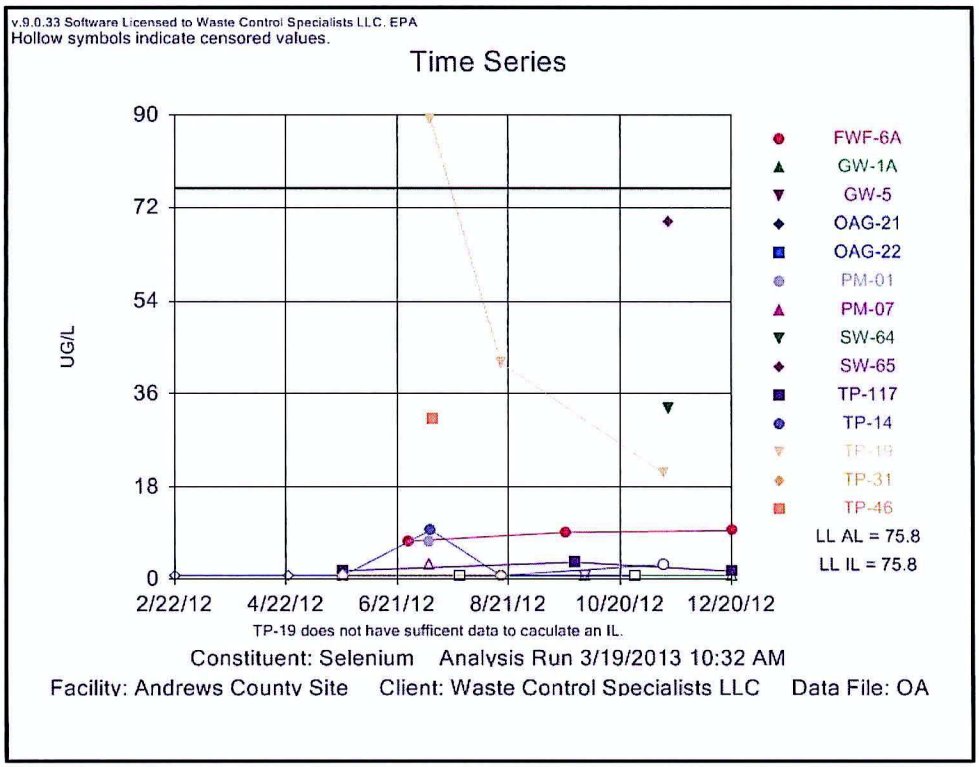

Figure 103 : Selenium Concentration in OAG Groundwater

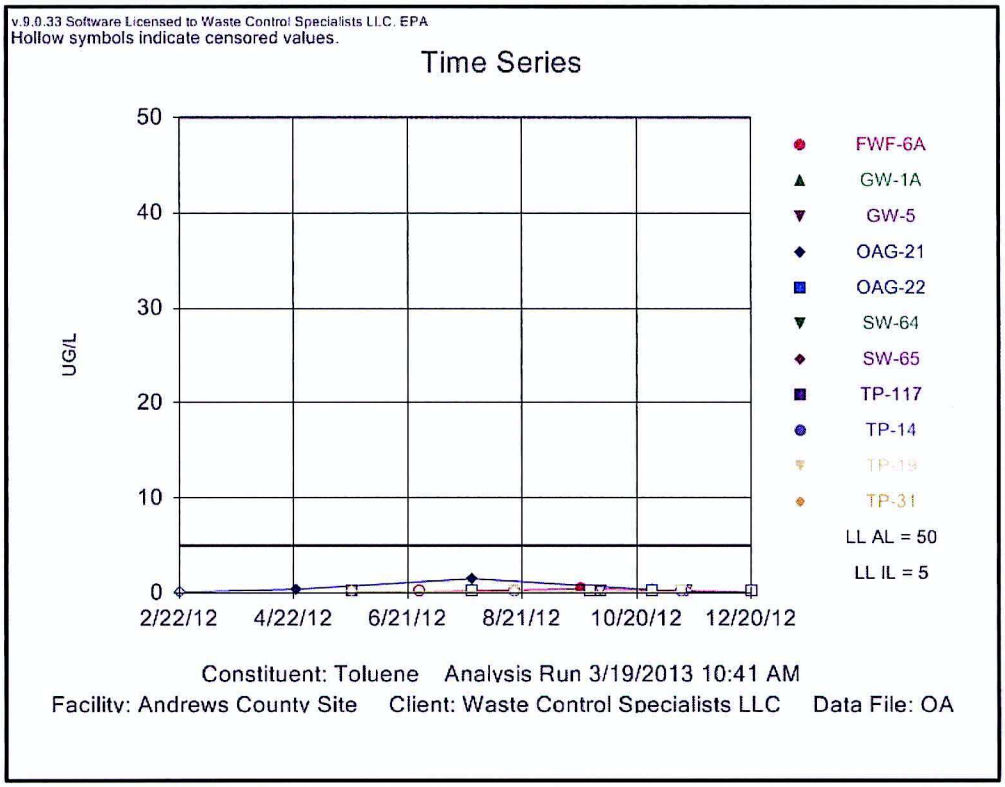

Figure 104 : Toluene Concentration in OAG Groundwater

3.10.1.2 125' Zone Groundwater Data

The following 125'-zone wells are currently in the radiological environmental monitoring program. As indicated in Table 30 below, all of the 125'-zone wells being monitored are dry,

Table 30 : 125' Zone Sample Availability.

Well	Saturation	Well	Saturation	Well	Saturation	Well	Saturation
CWF-1B	dry	CWF-11B	dry	FWF-15B	dry	FWF-25B	dry
CWF-2B	dry	CWF-12B	dry	FWF-16B	dry	FWF-26B	dry
CWF-3B	dry	CWF-13B	dry	FWF-17B	dry	FWF-27B	dry
CWF-4B	dry	CWF-110B	dry	FWF-18B	dry	FWF-6B	dry
CWF-5B	dry	FWF-10B	dry	FWF-19B	dry	FWF-9B	dry
CWF-6B	dry	FWF-11B	dry	FWF-1B	dry		
CWF-7B	dry	FWF-119 B	dry	FWF-21B	dry		
CWF-8B	dry	FWF-12B	dry	FWF-22B	dry		
CWF-9B	dry	FWF-13B	dry	FWF-23B	dry		
CWF-10B	dry	FWF-14B	dry	FWF-24B	dry		

NOTES: Values in Saturation Columns are:
Dry = Insufficient Groundwater is present in the well to collect a sample.

3.10.1.3 225' Zone Groundwater Data

Table 31 displays the 225'-zone wells currently in the radiological environmental monitoring program. Because all of these wells contain sufficient groundwater for routine sampling the "Saturation" column has been omitted from this table.

Table 31 : 225' Zone Sample Availability

Well	Well	Well	Well	Well	Well	Well
5E-A	CWF-5C	DW36A	FWF-17D	FWF-6C	FWF-23D	MW1A
6B2	CWF-5D	DW36B	FWF-18C	FWF-9C	FWF-24C	MW1BR
A-22	CWF-6C	FWF-10C	FWF-18D	FWF-9D	FWF-24D	MW2A
A-24	CWF-6D	FWF-10D	FWF-19C	MW11AR	FWF-25C	MW2B
CWF-10C	CWF-7C	FWF-11C	FWF-1C	MW11B	FWF-25D	MW3A
CWF-10D	CWF-7D	FWF-11D	FWF-21C	MW11C	FWF-26C	MW3B
CWF-110C	CWF-8C	FWF-119C	FWF-21D	MW11DR	FWF-26D	MW4A
CWF-110D	CWF-8D	FWF-119D	FWF-22C	MW11E	FWF-27C	MW4B
CWF-11C	CWF-9C	FWF-12C	FWF-22D	MW11F	FWF-6C	PM-03
CWF-11D	CWF-9D	FWF-12D	FWF-23C	MW11G	FWF-9C	PM-06
CWF-12C	DW32A	FWF-13C	FWF-23D	MW1A	FWF-9D	
CWF-12D	DW32B	FWF-13D	FWF-24C	MW1BR	MW11AR	
CWF-13C	DW33A	FWF-14C	FWF-24D	MW2A	MW11B	
CWF-1C	DW33B	FWF-15C	FWF-25C	MW2B	MW11C	
CWF-2C	DW34A	FWF-15D	FWF-25D	MW3A	MW11DR	
CWF-3C	DW34B	FWF-16C	FWF-26C	MW3B	MW11E	
CWF-4C	DW35A	FWF-16D	FWF-26D	FWF-22D	MW11F	
CWF-4D	DW35B	FWF-17C	FWF-27C	FWF-23C	MW11G	

Radiological summary statistics for radiological analytes in the 225' zone are presented in Table 32. Figure 105 through Figure 128 graphically depict the 225' zone groundwater results for analytes of note. All sample results for 225'-zone groundwater are given in Appendix G.

Table 32 : Summary of 225' Zone Groundwater Results, 2012

Analyte	No. of Stations	Observations	Above MDC or PQL	Mean	Standard Deviation	Max	Min	Units	BP IL	TSDF IL	LL IL	LL AL/ADL
Acetone	91	325	10	5.90E+0	3.67E+0	1.19E+1	2.67E+0	ug/L	N/A	N/A	**3.40E+0**	**3.40E+1**
ALPHA	96	369	250	1.54E+1	1.13E+1	6.18E+1	-8.01E+0	pCi/L	1.80E+2	1.80E+2	**1.96E+1**	**3.15E+1**
Americium-241	28	67	1	1.85E-3	8.89E-3	2.01E-2	-2.13E-2	pCi/L	N/A	N/A	3.26E-2	2.79E-1
Antimony	16	53	2	4.15E+0	6.58E-1	4.61E+0	3.68E+0	ug/L	N/A	N/A	1.71E+1	1.71E+1
Aroclor-1260	45	144	1	2.09E-1	N/A	2.09E-1	2.09E-1	ug/L	N/A	N/A	N/A	N/A
Arsenic	96	341	190	1.06E+1	5.03E+0	3.57E+1	5.10E+0	ug/L	N/A	N/A	2.23E+1	2.23E+1
Barium	16	53	53	1.38E+1	1.62E+1	1.05E+2	7.37E+0	ug/L	N/A	N/A	**1.14E+1**	**1.14E+2**
BETA	96	369	207	1.11E+1	1.10E+1	1.21E+2	-9.55E+0	pCi/L	1.60E+2	1.60E+2	3.34E+1	3.00E+2
Bismuth-214g	96	369	10	2.76E+0	5.31E+0	2.69E+1	-1.45E+1	pCi/L	N/A	N/A	3.53E+1	3.17E+2
Boron	9	36	36	1.78E+3	1.12E+2	1.92E+3	1.57E+3	ug/L	N/A	N/A	N/A	N/A
Cadmium	96	341	46	1.32E+0	2.27E-1	2.01E+0	1.00E+0	ug/L	N/A	N/A	1.40E+0	5.00E+0
Carbon disulfide	91	326	4	5.97E+0	6.31E+0	1.54E+1	2.21E+0	ug/L	N/A	N/A	5.00E+0	5.00E+1
Chloroethane	91	325	5	1.69E+0	9.18E-1	2.62E+0	6.00E-1	ug/L	N/A	N/A	1.00E+1	1.00E+2
Chloromethane	91	325	8	1.06E+0	1.02E+0	3.43E+0	3.80E-1	ug/L	N/A	N/A	7.16E-1	7.16E+0
Chromium	16	53	45	7.16E+0	8.69E+0	4.55E+1	1.00E+0	ug/L	N/A	N/A	2.09E+2	2.09E+2
Copper	9	36	16	1.32E+1	3.03E+0	2.03E+1	5.76E+0	ug/L	N/A	N/A	N/A	N/A
Endrin	9	36	1	2.82E-2	N/A	2.82E-2	2.82E-2	ug/L	N/A	N/A	N/A	N/A
Fluoride	9	36	36	9.46E-1	7.14E-2	1.08E+0	8.08E-1	ug/L	N/A	N/A	N/A	N/A
Lead	16	53	13	1.53E+1	6.63E+0	2.76E+1	3.96E+0	ug/L	N/A	N/A	4.05E+0	1.50E+1
Lead-210	40	129	2	2.11E+0	1.65E+0	4.72E+0	-3.22E+0	pCi/L	1.90E+1	2.00E-1	7.92E+0	1.23E+1
Lead-212g	96	369	1	2.08E+0	3.56E+0	1.44E+1	-8.87E+0	pCi/L	N/A	N/A	1.28E+1	1.15E+2
Mercury	16	53	1	7.30E-2	N/A	7.30E-2	7.30E-2	ug/L	N/A	N/A	9.70E-2	9.70E-1
Molybdenum	9	36	36	3.54E+1	9.91E+0	5.28E+1	1.21E+1	ug/L	N/A	N/A	N/A	N/A
Nickel	96	341	205	5.37E+0	7.45E+0	7.22E+1	1.50E+0	ug/L	N/A	N/A	**1.11E+1**	**1.11E+2**
Nitrate	9	27	26	5.96E-1	2.91E-1	1.06E+0	1.08E-1	ug/L	N/A	N/A	N/A	N/A
Nitrogen, Ammonia	9	36	36	4.92E+2	3.22E+2	1.21E+3	2.64E+1	ug/L	N/A	N/A	N/A	N/A
Nitrogen, Nitrate/Nitrite	9	11	11	6.76E-1	3.91E-1	1.23E+0	7.07E-2	ug/L	N/A	N/A	N/A	N/A
Phosphorus, Total as P	9	36	21	4.31E+1	1.97E+1	8.37E+1	1.82E+1	ug/L	N/A	N/A	N/A	N/A
Plutonium-238	33	74	1	7.23E-3	1.32E-2	6.89E-2	-2.09E-2	pCi/L	N/A	N/A	7.40E-2	6.32E-1
Potassium-40g	96	369	3	6.33E+0	2.68E+1	1.99E+2	-8.67E+1	pCi/L	N/A	N/A	7.99E+1	7.17E+2
Radium-226	40	130	116	6.59E-1	3.75E-1	1.80E+0	-5.87E-2	pCi/L	1.69E+0	2.40E+0	**6.77E-1**	**3.00E+0**
Radium-228	40	130	114	1.20E+0	6.91E-1	3.35E+0	-2.02E-1	pCi/L	2.74E+0	2.40E+0	**1.98E+0**	**4.68E+0**
Selenium	96	341	193	5.72E+0	4.29E+0	2.75E+1	1.51E+0	ug/L	N/A	N/A	3.34E+1	5.00E+1
Silver	16	53	14	1.06E+1	5.34E+0	1.91E+1	2.16E+0	ug/L	N/A	N/A	3.65E+0	3.65E+1
Thallium	9	36	1	7.55E+0	N/A	7.55E+0	7.55E+0	ug/L	N/A	N/A	N/A	N/A
Thallium-208g	96	369	3	3.65E-1	2.09E+0	8.39E+0	-5.22E+0	pCi/L	N/A	N/A	6.76E+0	6.07E+1
Thorium-228	41	132	9	2.59E-2	3.54E-2	1.82E-1	-1.35E-1	pCi/L	3.20E+0	8.00E+0	1.73E-1	1.55E+0
Thorium-230	41	132	12	2.79E-2	3.53E-2	1.65E-1	-5.67E-2	pCi/L	2.60E-1	N/A	2.76E-1	2.48E+0
Thorium-232	41	132	2	4.17E-3	1.04E-2	3.77E-2	-3.48E-2	pCi/L	2.80E+0	1.20E+1	5.35E-2	4.80E-1
Trichloroethylene	91	325	1	3.00E-1	N/A	3.00E-1	3.00E-1	ug/L	N/A	N/A	**5.00E+0**	**5.00E+0**
Uranium	9	36	36	7.05E+0	5.35E+0	1.88E+1	1.68E+0	ug/L	N/A	N/A	N/A	N/A
Uranium-233/234	41	132	130	1.19E+1	7.00E+0	4.10E+1	-1.58E-3	pCi/L	7.30E+1	1.20E+1	**4.25E+0**	**3.82E+1**
Uranium-235/236	41	132	79	1.97E-1	1.90E-1	9.93E-1	0.00E+0	pCi/L	4.40E+0	1.20E+1	**1.46E-1**	**1.31E+0**
Uranium-238	41	132	130	3.16E+0	3.13E+0	1.69E+1	0.00E+0	pCi/L	6.10E+1	1.20E+1	**7.80E-1**	**7.00E+0**
Vanadium	9	36	35	5.12E+0	3.17E+0	1.20E+1	1.31E+0	ug/L	N/A	N/A	N/A	N/A
Vinyl chloride	91	325	1	8.10E-1	N/A	8.10E-1	8.10E-1	ug/L	N/A	N/A	1.00E+1	1.00E+1
Zinc	16	53	47	2.34E+1	1.77E+1	1.08E+2	6.80E+0	ug/L	N/A	N/A	3.60E+3	7.33E+3

Please note that organic constituents detected in 225' Zone groundwater are "J" flagged data, meaning that they are too low to quantify accurately. WCS does not consider "J" flagged data to be a concern. Non-radioactive metal concentrations appear to be natural. Radionuclide concentrations, with two exceptions, also appear to be natural. These exceptions are a detection of plutonium-238 from CWF-13C and a detection of americium -241 from CWF-2C, which both appear to be false positives. Both values reported in the samples are extremely close to their associated MDCs. Both wells were resampled and the resampled results were below their respective MDCs. Byproduct groundwater results in exceedance of their associated ILs are discussed in Section 4, Investigations, of this report.

Several metal constituents 225' Zone Groundwater results were greater than the most conservative LL ALs. These included arsenic and lead. Sufficient data do not exist to create station specific ALs for these constituents. These metal are naturally present in the groundwater at the site and do not indicate a significant difference from background. Furthermore, the FWF facility is not open, and the CWF waste streams do not contain these metals.

Uranium-233/234 result MW-11Dr was greater than the most conservative LLRW AL. As indicated in Figure 115, the result of 4.10E+1 was less than the LLRW AL for MW-11Dr of 9.92E+1.

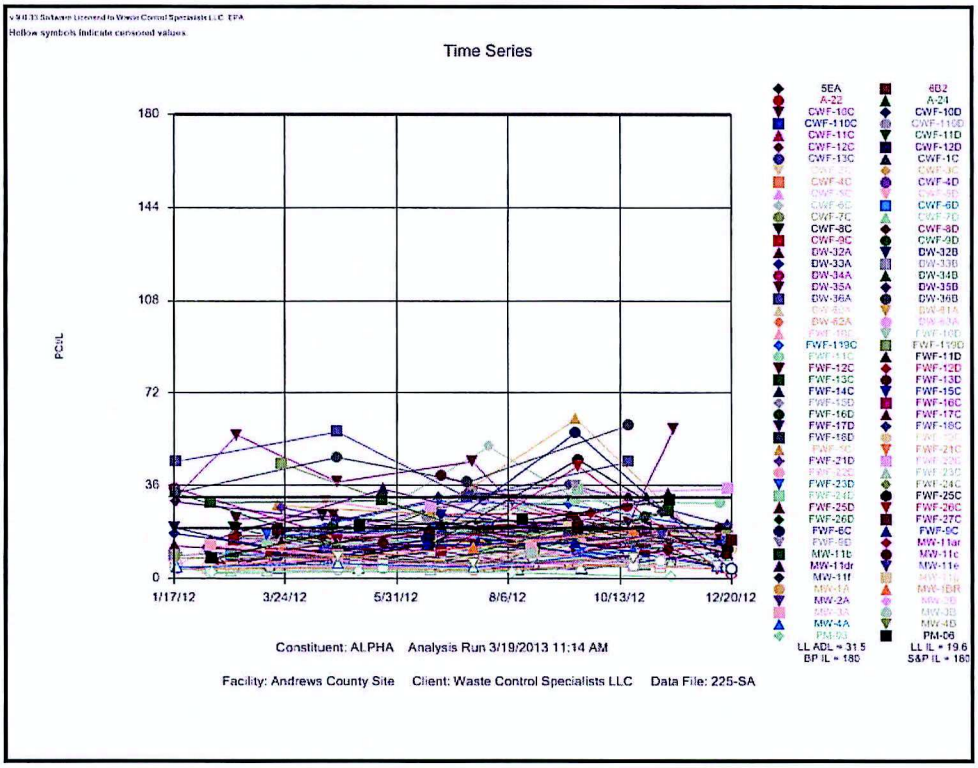

Figure 105 : Gross Alpha Concentration in 225' Zone Groundwater

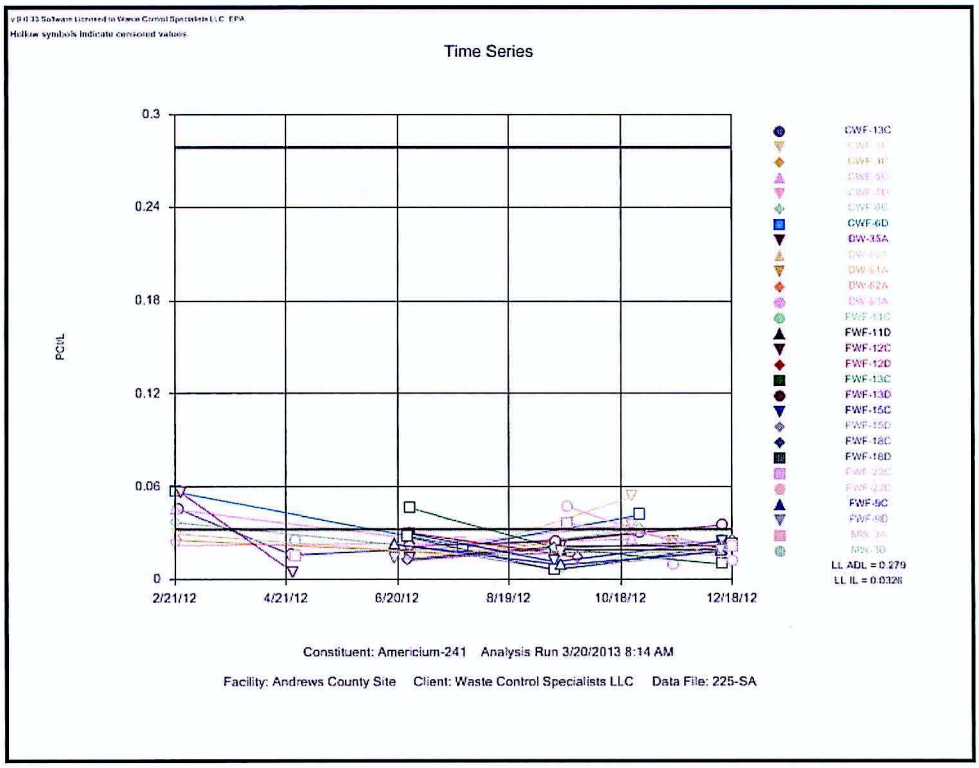

Figure 106 : Americium-241 Concentration in 225' Zone Groundwater

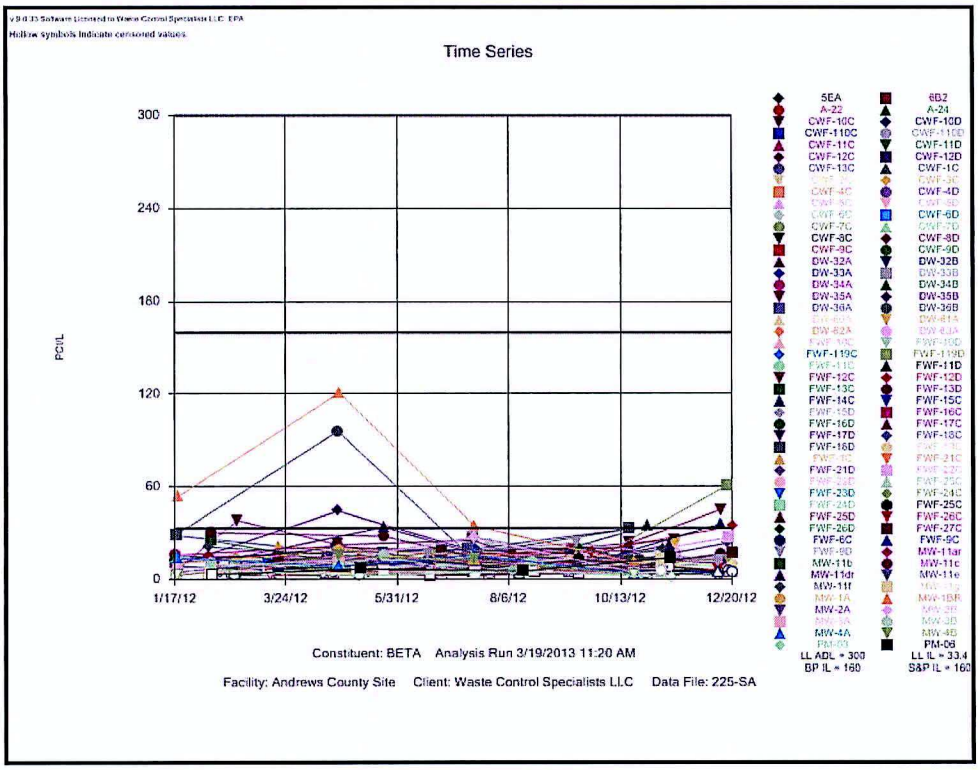

Figure 107 : Gross Beta Concentration in 225' Zone Groundwater

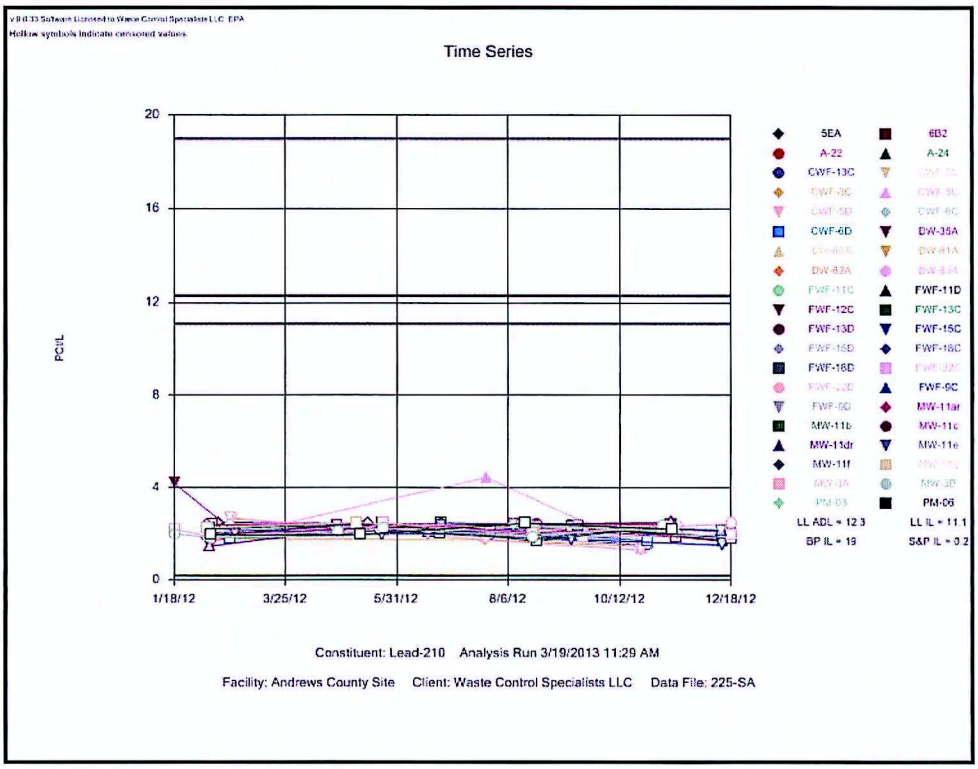

Figure 108 : Lead-210 Concentration in 225' Zone Groundwater

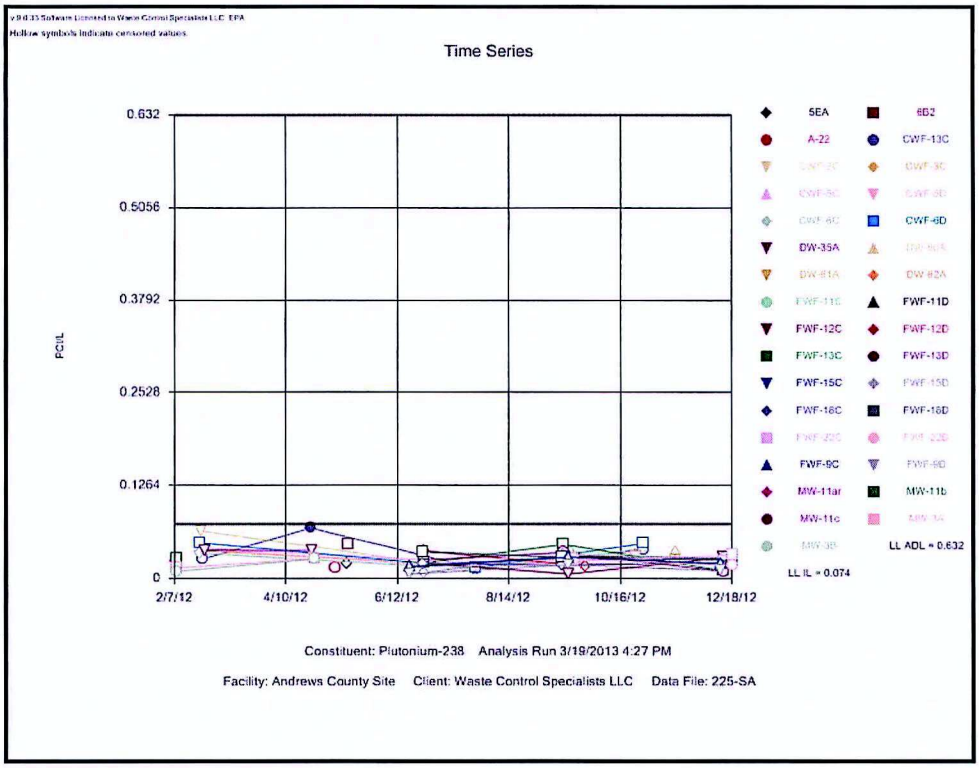

Figure 109 : Plutonium-238 Concentration in 225' Zone Groundwater

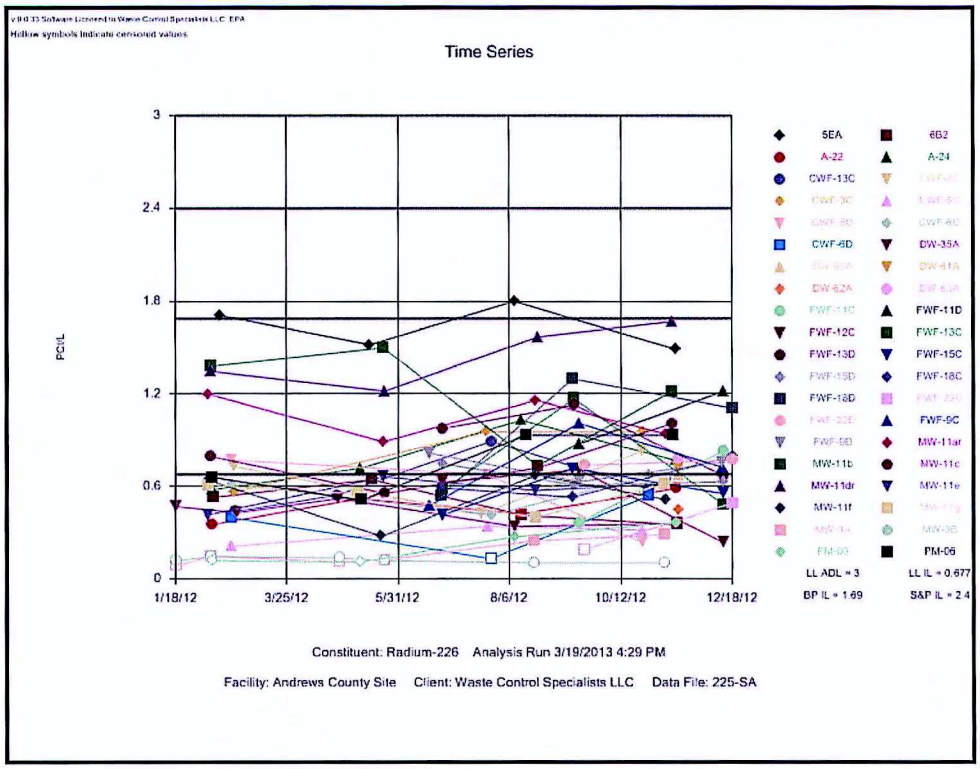

Figure 110 : Radium-226 Concentration in 225' Zone Groundwater

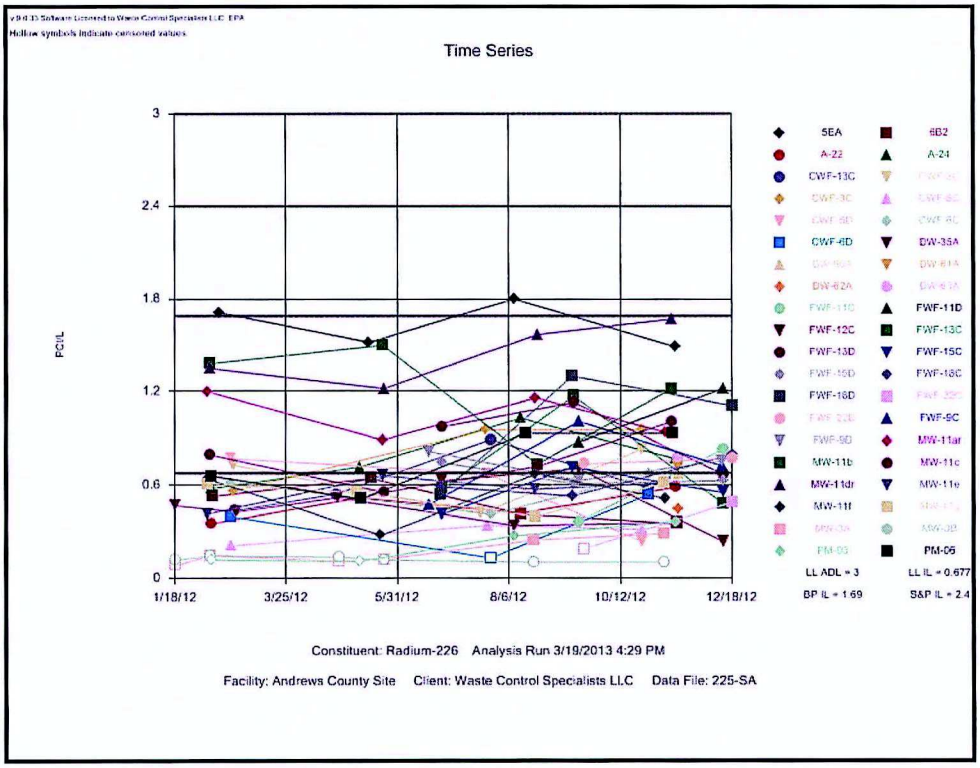

Figure 111 : Radium-228 Concentration in 225' Zone Groundwater

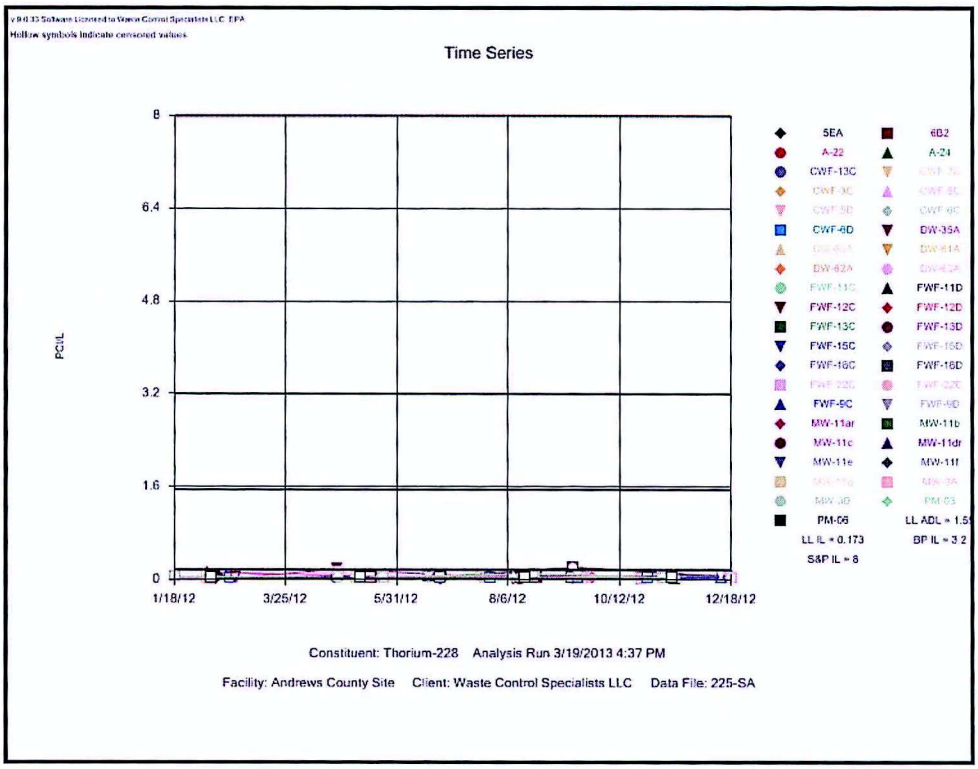

Figure 112 : Thorium-228 Concentration in 225' Zone Groundwater

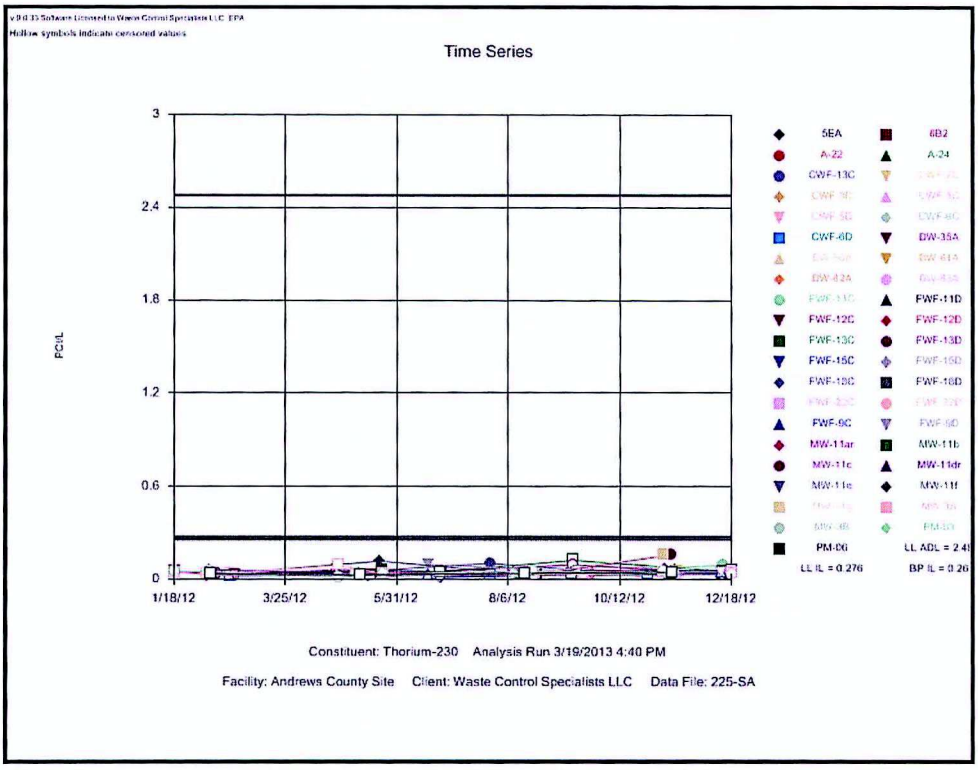

Figure 113 : Thorium-230 Concentration in 225' Zone Groundwater

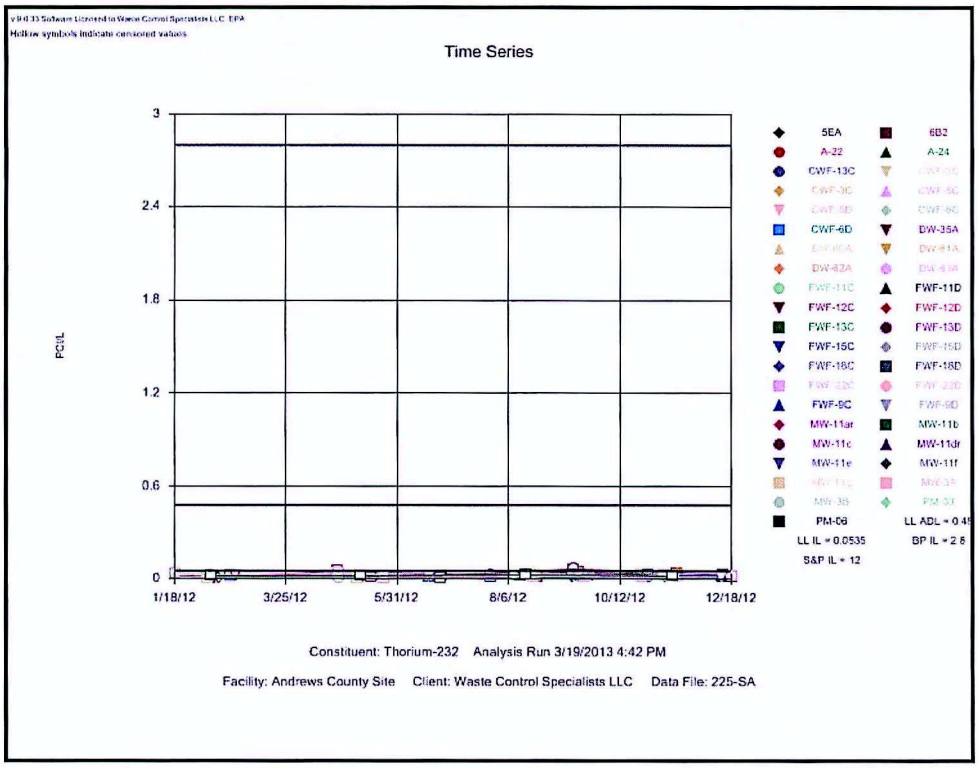

Figure 114 : Thorium-232 Concentration in 225' Zone Groundwater

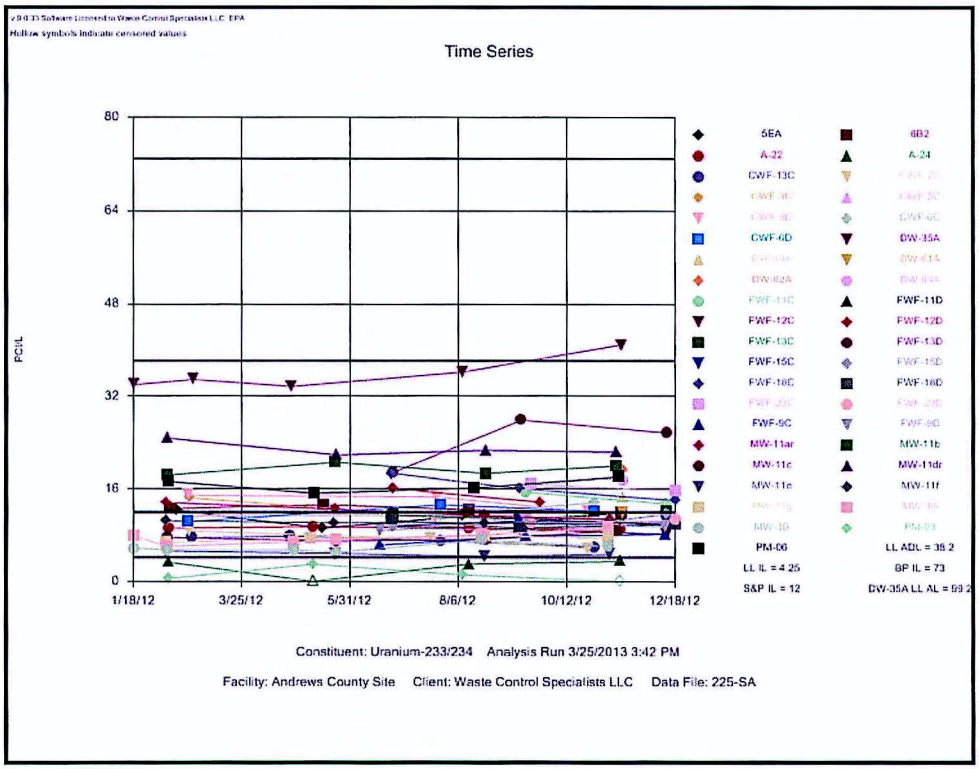

Figure 115 : Uranium-233/234 Concentration in 225' Zone Groundwater

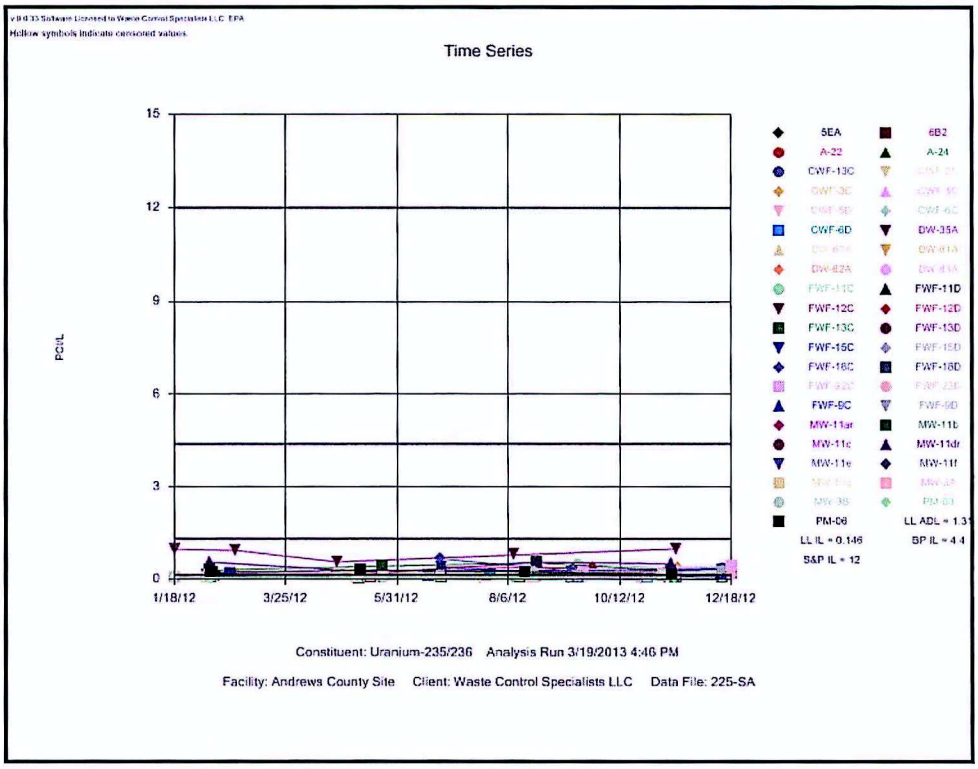

Figure 116 : Uranium-235/236 Concentration in 225' Zone Groundwater

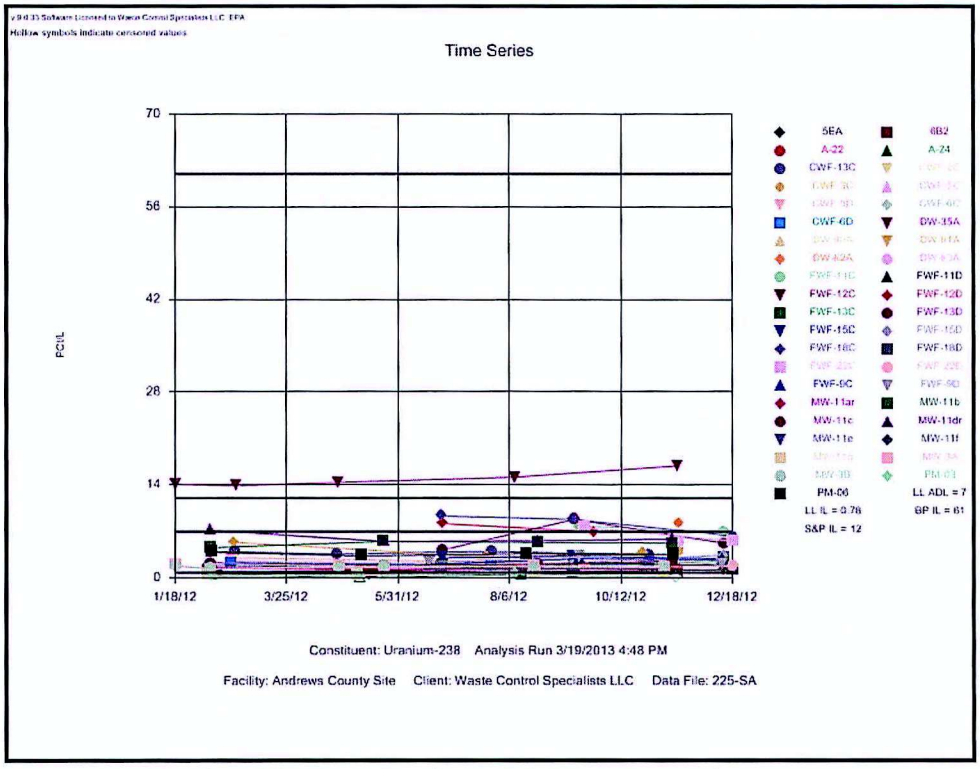

Figure 117 : Uranium-238 Concentration in 225' Zone Groundwater

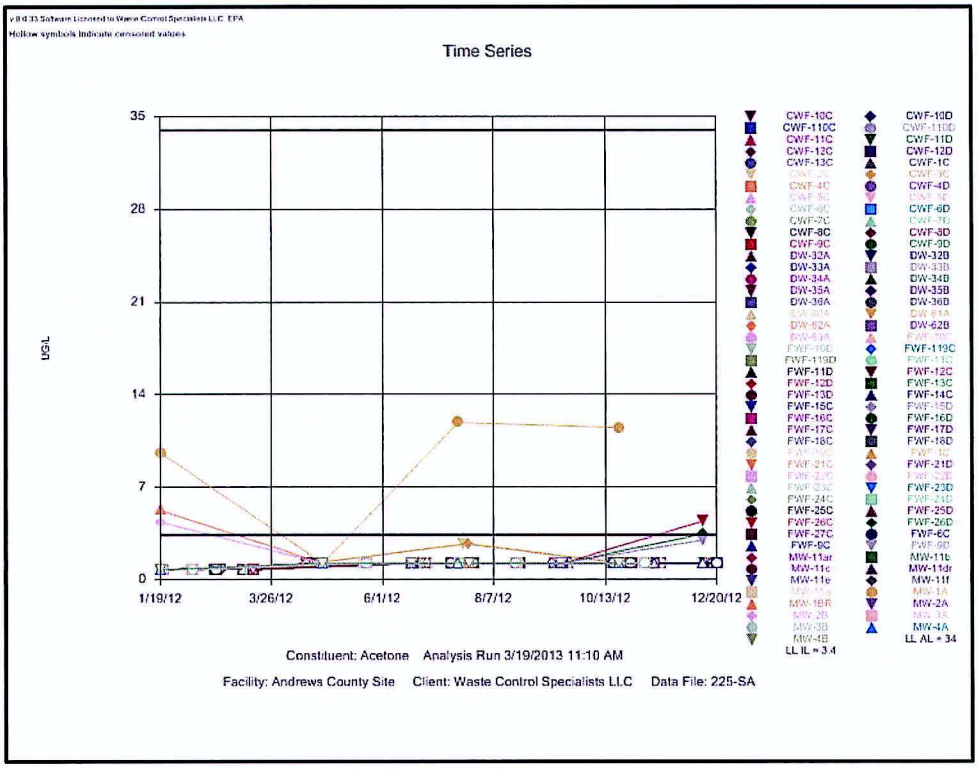

Figure 118 : Acetone Concentration in 225' Zone Groundwater

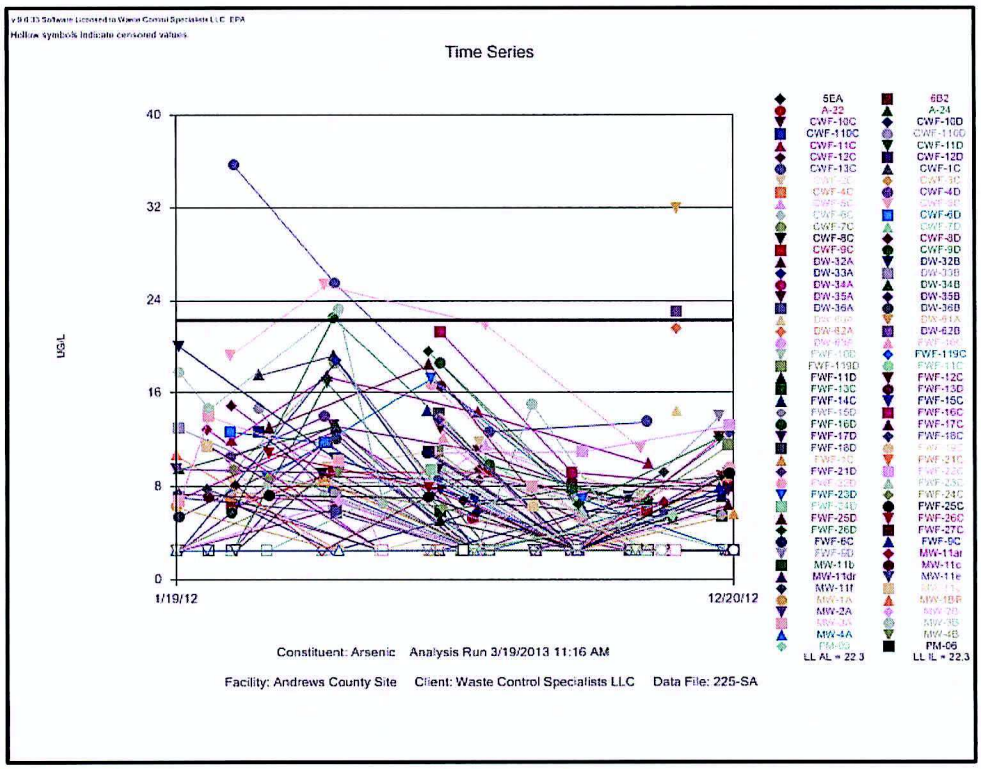

Figure 119 : Arsenic Concentration in 225' Zone Groundwater

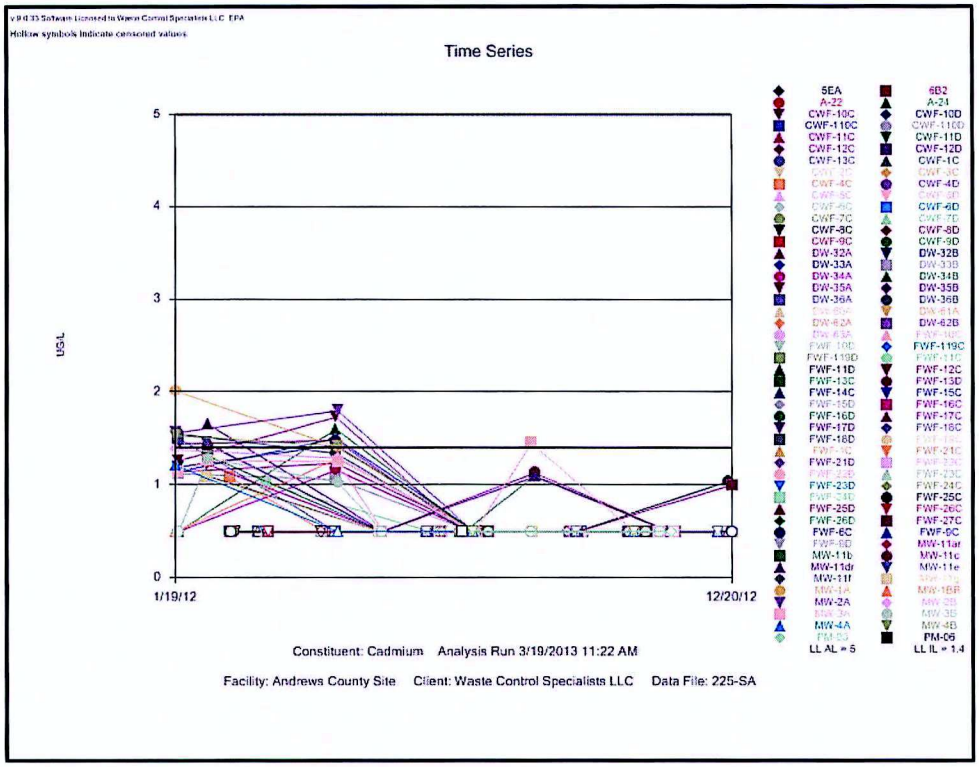

Figure 120 : Cadmium Concentration in 225' Zone Groundwater

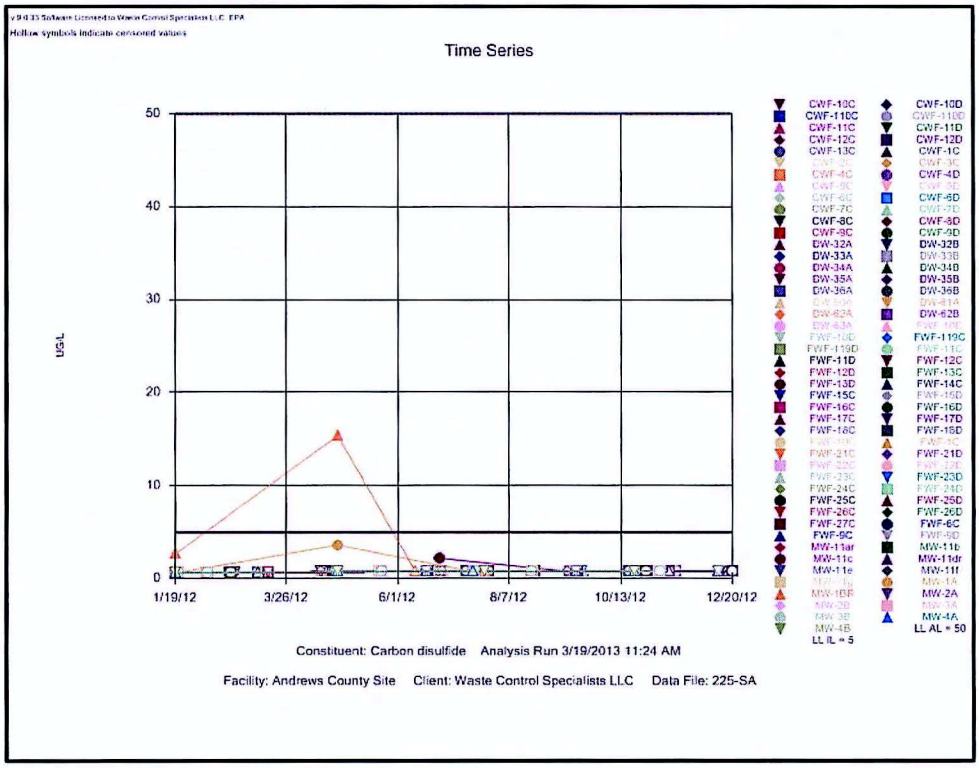

Figure 121 : Carbon Disulfide Concentration in 225' Zone Groundwater

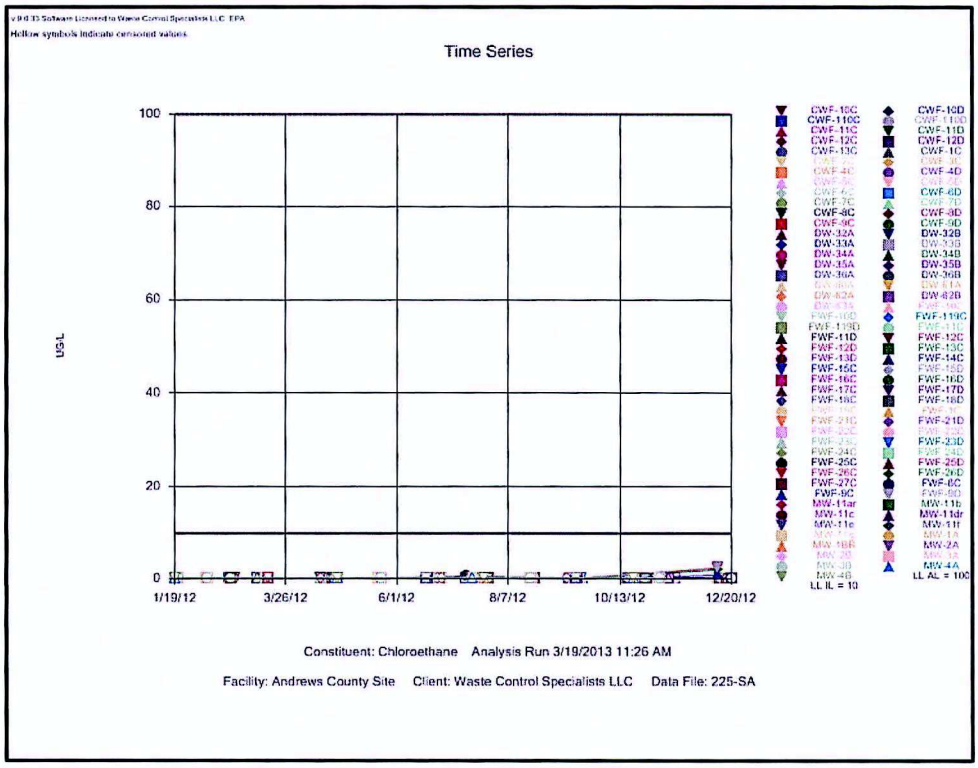

Figure 122 : Chloroethane Concentration in 225' Zone Groundwater

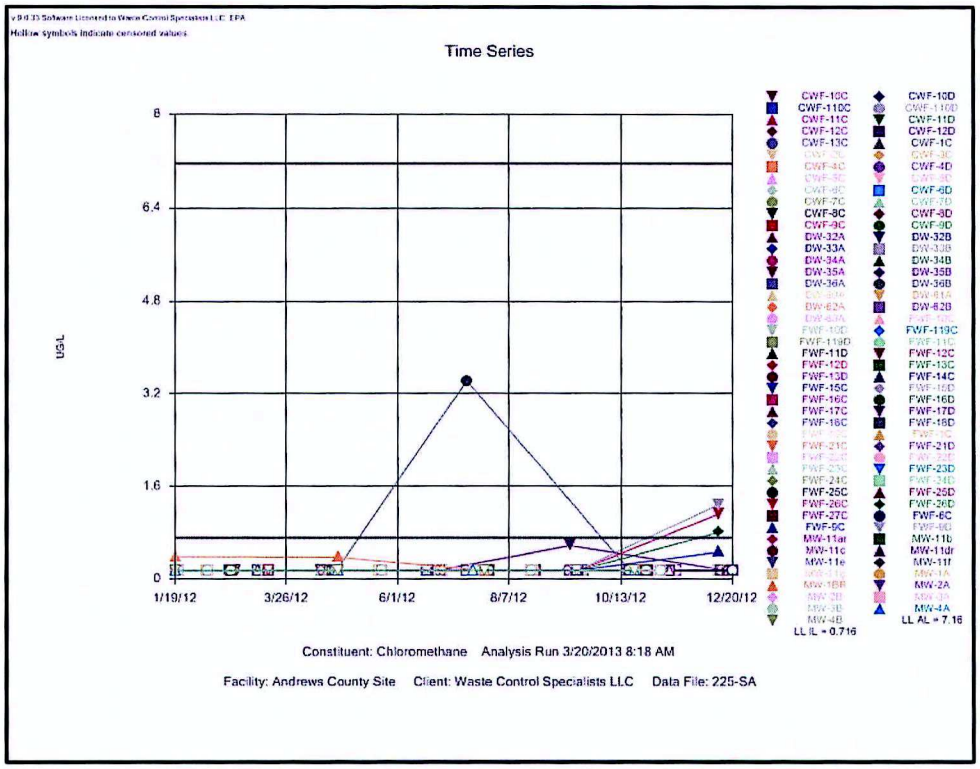

Figure 123 : Chloromethane Concentration in 225' Zone Groundwater

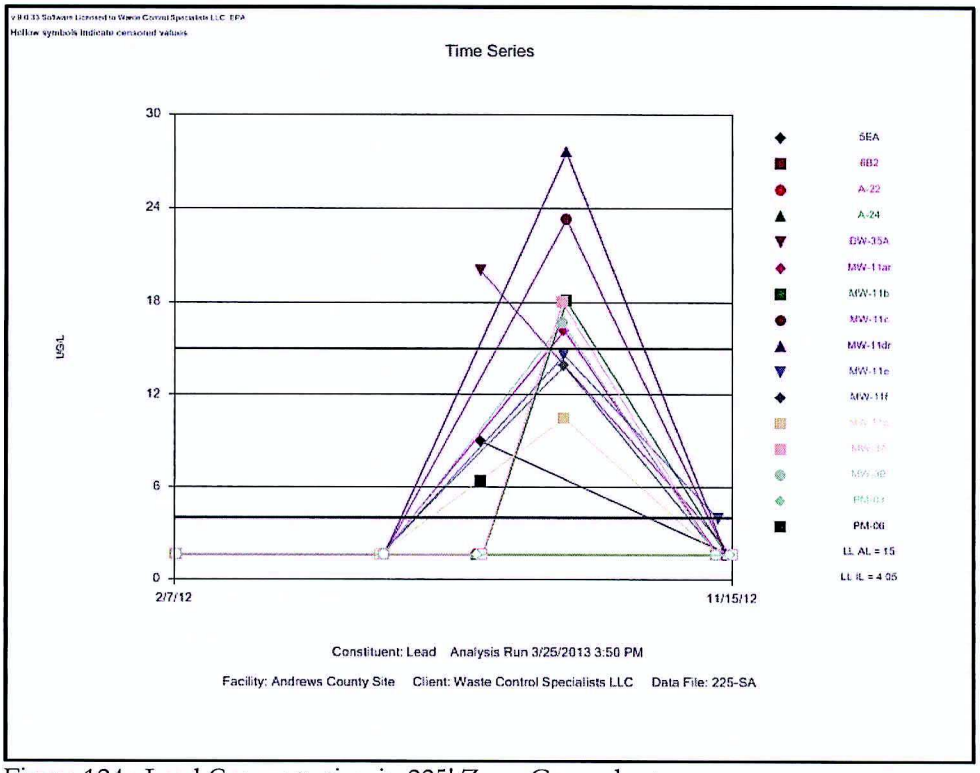

Figure 124 : Lead Concentration in 225' Zone Groundwater

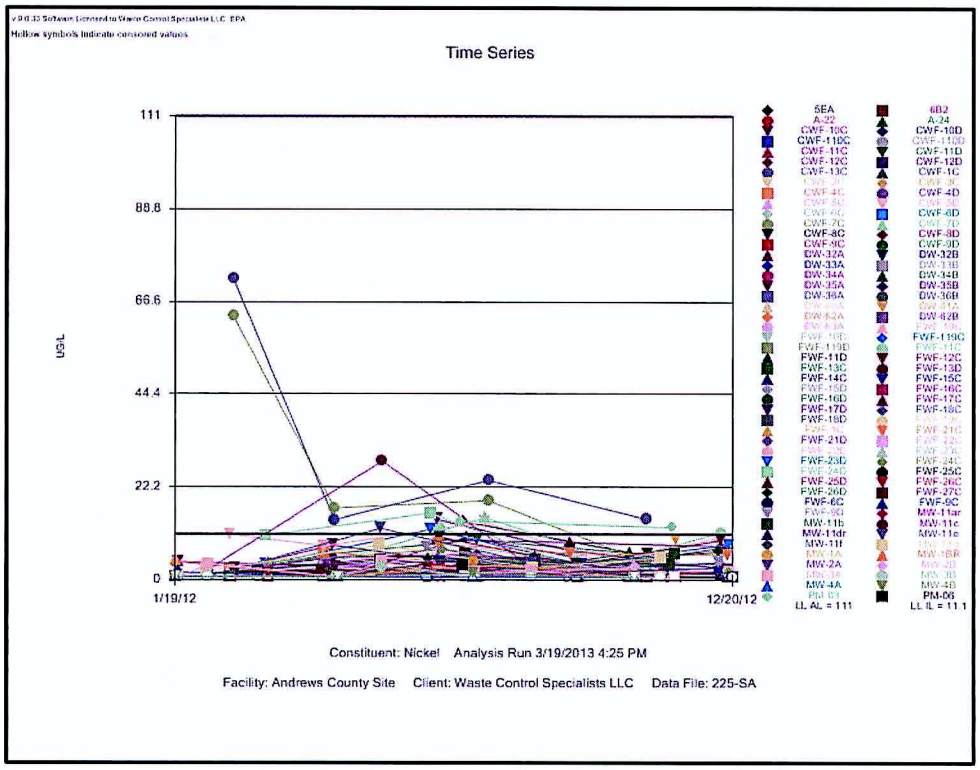

Figure 125 : Nickel Concentration in 225' Zone Groundwater

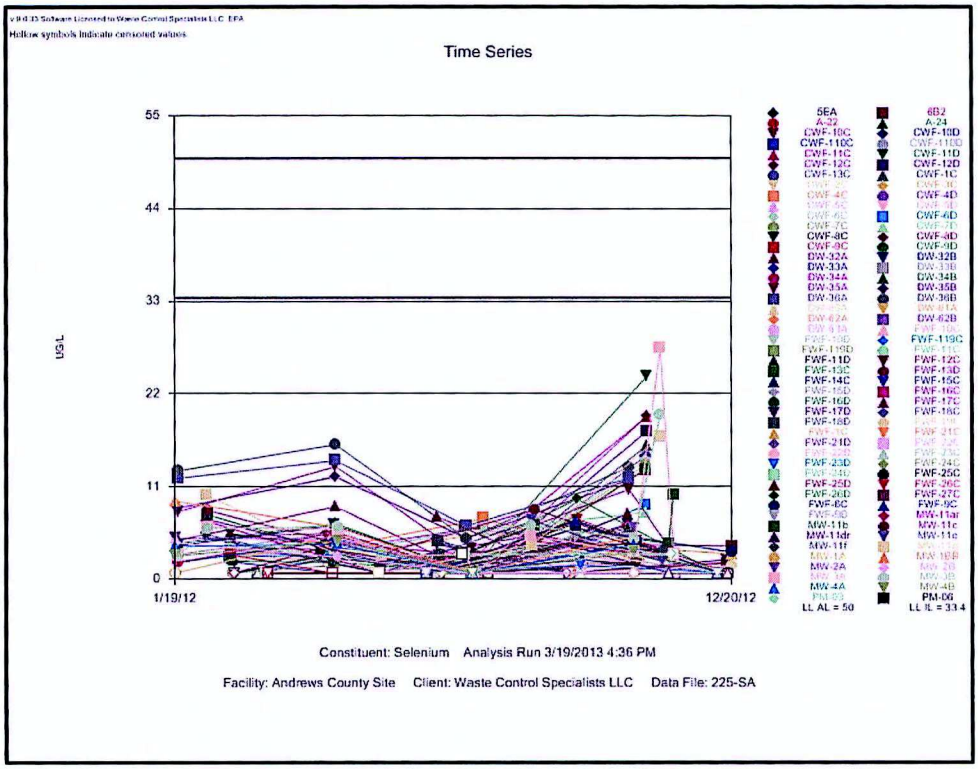

Figure 126 : Selenium Concentration in 225' Zone Groundwater

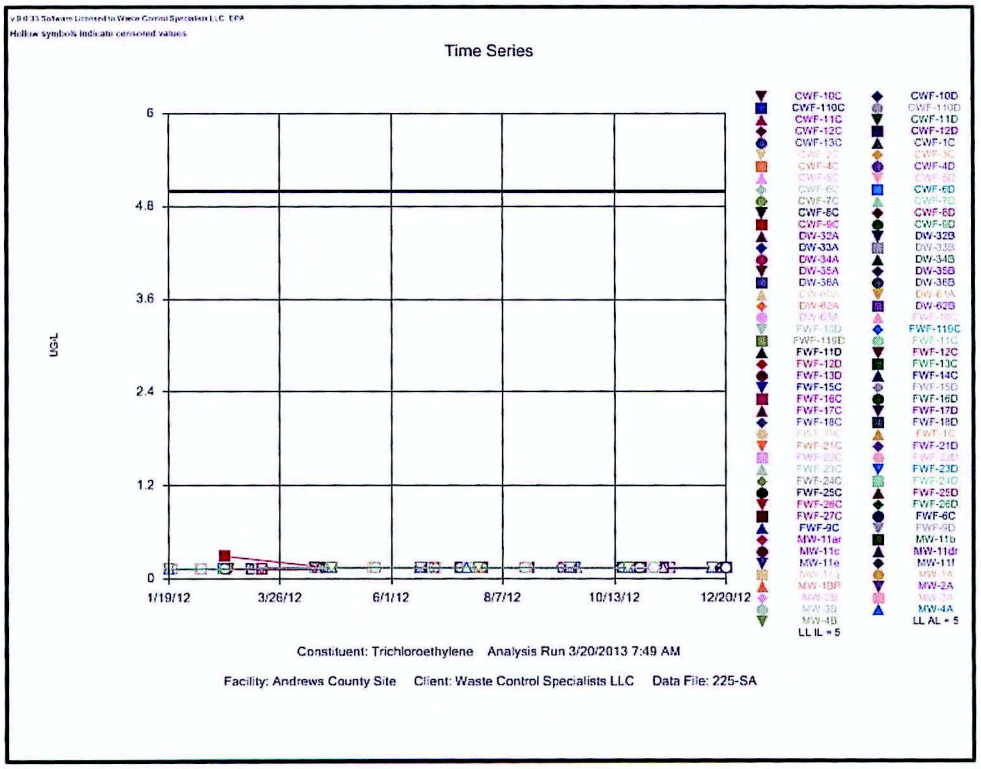

Figure 127 : Trichloroethylene Concentration in 225' Zone Groundwater

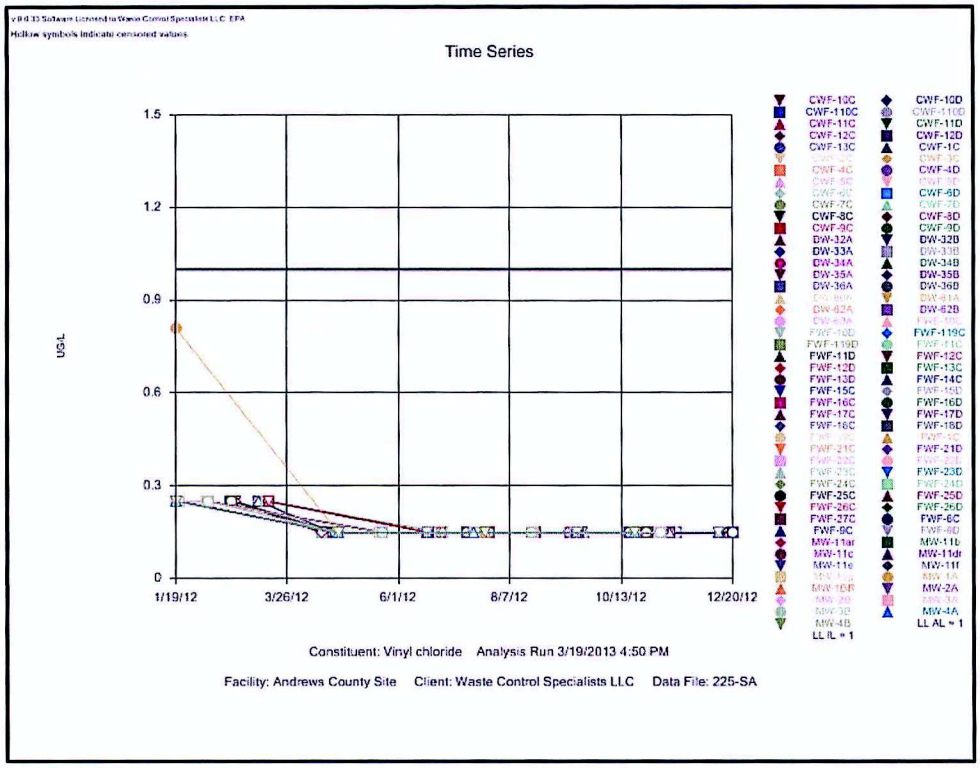

Figure 128 : Vinyl Chloride Concentration in 225' Zone Groundwater

3.10.1.4 Other Zone Groundwater Data

Table 33 list wells other than those in the OAG, the 125' zone or the 225' zone. Because all of these wells contain sufficient groundwater for routine sampling the "Saturation" column has been omitted from this table.

Table 33 : Other Zone Wells

Well	Zone
South Well	Trujillo
6B1	180' Zone

Summary statistics were not prepared because each of these wells is the only point monitored in those strata. However, these data are consistent with historical results, and all of the groundwater results for this reporting period for other zone groundwater are provided in Appendix G. Because these results are consistent with historical results, graphs depicting these results are not included in this report.

3.10.2 Surface Water

Collection of surface water is required at six surface water stations. Surface water samples are collected in accordance with procedure EV-7.1.13, *Surface Water Sampling.* Figure 129 displays the location the surface water stations. During this reporting period no surface water samples were collected due to the absence of sufficient moisture at the sample locations.

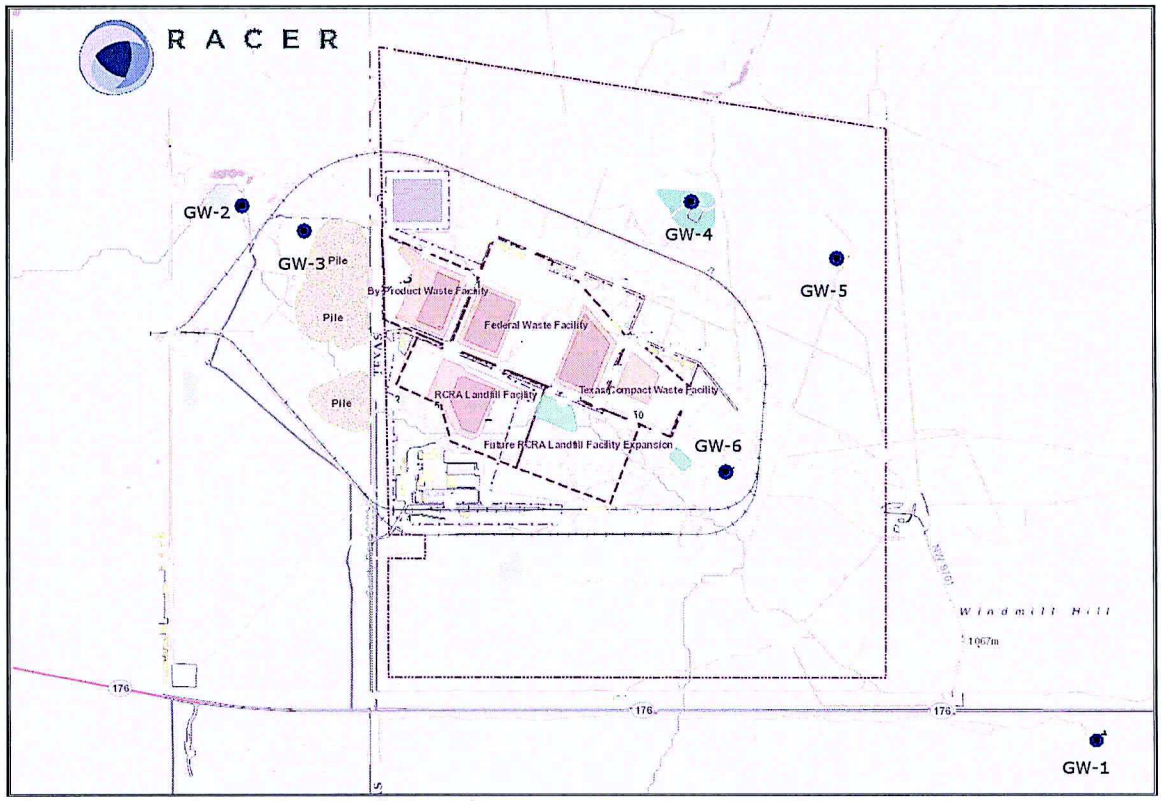

Figure 129 : Surface Water Sample Location

3.11 Aquatic Eco-Receptors

Samples of aquatic eco-receptors are collected annually if present from six locations as specified in RML No. R04100. The six locations are GW-1, GW-2, GW-3, GW-4, GW-5 and GW-6. Figure 130 contains a map of these locations. No aquatic eco-receptors sufficient for sampling and analysis were identified at any of the specified locations during this reporting period.

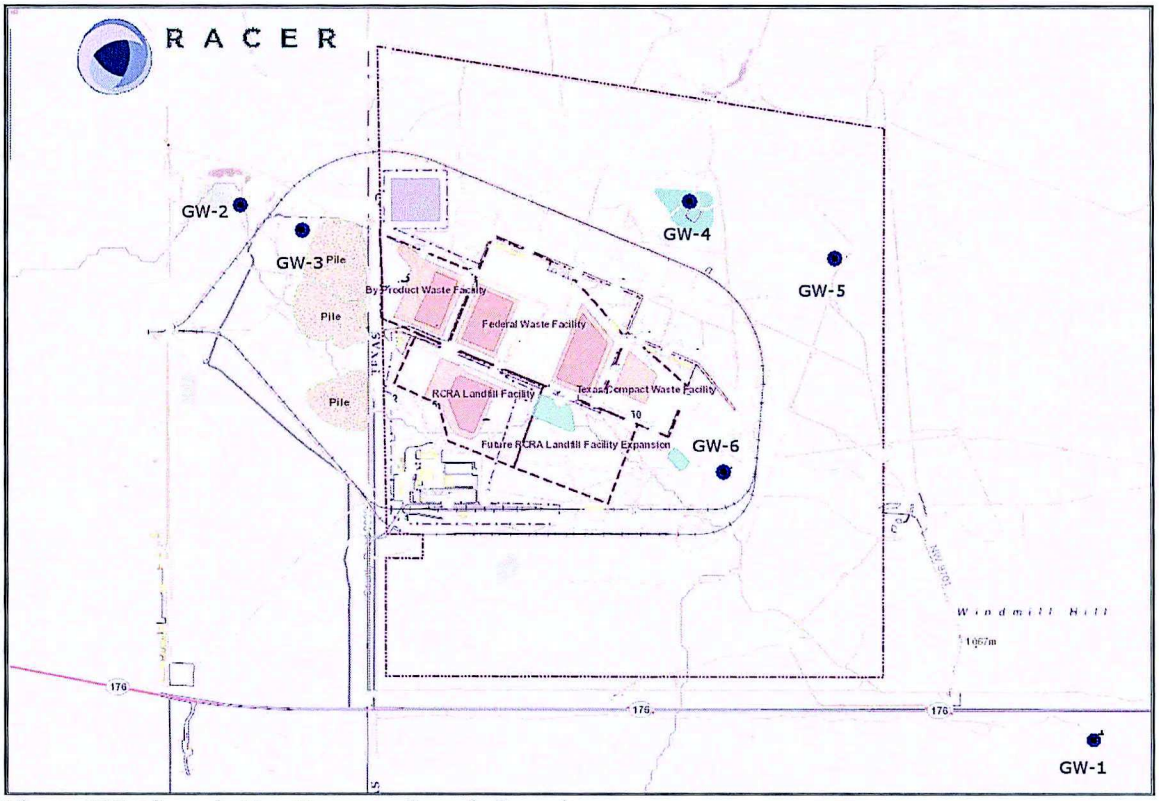

Figure 130 : Aquatic Eco-Receptor Sample Locations

3.12 Industrial Stormwater and Wastewater

3.12.1 Byproduct Facility

Liquids that collect in the Byproduct Facility Leachate Collection System (LCS) and Leak Detection System (LDS) are pumped into 500,000-gallon tanks (BPCT-1 and BPCT-2) for consolidation and storage prior to pre-release verification sampling and analysis. However, pursuant to RML No. R05807, LC 37.B, Table 37.B, liquid samples are also collected directly from the LCS and LDS sumps and analyzed on a monthly basis. LCS and LDS samples are shipped to a NELAP certified laboratory for analysis. Monthly samples were collected from the LCS and LDS sumps for this reporting period and the results are provided in Appendix H. Table 34 contains a summary of the LCS and LDS results from this reporting period.

Table 35 and Table 36 contain gross alpha and gross beta results respectively for 2012 leachate samples. Appendix H contains detailed results including MDC and sample numbers. The analytical results were compared with the discharge limit for gross alpha and the reporting limit for beta/gamma emitters (15 pCi/L and 50 pCi/L) respectively, under TPDES Permit No. WQ0004857000. All results were below these reporting limits. Stormwater collected from the LCS and LDS was discharged at outfall 103 on April 2, 2012. These results are consistent with the historical data from 2010.

Table 34 : Summary Results for Byproduct Leachate Collection System and Leak Detection System (pCi/L), 2012

	Alpha	Beta
Observations	48	48
No. of Stations	4	4
Less than MDC	6	1
Max. Value	14.9	21.3
Min. Value	0.5	-0.908
Mean Value	4.96	10.44
Standard Dev.	3.51	3.60
Mean ±Std*	2.49±1.64	8.27±4.37
***2010 Historical Average**		

Table 35 : Alpha Results for Leachate Collection System and Leak Detection System (pCi/L), 2012

Location	13-Jan-12	6-Feb-12	13-Mar-12	17-Apr-12	22-May-12	19-Jun-12
Cell A Leachate	0.732 ± 1.13*	2.64 ± 1.08	2.03 ± 1.54	5.04 ± 2.14	0.745 ± 0.516	0.629 ± 1.7*
Cell A Leak Detection	5.72 ± 1.68	6.55 ± 2.27	10.4 ± 2.88	14.9 ± 4.29	7.06 ± 1.79	7.89 ± 2.49
Cell B Leachate	2.08 ± 0.905	0.968 ± 0.745	2.4 ± 1.62	7.28 ± 2.81	2.01 ± 1.32	3.28 ± 2.27
Cell B Leak Detection	9.34 ± 2.68	7.4 ± 2.05	9.5 ± 3.47	5.02 ± 1.87	9.29 ± 2.45	4.93 ± 2.24
Location	**18-Jul-12**	**8-Aug-12**	**18-Sep-12**	**23-Oct-12**	**6-Nov-13**	**12-Dec-12**
Cell A Leachate	3.64 ± 2.53	1.45 ± 1.36*	9.78 ± 2.21	2.04 ± 1.13	3.77 ± 1.82	0.5 ± 1.05*
Cell A Leak Detection	9.98 ± 3.03	6.78 ± 2.66	1.41 ± 0.649	10.7 ± 2.72	11.1 ± 3.11	7.35 ± 2.9
Cell B Leachate	1.58 ± 2.27	1.17 ± 1.37*	1.79 ± 0.885	1.39 ± 1.23*	2.33 ± 1.5	2.54 ± 1.79
Cell B Leak Detection	5.05 ± 2.63	5.92 ± 2.71	3.87 ± 1.54	4.07 ± 1.67	7.18 ± 2.45	4.7 ± 2.23

* Result is less than MDC

Table 36 : Beta Results for Leachate Collection System and Leak Detection System (pCi/L), 2012

Location	13-Jan-12	6-Feb-12	13-Mar-12	17-Apr-12	22-May-12	19-Jun-12
Cell A Leachate	6.72± 1.57	14.8± 2.62	15.2± 2.87	16.4± 3.31	7.42± 1.4	-0.908± 2.02*
Cell A Leak Detection	8.24± 1.56	11.1± 2.05	8.85± 1.8	11.8± 2.81	11.3± 2.15	10.8± 3.42
Cell B Leachate	7.51± 1.41	9.51± 1.77	11.5± 2.26	16.6± 3.56	15.4± 2.73	15.9± 4.15
Cell B Leak Detection	8.42± 1.6	14.4± 2.54	7.05± 2.13	15± 2.93	9.56± 1.78	8.29± 3.02
Location	**18-Jul-12**	**8-Aug-12**	**18-Sep-12**	**23-Oct-12**	**6-Nov-13**	**12-Dec-12**
Cell A Leachate	10.1 ± 3.45	6.56 ± 1.7	7.57 ± 1.47	12 ± 2.41	11.1 ± 2.27	9.06 ± 2.07
Cell A Leak Detection	9.9 ± 3.25	9.25 ± 2.16	8.47 ± 1.56	10.6 ± 2.17	8.61 ± 1.94	7.76 ± 2.29
Cell B Leachate	13 ± 3.85	13.8 ± 2.82	21.3 ± 3.64	10.5 ± 2.26	9.08 ± 1.99	10.1 ± 2.36
Cell B Leak Detection	10.6 ± 3.46	8.18 ± 2.14	8.07 ± 1.64	9 ± 1.82	7.38 ± 1.75	8.44 ± 2.05

3.12.2 Sanitary Wastewater

During 2012, WCS has taken water recovered from the septic systems to a publicly owned treatment works (POTW) for disposal in Andrews, Texas. The effluents from the septic tanks are pumped into the above-ground sanitary holding tank (SHT) system for collecting and holding the septic tank effluents so they may be tested prior to release to a POTW or other appropriate disposition pathway. Samples were collected from the following tanks: SHT-1A, SHT-2A, SHT-3A, SHT-4A, SHT-1S, SHT-2S, SHT-1M, SHT-2M, SHT-3M, SHT-4M, LL-SHT-1A, LL-SHT-2A, LL-SHT-3A, LL-SHT-4A, LL-SHT-7G, and LL-SHT-8G. WCS manages these systems in accordance with procedure EV-7.15 *Managing Onsite Sanitary Systems.*

Under 30 TAC §336.219, *Disposal by Release into Septic Tanks,* no person is authorized to discharge radioactive material into a septic tank system unless authorized by TCEQ. Therefore, removal of the waste to a POTW was the chosen alternative for sanitary waste.

The regulatory language for sanitary waste is reproduced below.

> *A licensee may discharge licensed material into sanitary sewerage if each of the following conditions is satisfied:*
>
> *(1) the material is readily soluble in water, or is readily dispersible biological material;*
>
> *(2) the quantity of licensed or other radioactive material that the licensee releases into the sewer in one month divided by the average monthly volume of water released into the sewer by the licensee does not exceed the concentration listed in Table III of §336.359 of this title (relating to Appendix C, Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sanitary Sewerage);*
>
> *(3) if more than one radionuclide is released, the licensee shall determine the fraction of the limit in Table III of §336.359 of this title represented by discharges into sanitary sewerage by dividing the actual monthly average concentration of each radionuclide released by the licensee into the sewer by the concentration of that radionuclide listed in Table III of §336.359 of this title; the sum of the fractions for all of the radionuclides released shall not exceed one; and*
>
> *(4) the total quantity of licensed and other radioactive material that the licensee releases into the sanitary sewerage in a year does not exceed five curies (185 gigabecquerels) of hydrogen-3, one curie (37 gigabecquerels) of carbon-14, and one curie (37 gigabecquerels) of all other radioactive materials combined.*

The sanitary waste from septic tanks was removed and transported to a POTW located in Andrews, Texas. In accordance with 30 TAC §336.215, *Disposal by Release into Sanitary Sewerage*, WCS monitors and tracks discharged radioactive material into the POTW. The release limits and total quantities are specified in 30 TAC §336.215 (4) and Table III of §336.359.

As stated above, the septic systems were pumped and taken to the POTW. The septic holding tanks hold approximately 7,500 gallons of liquid each. The quantity released to the POTW is monitored prior to each release and with the associated sample analysis. All positive activity results are maintained in a database. These positive results are multiplied by the volume released to determine the total activity released per transfer. The results from the activities transferred are summed and used to calculate the total activity released during the report period for comparison to the regulatory limit of one Curie total for all radionuclides for a year. The total activity transferred to a POTW is calculated using:

$$A_{Total} = \sum_{1}^{N} A_d$$

$$A_d = \sum_{1}^{n} R_i * Vol$$

Where:

A_{Total} = Total activity released, Curies
N = Number of water transfers in the year, 30
A_d = Activity discharged per single transfer event, Ci
R_i = Activity of radionuclide *i*, pCi/L
Vol = Volume released per transfer, in liters

Carbon-14 and tritium were monitored with each transfer for comparison to the regulatory limit. All septic results for the calendar year of 2012 for carbon-14 and tritium were below the Minimum Detectable Concentration. The total activity released is also monitored with the monthly reports. The total activity that can be released to the POTW is given in 30 TAC §336.215 (4) such that "the total quantity of licensed and other radioactive material that the licensee releases into the sanitary sewerage in a year does not exceed five curies (185 gigabecquerels) of hydrogen-3, one curie (37 gigabecquerels) of carbon-14, and one curie (37 gigabecquerels) of all other radioactive materials combined." The cumulative total activity for all other radionuclide released for this reporting period has been calculated to be 3.06E-05 curies (Ci), which is well below 1 % of the one curie limit for all other radionuclides.

All calculated results were below the release limits and total quantities in 30 TAC §336.215, *Disposal by Release into Sanitary Sewerage*, allowing release to the POTW in Andrews, Texas. Therefore, for this reporting period, the releases to the Andrews Texas POTW are below regulatory limits for the State of Texas and each nuclide is below the monthly discharge concentration level. The total discharge to the POTW is below the 1 curie annual limit. Table 37 contains the sample and released dates for the septic holding tanks for this reporting period. Appendix I summarizes the septic data collected during the reporting period.

Table 37 : Septic Holding Tanks Sample and Release Dates, 2012

Location	Sample Date	Released to the POTW	Location	Sample Date	Released to the POTW
SHT-2S	12/20/11	1/12/12	LL-SHT-3A	6/26/2012	7/20/12
SHT-4A	12/21/11	1/10/12	LL-SHT-8G	6/29/2012	7/20/12
SHT-1A	1/3/12	1/19/12	SHT-1A	6/21/2012	7/24/2012
SHT-2A	1/13/12	2/1/12	SHT-4A	7/10/2012	7/31/2012
SHT-3A	1/24/12	2/12/12	SHT-2M	7/12/2012	8/30/2012
SHT-4A	2/1/12	2/21/12	LL-SHT-1A	7/18/2012	8/7/2012
SHT-3M	2/1/12	2/24/12	SHT-2A	7/18/2012	8/3/2012
SHT-1S	2/7/12	2/23/12	SHT-3A	7/30/2012	8/20/2012
LL-SHT-1A	2/8/12	2/27/12	SHT-2A	8/9/2012	8/30/2012
SHT-1A	2/10/12	3/2/12	LL-SHT-2A	8/10/2012	8/30/2012
SHT-2A	2/21/12	3/9/12	LL-SHT-7G	8/13/2012	8/30/2012
SHT-3A	3/1/12	3/29/12	LL-SHT-8G	8/14/2012	9/11/2012
SHT-4A	3/13/12	3/30/12	SHT-2S	8/20/2012	9/12/2012
SHT-1A	3/22/12	4/12/12	SHT-4A	8/20/2012	9/11/12
LL-SHT-2A	3/28/12	4/16/12	SHT-3M	8/27/2012	9/25/12
SHT-4M	4/2/12	4/18/12	SHT-1A	8/28/2012	9/25/12
SHT-2S	4/10/12	4/28/12	SHT-3A	9/10/2012	10/4/2012
SHT-3A	4/19/12	5/8/12	LL-SHT-1A	9/17/2012	10/12/12
SHT-4A	4/27/12	5/17/12	SHT-2A	9/20/2012	10/11/12
SHT-2A	5/9/12	5/24/12	SHT-4A	10/1/2012	10/26/12
LL-SHT-1A	5/11/12	6/4/12	LL-SHT-2A	10/2/2012	10/29/12
LL-SHT-8G	5/11/12	5/17/12	SHT-1A	10/15/2012	11/5/12
SHT-1A	5/9/12	6/4/12	LL-SHT-7G	10/23/2012	11/19/12
SHT-3A	5/21/12	6/7/12	SHT-1S	10/23/2012	11/19/12
LL-SHT-7G	5/25/12	6/15/12	LL-SHT-3A	10/25/2012	11/20/12
LL-SHT-8G	5/30/12	6/15/12	SHT-2A	10/25/2012	11/15/12
SHT-4A	6-1-12	6-22-12	SHT-3A	11/12/2012	12/7/2012
SHT-1M	6-6-12	6-29-12	SHT-4A	11/19/2012	12/12/2012
SHT-1S	6-6-12	6-29-12	SHT-4M	11/28/2012	12/26/2012
SHT-2A	6-13-12	6-28-12	LL-SHT-4A	11/28/2012	12/18/2012
LL-SHT-2A	6/8/12	7/2/2012	SHT-1A	12/5/2012	12/26/2012
SHT-3A	6/21/2012	7/12/2012			
LL-SHT-7G	6/25/2012	7/13/2012			

3.12.3 LLRW Facility

WCS collects stormwater and wastewater samples in accordance with Attachment B of RML No. R04100 when sufficient water is present. Samples are collected for radionuclide samples from the CWF and FWF contact water evaporation ponds on a monthly basis and the CWF and FWF non-contact water sedimentation ponds on a quarterly basis. The FWF contact water pond is also sampled for chemical constituents on a monthly basis. When sediment is present in sufficient quantity in these ponds, it is sampled at the same frequency and analyzed for the same analytes as the water samples. Leachate and other process wastewaters are sampled from each of the collection and holding systems on a monthly or quarterly basis as specified in Attachment B of RML No. R04100. Figure 131 shows the locations of the various sedimentation and evaporation ponds with respect to the LLRW facility.

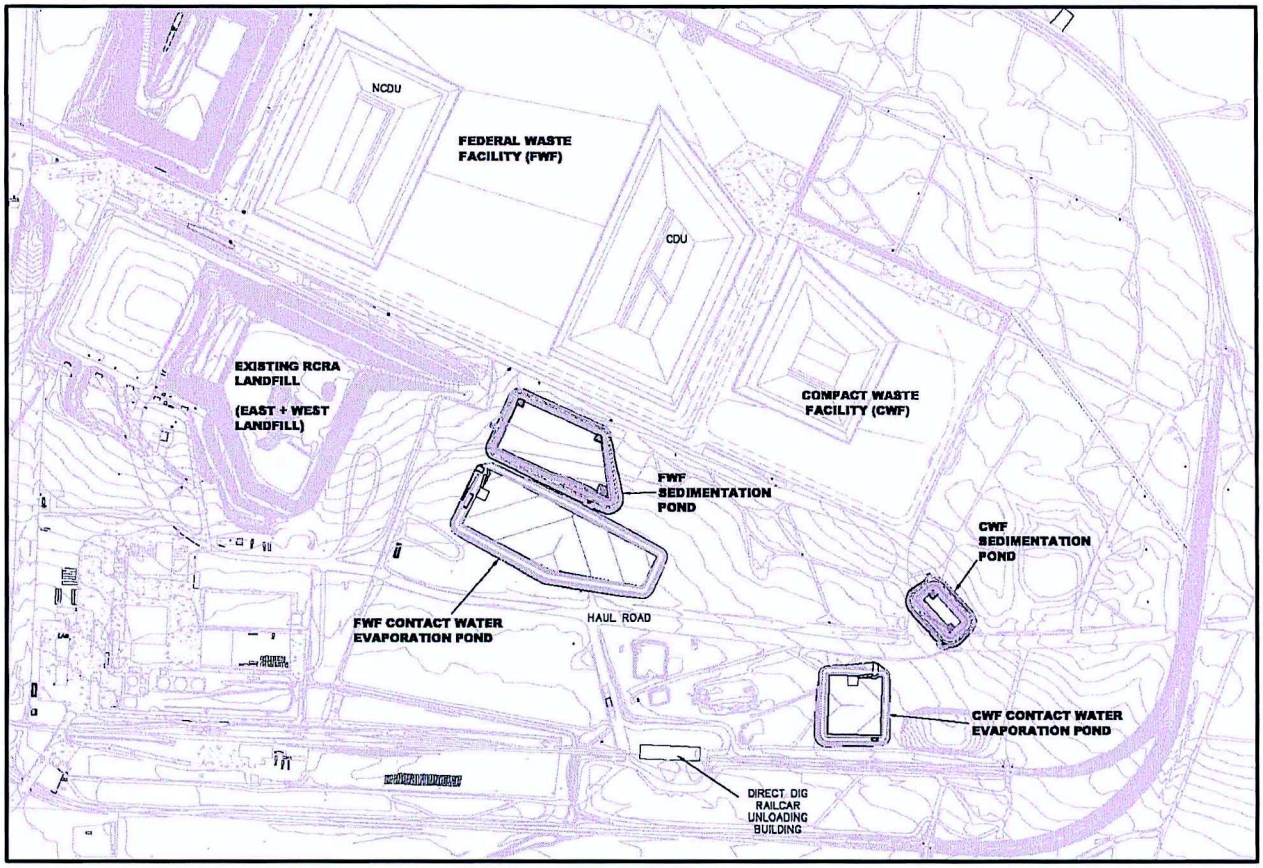

Figure 131 : Pond Locations

Regardless of the license or permit water samples are collected for, all are shipped to an offsite laboratory for analysis. Effluent results are compared against applicable regulatory limits or other permit or license required standards.

Table 38 displays the dates the sedimentation and evaporation ponds were sampled in accordance with RML No. R04100. During the report period, the FWF was not yet operational; therefore, there were no operational discharges to the FWF Sedimentation Pond or the FWF Contact Water Evaporation Pond. CWF operations did not commence until April 2012, as previously noted, and no rainfall events caused the discharge of non-contact stormwater to the Compact Sedimentation Pond. Similarly, no contact water was discharged during the report period to the CWF Contact Water Evaporation Pond. However, as indicated in Table 38, the CWF Contact Water Evaporation Pond and the CWF Sedimentation Pond were sampled during the report period. The water that was sampled represents precipitation that fell directly onto the ponds, and therefore represents background levels of analytes in rainwater. This sample was analyzed for the constituents specified in TLAP No. WQ0004948000. As expected, since the sample consisted of precipitation falling directly on the newly-constructed pond, all sample results were below the limits specified in TLAP No. WQ0004948000. The a summary of the results for the CWF Sedimentation Pond and the CWF Contact Water Pond are presented in Table 39 and Table 40, respectively.

Table 38 : Sample Collection Dates for Sedimentation/Evaporation Pond Samples

Location	Dates Sampled
CWF Sedimentation Pond	8-28-12 and 11-26-12 (water only)
FWF Sedimentation Pond	Not Sampled
CWF Contact Water Evaporation Pond	5/17/12 (water only)
FWF Contact Water Evaporation Pond	Not Sampled

Table 39 : Summary of CWF Sedimentation Pond Results Greater than MDC for 2012

Analyte	Mean	Standard Deviation	Max	Min	Count	Units	Limits
ALPHA	8.77E+00	1.93E+00	1.10E+01	7.64E+00	3	PCI/L	15
BETA	8.84E+00	4.93E+00	1.68E+01	2.80E+00	7	PCI/L	50
Bismuth-214	2.25E+01	7.07E-02	2.25E+01	2.24E+01	2	PCI/L	N/A
Radium-226	3.94E-01	1.11E-01	5.54E-01	2.50E-01	7	PCI/L	5
Radium-228	6.56E-01	4.51E-02	7.03E-01	6.13E-01	3	PCI/L	5
Uranium	5.39E-01	4.19E-02	6.04E-01	4.94E-01	10	UG/L	N/A

Notes: Limit refers to TLAP Permit Limit.

Table 40 : Water Data from CWF Contact Water Evaporation Pond Sampled 5/17/12

Analyte	Result	TPU	MDC	Units	Limit
ALPHA	6.13E-01	1.02E+00	1.86E+00	pCi/L	15
Actinium-228g	6.25E+00	1.79E+01	3.72E+01	pCi/L	N/A
Americium-241g	1.20E+01	1.41E+01	2.53E+01	pCi/L	N/A
Americium-243g	-7.35E-01	5.72E+00	9.91E+00	pCi/L	N/A
Antimony-124g	-9.48E+00	1.12E+01	1.64E+01	pCi/L	N/A
Antimony-125g	5.04E+00	9.89E+00	1.89E+01	pCi/L	N/A
BETA	6.34E+00	2.22E+00	2.15E+00	pCi/L	50
Barium-133g	-3.62E+00	4.84E+00	7.49E+00	pCi/L	N/A
Barium-140g	3.44E+00	1.59E+01	3.13E+01	pCi/L	N/A
Beryllium-7g	3.30E+01	3.92E+01	7.46E+01	pCi/L	N/A
Bismuth-212g	-1.99E+01	4.11E+01	7.14E+01	pCi/L	N/A
Bismuth-214g	6.95E+00	8.06E+00	1.59E+01	pCi/L	N/A
Cerium-139g	5.17E-01	2.77E+00	4.90E+00	pCi/L	N/A
Cerium-141g	2.71E+00	5.51E+00	9.73E+00	pCi/L	N/A
Cerium-144g	-1.59E+00	2.08E+01	3.61E+01	pCi/L	N/A
Cesium-134g	-5.04E-01	4.75E+00	8.93E+00	pCi/L	N/A
Cesium-136g	2.97E+00	6.12E+00	1.30E+01	pCi/L	N/A
Cesium-137g	1.08E+00	3.82E+00	7.65E+00	pCi/L	N/A
Chromium-51g	2.20E+00	2.79E+01	5.20E+01	pCi/L	N/A
Cobalt-56g	-3.18E-01	3.54E+00	6.75E+00	pCi/L	N/A
Cobalt-57g	-3.46E-02	2.90E+00	5.06E+00	pCi/L	N/A
Cobalt-58g	-5.13E+00	4.58E+00	5.55E+00	pCi/L	N/A
Cobalt-60g	-2.51E+00	4.25E+00	7.05E+00	pCi/L	N/A
Curium-243g	7.37E+00	1.17E+01	2.09E+01	pCi/L	N/A
Europium-152g	2.98E+00	9.53E+00	1.82E+01	pCi/L	N/A
Europium-154g	7.40E+00	1.04E+01	2.39E+01	pCi/L	N/A
Europium-155g	-1.16E+01	1.29E+01	1.90E+01	pCi/L	N/A
Iridium-192g	-6.62E-01	2.99E+00	5.38E+00	pCi/L	N/A
Iron-59g	3.71E+00	7.81E+00	1.65E+01	pCi/L	N/A
Lead-210g	9.65E+00	2.54E+02	4.68E+02	pCi/L	N/A
Lead-212g	-8.94E+00	8.45E+00	1.24E+01	pCi/L	N/A
Lead-214g	4.70E+00	9.32E+00	1.67E+01	pCi/L	N/A
Manganese-54g	2.15E+00	4.55E+00	8.92E+00	pCi/L	N/A
Mercury-203g	-2.09E-01	3.39E+00	6.20E+00	pCi/L	N/A
Neodymium-147g	1.52E+01	3.15E+01	6.28E+01	pCi/L	N/A
Neptunium-239g	-2.74E+01	3.17E+01	4.70E+01	pCi/L	N/A
Niobium-94g	-8.94E-01	3.71E+00	6.77E+00	pCi/L	N/A
Niobium-95g	-4.51E-01	3.00E+00	5.76E+00	pCi/L	N/A
Potassium-40g	0.00E+00	4.26E+01	8.05E+01	pCi/L	N/A
Promethium-144g	3.60E+00	4.02E+00	7.96E+00	pCi/L	N/A
Promethium-146g	9.85E-01	4.36E+00	8.27E+00	pCi/L	N/A
Radium-226	1.72E-01	1.68E-01	2.47E-01	pCi/L	5
Radium-228	2.04E-01	4.49E-01	7.60E-01	pCi/L	5
Ruthenium-106g	3.78E-01	3.33E+01	6.42E+01	pCi/L	N/A
Silver-110mg	-3.12E-01	3.20E+00	6.14E+00	pCi/L	N/A
Sodium-22g	2.60E+00	3.66E+00	8.37E+00	pCi/L	N/A
Thallium-208g	-1.24E+00	4.69E+00	8.66E+00	pCi/L	N/A
Thorium-230g	-2.76E+02	9.93E+02	1.74E+03	pCi/L	N/A
Thorium-234g	-1.76E+02	1.59E+02	2.19E+02	pCi/L	N/A
Tin-113g	-5.37E-01	4.62E+00	8.33E+00	pCi/L	N/A
Uranium-235g	-8.53E+00	2.35E+01	3.90E+01	pCi/L	N/A
Uranium-238g	-1.76E+02	1.59E+02	2.19E+02	pCi/L	N/A
Yttrium-88g	1.53E+00	5.09E+00	1.12E+01	pCi/L	N/A
Zinc-65g	4.51E+00	8.57E+00	1.81E+01	pCi/L	N/A
Zirconium-95g	2.02E-01	5.01E+00	1.02E+01	pCi/L	N/A
Uranium	4.18E-01	N/A	6.70E-02	µg/L	30

Notes: Limit refers to TLAP Permit Limit.

No process wastewaters were generated at the LLRW facility during the report period. Limited rain fall occurred after waste placement was initiated in the CWF and the cumulative amount of leachate generated was sufficient for transfer to the contact water tanks. The Contact water Tank results are summarized for this reporting period in Table 41. All results are reported in Appendix J.

Table 41 : Contact Water Tank Results greater than the MDC for 2012

Tank	Sample Date	Analyte	Result	TPU	MDC	Units
CWF-CWT-1	11/26/12	ALPHA	2.17	1.54	1.99	pCi/L
CWF-CWT-1	11/26/12	BETA	6.92	1.77	1.69	pCi/L
CWF-CWT-1	11/26/12	Uranium-233/234	0.874	0.306	0.173	pCi/L
CWF-CWT-1	11/26/12	Uranium-238	0.583	0.235	0.114	pCi/L
CWF-CWT-1	12/27/12	BETA	19.1	3.65	1.16	pCi/L
CWF-CWT-1	12/27/12	Uranium-233/234	0.924	0.299	0.142	pCi/L
CWF-CWT-1	12/27/12	Uranium-238	0.678	0.242	0.0798	pCi/L

3.12.4 Pre-Discharge/Discharge Samples

Permit-required sampling of wastewater and storm water was conducted for both radiological and non-radiological constituents. As mentioned previously, samples collected in accordance with the TPDES and/or TLAP permits have been summarized in monthly effluent reports that have been submitted separately. Those documents are incorporated herein by reference, and the information that they provide is not duplicated in this report.

In addition to the wastewater and storm water sampling that is conducted in accordance with the TPDES and TLAP permits, pre-discharge samples of non-contact stormwater runoff are collected from sumps associated with the open container storage areas in accordance with RML R04971. The pre-discharge data from these sumps are discussed herein, since those results have not been previously or otherwise reported to the TCEQ.

Table 42 displays the dates water samples were collected from the open container storage area sumps. All pre-discharge sump data are located in Appendix K.

Table 42 : Sampling Dates for Water Samples Associated with the TPDES Permits, 2012

Location	Sample Date(s)
BSU-2 Sump**	January 6, 2012; May 29, 2012; July 30, 2012 and October 4, 2012
LSA Sump**	January 6, 2012; February 29, 2012; May 29, 2012, July 30, 2012; October 5, 2012 and November 26, 2012

Notes: * = WCS voluntary protocol; no permit requirement for this sample.
** = Required by RML R04971, not TPDES or TLAP permits.

4 Investigations

Investigations are a necessary follow-up step when an exceedance of an IL occurs. This section does not address the exceedances of gross alpha, gross beta or lead-210. The exceedances of gross alpha and gross beta results trigger additional isotopic analysis. The very low levels corresponding to the IL for lead-210 do not allow for it to be readily distinguished from background. Therefore, elevated levels of the parent radionuclide radium-226 are used as the primary indicator for evaluating potentially elevated levels of lead-210. The ILs are currently established as the mean background plus three standard deviations (without correcting for natural background). For this reporting period results that exceeded the ILs for certain media triggered further analysis. Exceedances of the ILs were attributable to variation in background and associated uncertainty in laboratory measurement techniques. In this section, further discussion is provided addressing anomalies in results.

4.1 Soil

Certain results obtained for RML No. R05807 in soil at stations from the 0-2" bgs strata were excess of the Byproduct ILs and were investigated. Below in Table 43 is a list of exceedances for Soil from the 0-2" bgs strata for the year of 2012. These soil IL during the report period are based upon surface sample (0-2") bgs background data, and are not representative of (0-6") bgs samples.

Table 43 : Soil Values in Exceedance of IL (pCi/g $\pm$ 2σ)

Station	Sample Number	Collection Date	Parameter	Result	MDL	BP IL	BP AL	TCEQ Notification
6	12-SS-07-135	7/13/12	Thorium-230	0.793±0.19	0.0894	0.78	1.8	10/2/12
22	12-SS-10-012	10/8/12	Thorium-230	1.34±0.537	0.324	0.78	1.8	1/8/13

WCS tracks soil data over time at these locations. These data do not appear to be significantly different from the soil backgrounds at a depth of 0-2" at these locations. These results are presented with historical data in Figure 132 and Figure 133 for station 22 and station 6, respectively.

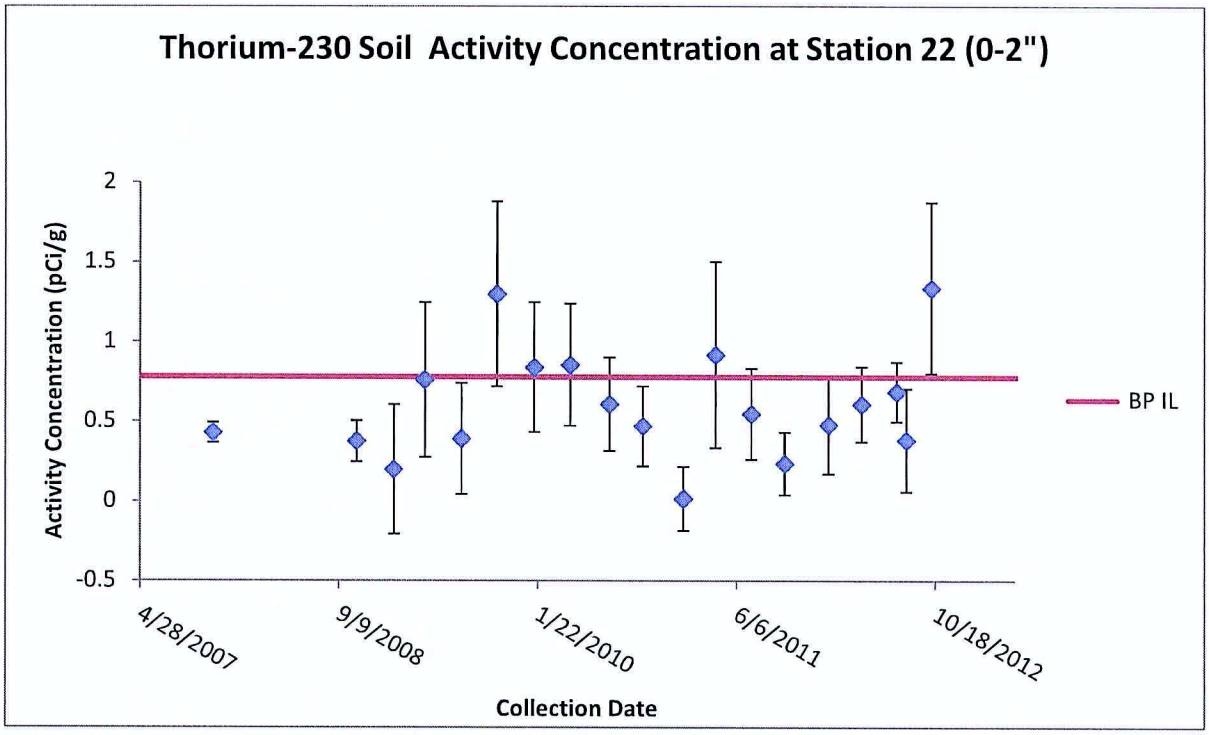

Figure 132 : Thorium-230 Activity Concentration in Soil at Station 22 (0-2")

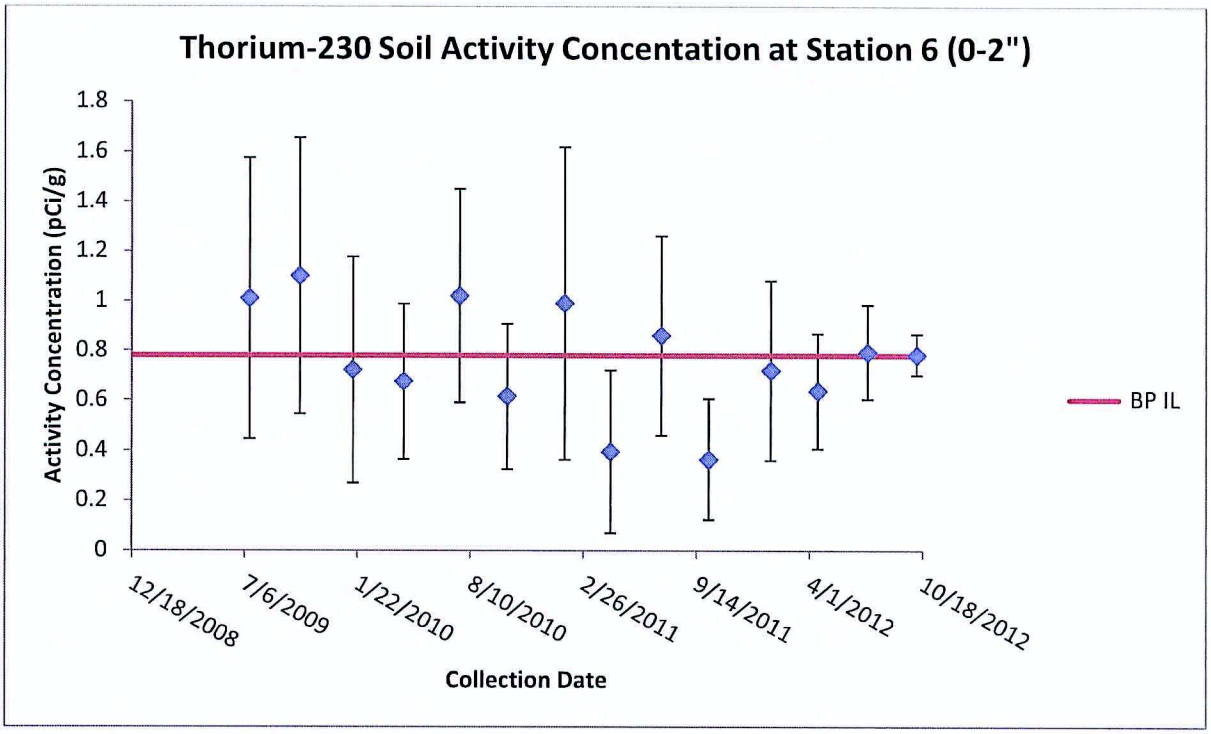

Figure 133 : Thorium-230 Activity Concentration in Soil at Station 6 (0-2")

4.2 Sediment

Results obtained for RML No. R05807 in sediment at station 18 (GW-2) had values in excess of the byproduct ILs and were investigated. Below in Table 44 is a list of exceedances for Sediment in 2012. No results exceeded their respective ALs. Results for certain sediment samples exceeded their respective ILs for gross alpha/beta; however, gross alpha/beta analysis is for screening purposes only. Isotopic analysis was performed as required when gross alpha and gross beta exceeded an IL level; no anomalous data were obtained for the subsequent isotopic analyses.

Table 44 : Sediment IL Exceedances (pCi/g ± 2σ), 2012

Station	Sample Number	Collection Date	Parameter	Result	MDL	BP IL	BP AL	TCEQ Notification
GW-2	12-SE-02-098	2/16/12	Radium-226	1.26±0.142	0.0449	0.9	1.4	3/23/12
GW-2	12-SE-02-098	2/16/12	Radium-228	1.18±0.183	0.083	0.9	1.4	3/23/12
GW-2	12-SE-02-098	2/16/12	Thorium-230	1.1±0.199	0.0405	0.78	1.8	3/23/12
GW-2	12-SE-07-036	7/9/12	Radium-226	1.35±0.17	0.0629	0.9	1.4	10/1/12
GW-2	12-SE-07-036	7/9/12	Radium-228	1.24±0.229	0.133	0.9	1.4	10/1/12
GW-2	12-SE-07-036	7/9/12	Thorium-230	1.06±0.383	0.24	0.78	1.8	10/1/12
GW-2	12-SE-07-036	7/9/12	Thorium-232	1.04±0.364	0.146	1.0	1.8	10/1/12
GW-2	12-SE-09-030	9/10/12	Radium-226	1.37±0.138	0.041	0.9	1.4	1/8/13
GW-2	12-SE-09-030	9/10/12	Radium-228	1.28±0.242	0.087	0.9	1.4	1/8/13
GW-2	12-SE-09-030	9/10/12	Thorium-230	1.43±0.543	0.277	0.78	1.8	1/8/13
GW-2	12-SE-09-030	9/10/12	Thorium-232	1.02±0.428	0.126	1	1.8	1/8/13
GW-2	12-SE-12-091	12/11/12	Radium-226	1.05±0.103	0.0379	0.9	1.4	3/5/13
GW-2	12-SE-12-091	12/11/12	Thorium-228	1.34±0.532	0.21	1.1	4.7	3/5/13
GW-2	12-SE-12-091	12/11/12	Thorium-230	1.22±0.508	0.299	0.78	1.8	3/5/13
GW-2	12-SE-12-091	12/11/12	Thorium-232	1.1±0.464	0.177	1	1.8	3/5/13

Figure 134, Figure 135, Figure 136, Figure 136, Figure 137 and Figure 138 below display sediment results over time at GW-2 for radium-226, radium-228, thorium-228, thorium-230, and thorium-232, respectively. These sediment results are consistent with historical values and do not indicate a change.

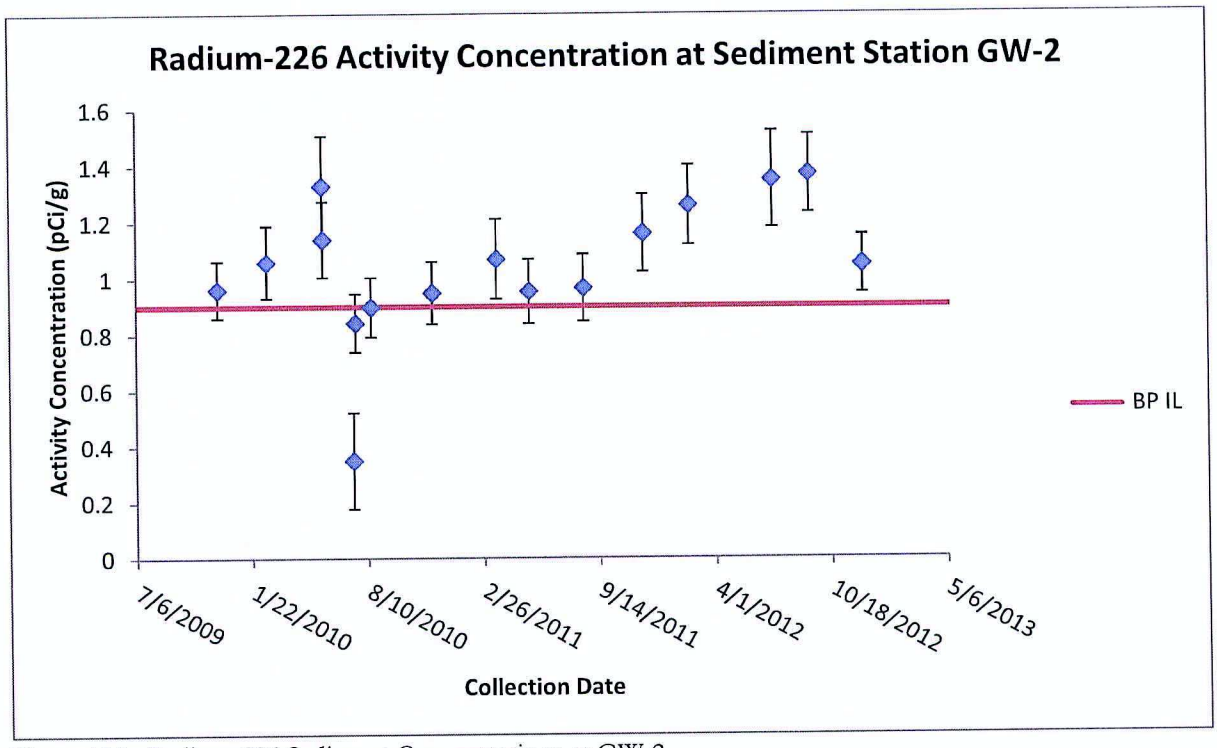

Figure 134 : Radium-226 Sediment Concentrations at GW-2

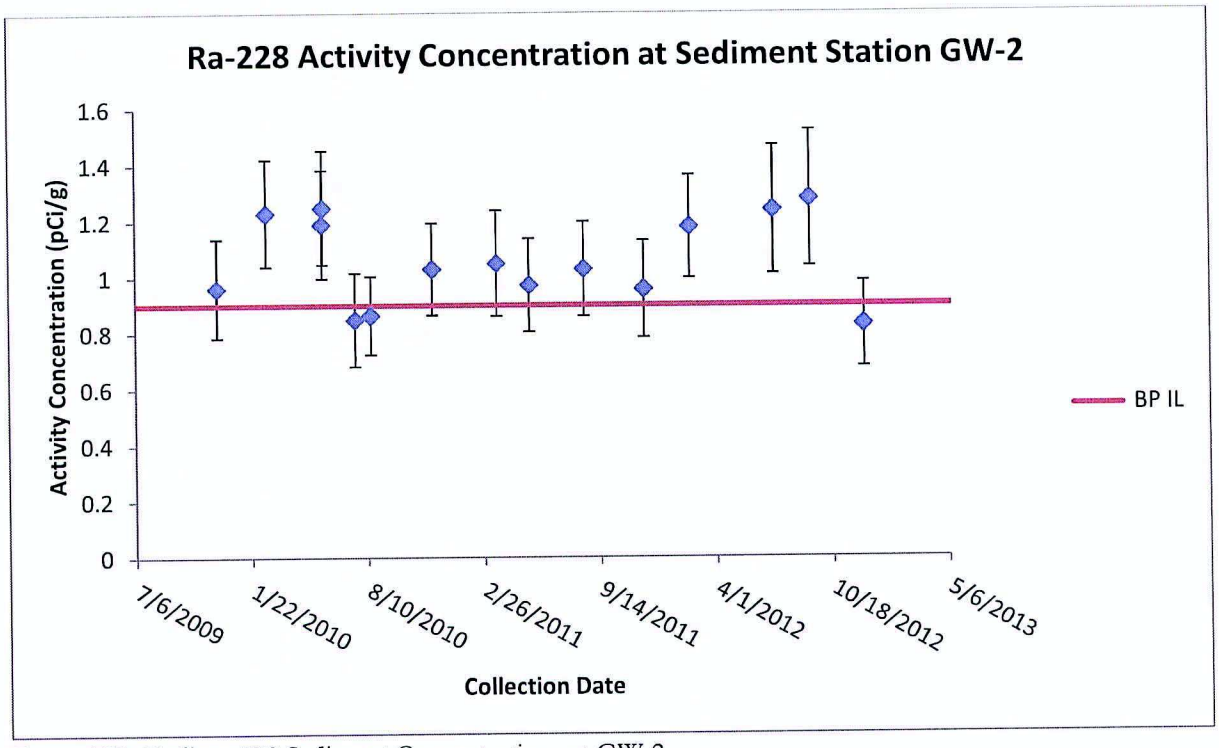

Figure 135 : Radium-228 Sediment Concentrations at GW-2

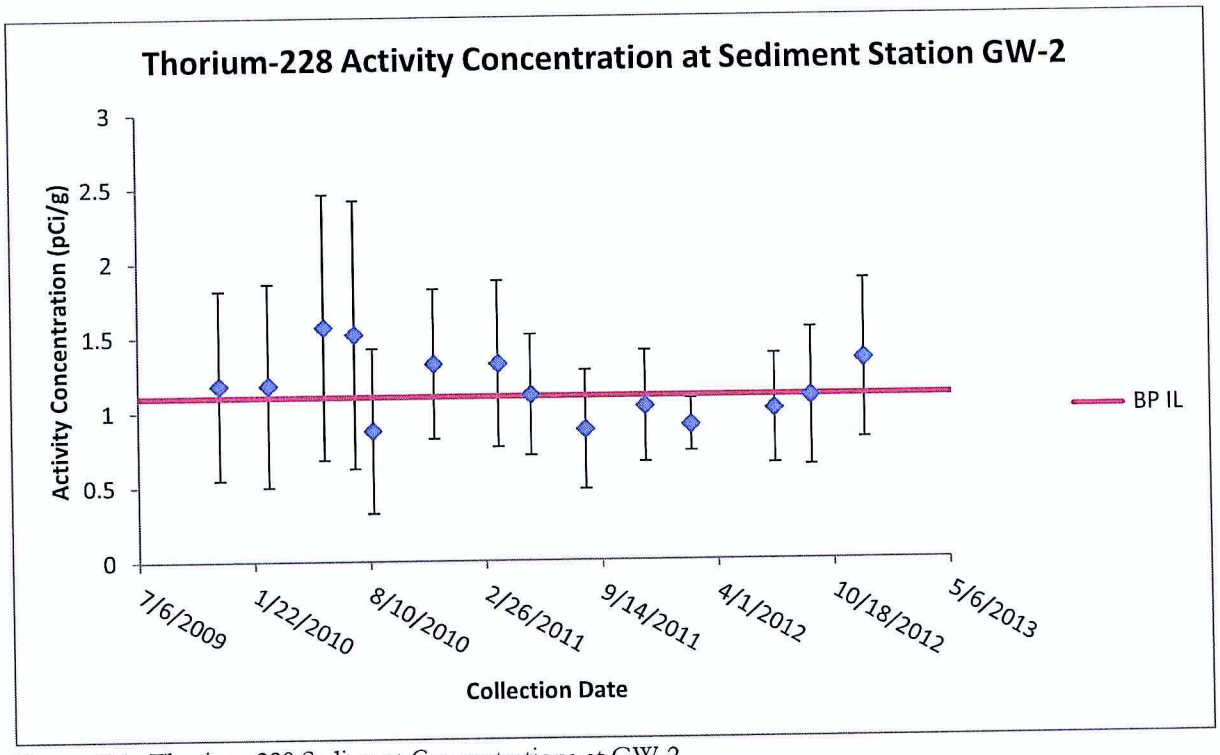

Figure 136 : Thorium-228 Sediment Concentrations at GW-2

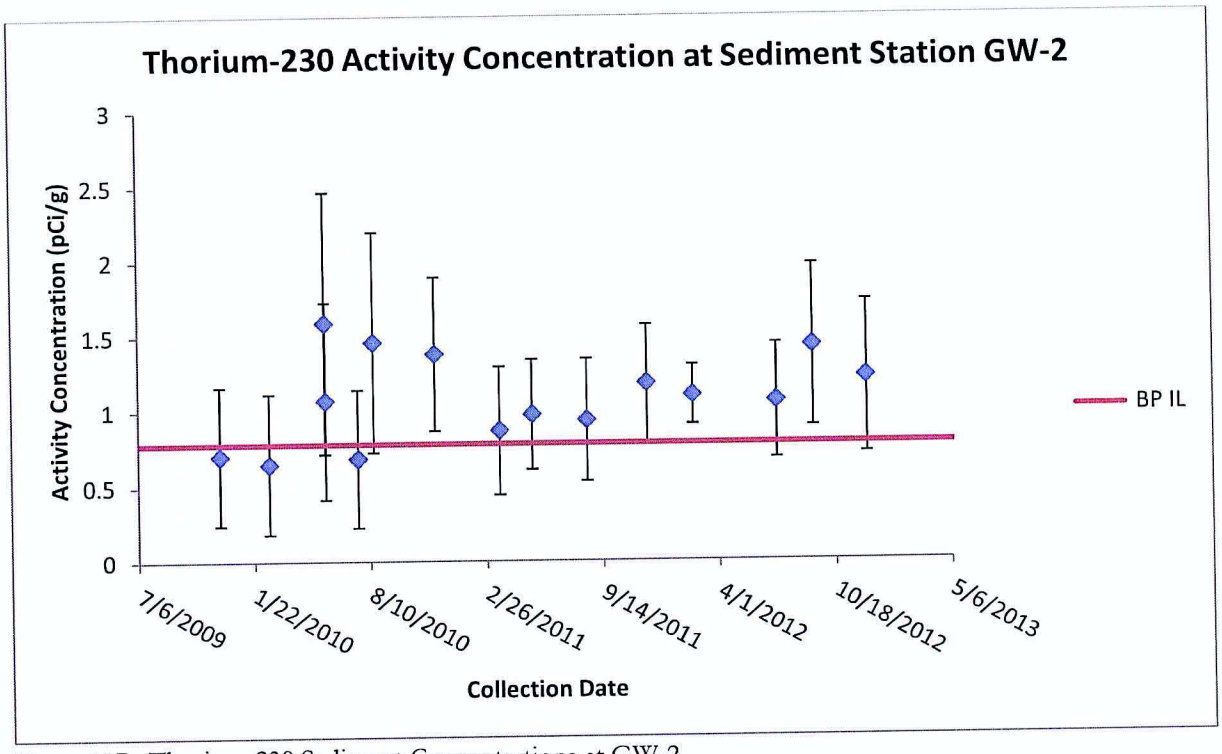

Figure 137 : Thorium-230 Sediment Concentrations at GW-2

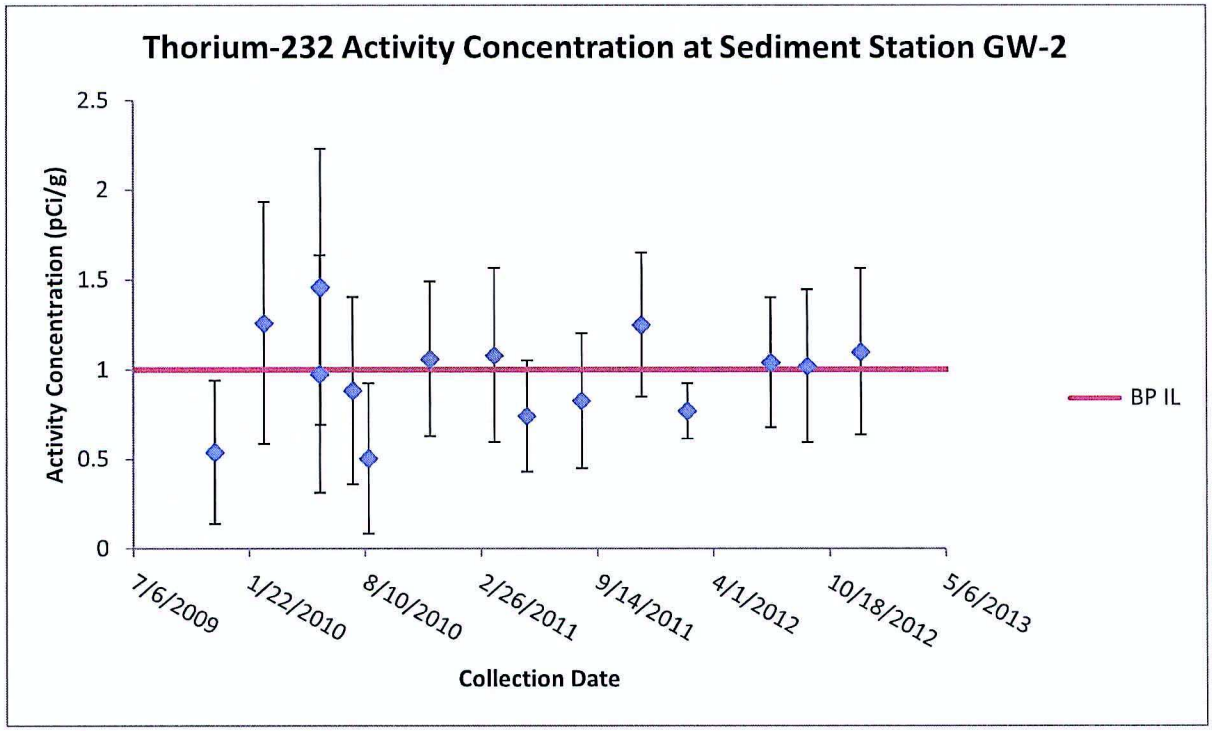

Figure 138 : Thorium-232 Sediment Concentrations at GW-2

4.3 Groundwater

Groundwater results for the from Byproduct Facility wells 5EA, MW-11Ar, MW-11B and TP-19 had values in excess of the ILs and were investigated. Below in Table 45 is a list of exceedances for groundwater in 2012.

Table 45 : Byproduct Groundwater IL Exceedances (pCi/L $\pm 2\sigma$), 2012

Sample Number	Station	Collection Date	Parameter	Result	MDL	BP IL	BP AL	TCEQ Notified
12-WS-02-096	5EA	2/14/12	Radium-226	1.71±0.684	0.202	1.69	5.5	3/23/12
12-WS-02-063	MW-11B	2/8/12	Radium-228	3.29±1.02	0.46	2.74	5.8	3/13/12
12-WS-05-194	MW-11B	5/22/12	Radium-228	3.35±0.997	0.477	2.74	5.8	7/20/12
12-WS-05-201	TP-19	5/23/12	Radium-228	3.79±1.1	0.451	2.74	5.8	7/20/12
12-WS-11-046	MW-11Ar	11/8/12	Radium-228	3.04±0.937	0.457	2.74	5.8	3/5/13
12-WS-11-108	MW-11B	11/8/12	Radium-228	2.78±0.892	0.443	2.74	5.8	3/5/13

Figure 139 plots the ratio of the maximum radium-226 groundwater concentrations to the IL for this reporting period. Figure 140 plots the historical radium-226 results from the third quarter of 2009 to the present for groundwater at Station 5EA. These plots illustrate that the results do not indicate any significant differences from historical data.

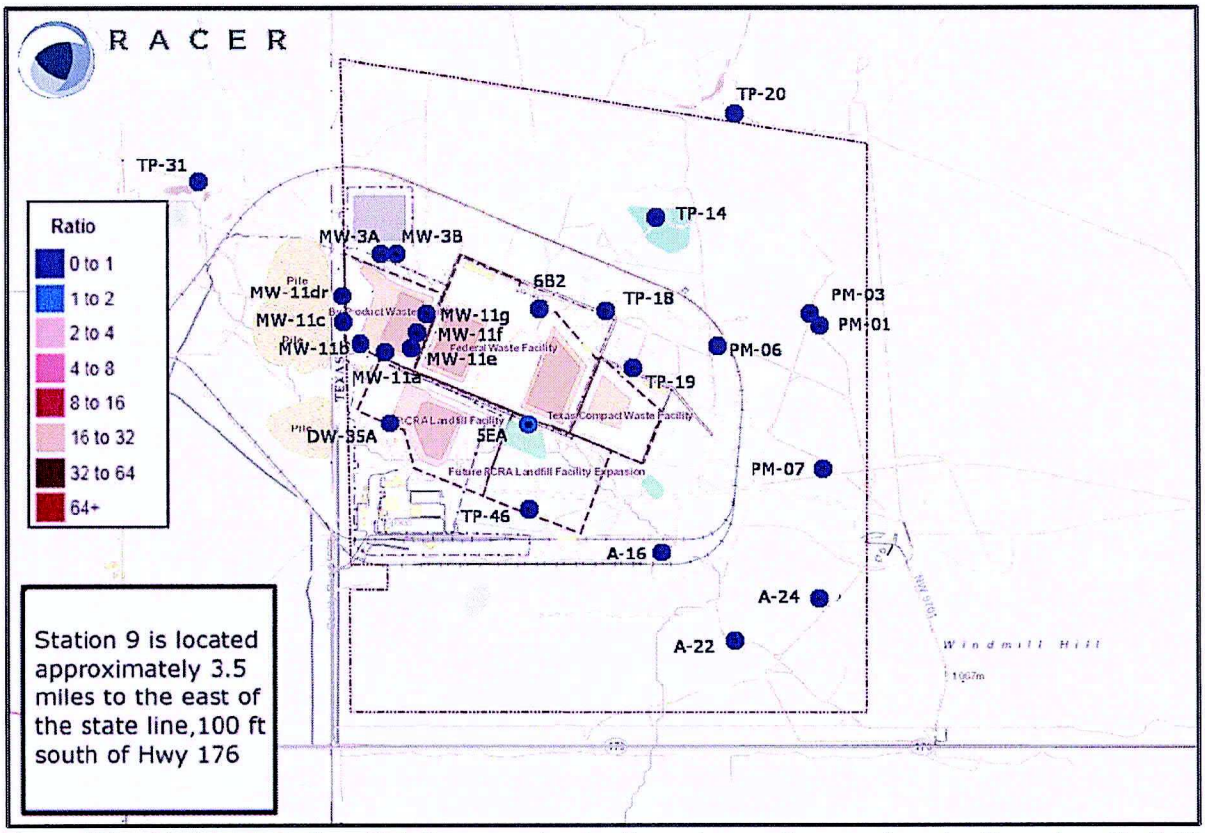

Figure 139 : Maximum Radium-226 Concentration in Groundwater Compared to the Byproduct IL (1.69 pCi/L)

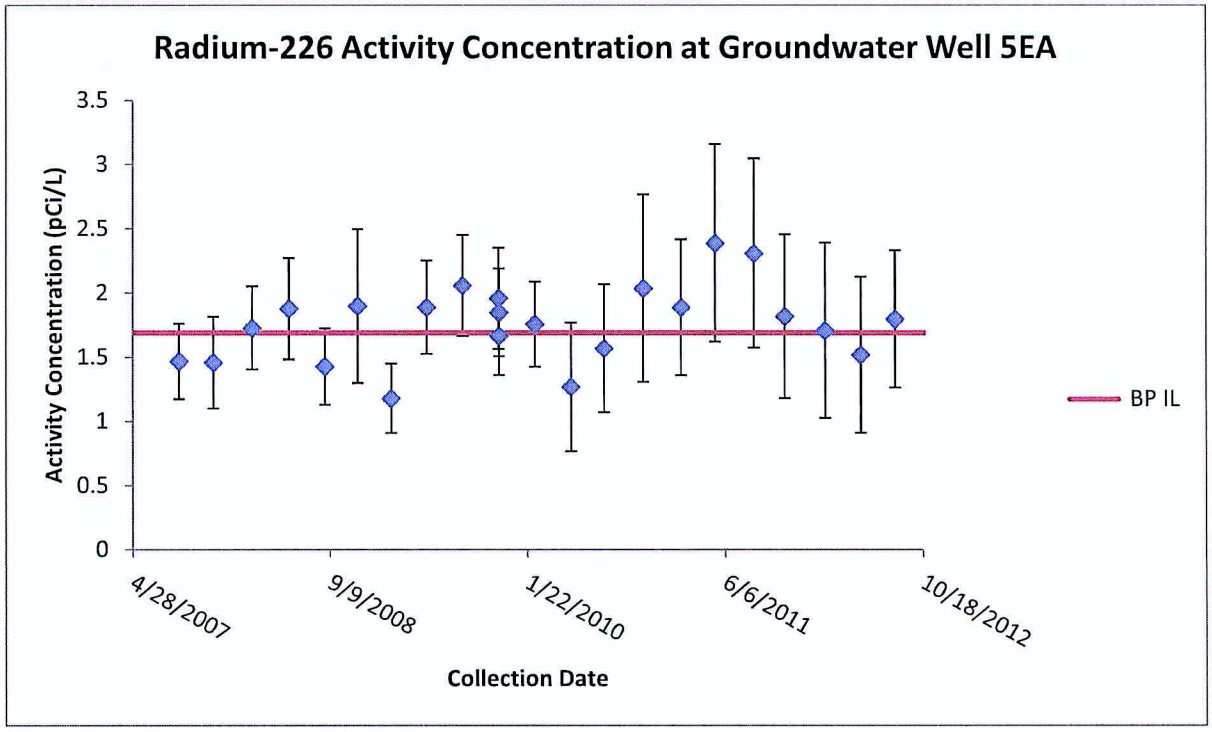

Figure 140 : Radium-226 Concentration in Well 5EA

Figure 141 plots the ratio of the maximum radium-228 groundwater concentrations for to the IL for this reporting period. Figure 142, Figure 143 and Figure 144 plot the historical radium-228 results from the third quarter of 2009 to the present for groundwater at stations TP-19, MW-11Ar and MW11B respectively. These plots illustrate that the results do not indicate any significant differences from historical data.

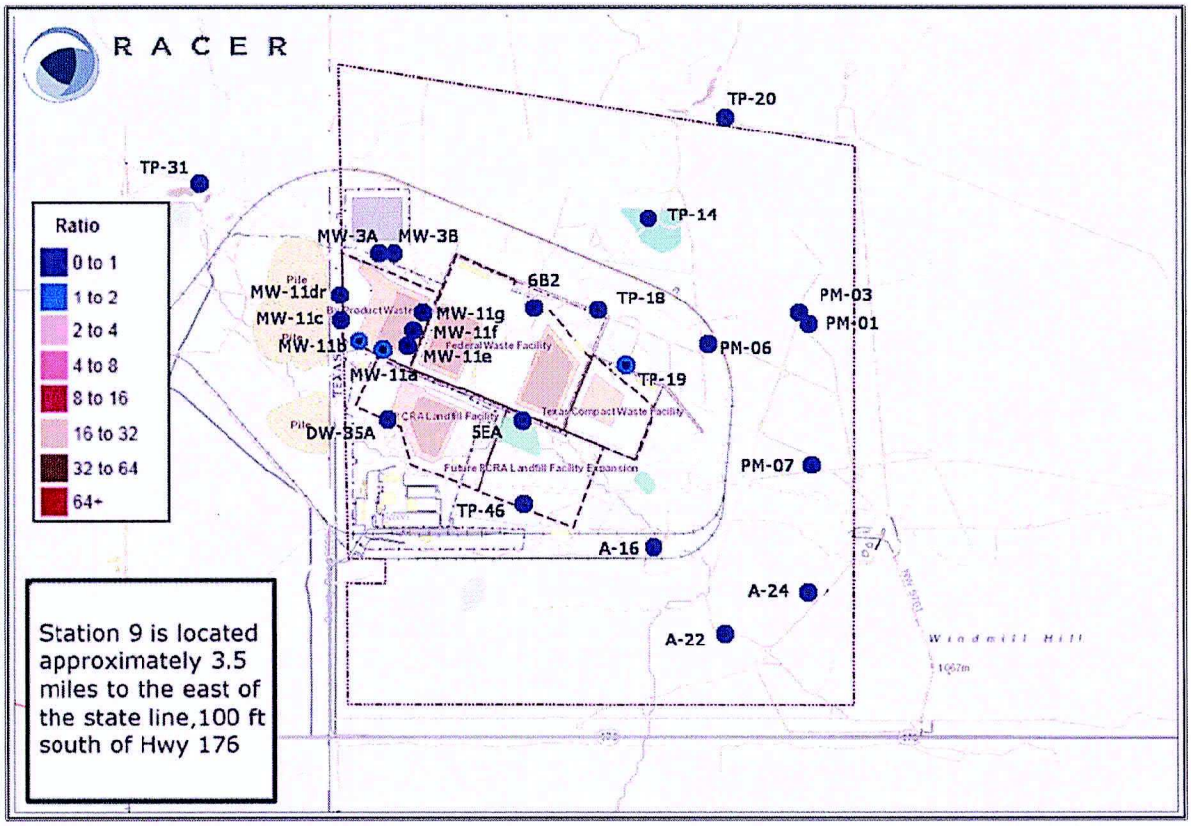

Figure 141 : Maximum Radium-228 Concentration in Groundwater Compared to the IL (2.74 pCi/L)

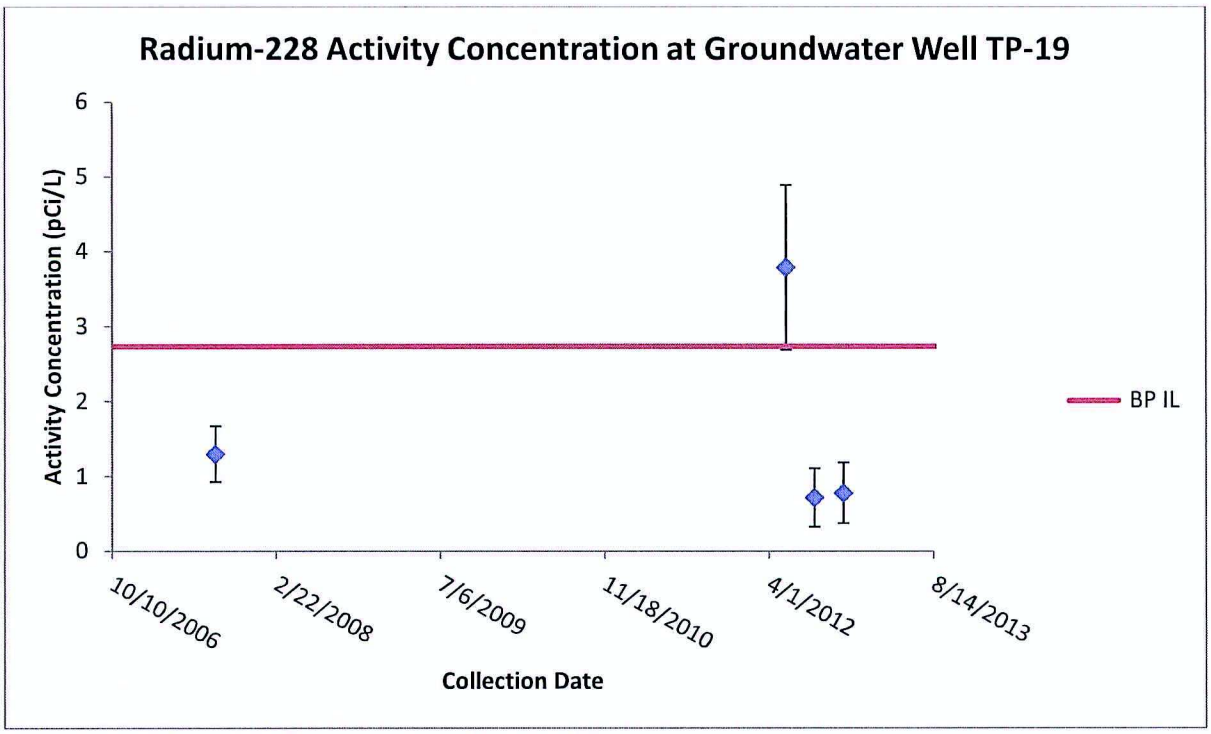

Figure 142 : Radium-228 Concentration in Well TP-19

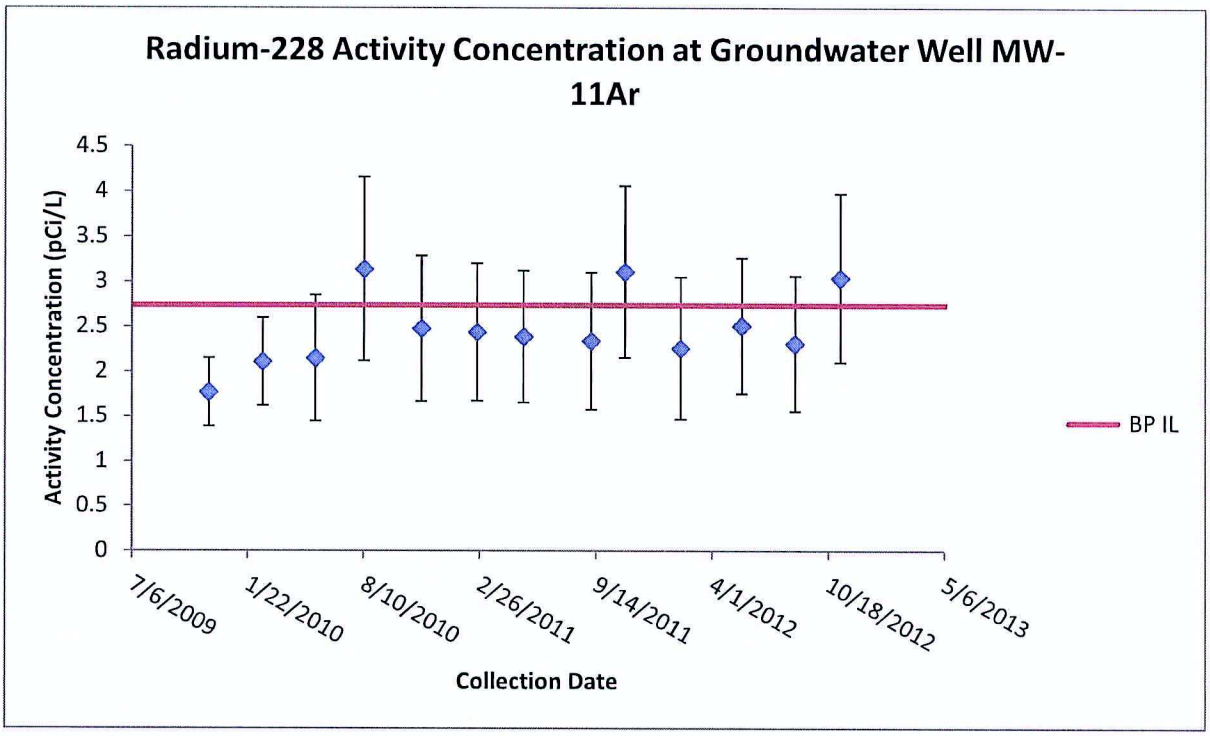

Figure 143 : Radium-228 Concentration in Well MW-11Ar

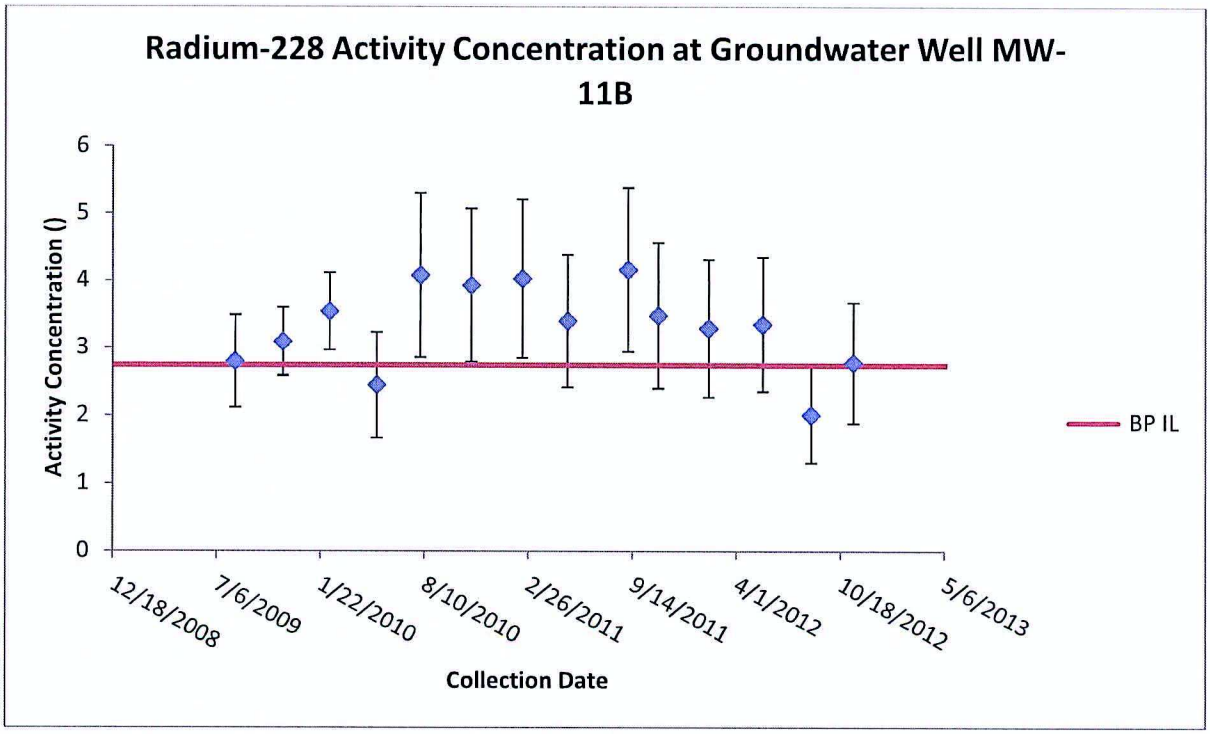

Figure 144 : Radium-228 Concentration in Well MW-11B

4.4 Vegetation

A vegetation result for station GW-6 was detected for cobalt-60 and a radium-226 result for station 17 was greater than the respective TSDF IL. These results are presented below in Table 46. The cobalt-60 result at station GW-6 was greater than the MDC, but has relatively high uncertainly associated with it. This result is a suspected false positive. The next result was below the MDC. Figure 145 displays the radium-226 result at vegetation station 17 with historical data. The result does not appear to be significantly different from the historical data, and the next sampling event was below the radium-226 IL.

Table 46 : Vegetation IL Exceedances (pCi/g $\pm 2\sigma$), 2012

Sample Number	Station	Collection Date	Parameter	Result	MDC	S&P IL	S&P AL
12-VE-05-117	GW-6	5/16/12	Cobalt-60	0.103±0.0428	0.0422	N/A	N/A
12-VE-05-144	Station 17	5-17-12	Radium-226	0.277±0.153	0.139	0.2	0.5

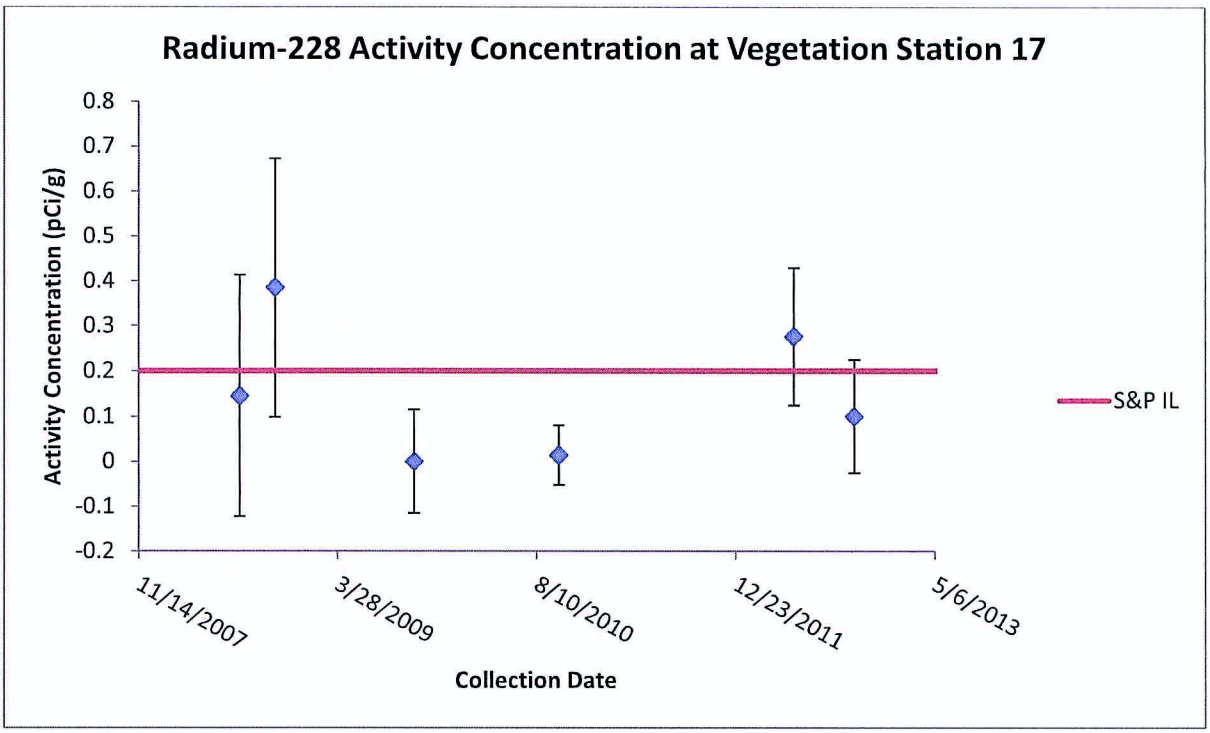

Figure 145 : Radium-228 Activity Concentration at Vegetation Station 17

5 Reporting

License Condition 92.K of RML No. R05807 requires that WCS report when byproduct results exceed the ILs associated with the byproduct license to the TCEQ. This section covers all the exceedances that require that WCS notify the TCEQ. Table 47 contains all results WCS were required to report to the TCEQ for the calendar year of 2012.

Table 47 : 2012 Results Reported to the TCEQ

Station	Sample Number	Collection Date	Parameter	Result	Units	MDL	BP IL	BP AL	TCEQ Notification
6	12-SS-07-135	7/13/12	Thorium-230	0.793±0.19	pCi/g	0.0894	0.78	1.8	10/2/13
22	12-SS-10-012	10/8/12	Thorium-230	1.34±0.537	pCi/g	0.324	0.78	1.8	1/8/13
GW-2	12-SE-02-098	2/16/12	Radium-226	1.26±0.142	pCi/g	0.0449	0.9	1.4	3/23/12
GW-2	12-SE-02-098	2/16/12	Radium-228	1.18±0.183	pCi/g	0.083	0.9	1.4	3/23/12
GW-2	12-SE-02-098	2/16/12	Thorium-230	1.1±0.199	pCi/g	0.0405	0.78	1.8	3/23/12
GW-2	12-SE-07-036	7/9/12	Radium-226	1.35±0.17	pCi/g	0.0629	0.9	1.4	10/1/12
GW-2	12-SE-07-036	7/9/12	Radium-228	1.24±0.229	pCi/g	0.133	0.9	1.4	10/1/12
GW-2	12-SE-07-036	7/9/12	Thorium-230	1.06±0.383	pCi/g	0.24	0.78	1.8	10/1/12
GW-2	12-SE-07-036	7/9/12	Thorium-232	1.04±0.364	pCi/g	0.146	1.0	1.8	10/1/12
GW-2	12-SE-09-030	9/10/12	Radium-226	1.37±0.138	pCi/g	0.041	0.9	1.4	1/8/13
GW-2	12-SE-09-030	9/10/12	Radium-228	1.28±0.242	pCi/g	0.087	0.9	1.4	1/8/13
GW-2	12-SE-09-030	9/10/12	Thorium-230	1.43±0.543	pCi/g	0.277	0.78	1.8	1/8/13
GW-2	12-SE-09-030	9/10/12	Thorium-232	1.02±0.428	pCi/g	0.126	1	1.8	1/8/13
GW-2	12-SE-12-091	12/11/12	Radium-226	1.05±0.103	pCi/g	0.0379	0.9	1.4	3/5/13
GW-2	12-SE-12-091	12/11/12	Thorium-228	1.34±0.532	pCi/g	0.21	1.1	4.7	3/5/13
GW-2	12-SE-12-091	12/11/12	Thorium-230	1.22±0.508	pCi/g	0.299	0.78	1.8	3/5/13
GW-2	12-SE-12-091	12/11/12	Thorium-232	1.1±0.464	pCi/g	0.177	1	1.8	3/5/13
5EA	12-WS-02-096	2/14/12	Radium-226	1.71±0.684	pCi/L	0.202	1.69	5.5	3/13/12
MW-11B	12-WS-02-063	2/8/12	Radium-228	3.29±1.02	pCi/L	0.46	2.74	5.8	3/13/12
MW-11B	12-WS-05-194	5/22/12	Radium-228	3.35±0.997	pCi/L	0.477	2.74	5.8	7/20/12
TP-19	12-WS-05-201	5/22/12	Radium-228	3.79±1.1	pCi/L	0.451	2.74	5.8	7/20/12
MW-11Ar	12-WS-11-046	11/8/12	Radium-228	3.04±0.937	pCi/L	0.457	2.74	5.8	3/5/13
MW-11B	12-WS-11-108	11/8/12	Radium-228	2.78±0.892	pCi/L	0.443	2.74	5.8	3/5/13

6 Dose to the General Public

The dose to a member of the general public potentially affected by operation of the Waste Processing and Storage license activities conducted at the WCS site during calendar year 2012 was calculated. The dose was based on results of air effluent data, and direct gamma monitoring performed. Groundwater, soil, and vegetation were not included in the dose assessment because there is not a credible dose pathway associated with these media. The results of groundwater, soil, and vegetation are considered in this report to evaluate trends, to ensure early identification, and to correct any conditions that could lead to the offsite migration of radioactive effluents.

6.1 Airborne Dose Calculations

The effective dose equivalent (EDE) for low levels of airborne radioactive materials dispersed into the environment was calculated for the MWTF stacks and the CWF Sampling Room Stack with midpoint distances of 100 meters (distance to site fence-line), 1000 meters (distance from site to LES) and 6000 meters (distance to the nearest resident). Meteorology data from the Midland/Odessa Airport were used to calculate annual dispersions for each midpoint. Facility-specific radionuclide release rates (in curies per year [Ci/yr]) were also used. The calculations were performed using the CAP88-PC computer code, which calculates total doses from the immersion and inhalation pathways. The dose and risk estimates were based on low levels of chronic intake of radionuclides. The maximum effective dose equivalent was 5.82E-04 mrem/year at 100 meters north of the CWF Sampling Room Stack stacks.

6.2 Public Occupancy Times

Three public dose scenarios were evaluated for direct gamma exposure. The first is referred to as a bounding scenario that assumes exposure to a WCS worker that has not completed radiation worker training and is assigned to the site administrative area. The non-trained WCS worker was assumed to be a member of the general public and exposed for 2,000 hr/yr to direct gamma exposure.

The second scenario is referred to as the site-specific scenario and uses a more realistic definition of a member of the general public and corresponding potential occupancy times. As provided in correspondence between WCS and the Texas Department of State Health Services in 2002, the site-specific occupancy time for the member of the general public was assumed to be 442 hr/yr. This number was based on an assumption that a casual observer of the site would spend 0.5 hr/day at the site boundary. In addition, the same individual was assumed to spend 5 hr/week at a location inside the WCS owner-controlled area.

The third scenario is the continuous occupancy scenario where an individual is at the site boundary 365 days a year 24 hours a day for 8,760 hours.

6.3 Direct Gamma Dosimetry

The dose calculation for direct gamma exposure is based on OSL and TLD measurements for the locations that were reported. The net increased dose above background for each location was determined by taking the total annual dose for each location and subtracting the dose from station 9. The OSLs and TLDs were in place continuously over the entire year resulting in 8,760 hours of exposure. Since the occupancy times for two of the general public dose scenarios evaluated were 2,000 and 442 hours, the general public dose was calculated by multiplying the annual dosimeter reading (background corrected) net TLD or OSL results by 2000/8760 and 442/8760, for the bounding and site-specific scenarios, respectively. Environmental OSL and TLD results for 2012 are given in Table 48 and Table 49, respectively.

The ambient gamma radiation readings from Stations 22 (near the LSA pad) and Stations 52, 54, 55, 56, and 65 (located near CWF operations) were elevated. These locations are affected by the transfer and movement of shipments. These stations do not represent dose to the general public because these areas are controlled by the WCS occupational radiological protection plan during transfers. For this reason, station 52, 54, 55, 56, and 65 are not accessible to a "member of the public" and was not considered for dose calculations to the public.

The highest OSL reading considered for this section was recorded at Station 23. The OSL dosimeters at Station 23 gave a background corrected dose of 3 mrem/year, 0.7 mrem/year, and 13 mrem/year for the bounding, site specific, and continuous occupancy scenarios, respectively. The Andrews locations gave a background corrected dose of 2.5 mrem/year, 0.6 mrem/year, and 11 mrem/year for the bounding, site specific, and continuous occupancy scenarios, respectively.

The highest TLD reading considered for this section was recorded at Station 25. The TLD dosimeter at Station 25 gave a background corrected dose of 5.7 mrem/year, 1.3 mrem/year and 24.8 mrem/year for the bounding, site specific, and continuous occupancy scenarios, respectively. The Andrews locations gave a background corrected dose of 5.2 mrem/year, 1.1 mrem/year, and 22.7 mrem/year for the bounding, site specific, and continuous occupancy scenarios, respectively.

Table 48 : Direct Radiation Doses From OSLs with Background Subtracted (mrem/yr), 2012

	Before Background Subtraction				After Background Subtraction			
Station	Annual Total (mrem/y)	Public Dose Bounding (mrem/y)	Public Dose Site Specific (mrem/y)	Continuous Occupancy (mrem/y)	Annual (mrem/y)	Public Dose Bounding (mrem/y)	Public Dose Site Specific (mrem/y)	Continuous Occupancy (mrem/y)
1	2	0.5	0.1	2	1	0.2	0.1	1.0
3	0	0.0	0.0	0	0	0.0	0.0	0.0
4	9	2.1	0.5	9	8	1.8	0.4	8.0
6	8	1.8	0.4	8	7	1.6	0.4	7.0
7	0	0.0	0.0	0	0	0.0	0.0	0.0
8	2	0.5	0.1	2	1	0.2	0.1	1.0
9	1	0.2	0.1	1	0	0.0	0.0	0.0
11	8	1.8	0.4	8	7	1.6	0.4	7.0
12	14	3.2	0.7	14	13	3.0	0.7	13.0
13	1	0.2	0.1	1	0	0.0	0.0	0.0
14	0	0.0	0.0	0	0	0.0	0.0	0.0
15	3	0.7	0.2	3	2	0.5	0.1	2.0
16	0	0.0	0.0	0	0	0.0	0.0	0.0
17	2	0.5	0.1	2	1	0.2	0.1	1.0
18	7	1.6	0.4	7	6	1.4	0.3	6.0
19	3	0.7	0.2	3	2	0.5	0.1	2.0
21	7	1.6	0.4	7	6	1.4	0.3	6.0
23	14	3.2	0.7	14	13	3.0	0.7	13.0
24	3	0.7	0.2	3	2	0.5	0.1	2.0
25	4	0.9	0.2	4	3	0.7	0.2	3.0
26	2	0.5	0.1	2	1	0.2	0.1	1.0
27	5	1.1	0.3	5	4	0.9	0.2	4.0
28	10	2.3	0.5	10	9	2.1	0.5	9.0
30	6	1.4	0.3	6	5	1.1	0.3	5.0
31	6	1.4	0.3	6	5	1.1	0.3	5.0
32	14	3.2	0.7	14	13	3.0	0.7	13.0
33	4	0.9	0.2	4	-1	-0.2	0.0	0.0
34	0	0.0	0.0	0	0	0.0	0.0	0.0
58	4	0.9	0.2	4	-1	-0.2	0.0	0.0
59	1	0.2	0.1	1	0	0.0	0.0	0.0
60	1	0.2	0.1	1	0	0.0	0.0	0.0
61	5	1.1	0.3	5	-1	-0.2	0.0	0.0
62	9	2.1	0.5	9	-1	-0.2	0.0	0.0
63	2	0.5	0.1	2	-1	-0.2	0.0	0.0
64	10	2.3	0.5	10	-1	-0.2	0.0	0.0
Andrews	12	2.7	0.6	12	11	2.5	0.6	11.0

Table 49 : Direct Radiation Doses From TLDs with Background Subtracted (mrem/yr), 2012

	Before Background Subtraction				After Background Subtraction			
Station	Annual Total (mrem/y)	Public Dose Bounding (mrem/y)	Public Dose Site Specific (mrem/y)	Continuous Occupancy (mrem/y)	Annual (mrem/y)	Public Dose Bounding (mrem/y)	Public Dose Site Specific (mrem/y)	Continuous Occupancy (mrem/y)
13	5.1	1.2	0.3	5.1	4.1	0.9	0.2	4.1
15	7.7	1.8	0.4	7.7	6.7	1.5	0.3	6.7
17	14.7	3.4	0.7	14.7	13.7	3.1	0.7	13.7
25	15.5	3.5	0.8	15.5	14.5	3.3	0.7	14.5
Andrews	23.7	5.4	1.2	23.7	22.7	5.2	1.1	22.7
18	18.8	4.3	0.9	18.8	17.8	4.1	0.9	17.8
21	17.5	4.0	0.9	17.5	16.5	3.8	0.8	16.5
22	49.5	11.3	2.5	49.5	48.5	11.1	2.4	48.5
24	9.7	2.2	0.5	9.7	8.7	2.0	0.4	8.7
7	7.9	1.8	0.4	7.9	6.9	1.6	0.3	6.9
12	20.5	4.7	1.0	20.5	19.5	4.5	1.0	19.5
14	4.7	1.1	0.2	4.7	3.7	0.8	0.2	3.7
33	17.7	4.0	0.9	17.7	16.7	3.8	0.8	16.7
16	0.8	0.2	0.0	0.8	0	0.0	0.0	0.0
31	15.1	3.4	0.8	15.1	14.1	3.2	0.7	14.1
55	25.8	5.9	1.3	25.8	24.8	5.7	1.3	24.8
59	8.8	2.0	0.4	8.8	7.8	1.8	0.4	7.8
34	3.8	0.9	0.2	3.8	2.8	0.6	0.1	2.8

6.4 General Public Dose Assessment Summary

WCS calculated an estimate of dose based on a general member of the public who spends half an hour a week at the site boundary in addition, the same individual was assumed to spend 5 hr/week at a location inside the WCS owner-controlled area. WCS estimated the dose to this general member of the public by adding the doses from the maximum airborne dose form CAP88 to the results from the highest TLD station accessible to a "member of the public." This is a conservative approach since the highest air dose and gamma monitoring stations are not at the same locations. The sum of these doses after background correction is 5.70E+00 mrem/year. This dose is well below the annual regulatory limit of 100 mrem.

7 Conclusion

Waste Control Specialists (WCS) collected environmental samples to assess potential migration of radioactivity to unrestricted areas from the Andrews County Facility in accordance with RML Nos. R05807, R04100 and R04971. This program monitors air, aquatic eco-receptor, groundwater, precipitation, surface water, wastewater, soil, sediment, soil moisture, vegetation, and fauna. WCS also operates a meteorological monitoring program that supports several of the environmental monitoring requirements. Samples were routinely collected for the reporting period of January 1 through December 31, 2012 in and around the WCS site, and over 90,000 results were collected for concentrations of substances including metals, volatiles, semi-volatiles, radionuclides, pesticides, polychlorinated biphenyls (PCBs) and water quality indicators.

The air radiological monitoring results for the reporting period of January 1 through December 31, 2012 were consistent with those of previous years. All air results were below the established ILs and ALs.

Groundwater monitoring results for the reporting period of January 1 through December 31, 2012 were consistent with those of previous years. Groundwater was sampled from 120 wells and both radiological and non-radiological analysis were preformed when water sufficient for all analysis was present. These results show no significant differences from background. Groundwater results exceeded the established Byproduct IL for radium-228 at wells MW-11Ar, MW-11B and TP-19, and a groundwater result exceeded the established Byproduct IL for radium-226 at well 5EA. These results were reported to the TCEQ within four hours of confirmation in accordance with LC 92.K of RML No. R05807. These results were not indicative of a release, but are instead attributable to spatial variability of naturally-occurring radionuclides in groundwater at the site. All groundwater results were below the established ALs.

Stormwater collected in the Byproduct Facility LCS and LDS are pumped into tanks for consolidation and storage prior to pre-release verification sampling and analysis. Pursuant to RML No. R05807, LC 37.B, Table 37.B, liquid samples are also collected directly from the LCS and LDS sumps and analyzed on a monthly basis. The analytical results were compared with the reporting limits for gross alpha and beta/gamma emitters (15 pCi/L and 50 pCi/L) respectively, under Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0004857000. All results were below these reporting limits.

Permit-required sampling of wastewater and storm water was conducted for both radiological and non-radiological constituents. Sampling at the WCS Andrews County site was conducted at outfalls and evaporation ponds in accordance with TPDES Permit No. WQ0004857000, TPDES Permit No. WQ0004038000 and TLAP No. WQ0004948000. Results of permit-required sampling were reported monthly, quarterly, and annually to the TCEQ. The results of TDPES and TLAP samples are provided to the TCEQ in monthly effluent reports and are not repeated in this document.

Sanitary wastewater generated at the WCS site is collected in above ground tanks and transported to a POTW in Andrews, Texas. All septic results for the reporting period for carbon-14 and tritium were below the MDC. All calculated results were below the release limits and total quantities in 30 TAC §336.215, *Disposal by Release into Sanitary Sewerage*, allowing release to the POTW in Andrews, Texas. The releases to the Andrews Texas POTW were below regulatory limits for the state of Texas; each radionuclide was below the monthly discharge concentration level, and the total discharge to the POTW was less than 1% of the 1 curie annual limit.

Soil and sediment samples were collected during this reporting period. Although these results do not show any significant differences from historical soil and sediment data, some of the sediment data for naturally occurring radionuclides exceeds currently applicable comparison values. These exceedances are common and

are not the result of a release; rather, they are due to ILs and ALs that are inappropriately low when compared against natural conditions. Those locations are:

- Sediment samples at GW-2 were reported with concentrations for radium-226, radium-228, thorium-230 and thorium-232 greater than the respective Byproduct ILs for these radionuclides. The concentrations did not exceed the Byproduct ALs for these isotopes. These exceedances were reported to the TCEQ within four hours of confirmation as required by LC 92.K of R05807. None of these concentrations exceeded the more recently proposed ILs in the Part-B Data Quality Objective (DQO-B) report[12].
- Soil samples at Station 6 and Station 22 were reported with concentrations for thorium-230 greater than the respective Byproduct IL for thorium-230. The concentrations did not exceed the Byproduct ALs for these isotopes. These exceedances were reported to the TCEQ within four hours of confirmation as required by LC 92.K of R05807.

Precipitation, aquatic-eco receptors, soil moisture and surface water samples were not collected during this reporting period due to the unavailability of samples for collection.

WCS calculated an estimate of dose based on a general member of the public who spends half an hour a week at the site boundary, in addition, the same individual was assumed to spend 5 hr/week at a location inside the WCS owner-controlled area. WCS estimated the dose to this general member of the public by adding the doses from the maximum airborne dose form CAP88 to the results from the highest TLD station accessible to a "member of the public." This is a conservative approach since the highest air dose and gamma monitoring stations are not at the same locations. The sum of these doses after background correction is 5.70E+00 mrem/year. This dose is well below the annual regulatory limit of 100 mrem.

Radioanalytical results collected during this reporting period were indistinguishable from natural background. WCS will continue to monitor for potential releases of radioactivity as required. These environmental monitoring activities document that the waste management operations at WCS are not inimical to public health or the environment.

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[12] *Environmental Surveillance Data Quality Objectives Part B – Results of Statistical Analyses, Revision 2*, dated October 14, 2011, and revised DQO-B summary tables that were provided with a May 15, 2012 letter from Scott Kirk (WCS) to Lorraine Council (TCEQ) entitled, *Environmental Monitoring Information in response to Amendment 13 of Radioactive Material License No. R04100.*